Design Proposal Report

J-M Farms

Bella Corp

Brady Brewer Stephen Eller

David Haury Michelle Jones

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Introduction to the Problem

PROBLEM STATEMENT

Our project is to improve the harvesting and packaging efficiency at J-M satellite farms. The most important factors affecting design are: ergonomics, cost effectiveness, maintenance, and simplicity.

MISSION STATEMENT

Our mission is to provide a quality solution to improve J-M Farm's packing efficiency.

PROJECT SIGNIFICANCE

At present time, the main buyer of product from J-M Farms is Wal-Mart. Because of this, J-M must adhere to certain packaging and sustainability standards. Meeting sustainability standards is a priority especially since Wal-Mart has developed a sustainability index.

J-M is a regional leader in mushroom production, and the company's primary competition comes from Texas. However, with this lack of local competition, J-M still needs to be cognizant of the other competition as losing a few key buyers such as Wal-Mart could be very detrimental. To help in maintaining J-M's current sales positions, steps must be taken to offer a lower priced product with a higher quality.

STATEMENT OF WORK

Objectives

Provide a quality solution to improve J-M Farms packing efficiency.

Task Background

J-M Farms is a mushroom production business located in Miami, Oklahoma. J-M Farms has a central mushroom production facility, along with five satellite farms located at various distances from the main facility. Of the five satellite farms, four grow white mushrooms and one grows portabella and brown mushrooms. Together they harvest the majority of J-M Farms total product. An example of a mushroom harvesting room can be seen in Figure 1.

All of the mushrooms from J-M Farms are handpicked and placed into containers, known as tills. Tills are typically a foam material, but some are clear plastic containers, similar to strawberry and other small fruit containers. Tills fit into returnable plastic containers, RPCs, which are rented and used to ship the mushrooms to corporate buyers, such as Wal-Mart. An RPC can hold twelve, six ounce tills, see Figure 2. RPCs are the primary method used to ship mushrooms. Bulk mushroom orders are sold in five or 10 pound boxes. Currently, all of the mushrooms harvested at the satellite farms must be shipped to the main facility for packaging. This process can result in several problems. It increases the amount of time it takes to get mushrooms directly to a supermarket shelf. Additionally, bruising is much more likely since the mushrooms are handled up to eight times before it is a finished product, resulting in a shorter shelf life. At this time, mushrooms also are picked by volume, not weight.

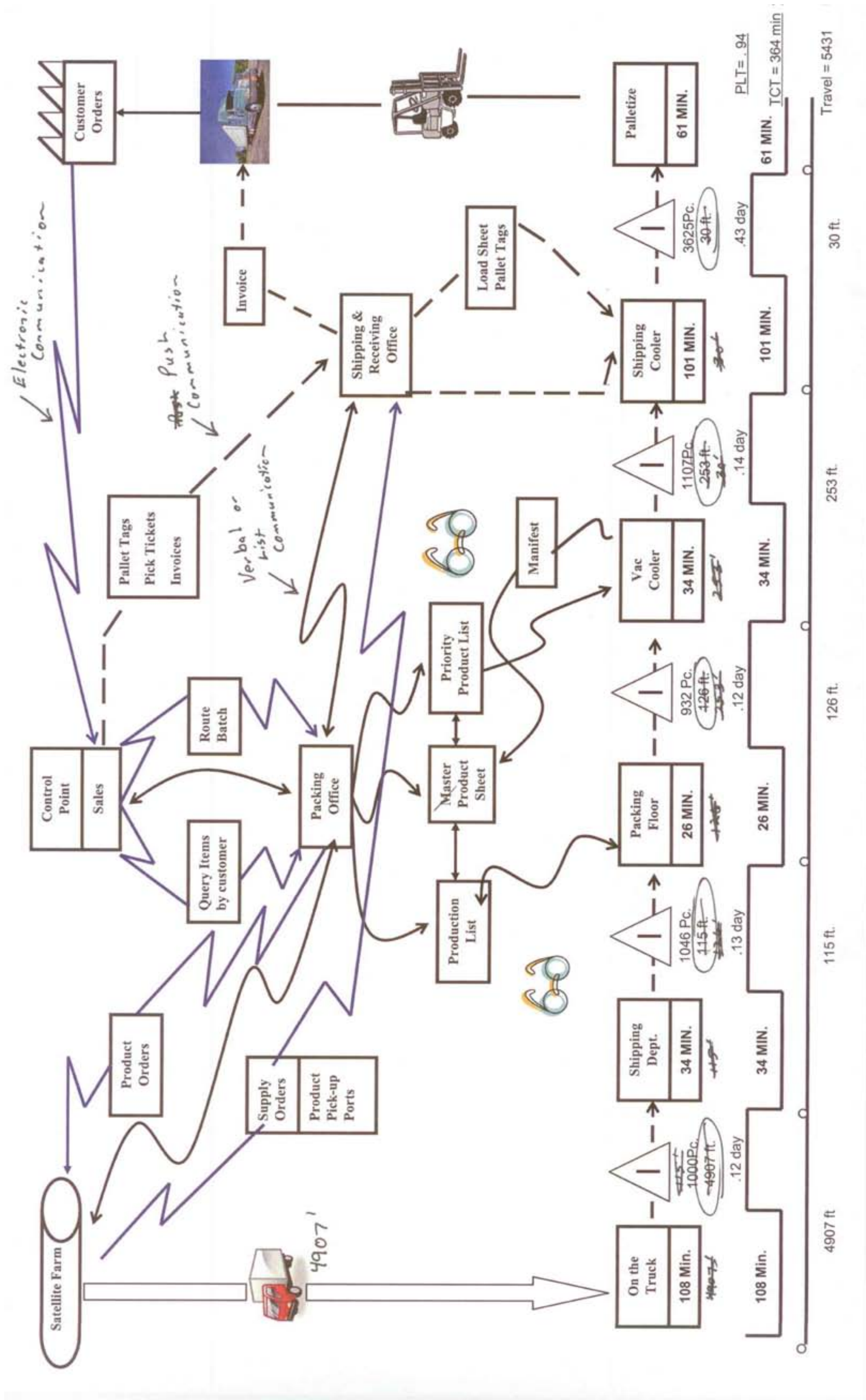
Therefore, the mushrooms must go through a Quality Assurance weighing station in the packing room. If pickers were able to pick by weight, not volume, the Quality Assurance line could be eliminated at the main facility.

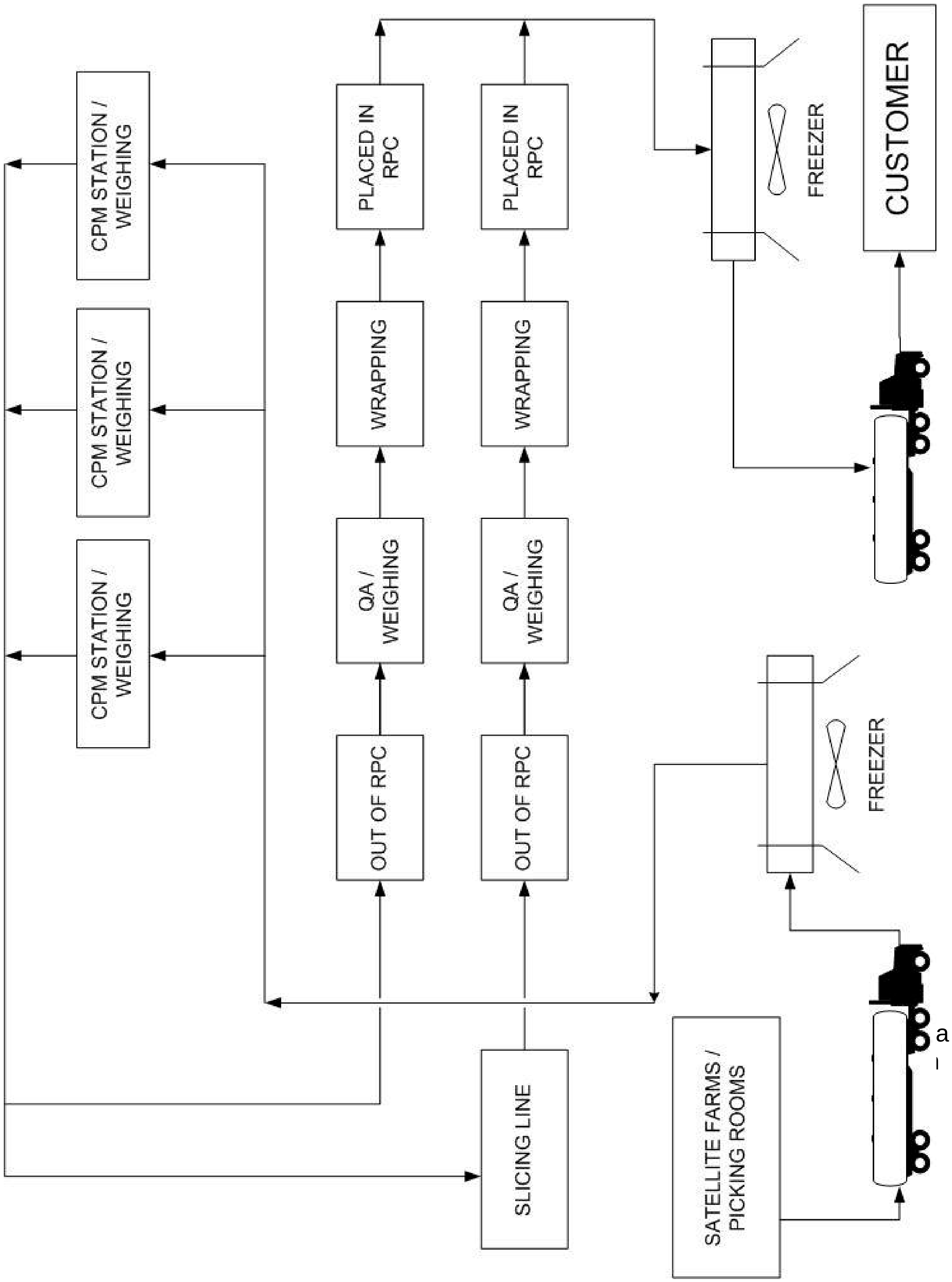
If J-M Farms were able to use a mechanism, device, or cart to package mushrooms in the picking room, the above mentioned problems would be eliminated.

Figure 3 on page 5 is a diagram of the production process and information flow at J-M Farms. Each segment of the production process is broken down by the time and distance it takes to complete each task. Figure 4 on page 6 is a diagram of the packing floor process. This displays the flow of mushrooms through the packing floor to distribution.

Figure 1. Harvesting Room at J-M Satellite Farm.

Figure 2. RPC holding eight (8) blue tills.


Customer Orders
Electronic Communication
Push Communication
Verbal or List Communication
Invoice
Shipping & Receiving Office
Load Sheet Pallet Tags
Pallet Tags
Pick Tickets
Invoices
Control Point
Sales
Route Batch
Query Items by customer
Packing Office
Priority Product List
Master Product Sheet
Manifest
Production List
Product Orders
Supply Orders
Product Pick-up Ports
Satellite Farm
4907'
On the Truck
108 Min.
1000Pc.
4907 ft.
.12 day
Shipping Dept.
34 MIN.
1046 Pc.
115 ft.
.13 day
Packing Floor
26 MIN.
932 Pc.
126 ft.
.12 day
Vac Cooler
34 MIN.
1107Pc.
253 ft.
.14 day
Shipping Cooler
101 MIN.
3625Pc.
30 ft.
.43 day
Palletize
61 MIN.
108 Min.
34 MIN.
26 MIN.
34 MIN.
101 MIN.
61 MIN.
4907 ft
115 ft.
126 ft.
253 ft.
30 ft.
PLT= .94
TCT = 364 min
Travel = 5431


CPM STATION / WEIGHING
CPM STATION / WEIGHING
CPM STATION / WEIGHING
PLACED IN RPC
PLACED IN RPC
WRAPPING
WRAPPING
QA / WEIGHING
QA / WEIGHING
OUT OF RPC
OUT OF RPC
SLICING LINE
SATELLITE FARMS / PICKING ROOMS
FREEZER
FREEZER
CUSTOMER

Packing Line Detail
The primary handling issue to for J-M Farms is with eight ounce, 12 ounce, and 16 ounce tills. Mushrooms picked at the satellite farms are shipped to the main facility, where they enter a cooling room. Next, they go to the Crop Production Measurement (CPM) line where each individual RPC is weighed. Here the picker's data and traceability data are recorded. After weighing, the RPCs are moved to the packing line. The tills are then taken off the RPC, weighed for sale weight accuracy and evaluated for quality grade and for quality assurance. The tills then go through a plastic wrapping machine to be sealed properly. A logo sticker is mechanically applied to each package. The tills are put back into RPCs, ready for shipping.

One problem with the current packing line is traceability. Once tills come off the RPC for packaging, traceability is lost. There is now way to tell who picked the mushrooms in each individual till since the current labeling methods label RPCs and not individual tills.

Ideally, the mechanism produced by Bella Corp will eliminate the entire process above, or provide the means for it to take place at the satellite farms. Additionally, it will allow J-M to weigh the mushrooms by individual tills with proper labeling so the traceability is not lost.

Figure 5. CPM Station

Figure 6. Quality Control

Picker Cart Detail
At the J-M satellite farms, pickers use a cart to hold the shipping containers of the mushrooms, RPCs and bulk boxes. These carts are a utility device that helps the picker move around the harvesting room quickly and flexibly. When a picker is working in the harvesting room, he or she rapidly picks mushrooms and throws them into the

appropriate container on their cart. Each picker has his or her own individual cart and uses it to their preference.

J-M's current cart is made from galvanized angled iron. There are five levels that can hold a combination of RPCs and bulk boxes. The upper three levels are sloped, because it is easier for the picker to throw a mushroom and have it land in the box on these levels. The cart is maneuverable by casters. See Figures 7 and 8 for a visual of J-M's picker cart.

Figure 7. Picker Cart

Figure 8. Picker Cart with Mushrooms

Limitations

According to J-M Farms, mushrooms produce a thick brown film or grimy residue that is a major sanitation issue, especially with the added amounts of moisture present in the harvesting rooms. This brown residue creates major complications for moving or mechanical parts. Consequently, the number of moving parts that can be in the harvesting room is limited.

The next limitation is space. The rows in the picking rooms are only three feet apart. Today, J-M's current plastic wrap machine will not fit in the limited space. Other packaging mechanisms are likely to be large and prohibit flexible and quick movement throughout the picking room.

The final limitation is cost. If J-M were to adjust the method of packaging mushrooms, capital investment will be a major factor.

Deliverables
Initially, Bella Corp viewed the project as a machine design project, where the deliverables would include a compact and moveable weighing and packing line, so each picker could package his or her mushrooms in the picking room. However, after the second trip to the facility, the team realized this problem may be too complicated with the limitations listed above.

As machine design was the initial concern, ergonomics was focused on very minimally. However, as Bella Corp keeps the big picture in mind, the team realizes the best way to accomplish the objectives will include some modifications to the packing line at J-M Farm's main facility. In its observations at the facility, the team has noticed that there are significant losses in the packing room. Potential ergonomics studies include a temperature study, handling study, time-motion studies, and activity based costing.

At the Final Presentation of the Fall Semester, J-M Farms indicated that they would like Bella Corp to design a new cart that would be used by the pickers. This cart would utilize one or more scales that would allow the picker to weigh the various mushroom containers at the time of picking, creating a "One Touch" system.

Research was completed on applicable scale models and a new cart was designed in SolidWorks. After analyzing the costs of the various scales, Bella Corp decided to use lower-cost scales in a proof-of-concept model, as opposed to using industrial, food-grade, washdown-capable scales which were many times more expensive. In the actual application at J-M Farms, the latter scales would be necessary to survive the demanding conditions.

In addition to the completed cart, its Solidworks drawings, and a list of the scales researched, several Communications and Business Reports were generated, as listed in the table below, Table 1.

Period of Performance
Project start date: August 17, 2009.
Project completion date: May 7, 2010.

Delivery Requirements
Deliverables schedule: As shown in Table 1.

Item	**Delivery Date**
Competitive Analysis Report	Oct. 26, 2009
Statement of Work	Oct. 30, 2009
Work Breakdown Structure	Nov. 2, 2009
Task List	Nov. 6, 2009
Fall Design Proposal Report Draft	Nov. 22, 2009
Gantt Chart	Nov. 23, 2009
Fall Design Proposal Report	Dec. 4, 2009
Fall Design Proposal - Oral Presentation	Dec. 4, 2009
Self And Peer Evaluations	Dec. 4, 2009
Team Leader Interview	Dec. 7, 2009
Project Notebooks	Dec. 8-11, 2010
Team website	Dec. 11, 2009
Revised Gantt Chart	Jan. 22, 2010
Send Cart Designs to BAE Lab	Mar. 12, 2010
Spring Design Proposal Report Draft	Apr. 2, 2010
Business Draft	Apr. 5, 2010
Campaign Elements Drafts	Apr. 5, 2010
Working Prototype	Apr. 9, 2010
Spring Design Proposal Report	Apr. 29, 2010
Spring Design Proposal - Oral Presentation	Apr. 29, 2010
Self And Peer Evaluations	Apr. 30, 2010
Finalized Campaign Elements & Team website	Apr. 30, 2010
Archival of All Material	Apr. 30, 2010
Team Leader Interview	May 3, 2010
Project Notebooks	May 4-7, 2010

Table 1. Deliverables schedule

The Bella Corp team leader will provide weekly updates to class professors on the progress of engineering, business, and communications deliverables.

WORK BREAKDOWN STRUCTURE

Communications

- website
  - Pictures of Team
  - Team Page
  - J-M Page
- Reports

- Materials
    - Recipe Cards
    - Informational Cards

Engineering

- Design Concepts
    - Patent / Journal Article Search
    - Full evaluation of current system
    - Develop List of Pros/Cons for each Concept
    - Select Design based on input from J-M Farms
- Build Prototype
    - Create design using SolidWorks
    - Send designs to BAE lab for machining and parts acquisition
    - Acquire any needed electronics or non-structural parts
    - Assemble
- Gantt Chart

Economics

- Competitive Analysis
    - Market Research
    - J-M's Capabilities
    - Competition
- Business Plan
    - Cost Breakdown
    - Costly Processes that need to be redesigned
    - Overall Flow of System
- Proposed Budget for Prototype

TASK LISTS

Communications—Michelle

- website
    - Pictures of Team—November 6, 2009
    - Conceptual Drawing—November 23, 2009
    - Execution
        - Build index page—December 2, 2009
        - Build team page—December 4, 2009
        - Build JM page—December 5, 2009
- Reports
    - Fall Report
        - Receive materials—November 18, 2009
        - First Draft—November 22, 2009
        - Receive updated/corrected materials—December 1, 2009
        - Final Draft—December 4, 2009
    - Spring Report
        - Receive materials—March 26, 2010
        - First Draft—April 2, 2010
        - Receive updated/corrected materials—April 19, 2010
        - Final Draft—April 21, 2010

- Materials
    - Recipe Cards
        - Cost—January 22, 2010
        - Recipes—February 5, 2010
        - Method of Delivery—February 19, 2010
    - Informational Cards
        - Cost—January 29, 2010
        - Information/Facts—February 12, 2010
        - Method of Delivery—February 26, 2010
    - Buyer Web page
        - Design—February 19, 2010
        - Completed—March 12, 2010
    - Package Recipe/Information Card
        - Cost—February 12, 2010
        - Recipes and Information—March 5, 2010
        - Design—March 26, 2010

Engineering—Stephen/David

- Design Concepts
    - Existing Documents
        - Journal Article Search—October 30, 2009
        - Patent Search—October 30, 2009
    - Full evaluation of current system—November 13, 2009
    - Develop List of Pros/Cons for each Concept—November 23, 2009
    - Conceptual Drawings/Sketches—November 23, 2009
- Develop Alternatives
    - List of Alternatives—November 18, 2009
    - Input from J-M Farms after Fall Presentation—December 3, 2009
- Project Planning (Fall)
    - Work Breakdown Structure—November 6, 2009
    - Task List—November 13, 2009
    - Gantt Chart
        - First Draft—November 23, 2009
        - Final Draft—January 22, 2010
- Project Planning (Spring)
    - Scale Selection
        - Define List of Scales—February 5, 2010
        - Pick Top Two Scales & Place Order—February 26, 2010
    - Idea Selection
        - Define List of Ideas—February 3, 2010
        - Pick Top Idea—February 17, 2010
- Build Prototype
    - Create design using SolidWorks—March 5, 2010
    - Send designs to BAE lab for machining and parts acquisition—March 12, 2010
    - Acquire any needed electronics or non-structural parts—February 26, 2010

    - Assembly Completed—April 9, 2010

Economics—Brady

- Market Research
    - Industry Analysis—November 27, 2009
    - Consumer Research—October 16, 2009
- J-M's Capabilities
    - Management—October 30, 2009
    - Products—November 23, 2009
- Competitive Analysis
    - Internal Competition—November 13, 2009
        - Picking Competition
        - Packing Line Competition
    - External Competition—October 16, 2009
        - Regional Competition
        - National Competition
- Cost Breakdown
    - Activity Based Costing for Entire Process—November 23, 2009
    - Overall Flow of System/Process Flow Chart— October 30, 2009
    - Identify Costly Processes that need to be redesigned—December 4, 2009
    - Cost Saving from proposed redesign of project—January 15, 2010
- Proposed Budget for Prototype of Cart— March 12, 2010
- Proposed Budget for Project—March 26, 2010
- Business Plan—April 2, 2010

Revised Competitive Analysis/Market Research/Patent Search

Industry Analysis (IBIS World)

THE ECONOMIC CONDITIONS AFFECTING THE MUSHROOM INDUSTRY ARE

Economies of Scale
Economies of scale in production generate cost savings for greenhouse growers. Specifically, economies of scale result in lower per unit growing costs that ultimately result in higher net returns. (IBIS World, 2009)

Production of Premium Goods/Services
Farmers who produce premium fruit and vegetables can find buyers in the fresh produce market, where prices are highest as compared to the processing market, as well as generate brand loyalty. (IBIS World, 2009)

Ability to Alter Goods and Services Produced in Favor of Market Conditions
The ability to alter the balance between various food crops in response to changes in market conditions is important for a farm's viability. Farmers need to be able to change their production mix to maximize farm returns. (IBIS World, 2009)

Establishment of Export Markets
The ability to identify and market food crops to customers overseas reduces a farmer's dependence on the local market. (IBIS World, 2009)

Appropriate Physical Growing Conditions
The presence appropriate growing conditions (such as sunshine and temperature levels) play a critical role in shaping the success of growing food crops under cover. Growing conditions influence harvest levels and crop quality. (IBIS World, 2009)

Access to the Latest Available and Most Efficient Technology and Techniques
The success of farmers in this industry depends on using the latest available technology, to ensure efficient production of high quality fruit and vegetable. (IBIS World, 2009)

Availability of Irrigation Water
Water access issues can impact on the quality of harvests and the area of land devoted to greenhouse production. (IBIS World, 2009)

KEY SENSITIVITIES

The key sensitivities affecting the performance of the Mushroom & Tomato Production industry include:

Domestic Price - Horticulture - Mushrooms
An increase in the price of mushrooms impacts positively on returns at the farm gate. Price fluctuations reflect supplies levels, final consumer levels, global demand, and a

host of other factors. (IBIS World, 2009)

Domestic Price - Horticulture - Vegetables
An increase in the price of food crops grown under cover impacts positively on returns at the farm gate. Price fluctuations reflect supplies levels, downstream vegetable processing activity, global demand, and a host of other factors. (IBIS World, 2009)

Downstream Demand - Supermarkets & Grocery Stores in the US
Farmers of crops grown under cover rely on supermarkets and groceries for sales as mush of their produce is sold as part of forward contracts. Retailers will respond to a rise in retail demand by increasing their orders of food grown under cover. Rising demand generally results in greater activity in this US industry. (IBIS World, 2009)

Exchange Rates - Trade Weighted Index
Base Year 1973 - historical and forecast data and analysis.
Exchange rate levels affect the price competitiveness of US exports of food crops grown under cover. An appreciation of the US dollar raises the price of the industry's output in international markets, thereby eroding the industry's price competitiveness. (IBIS World, 2009)

Nutrition - Vegetables Consumption
Increased public concern about nutrition and diet is having a positive impact on the consumption of horticulture (including that grown under cover). According to the USDA, Americans need to increase their vegetable consumption by about 25% in order to meet health recommendations. (IBIS World, 2009)

Quarantine Restrictions (Overseas) - Mushroom & Tomato Production
The presence of quarantine restrictions and other artificial barriers to trade adversely impact on US vegetable and fruit exports. Countries like Australia have traditionally imposed tight restrictions on horticultural imports, seriously inhibiting exporting efforts by US growers. (IBIS World, 2009)

INDUSTRY SIZE AND GROWTH

Inflation Adjusted	2005	2006	2007	2008	2009	
Industry Revenue	*1,221.8	*1,187.6	*1,230.2	*1,291.5	*1,338.9	$Mil
Industry Gross Product	*568.1	*546.3	*553.6	*590.1	*612.8	$Mil
Number of Establishments	*326	*335	*330	*328	*324	Units
Number of Enterprises	*320	*329	*325	*232	*319	Units
Employment	*1,680	*1,700	*1,667	*1,750	*1,785	Units
Exports	*26.7	*28.9	*44.3	*58.6	n/a	$Mil
Imports	*97.7	*98.2	*97.3	*89.3	n/a	$Mil
Total Wages	*175.6	*176.5	*187.9	*182.1	n/a	$Mil
Domestic Demand	*1,292.8	*1,256.9	*1,283.2	*1,322.2	NC	$Mil
Mushroom production	*853.2	*843.4	*851.5	n/a	n/a	Million Pounds (lb)

Table 2. Adjusted inflation of covered vegetable industry (IBIS World, 2009)

Real Growth	2005	2006	2007	2008	2009	
Industry Revenue	*1.0	*-2.8	*3.6	*5.0	*3.7	%
Industry Gross Product	*-1.7	*-3.8	*1.3	*6.6	*3.9	%
Number of Establishments	*5.8	*2.8	*-1.5	*-0.6	*-1.2	%
Number of Enterprises	*6.0	*2.8	*-1.2	*-28.6	*37.5	%
Employment	*7.0	*1.2	*-1.9	*5.0	*2.0	%
Exports	*-13.7	*8.2	*53.2	*32.2	NC	%
Imports	*16.1	*0.5	*-0.9	*-8.2	NC	%
Total Wages	*-2.5	*0.6	*6.5	*-3.1	NC	%
Domestic Demand	*2.4	*-2.8	*2.1	*3.0	NC	%

Table 3. Real growth of covered vegetable industry (IBIS World, 2009)

RELEVANT TRADE PUBLICATIONS

Citrus and Vegetable
The Packer

Customers/ Buyer Information

CONSUMER RESEARCH

Please see appendix

CONSUMER ANALYSIS

Please see appendix

ECONOMIC STATUS OF YOUR CUSTOMERS/BUYERS

Mushroom Buyers Tend to be Wealthier and Highly Educated.

- Income of about $70, 000 or more
- Households tend to be more educated with bachelor's degrees as well as masters and doctorates. (Mushroom Council, 2004, 2005, 2005)

DEMOGRAPHIC CHARACTERISTICS OF CUSTOMERS/BUYERS

Ethnicity of Mushroom Buyers

- Majority of consumers are Caucasian with an increase towards Asian households (Mushroom Council, 2004, 2005)

Purchasing Characteristics of Mushroom Buyers

- Mushroom consumers tend to purchase mushrooms four to five times per year.
- Average consumer spends $10 a year on mushrooms. (Mushroom Council, 2004, 2005, 2004,2005)

Demographic Profile by Region

- West
    - Income $70,000 or more
    - Two member household
    - Empty nesters, living comfortably, childless younger couples

        - Affluent
        - Asian
- Central
    - Income $70,000 or greater
    - Childless younger couples, middle aged singles, older singles, younger singles, childless younger couples, established families
        - Affluent
        - Hispanic
- East
    - Income $70,000 or above
    - Three to four member households
    - Older Female head of household, new families, empty nesters
        - Affluent
        - Asian
- South
    - Income $50-70,000 or more
    - Five member or greater household
    - Kids less than six years old
    - Childless younger couples, empty nesters living comfortably
        - Affluent
        - Asian, Hispanic & Other Race (Mushroom Council, 2004, 2005, 2005)

Buyer Distribution by Region

The buyer distribution by region is almost equal with the South having the largest buyer distribution of 28 percent.

- West 25%
- East 23%
- Central 24 %
- South 28 % (Mushroom Council, 2004, 2005)

Buyer Distribution by Mushroom Type

- Packaged Mushrooms
    - West 20%
    - East 24%
    - Central 25%
    - South 31%
- Raw Mushrooms
    - West 44%
    - East 20%
    - Central 14%
    - South 22%

The demographics of mushroom buyers are very important because it identifies the type of customer currently purchasing mushrooms as well as new customers to pursue in the market. (Mushroom Council, 2004,2005)

CHARACTERISTICS OF BUYING FIRMS/GOVERNMENT AGENCIES

Customer Influence on Buying Firms

- Mushroom shoppers are valuable to retailers. The average shopping basket with mushrooms is double the value of shopping baskets without mushrooms.
- Specific products are usually purchased with mushrooms
    - Fresh carrots, packaged salads, lettuce and fresh potatoes
    - Sour cream, shredded cheese, yogurt and fresh eggs
    - Spaghetti/ marinara sauce, canned soups, margarine and spreads
- Target customers and customer preference per region
    - West
        - Bulk items or smaller package sizes
        - Position in high end, perhaps part of gourmet meal solution
        - Asian recipes for point of source materials
    - Central
        - Offer larger package sizes
        - Position in high end, perhaps part of gourmet meal solution
        - Hispanic recipes for point of source materials
    - South
        - Offer larger package sizes
        - Position in high end, perhaps part of gourmet meal solution
    - East
        - Some bulk with moderate package sizes
        - Position in high end, perhaps part of gourmet meal solution
        - Asian and Hispanic recipes for point of source materials. (Mushroom Council, 2004,2005)

Penetration & Buy Rate by Market

- Penetration is highest among the San Francisco, Los Angeles, and Chicago markets. (Mushroom Council, 2004,2005)

Deal Activity

- A greater percentage of mushroom dollars is sold by deals (features, displays, store coupons, manufacturer coupons, and other deals such as price packs or bonus packs) than other vegetables. Almost a third of all packaged mushroom sales are associated with deals.
- The East region has the highest deal activity followed by the Central region, followed by the South region, and finally the West region. (Mushroom Council, 2004,2005)

Buying Channel

- Grocery Stores – 1
- Super Centers – 2
- Mass – 3
- Warehouse Club – 4
- Fruit Stand – 5, portion of raw mushroom consumers purchase here. (Mushroom Council, 2004, 2005)

PSYCHOGRAPHIC CHARACTERISTICS OF CUSTOMERS/BUYERS (HOW DO THEY THINK?)

Convenience

- Today’s cooks want to cook 15 minutes for less
- Ease of preparation is very important

- Low price is only moderately important
- Speed of Consumption is only moderately important
- Ready-to-eat/ no preparation is moderately important
- Portability is slightly important
- Ready-to-heat ingredients are very important
- Mushrooms are an impulse purchase (Mushroom Council, 2004, 2005)

Obstacles

- "I don't like or have time to get them ready."
- "I forget to buy them."
- "I don't know how to use them."
- "I don't know how to store them." (Mushroom Council, 2004, 2005)

HOW IS THE PRODUCT USED? HOW COULD IT BE USED?

Cooking Facts

- Mushrooms are very easy to cook
- They are very, very fast to cook
- They go with most every food
- They are available all year
- They come in varieties (Mushroom Council, 2004, 2005)

Nutritional Facts

- They are low in carbohydrates
- They are low fat (Mushroom Council, 2004, 2005)

AVAILABLE MARKET RESEARCH- PROMOTIONAL PROGRAMS AND CURRENT CAMPAIGNS

Current Programs

- Placement next to bagged salad section
- Secondary displays
    - Inside bagged salad section
    - Meat alternative healthy section
    - Organic produce section
- Proper assortment and display
    - Larger displays of sliced, minimum 50 percent of display
    - Feature browns at eye level and minimum 20 percent of display
- Promote frequently and across the different sub-categories
- Cold chain temperatures are key to fresher product, longer shelf-life, better sales and less shrink (Mushroom Council, 2004, 2005)

Possible Programs

- Targeted programs on usage and preparation. In store demos and point of source material with recipes are recommended to boost penetrations.
    - These should be formed with Hispanic and Asian population in mind.
- Point of Source materials
    - Recipe booklets/labels
    - Informational signs
    - Informational website.

- Place mushrooms in a variety of food areas based on what they can be served with which increases purchasing. Place in meat sections, salad sections, etc.
- Consumers purchase for specific occasions, may need to create more occasions and options
    - Summer grilling recipes/themes
    - Holiday recipes

The customer information and market research suggests programs need to be implemented to inform current and potential customers with more information about mushroom, including nutritional analysis, handling and storage, preparation, and recipes. Using point of source materials looks to have the most potential for reaching the customers with this information. (Mushroom Council, 2004, 2005, 2004)

Client Company and its Resources

MANAGEMENT TEAM (EXPERIENCE AND KEY PEOPLE)

Pat Jurgensmeyer
President, J-M Farms
PatJ@JMFarms.com
918-533-3520

Terry Jurgensmeyer
President, Miami Industrials Supply
TerryJ@MiamiIndustrialSupply.com
918-533-4005 Cell
918-542-6311 Office

Steve Engelbrecht
Satellite Farm Owner
EFI@jmfarms.com
918-533-0390

Eric Riley
Satellite Farm Manager
JMCI@jmfarms.com
918-533-5485

John Tune
Satellite Farm Manager
QMI@jmfarms.com
918-533-8863

MANUFACTURING EXPERTISE AND CAPACITY

J-M Farms, Inc
7001 S 580 Rd
Miami, Oklahoma 74354-6501

- Stock Symbol: J-M Farms, Inc

- Line of Business: Covered Food Crops Farm Mfg Food Preparations
- Estimated Annual Sales: $12,800,000
- Estimated # of Employees: 320
- Year Founded: 1979
- Estimated Employees for This Location: 320 (All Business)

http://www.allbusiness.com/companyprofile/J-M_Farms_Inc/F2AEFBE73033412DBB40834BBF346057-1.html

Competitor Analysis

MAJOR PLAYERS IN MARKET SEGMENT

The US Food Crops Grown Under Cover Industry is characterized by the presence of privately owned farms, with an average harvested area of less than 10 acres. Apart from Monterey and Sylvan, some large establishments do operate in this industry, and these are often forward-integrated into grading and packaging.

Top Companies by Sales

1. Monterey Mushrooms, Inc
2. Creekside Mushrooms, Ltd
3. Amycel, Inc
4. C P Yeatman & Sons Inc
5. Elite Mushroom Co Inc
6. J-M Farms, Inc
7. Gino Gaspari & Sons Inc
8. To-Jo Mushrooms, Inc
9. Leo, John C & Son, Llc
10. Gourmet's Delight Mushroom Co Inc

AllBusiness has profiles of 258 companies in Mushroom Production. Taken together these companies have estimated annual sales of $591,848,493 and employ an estimated 10,063 people.
http://www.allbusiness.com/companyindex/Mushroom_Production/669801A3F365CB68179C6534632FB340-1.html

Monterey Mushrooms

260 Westgate Drive
Watsonville, Ca 95076
Tel: (800) 333-Mush (6874)
Fax: (831)763-0700
www.montereymushrooms.com

Overview

Monterey Mushrooms, Inc. was established in 1971 as a single farm operation in Royal Oaks, California. Today, this multi-site business is headquartered in Watsonville, California, and has production, sales and administrative offices, internationally. Monterey is the country's largest and only national marketer of fresh mushrooms, supplying products for sale to supermarkets, foodservice and ingredient manufacture operations, and for preparation of processed, canned, and frozen mushroom products. Monterey Mushrooms has15 percent Market Share (estimated $350 Million annual revenues). (Monterey Mushrooms)

Figure 3 is a distribution map for the Monterey Group of Mushroom Farms. As demonstrated by the map, Monterey has distribution across the United States and Mexico

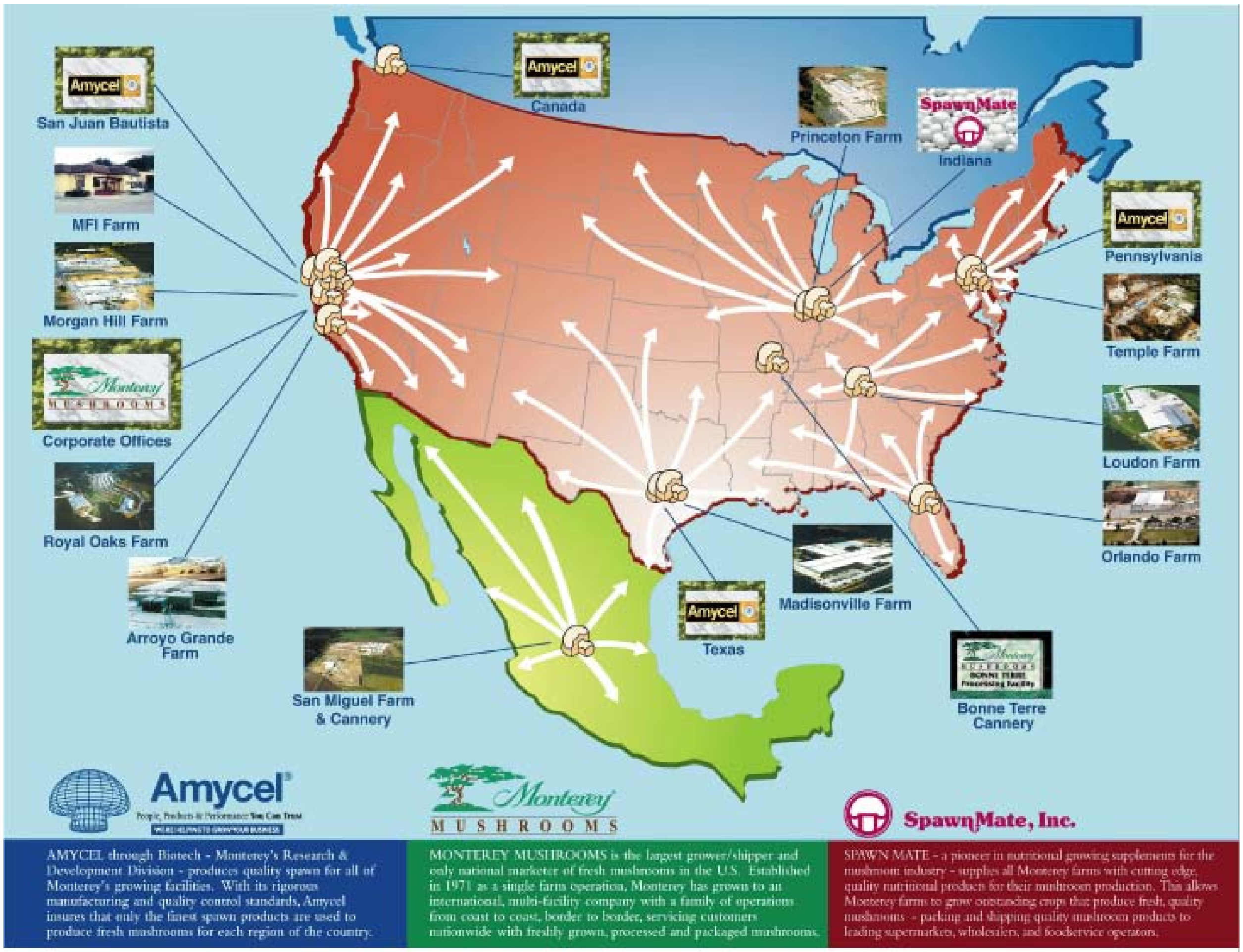


Figure 9. Monterey mushroom distribution
http://www.montereymushrooms.com/overview.htm

Products

- Retail
  - Clean N Ready® Mushroom
  - Clean N Ready® Bagged Packs
  - Gourmet White Mushrooms
  - Gourmet Portabella Mushrooms
  - Baby Bellas / Brown Mushrooms
  - Gourmet Specialty Mushrooms
  - Fresh Dried Mushrooms

- Organic Mushrooms

- Processed
    - Canned Stems & Pieces Mushrooms
    - Canned marinated Mushrooms
    - Fresh Jarred marinated Mushrooms
    - Frozen Sauces
    - Refrigerated Quick Blanched Mushrooms
    - Services/Product Development/Private Label (Monterey Mushrooms)

Regional Productions Sites

- Royal Oaks, CA
- Las Lomas, CA
- Morgan Hill, CA
- Arroyo Grande, CA
- Madisonville, TX
- Loudon, TN
- Temple, PA
- Princeton, IL
- Orlando, FL
- San Miguel, Mexico (Monterey Mushrooms)

Creekside Mushrooms Ltd.

One Moonlight Drive
Worthington, PA 16262-9730
724-297-5491
http://www.creeksidemushrooms.com/contact.htm

Overview
Creekside Mushrooms Limited is the world's largest underground mushroom farm, 300 feet under the earth, in a 150-mile web of tunnels originally created by limestone mining. Creekside is the world's largest mushroom growing facility and the only underground mushroom farm in the United States. Creekside is comprised of over 500 people from the local community. Creekside's major market focus is retail and foodservice with our commitment to provide long term partnerships with each and every customer. (Creekside Mushrooms)

Products (Creekside Mushrooms)

QTY.	OVERWRAP WHITES	QTY.	OVERWRAP SPECIALTY	QTY.	JARED & CANNED
	4oz. Miniatures - 6		3.5oz. Oyster - 6		8oz. Jars Marinated - 12
	4oz. Mini-Sliced - 6		3.5oz. Shitake - 6		8oz. Jars Garlic Italian - 12
	8oz. Sliced - 6		3.5oz. Enoki - 6		8oz. Jars Sweet Italian - 12
	8oz. Sliced - 12		4oz. Gourmet Blend - 6		8oz. Jars Zesty Salad- 12
	8oz. Whole - 12		6oz. Baby Bella - 6		8oz. Jars Mixed Pack - 12
	10oz. Whole - 10		6oz. Baby Bella's sliced		4oz. Cans Stems&Pieces - 24
	12oz. Whole - 10		10oz. Baby Bella's - 10	**QTY.**	**DRIED MUSHROOMS**

	14oz. Moon-Bello's - 8		6oz. Portabella Caps - 6		.5oz. Dried Combo #1 - 10
	16oz. Whole - 8		6oz. Portabella Sliced - 6		.5oz. Dried Combo #2 - 10
	24oz. Family Pak - 6		7oz. Portabella n' Sauce - 6		.5oz. Dried Combo #3 - 10
			14oz. Portabella Caps - 4		.5oz. Dried Combo
QTY.	**BULK WHITES**		3.2oz. Bella Burgers - 6	**QTY.**	**WILD MUSHROOMS**
	3 lb. Fancy large		8oz. Exotic Tri-Pac - 5		2oz. Chanterelle - 6
	5 lb. Medium		2.5oz. Beech - 6		2oz. Hedgehog - 6
	5 lb. large		3.5oz. Maitake - 6		1oz. Black Trumpet - 6
	5 lb. Sliced		Variety Pack - 6		2oz. Woodear - 6
	5 lb. Sliced Tubs x 1				.75oz. Morel - 6
	5 lb. Sliced Tubs x 2	**QTY.**	**BULK SPECIALTY**		1.5oz. Porcini - 6
	10 lb. small		2 lb. Enoki		2oz. Lobster - 6
	10 lb. medium		3 lb. Oysters		5 lb. Chanterelle
	10 lb. Large		3 lb. Shiitake #1's		5 lb. Hedgehog
	10 lb. Jumbo		3 lb. Shiitake #2's		5 lb. Black Trumpet
	10 lb. Sliced 3/16"cut **thick**		4.5 lb. Combo Pack		5 lb. Woodear
	10 lb. Sliced 1/4"cut **thick**		3 lb. Port Caps 3 1/2"		1 lb. Morel
	10 lb. Value Pack		3 lb. Port Caps 4 1/2"	**OTY.**	**ORGANIC MUSHROOMS**
	10 lb. Fresh matures		5 lb. Baby Portabellas		8oz. White Whole - 6
	10 lb. Fresh Pieces		5 lb. Portabella Sliced		8oz. White Whole - 12
			5 lb. Portabella Small		8oz. Baby Bellas - 6
			5 lb. Portabella		8oz. Port. Sliced - 6
			10 lb. Baby Portabellas		8oz. Port. Caps - 6

Table 4. Creekside Mushroom product list

Amycel Inc.

260 Westgate Drive
Watsonville, CA 95076
831-763-5300
831-763-0700 or 763-0700 Fax
http://www.amycel.com

Overview

Mushroom spawn is produced by Amycel Inc. at one of its 2 locations in the United States, San Juan Bautista California and Madisonville Texas.

Amycel San Juan Bautista is also the site for production of the inoculums used at all Amycel spawn plants. Culture maintenance and inoculum production activities are conducted by technicians with many years of experience in all phases of spawn production. Master cultures are preserved in liquid nitrogen for long term stability with duplicate cultures stored at the Biotechnical Research Laboratory.

Amycel San Juan Bautista is the home office for the company, not only for inoculum production, but for business administration and process development.

Amycel produces a full range of mushroom spawn including off white hybrids, brown strains for Portabella / Crimini production, in addition to Pleurotus (oyster) and Shiitake strains. (Amycel)

Logos:

Figure 10. and 11. Amycel logos

C P Yeatman & Sons Inc.

600 North Baker Station Rd.,
West Grove, PA 19390
610-869-7211
http://www.organicmushrooms.com

Divisions of C P Yeatman & Sons Inc.

- Mother Earth Organic Mushrooms
- Mother Earth Country Store
- Mushroom Specialties Marketing Division

Overview

Organic refers to an "earth friendly" method of growing and processing foods. Weeds and pests are controlled using environmentally sound practices which sustain the health of our planet. Our Organic Mushrooms are grown to these strict standards to insure you a healthy, delicious product. (C P Yeatman & Sons)

Logo:

Figure 12. C P Yeatman & Sons logo

Phillips Mushroom Farms

1011 Kaolin Road
Kennett Square, PA 19348
1-800-722-8818
www.phillipsmushroomfarms.com

Phillips Mushroom Farms is located in eastern Pennsylvania. They are not a direct competitor with J-M Farms as they do not sell east of the Mississippi River. They recently converted all of their production facilities to new, state of the art facilities that supposedly add shelf life to the mushroom once it is harvested. Phillips also has another legal entity under its ownership call Phillips Gourmet Mushrooms. This entity specializes in gourmet blends and specialty orders. (Phillips Mushroom Farms)

Strict Quality Control

- "Trained lab technicians inspect all mushroom spawn to ensure pure mushroom cultures." (Phillips Mushroom Farms)
- "All Phillips mushrooms are hand picked, graded and packed swiftly to maintain freshness." (Phillips Mushroom Farms)
- "Phillips Mushroom Farms sells over 35 million pounds of specialty mushrooms per year, more than any other mushroom farm in the United States."
- "Phillips Mushroom Farms is capable of shipping to every major city in the United States and Canada." (Phillips Mushroom Farms)

State Of The Art Equipment

- "Phillips Mushroom Farms has invested millions of dollars to build research facilities and expand production capabilities. (Over 1 million square feet of growing space.)" (Phillips Mushroom Farms)
- "Post-Harvest Vacuum Cooling helps to keep Phillips mushrooms fresher longer." (Phillips Mushroom Farms)
- "Research Mycologists work to bring new varieties to the marketplace." (Phillips Mushroom Farms)
- "Computer-controlled growing environments help to maintain quality and consistent production of Phillips specialty mushrooms" (Phillips Mushroom Farms)

Logos:

PHILLIPS
MUSHROOM FARMS, L.P.

Figure 13. Phillips Mushroom Farms logo

Figure 14. Phillip Gourmet Mushroom logo
Packaging Photos:

Figure 15. and 16. Phillips Packaging

OTHER PLAYERS

Eurofresh (estimated market share: 4 percent)
Established in Pennsylvania in 1992, Eurofresh now operates one of the largest greenhouses in the US, located in Arizona over 265 acres. The company is one of the biggest producers of greenhouse tomatoes, with annual sales of about $55 million. According to its website, Eurofresh has a 20 percent share of the greenhouse tomato market in the US, producing up to 600,000 pounds of tomatoes each week. The company has been introducing new varieties, such as the Campari tomato, in an effort to increase its share of the foodservice market. (IBIS World, 2009)

Village Farms (estimated market share: 2 percent)
Since it began operations in 1991, Village Farms expanded their greenhouses from 10 to over 130 acres, relocating from Pennsylvania to Texas, in order to supply tomatoes year-round. The company also grows peppers and cucumbers. (IBIS World, 2009)

Mountain Meadow Mushrooms (estimated market share: less than 1 percent)
Mountain Meadow Mushrooms is primarily engaged in the production of mushrooms. At its central 17-acre facility in California, the farming operation grows white button, brown crimini and Portobello mushrooms for sale and distribution across the US. According to

reports, Mountain Meadow harvests up to 17,000 pounds of mushrooms every day of the year, with annual sales of about $7.5 million. (IBIS World, 2009)

Technical Analysis

SCIENTIFIC LITERATURE REVIEW

Introduction

- Little technical or scientific research can be found on mushroom packaging or packing lines. Additionally, research on mushroom production, harvesting and handling techniques, and bruise elimination was limited. Therefore, research on similar fruits and vegetables, such as apples, peaches, strawberries, and tomatoes was used for investigation.
- The articles below cover a variety of topics, and are broken into several categories. Most of the scientific research concerns the design of packing lines and ways to optimize the process by reducing the impacts encountered by the fruit or vegetable. Minimizing rough contact decreases bruising, a major factor in mushroom production. Some articles were applicable to more than one research area, but will only be listed in one category.
- The authors and abstracts of each article are available in alphabetical order by article title in the appendix material.

Scientific Articles

- Mushroom Production
  - "Design of a Shitake Mushroom Packing Line"
  - "Grading of Mushrooms using Machine Vision System"
- Packing Lines
  - "Peach Physical Characteristics for Orientation"
  - "A Procedure for Testing Padding Materials In Fruit Packing Lines Using Multiple Logistic Regression"
  - "Sorting Table Illumination on Stonefruit Packing Lines in California"
- Packing Line Impact/Damage Evaluation
  - "Analysis of the Factors Implied in the Fruit to Fruit Impacts on Packing Lines"
  - "Analysis of the Mechanical Aggressiveness of Three Orange Packing Systems: Packing Table, Box Filler and Net Filler"
  - "Assessment of Apple Damage on Packing Lines"
  - "Fruit Damage Assessment in Peach Packing Lines"
  - "Impact Bruise Estimates for Onion Packing Lines"
  - "Impacts Recorded on Avacado, Papaya, and Pineapple Packing Lines"
  - "Instrumented Sphere Impact Analysis of Tomato and Bell Pepper Packing Lines"
  - "Packing Line Bruise Evaluation for 'Walla Walla' Summer Sweet Onions"
- Packing Line Impact/Damage Reduction
  - "Apple Packing Line Damage Reduction"
  - "Reduction of Mechanical Damage to Apples in Packing Lines Using Mechanical Devices"
- Packaging/Shipping
  - "Analysis of Automatic Weight-Fill Bagging Machinery for Fresh Citrus"
  - "Suspended Tray Package for Shipping Soft Fruit"
- Bruise Estimation and Evaluation Articles

    - “Apple Impact Damage Thresholds”
    - “Fruit and Vegetable Bruise Threshold Prediction Using Theory of Elasticity and Failure Tissue Properties”
- Mechanical Harvesting Articles
    - “Mechanical Harvesting System for Burley Tobacco”
    - “Multi Purpose, Vegetable Production Machine Investigation”

PATENT SEARCHES

Electronic Scales - If Bella Corp incorporates a scale into the cart design, there will likely need to be an integrated printer that can print a barcode sticker to label each till. These four patents deal with the design of a scale, and some of include a printer.

- **United States Patent # 4,700,791 -** *Electronic Scale Printer (1987)*
    - This invention incorporates an electronic scale and a printer into one system. If implemented in future picker carts, this would make installation easier because it is a single unit.
- **United States Patent # 4,091,449 -** *Computing Scale System (1978)*
    - This device computes the value of a product being weighed and controls the operation of a label printer associated with it. Most present-day scales have this capability, but the concept is still important for recording data measured by the scale.
- **United States Patent # 4,153,125 -** *Digital Electronic Scale (1979)*
    - An electronic scale is preferred to a mechanical scale because the results can be quickly and easily transferred to another device, such as a printer or a wireless network.
- **United States Patent # 4,800,973 -** *Portable Electronic Scale of Minimal Thickness and Weight (1989)*
    - Minimizing scale weight means that the cart will be easier for the workers to push. Reducing the size of the scale minimizes wasted space and allows for greater clearance between each level of boxes or RPCs.

Wireless Communications - Depending on what electronics are used on the cart, they may need to communicate with the J-M server to update the CPM system remotely. Since the picker carts must be moved throughout the satellite farm, a hard-wired system would be impractical, necessitating a wireless connection.

- **2.1 United States Patent # 5,159,592 -** *Network Address Management for a Wired Network Supporting Wireless Communication to a Plurality of Mobile Users (1992)*
    - This is an early system demonstrating the potential for wireless data transfer between multiple users.
- **2.2 United States Patent # 5,276,703 -** *Wireless Local Area Network Communications System (1994)*
    - This system proposes a specific use for wireless communication in a local network. This is similar to what J-M Farms could implement, because they would only need the data to be distributed in a small area.

Packaging - To weigh the tills individually, they must be filled individually. A good way to close the package and apply a sticker would be to do it at the same time. Also, till design must be conducive to efficient cooling, as shelf life increases as cooling time decreases.

- **3.1 United States Patent # 5,866,183 -** *Package Closing Label (1999)*
    - This label incorporates a barcode sticker that also closes the package securely. J-M already uses stickers for traceability and quality control, but they aren't used to close the package.
- **3.2 United States Patent # 5,738,890 -** *Method and Container for the Improved Packing and Cooling of Produce (1998)*
    - The faster the mushrooms can be cooled, the greater their shelf life is in the store. This is determined by several factors, but one important factor is a container design that allows for rapid heat transfer.
- **3.3 United States Patent # 6,007,854 -** *Tray for the Improved Packing and Cooling of Produce (1999)*
    - This uses a similar concept to the previous patent, but applies it to trays that hold packages of produce. This translates to the RPCs used by J-M Farms.

Definition of Customer Requirements & Development of Engineering Specifications

CUSTOMER REQUIREMENTS

J-M Farms hired our team to improve the efficiency and quality of their mushroom packaging process, specifically at their satellite farms. Their suggestion at the beginning of the project was to design a new picker cart that would be able to carry out all of the functions of the packaging line in a compact unit.

This new picking/packaging cart was not an initial requirement, and the team even looked into other areas to accomplish its mission statement, such as improving the efficiency and quality of the mushroom packaging process. As we have collected more data and assessed the situation more in-depth, we realized we are more of a consultant team than a design team.

Last semester the team presented its ideas to J-M Farms. Based on discussion with J-M Farms, our final design will be an example cart that will allow mushroom harvesters to pick by weight and not volume.

Proposed Media/Communications Plan

MEDIA MATERIALS

The communications plan for J-M Farms includes both business-to-business elements as well as business-to-customer elements. While the business-to-business relationship is already developed, there are areas of improvement. Based on customer analysis, the best way to reach the customer is through point of source materials.

Business-to-Business

- Web page
  - J-M Farms already has a very good website. An additional Web page for buyers to access information about J-M Farms such as quality control, traceability statistics, efficiency data, recycling and conservation efforts may increase orders or reach new buyers.
- Flier or Brochure
  - An informative brochure to distribute to all current buyers and potential buyer explaining J-M's dedication to quality mushrooms, next-day service, traceability standards, recycling and conservation effort. This provides the buyer with quality information to pass on to the customer. Also, this option will make the buyer a more satisfied customer of J-M farms, and may lead to an increase in sales or new buyers.

Business-to-Customers

Customer analysis shows most people do not know how to store, handle, and prepare mushrooms, which prevents them from purchasing mushrooms. Research also shows people are willing to learn how to include mushrooms in their diet.

- Web page
  - An additional Web page could be launched for customers to learn about J-M Farms' efforts to produce a quality product, recipes, storage and handling procedures, recycling and conservation efforts, and traceability statistics. This provides customers with around-the-clock access about J-M Farms and mushrooms.
- Recipe/Fact Booklet Label
  - This will be similar to the label booklet sometimes found on strawberry containers that have recipes and information when you unfold the booklet. This will serve as a point of source material with recipes and facts about mushrooms. As the product will go directly to the customer, J-M Farms would not have to worry about buyer providing the information to customers.
- Recipe Cards
  - This will serve as another point of source material. The card would have recipes including mushrooms for consumers to expand their experience with mushrooms. The delivery method for the recipe cards has two alternatives, including mail and displays with the mushrooms. The main challenge with both alternatives is ensuring that the recipe card actually reaching the customer.
- Fact Cards

- o This will include information such as storing, handling, and preparing mushrooms as well as nutritional facts. The delivery method has the same possibilities and problems as the recipe card.

Through many conversations and discussions with J-M Farms, the communications plan materials developed include restructure of the current J-M Farms website, recipe cards, and fact cards.

The website restructure places important information to customers and buyers in easy to find locations. The figure below represents the restructure of J-M's website. While most of the headings remain the same the nutrition heading is removed and the consumers heading is added. The nutrition information is listed under the consumers heading. Recipes are listed as a heading and an option under consumers heading. The option under consumers would be linked to the recipes heading. By listing the information in two places, you allow consumers more options. Those consumers who only are looking for recipes have the ability to quickly access them through the recipe heading. Those consumers who need more information about cooking with mushrooms before selecting recipes are able to access all necessary information through the consumers heading.

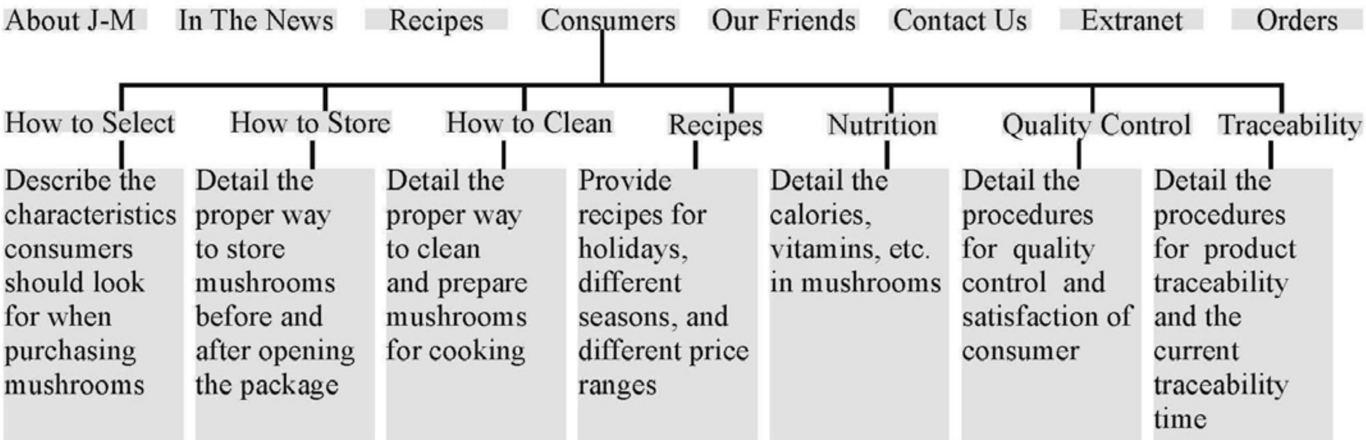


Figure 17. Diagram of website Restructure

The recipe cards and fact cards are designed to be placed in grocery stores and mailed to potential consumers. The cards are designed to be small enough to fit in a recipe book or recipe box. A variety of recipes are incorporated to reach multiple potential customers.

Baja Salmon with Mushrooms

Preparation Time: 7 minutes • Cooking Time: 8 minutes
Serves: 4 • Average cost per serving: $3.21

1 tablespoon olive oil, divided
6 ounces white button mushrooms, quartered or halved
1 packet dry citrus marinade
3/4 cup frozen white sweet corn kernels, thawed
1/2 cup red onion, diced, run under cold water
1/2 cup red bell pepper, diced
1/4 cup cilantro leaves, minced
2 tablespoons lime juice, freshly squeezed
1/2 teaspoon kosher salt
4 salmon filets (about 5 ounces each)
1/4 cup water

Heat a large sauté pan over medium high heat. Add 2 teaspoons oil and swirl to coat bottom of pan. Add mushrooms and sauté 2 minutes. Add 1 tablespoon of dry citrus marinade mix to the mushrooms and continue cooking another 3 minutes. Remove mushrooms from the pan and place in a large mixing bowl. Add the corn, onion, red pepper, cilantro, lime juice and salt to the cooked mushrooms and toss to combine. In same sauté pan, add remaining teaspoon of oil and swirl to coat pan.

Sprinkle the top of each salmon filet with 1 teaspoon dry citrus marinade mix. Add salmon, seasoned side down, to hot pan and sear 1 minute. Flip over and add water to the pan. Cover and cook another 2 minutes, or until done to taste preferences. Remove from the heat and uncover.
Place a spoonful of the mushroom salsa on each serving plate, top with a salmon filet. Garnish with a sprig of cilantro and a lime wedge.

Photo and recipe courtesy of the Mushroom Council and mushroominfo.com

Figure 18. Baja Salmon with Mushrooms Recipe Card

Mushroom and Egg Wrap

Preparation Time: 3 minutes • Cooking Time: 2 minutes
Serves: 1 • Average cost per serving: $1.25

1/4 cup potato, pepper and onion blend, diced, frozen
Pinch of kosher salt
1/2 cup white button mushrooms, sliced
1 egg, beaten
2 tablespoons (1/2 ounce) reduced fat cheddar cheese, shredded
1/2 teaspoon black pepper, freshly ground (to taste)
1 8–inch flour tortilla
2 tablespoons prepared salsa

Place potato, pepper, and onion blend in a 2–cup microwaveable measuring cup, loosely cover and microwave on high for 1 minute, stirring once and adding a pinch of salt at the 30 second mark.
Add mushrooms and microwave on high for another minute, stirring at the 30 second mark. Drain off excess liquid before stirring in the egg, then cover and microwave on high for 30 seconds. Remove from microwave and stir in cheese and pepper.
Spoon mixture into a warmed wrap and add salsa on top. Fold the botton of the wrap over the eggs, and then roll the remaining sides around.

Wrap in waxed paper and refrigerate until ready to eat. When ready to serve, place wrap in microwave on high for 45–60 seconds, just until heated through. Grab it and go! Individually, these wraps will hold in the refrigerator up to 3 days.

Photo and recipe courtesy of the Mushroom Council and mushroominfo.com

Figure 19. Mushroom and Egg Wrap Recipe Card

Grilled Portabella Caps Stuffed with Herb Cheese

Preparation Time: 2 minutes • Cooking Time: 13 minutes
Serves: 4 • Average cost per serving: $3.00

4 Portabella mushrooms, stems removed
1 tablespoon olive oil
2 Roma tomatoes, diced
1 cup baby spinach, rough chopped
1/2 cup spreadable reduced fat herb cheese
1/3 cup buttery crackers, lightly crushed

Heat grill to 400°. Brush both sides of mushrooms with oil. Mix tomatoes and spinach with herb cheese. Spread the gill side of each mushroom with 2 tablespoons of herb cheese mixture. Sprinkle with buttery cracker crumbs.
Place mushrooms, gill side up, on grill. Close cover and cook 13 minutes. For a more quiche-like consistency, cook 2 minutes more.

Photo and recipe courtesy of the Mushroom Council and mushroominfo.com

Figure 20. Grilled Portabella Recipe Card

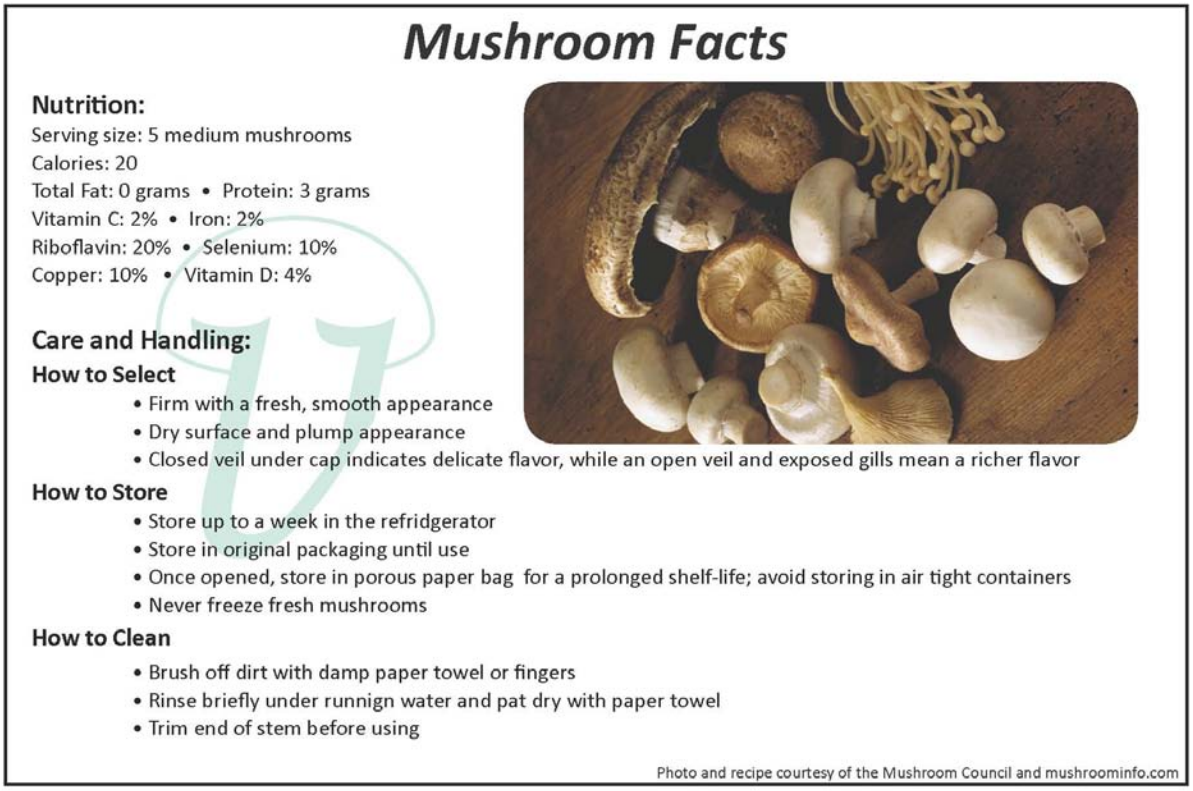


Figure 21. Mushroom Fact Card

Communications Budget

The communications budget for Recipe/Fact cards is listed below. Obtaining prices from two printing companies enables one to see what the market price is. While the quantity and the size of the cards does not change, the option of color and how many sides to print on is adjusted.

Communication Material Costs Recipe/Fact Cards	
Overnightprint.com	
5000 4x6 (Single Sided)	$ 299.95
5001 4x6 (Double Sided)	$ 324.95
Gotprint.com	
5000 4x6 (Single Sided)	$ 94.55
5001 4x6 (Double Sided, B&W)	$ 105.99
5002 4x6 (Double Sided, Color)	$ 112.99
Maximum Projected Costs	**$ 324.95**
Minimum Projected Costs	**$ 94.55**

Table 5. Communication Materials Costs.

The table above indicates that the range is from $94.55 to $324.95. These costs are fairly broad for this low of quantity and price.

Proposed Business Plan/Financial Analysis

BUSINESS MATERIALS

Executive Summary

- Please not that ordinarily, a Business Plan is a stand alone document; however, due to this report having other criteria, some of the sections that are found in the Business Plan are found in other areas of this report.

J-M Farms is located in Miami, Oklahoma with an emphasis on white and brown mushrooms. J-M is a regional leader as the main competition comes from Texas. However, with this lack of local competition, J-M still need to be cognizant of the other completion as losing a few key buyers such as Wal-Mart could be very detrimental. To help in maintaining J-M's current sales positions, several things can be done to offer a lower priced product with a better quality

Their production and growing processes are central to the main growing facility with most of mushrooms being harvested at satellite farms. This setup, while it produces a quality product, contributes to higher production costs for J-M due to the transportation costs and moving costs of the products. It should also be noted that J-M has a relatively narrow product line compared to the major market players as their main products are general white and brown mushrooms with very few portabella and shitake mushrooms grown. A continual look at the product process flow is imperative to maintain an efficient product line and to minimize costs.

At present time, the main buyer of product from J-M Farms is Wal-Mart. Because of this, J-M must adhere to certain packaging and sustainability standards. Meeting sustainability standards is a priority especially since Wal-Mart has developed a sustainability index.

Industry Analysis

- Please see the industry analysis earlier in this report.

Competitive Analysis

- The main competition that J-M faces is from regional leaders in Pennsylvania and California. In California, the major competitor is Monterey Mushrooms. Monterey's distribution includes most of the United States going from California to Texas to cover the western half of the United States and a distribution centralized in Pennsylvania for the northeast part of the United States. Pennsylvania has the heaviest concentration of mushroom farms among the states. Creekside Mushrooms and Phillips Mushrooms are the two largest farms and offer a wide range of product. It is imperative that J-M maintains lower prices and higher quality than its competitors to maintain their current sales and obtain future sales.
- Please see the competitive analysis earlier in this report for details on specific competitors.

S.W.O.T Analysis

- Strengths— The strengths of J-M are the quality offered and traceability of product for safety. J-M takes pride in the quality of product that it delivers and this is a major reason why it continues its good relations with its buyers. It also has very good traceability standards as it has sent requested information 12 minutes after it has been requested that contains the all the information about the product in question.
- Weaknesses—The main weakness of J-M farms is the inefficiency of the product line. At present time, the product can be moved an estimated eight times before it is shipped. This decreases the shelf life of the product and also increases costs for J-M
- Opportunities—The opportunities for J-M include the adaptation of new technology to lower costs in the production line and also a switch to new packaging that would improve the sustainability of J-M but would also be a selling point to potential buyers
- Threats—The major threat for J-M is the possibility of losing a major buyer to a competitor. This would severely cut J-M's profits

Marketing/Communications Analysis

- Please see the Communications Analysis for this portion.

Generation of Design Concepts

FEASIBILITY EVALUATION AND DETERMINATION OF POSSIBLE SUITABLE DESIGNS

Ergonomic/Industrial Ideas

- Crop Production Measurement, CPM, Weighing Station at Satellite Farms
  - Description
    - This design idea involves implementing a CPM weighing station at some or all of J-M's satellite farms. The mushrooms will be weighed at each satellite farm once they are picked. This will eliminate all but one CPM station at the main facility.
  - Advantages
    - The major advantage to this implementation is that it will free up space at the main facility that could be used for other processes. By taking away the weighing stations at the main farm, the available space in the packing room will increase. This will allow the company to easier implement some changes on the packaging floor if deemed necessary.
    - The pickers will have a deepened relationship with management. The growers at the satellite farms are able to maintain closer relationships with the pickers than at the main facility. If a single QA team was assigned to each farm, the satellite growers will be able to maintain a similar type of relationship.
  - Disadvantages
    - Initial cost and capital investment required to put the new equipment in the satellite farms is the major disadvantage.
    - A potential, but not certain, disadvantage is space. Bella Corp does not know if each satellite farm has the current space requirements required for the equipment.
  - Feasibility
    - The feasibility of this idea is high. J-M Farms has contemplated this idea in the past, but never had the opportunity to do it. This idea has the easiest implementation of all ergonomics ideas listed.
- CPM Station and Packing Line at Satellite Farms
  - Description
    - This requires the implementation of a CPM weighing station and mushroom packaging line at some or all of J-M's satellite farms. Here, the mushrooms picked at the satellite farms are weighed and packaged on site. The mushrooms will be ready for shipment when leaving the satellites. This will eliminate all but one CPM station at the main facility, and decrease the volume of packaging at the main facility.
  - Advantages
    - The mushrooms will be ready for shipment at the satellite farms.
    - The work load will decrease for those at the main facility.
    - The amount of available space on the main packaging room floor will increase. This extra space will allow the main facility to focus primarily on sliced mushrooms. This is beneficial because there is

a substantial amount of loss associated with the process of slicing mushrooms.
    - The satellite farms could be used to test the feasibility of a new streamlined process.
  - Disadvantages
    - Initial cost and capital investment required to put the new equipment in the satellite farms is the major disadvantage.
    - The next disadvantage is space. Ten percent of the current space at the satellite farms will be consumed with a CPM weighing station and packaging line. This decreases the space available for mushroom growth, and may not be feasible.
  - Feasibility
    - Feasibility for this alternative is lower than the feasibility of a CPM weighing station at the satellite farms, since it will require an additional amount of extra floor space, but that doesn't mean that it is infeasible. This idea has been previously mentioned by administrators of J-M Farms.
- Redesign/Alter Packing Floor at Main Facility
  - Description
    - This design concept involves streamlining the packaging process at the main facility. This will be done by altering the layout of the packing room floor.
  - Advantages
    - This eliminates redundant and unnecessary processes resulting in increased efficiency.
    - This could also minimize mushroom loss in the system.
  - Disadvantages
    - This implementation will disrupt the repetition cycles of the current workers at the main facility. It requires the workers to adjust to the new set up. It may take several weeks for these people to adjust to the changes.
    - Depending on the changes implemented, a shut down day may be required to get all the equipment moved and set up in the correct location.
  - Feasibility
    - This is feasible for J-M Farms. Moving all of the equipment to the proper location will require the most work and the most inconvenience for J-M Farms, but these changes can be implemented with a night crew, without requiring the company to stall production.
    - One worker in the packaging process at J-M Farms mentioned to Bella Corp that the J-M administration has alluded to streamlining/redesigning the process for several years.
- Redesign/Alter Slicing Line at Main Facility
  - Description

    - This design concept involves streamlining the slicing line to a packaging line at the main facility. This requires altering the layout of the packing room floor. This may involve a machine design component, if necessary, to catch mushrooms that are currently being dropped, since there are substantial losses associated with the slicing line.
  - Advantages
    - Streamlining the mushroom slicing line to the packaging line will increase the efficiency by eliminating some unnecessary steps in the current process.
    - Mitigating dropped mushrooms associated with the slicing line will significantly increase the total product going to stores.
  - Disadvantages
    - This implementation will disrupt the repetition cycles of the current workers at the main facility. It requires that the workers to adjust to the new set up. It may take several weeks for people to adjust to the changes.
    - Depending on the changes implemented, a shut down day may be required to get all the equipment moved and set up in the correct location.
  - Feasibility
    - This idea is feasible. Moving all of the equipment to the proper location will require the most work and the most inconvenience for J-M Farms, but these changes can be implemented with a night crew, without requiring the company to stall production.
    - The slicing line is not always running at the same times as the packaging line. The slicing line could easily be moved or altered while production continued.
- Temperature/Time Studies of Entire Operation
  - Description
    - This study will determine where the mushrooms see the highest temperatures, and sit for the longest periods of time. This study could also reveal the length of time it takes for a mushroom to go through the entire system, from picking to shipment. Focus would be given to Mondays and Fridays, and late in the evening when worker productivity is expected to be at its lowest.
  - Advantages
    - Weaknesses in the system would discovered for future improvements.
  - Disadvantages
    - None
  - Feasibility
    - This option is not feasible for the team, since J-M has encouraged Bella Corp to pursue another area to improve the harvesting efficiency.

Machine Design Ideas

- Picker Cart with Scales
    - Description
        - This design will focus on altering the current picker cart, to one that has scales, where the pickers are able to pick mushrooms based on weight and not volume.
    - Advantages
        - This will allow the pickers to pick mushrooms by weight and not volume.
        - According to JM Farms, handling is the most significant cause of mushroom bruising, which is the limiting factor in the shelf life of the product. Any decreased handling will prolong the product shelf life when it reaches the produce shelves.
        - This will likely eliminate the QA lines in the packaging line. With this alternative, the tills will already have the appropriate weight of mushrooms when shipped to the main facility. Once arriving, these mushrooms will get weighed for CPM data, and will go directly to the packaging process.
    - Disadvantages
        - The carts will be exposed to high levels of dirt and grime in the picking rooms. The electronic and mechanical components of the scales will have to be able to handle this harsh environment.
        - Since the carts get washed and sanitized every day, the components will have to be removed prior to washing, or able to withstand getting wet.
        - By adding scales to the cart, the size will likely have to be increased. Increased size of the cart will restrict the flexibility of movement and speed of transportation in the picking rooms and around the satellite farms.
        - If a new cart is designed, all of the old carts will not be useful. A new cart design will require a large capital investment for J-M Farms. One hundred (100) carts will have to be fabricated, since this is roughly the number of pickers working for the company.
        - This new cart requires more work out of the pickers, so they will have to be paid more.
        - Implementing a new cart could require the design of a new plastic container for shipment around the facility. This will require a substantial capital investment, while still renting the RPCs for shipment to and from their current market.
        - J-M Farms will have to produce and manufacture a new cart in house. Producing large numbers of these carts will require a large time input, and will be inconvenient.
    - Feasibility
        - The team has observed that the current cart used at J-M Farms works great. A new cart design may or may not be as satisfactory as their current design. Of the cart designs, this is the most likely to

be successful because of the overwhelming disadvantages with a cart that weighs and packages mushrooms.

- Weighing/Packaging Cart (using tills with plastic wrap)
  - Description
    - This design focuses on altering the current picker cart, to one that has scales and a packaging line that wraps the tills in plastic. This design will provide the company with 'field packaged' produce.
  - Advantages
    - Once the mushrooms come out of the picking room, they will be completely ready for shipment.
    - The shelf life of the mushrooms will increase because of decreased handling.
    - The produce can be marketed as 'One-Touch' products.
    - This will eliminate the entire CPM station, packaging line, and QA line at the main facility.
    - Labor costs will decrease at the main facility, because employees needed to run the eliminated processes will no longer be needed.
  - Disadvantages
    - The carts will be exposed to high levels of dirt and grime in the picking rooms. The electronic and mechanical components of the scales will have to be able to handle this harsh environment.
    - Since the carts get washed and sanitized every day, the components will have to be removed prior to washing, or able to withstand getting wet.
    - By adding scales and a packaging process to the cart, the size will have to be increased. Increased size of the cart will substantially restrict the flexibility of movement and speed of transportation in the picking rooms and around the satellite farms.
    - If a new cart is designed, the old carts will no longer be useful. This cart design will require the heaviest capital investment for J-M Farms. One hundred (100) carts will have to be fabricated, since this is roughly the number of pickers working for the company.
    - Of the three cart options, this requires the most work out of the pickers. This option increases their work load substantially. The satellite farms will probably have to make a few manual labor additions to cover the increased work load of the pickers.
    - Implementing a new cart may require the design of a new plastic container for shipment around the facility. This requires a substantial capital investment, while still renting the RPCs for shipment to and from their current market.
  - Feasibility
    - The team has observed that the current cart used at J-M Farms works great. A new cart design may or may not be as satisfactory as the current design. Of the cart designs, this is the least likely to be successful because of the overwhelming disadvantages with a cart that weighs and packages mushrooms.

- Weighing/Packaging Cart (using tills with snap on lids)
  - Description
    - This design focuses on altering the current picker cart, to one that has scales and a packaging line, but instead of wrapping the tills in plastic, the tills have a snap on lid. This design will provide the company with ‘field packaged’ produce.
  - Advantages
    - Once the mushrooms come out of the picking room, they are completely ready for shipment.
    - The shelf life of the mushrooms will increase because of less handling.
    - The produce can be marketed as ‘One-Touch’ products.
    - This will eliminate the entire CPM station, packaging line, and QA line at the main facility.
    - Labor costs will decrease at the main facility, because employees needed to run the eliminated processes will no longer be needed.
  - Disadvantages
    - The carts will be exposed to high levels of dirt and grime in the picking rooms. The electronic and mechanical components of the scales will have to be able to handle this harsh environment.
    - Since the carts get washed and sanitized every day, the components will have to be removed prior to washing, or able to withstand getting wet.
    - By adding scales and a packaging process to the cart, the size will be increased. This significant size increase of the cart will substantially restrict the flexibility of movement and speed of transportation in the picking rooms and around the satellite farms.
    - If a new cart is designed, the old cart no longer be useful. A new cart design will require a large capital investment for J-M Farms. The cost of this cart will be between the other two mentioned. One hundred (100) carts will have to be fabricated, since this is roughly the number of pickers working for the company.
    - This new cart requires more work out of the pickers, so they will have to be paid more. The satellite farms would probably have to make a few manual labor additions to cover the increased work load of the pickers.
    - Implementing a new cart may require the design of a new plastic container for shipment around the facility. This will require a substantial capital investment, while still renting the RPCs for shipment to and from their current market.
  - Feasibility
    - The team has observed that the current cart used at J-M Farms works great. A new cart design may or may not be as satisfactory as their current design. This is less likely to be successful than a cart that just weighs the tills because of the added disadvantages with the packaging side.

        - One way to make this idea more feasible is to require the pickers to put the lids on the tills, but this added responsibility will decrease their speed at picking mushrooms.

Radical Ideas

- Team Pay Groups
    - The current payment system pays the picker by the pound and the packing line workers at an hourly rate. In this system, the picker is paid for the mushroom he has picked, even if some of them get dropped or spilled before packaging. Instead of approaching it as "you do your job, I do mine," the workers could be reorganized into team pay groups. The team would get paid based on what goes onto the truck, ready to ship out. This would increase motivation to decrease waste and would foster teamwork among the members across the different steps in the harvesting process.
- Sell Mushrooms by Count, Not Weight
    - Mushroom packages sold in stores today must meet a certain minimum weight. This unfortunately leads to unsold product, as the customer doesn't pay for whatever excess weight is in the container. Meat, on the other hand, has a variable price determined by what the weight is. This allows for a larger range of acceptable values, while assuring that the entire product is being paid for.
    - This concept could be applied to mushrooms. For example, mushrooms could be packaged by count, not by weight. The till could be weighed once, yielding a sticker to show what weight the box is. If a store still insists mushrooms be sold by weight, the weight will be available, but the process of packing will be simplified. Currently, each till must be weighed three times to assure it meets minimum weight. Placing a certain number of mushrooms inside a till will be easy for the picker to do without any fancy equipment.

IMPLEMENTATION OF DESIGN

Introduction

In December of 2009, Bella Corp presented design ideas to J-M Farms, the client company. J-M Farms decided not to pursue the industrial engineering portion of solutions the team presented. The client decided they would prefer to have a way to pick mushrooms by weight, and not volume. The design presented below is only proof of concept, because of the price associated with wash-down safe scales. These scales can cost over $1500 per unit, and in the scope of this class is not feasible.

Figure 22. Cart as Fabricated w/ scales. Figure 23. Cart w/ Scales, Boxes.

Material

J-M Farm's existing cart is made of galvanized steel. As these scales are washed down every day, they are normally in the presence of water, which presents a metallurgical challenge. The current carts are replaced once every three months. Because of this issue, it was decided to make the new cart out of steel and have it powder coated. This should address the corrosion associated with the current method at J-M Farms.

Cart Frame

The team decided to design a new cart very similar to J-M Farms' existing one. J-M Farms' existing cart has five levels that can hold trays, RPCs, or other boxes of mushrooms. Bella Corp's design also has five levels. Two of these levels will hold scales. The bottom level holds a scale large enough to hold one five or ten pound box of mushrooms. An indicator is mounted in front of the scale, so the picker can easily see it. A second scale is located one level from the top. This scale has a platform large enough to properly hold an RPC. This scale has an indicator mounted in front of it. The scale has check weighing capacity to allow the picker to fill one till at a time, tare the scale, and fill another till.

Scales

Two scales were selected for this design in order to allow the picker to simultaneously pick tills and bulk mushrooms by weight. Since this design is only a proof of concept, a list of other applicable scales and indicators can be viewed in the appendix material. The first scale is an Adam Equipment CPWplus200 Platform Scale. The platform size is 12" by 12", appropriate for weighing the bulk boxes of mushrooms. The second model is an Acculab SVI-100E with a platform size of 20.5" by 15". This scale will be used to weigh individual tills that are in the RPC.

Figure 24. Adam Equipment, CPWplus200 Platform Scale

Figure 25. Acculab SVI-100E Platform Scale.

Casters/Wheels
The newly designed cart weighs significantly more than the cart currently being used by J-M Farms. The extra weight will require larger casters in order to roll smoothly. This new design has increased the size of the casters from two to five inches.

Bill of Material
The Bill of Material is listed below in Table 6. Please refer to page 51 for the costs of the materials. For drawings of each part and sub assembly, please see the drawings in the appendix.

Sub Assembly		Part	Qty
1.	Bottom Scale Frame	11" Angled Steel	4
2.	Top Scale Frame	19.375" Angled Steel	2
2.	Top Scale Frame	14.75" Angled Steel	2
3.	Bottom Indicator Mount	28" Angled Steel	1
3.	Bottom Indicator Mount	6" Square Tubing	2
4.	Top Shelf	27.75" Angled Steel	2
4.	Top Shelf	16.5" Angled Steel	2
5.	Cart Base	28" Square Tubing	2
5.	Cart Base	28" Angled Steel	2
5.	Cart Base	26" Square Tubing	4
6.	Cart Frame	76" Square Tubing	2
6.	Cart Frame	72" Square Tubing	2
6.	Cart Frame	14" Square Tubing	8
6.	Cart Frame	26" Square Tubing	3
6.	Cart Frame	26" Angled Steel	4
NOTE: All Square Tubing 1" x 1"			
NOTE: All Angled Steel Right Angle 1" x 1" x 0.125"			
TOTAL SQUARE TUBING - 658"			
TOTAL ANGLED STEEL - 388.75"			

Table 6. Bill of Material

IMPACTS OF PROPOSED DESIGN SOLUTIONS

Societal

- A successful design of a new cart that allows pickers to harvest mushrooms by weight will increase the number of workers needed at the satellite farms, so jobs will be created. Adversely, some jobs involved with latter parts of the mushroom packaging process may be eliminated, depending on the effectiveness of the proposed design. It is possible that the eliminated jobs will transfer to the satellite farms.

Environmental

- The design of a new cart may encourage J-M Farms to use snap on plastic lids instead of plastic wrap. These lids have a higher recyclable rating than the current plastic. Here, the entire mushroom package will be 100% recyclable.

Global

- No global impacts could be determined.

TESTING RESULTS, DISCUSSION, CONCLUSIONS AND RECOMMEDATIONS

Testing of Prototype

Testing of the prototype is unable to be completed because the scales in this design are not of food-grade. The scales are intended as a proof-of-concept, and while they can measure the weights of mushroom packages, they would not survive long in the conditions of the mushroom farm.

Additionally, the cart with only scales added provides little true benefit because it has no way to communicate with the central computer system at J-M to report data obtained. A wireless link and/or a printer system would need to be added to the cart to make it fully functional.

Scale Options and Research

The equipment displayed on our current design is not entirely applicable for J-M Farms, because it is not wash-down capable. Figures 13 and 14 show an applicable indicator, along with some applicable scales. The indicator is a GSE 250 X, IP69K for High Temp, high pressure wash-down, food-grade, high impact plastic enclosure, and has a built-in check weighing functionality. The platforms are made by Avery Weigh-Tronix, model 3700 LP. The applicable sizes are 14” x 14” and 18” x 18”. These platforms are stainless steel and compatible with a variety of indicators. The indicator and platforms can be purchased through most scale companies throughout the country.

Figure 26. GSE 250-X Indicator.

Figure 27. Avery Weigh LP Bench Bases.

In order for this new system to eliminate the CPM stations at J-M Farms, some form of data logging will need to take place. Scales with the ability to log and record data are termed 'smart' scales. The GSE Indicator shown above does not have the ability to log and record data. Bella Corp recommends J-M Farms incorporate smart scales into their new harvesting system along with a remote printing location. Printers compatible with scales have the ability to print several lines of data and also can print bar codes. A smart scale can be used by the pickers to record their harvesting data, and then the data can be printed at a site located somewhere in the production facility. This will eliminate the CPM Stations and the need for check weighing later in the packaging process.

Bella Corp engineers have compiled a range of applicable scales for J-M Farms. These scales and their manufacturers are listed below in Table 7.

Company	**Model**	**Phone Number**	**Price**
A&D Weighing	HV-WP	(408)-263-5333	N/A
A&D Weighing	HW-WP Series	(408)-263-5333	N/A
Alliance Scale	Defender 7000 Xtreme, Item # D71XW10WR3	(800)-343-6803	$1,467
Alliance Scale	Defender 5000 Xtreme, Item #D51XW10WR3	(800)-343-6803	$1,229
Cardinal	EB-15 / EB-30 Stainless Steel Bench Scales	(800) 441-4237	$765-$940
Cardinal	Nautilus	(800) 441-4237	$2,361
Cardinal	EB-60 / EB-150 Stainless Steel Bench Scales	(800) 441-4237	-
Cardinal	Admiral Series Stainless Steel Bench Scales	(800) 441-4237	$1,190
Central Carolina	Doran 7400	(919) 776-7737	N/A
Central Carolina	Doran 8000XL Washdown Safe SS Bench Scale	(919) 776-7737	N/A
Central Carolina	Cardinal Nautilus Series	(919) 776-7737	N/A
Central Carolina	Cardinal EB 15 & EB 30 Bench Scales	(919) 776-7737	N/A
Central Carolina	Ohaus Champ CQ11 SQ Washdown Indus. Bench Scale	(919) 776-7737	N/A
Central Carolina	GSE 460 Digital Readout w/ GSE X-Frame Bench Scale	(919) 776-7737	N/A
Central Carolina	SURVIVOR® CW-80 Over/Under Checkweigher	(919) 776-7737	N/A
Central Carolina	UWE Model PS Stainless Steel Washdown Bench Scale	(919) 776-7737	N/A
Emery Winslow	Bench Scale Model 437	(800)-891-3952	$2,495
Fairbanks	NexWeigh Bench Scales	(214)-428-8181	$1,395
Gainco	GS-9700	(770)534-0703	$1,595
GSE	250-X	(507) 238-4461	$750
InterWeigh Sys.	FS-I Checkweigher (10x10)	(800) 268-3269	$980
InterWeigh Sys.	The Ultimate Checkweigher	(800) 268-3269	$1,227
M&D Controls	Enviro Scale 12x12 - 50#	(918)-664-7511	$2,295.00
M&D Controls	Enviro Scale 12x12 - 30#	(918)-664-7511	$2,295.00
M&D Controls	Enviro Scale 10x10 - 25#	(918)-664-7511	$1,995.00
Ohaus	Defender™ 5000XW - D51XW10WR3	(800)-672-7722	$1,397
Ohaus	Defender™ 7000XW - D71XW10WR3	(800)-672-7722	$1,541
RiceLakes	CW-90X	(214)-428-8181	$1,595

Table 7. Applicable Scales

Conclusions and Recommendations

An attractive alternative to using scales would be to design a load cell system. Load cells can be completely customized to fit the demands of the job, and are much cheaper to implement than food-grade industrial scales. They are also much smaller and lighter than bulky scales. The primary downside to load cells is the initial effort in developing the system, since they do not come ready to go “out-of-the-box.”

A load cell system could be built into the existing cart frames, since they don’t take up much space. This system would be implemented at one of the satellite farms to test its efficiency and to gauge the workers’ responses. If deemed successful, the system could be mimicked at the other satellite farms, as well.

Project Schedule

GANTT CHART

Below is Bella Corp's project schedule using a Gantt Chart.

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Communications**	**108 days?**	**Fri 11/6/09**	**Mon 4/5/10**	
2	**Web Site**	**22 days?**	**Fri 11/6/09**	**Fri 12/4/09**	
3	Pictures of Team	1 day	Fri 11/6/09	Fri 11/6/09	
4	Conceptual Drawing	13 days?	Fri 11/6/09	Mon 11/23/09	
5	Build Index Page	4 days?	Thu 11/19/09	Mon 11/23/09	
6	Build Team Page	6 days?	Mon 11/23/09	Mon 11/30/09	
7	Build J-M Page	5 days?	Mon 11/30/09	Fri 12/4/09	
8	**Reports**	**14 days?**	**Wed 11/18/09**	**Fri 12/4/09**	
9	**Drafts**	**11 days?**	**Wed 11/18/09**	**Tue 12/1/09**	
10	Receive Materials	1 day?	Wed 11/18/09	Wed 11/18/09	
11	Receive Updated/Corrected Materi	10 days?	Thu 11/19/09	Tue 12/1/09	10
12	**Editing**	**11 days?**	**Sun 11/22/09**	**Fri 12/4/09**	
13	First Draft	1 day?	Sun 11/22/09	Sun 11/22/09	
14	Final Draft	10 days?	Mon 11/23/09	Fri 12/4/09	13
15	**Materials**	**58 days?**	**Thu 11/19/09**	**Fri 2/5/10**	
16	Recipe Cards	1 day?	Thu 11/19/09	Thu 11/19/09	
17	Informational Cards	1 day?	Thu 11/19/09	Thu 11/19/09	
18	**Displays**	**20 days?**	**Mon 1/11/10**	**Fri 2/5/10**	
19	Holders	10 days?	Mon 1/11/10	Fri 1/22/10	
20	Stands	1 day?	Fri 2/5/10	Fri 2/5/10	19
21	Buyer Web Page	1 day?	Thu 11/19/09	Thu 11/19/09	
22	**Media**	**36 days?**	**Mon 2/15/10**	**Mon 4/5/10**	
23	Videos	36 days?	Mon 2/15/10	Mon 4/5/10	
24	Photos of Project	36 days?	Mon 2/15/10	Mon 4/5/10	
25	**Engineering**	**117 days?**	**Fri 10/30/09**	**Fri 4/9/10**	
26	**Design Concepts**	**18 days?**	**Fri 10/30/09**	**Mon 11/23/09**	
27	**Existing Documents**	**1 day?**	**Fri 10/30/09**	**Fri 10/30/09**	
28	Journal Article Search	1 day?	Fri 10/30/09	Fri 10/30/09	
29	Patent Search	1 day?	Fri 10/30/09	Fri 10/30/09	
30	Full Evaluation of Current System	1 day?	Fri 10/30/09	Fri 10/30/09	
31	Develop List of Pros/Cons for Each Cor	18 days?	Fri 10/30/09	Mon 11/23/09	
32	Conceptual Drawings/Sketches	18 days?	Fri 10/30/09	Mon 11/23/09	
33	**Develop Alternatives**	**13 days?**	**Thu 11/19/09**	**Fri 12/4/09**	
34	List of Alternatives	1 day?	Thu 11/19/09	Thu 11/19/09	
35	Select Project based on Input from J-M	2 days?	Thu 12/3/09	Fri 12/4/09	
36	**Project Planning (Fall)**	**57 days?**	**Fri 10/30/09**	**Fri 1/15/10**	
37	Work Breakdown Structure	6 days?	Fri 10/30/09	Fri 11/6/09	
38	Task List	1 day?	Fri 11/13/09	Fri 11/13/09	37
39	**Gantt Chart**	**40 days?**	**Mon 11/23/09**	**Fri 1/15/10**	**38**
40	First Draft	5 days?	Mon 11/23/09	Fri 11/27/09	
41	Final Draft	5 days?	Mon 1/11/10	Fri 1/15/10	40
42	**Project Design (Spring)**	**65 days?**	**Mon 1/11/10**	**Fri 4/9/10**	
43	**Scale Selection**	**11 days?**	**Mon 1/11/10**	**Mon 1/25/10**	
44	Define List of Scales	8 days?	Mon 1/11/10	Wed 1/20/10	
45	Pick Top Two Scales & Place Ord	4 days?	Wed 1/20/10	Mon 1/25/10	
46	**Idea Selection**	**26 days?**	**Mon 1/11/10**	**Mon 2/15/10**	
47	Define List of Ideas	16 days?	Mon 1/11/10	Mon 2/1/10	
48	Pick Top Idea	11 days?	Mon 2/1/10	Mon 2/15/10	

Page 1

Figure 28.

Project Schedule, Page 1

ID		Task Name	Duration	Start	Finish	Predecessors
49		**Build Prototype**	**40 days?**	**Mon 2/15/10**	**Fri 4/9/10**	
50		Draw SolidWorks Model	8 days?	Mon 2/15/10	Wed 2/24/10	
51		Send Designs to BAE Lab	9 days?	Wed 2/24/10	Mon 3/8/10	
52		Manufacture	8 days?	Thu 3/11/10	Mon 3/22/10	
53		Powdercoat and Fitting of Scales	8 days?	Wed 3/31/10	Fri 4/9/10	
54		**Economics**	**77 days?**	**Fri 10/30/09**	**Fri 2/12/10**	
55		**Market Research**	**22 days?**	**Fri 10/30/09**	**Fri 11/27/09**	
56		Industry Analysis	7 days?	Fri 10/30/09	Fri 11/27/09	
57		Consumer Research	1 day?	Fri 10/30/09	Fri 10/30/09	
58		**J-M's Capabilities**	**18 days?**	**Fri 10/30/09**	**Mon 11/23/09**	
59		Management	1 day?	Fri 10/30/09	Fri 10/30/09	
60		Products	1 day?	Mon 11/23/09	Mon 11/23/09	
61		**Competitive Analysis**	**18 days?**	**Fri 10/30/09**	**Mon 11/23/09**	
62		**Internal Competition**	**1 day?**	**Mon 11/23/09**	**Mon 11/23/09**	
63		Picking Competition	1 day?	Mon 11/23/09	Mon 11/23/09	
64		Packing Line Competition	1 day?	Mon 11/23/09	Mon 11/23/09	
65		**External Competition**	**1 day?**	**Fri 10/30/09**	**Fri 10/30/09**	
66		Regional Competition	1 day?	Fri 10/30/09	Fri 10/30/09	
67		National Competition	1 day?	Fri 10/30/09	Fri 10/30/09	
68		**Cost Breakdown**	**57 days?**	**Fri 10/30/09**	**Fri 1/15/10**	
69		Activity Based Costing for Entire Proces	1 day?	Mon 11/23/09	Mon 11/23/09	
70		Overall Flow of System/Process Flow C	1 day?	Fri 10/30/09	Fri 10/30/09	
71		Identify Costly Processes that Need to I	1 day?	Fri 12/4/09	Fri 12/4/09	
72		Cost Saving from Proposed Redesign c	1 day?	Fri 1/15/10	Fri 1/15/10	
73		Proposed Budget for Prototype of Chart	1 day?	Fri 1/15/10	Fri 1/15/10	
74		Business Plan	1 day?	Fri 2/12/10	Fri 2/12/10	

Figure 29. Project Schedule, Page 2

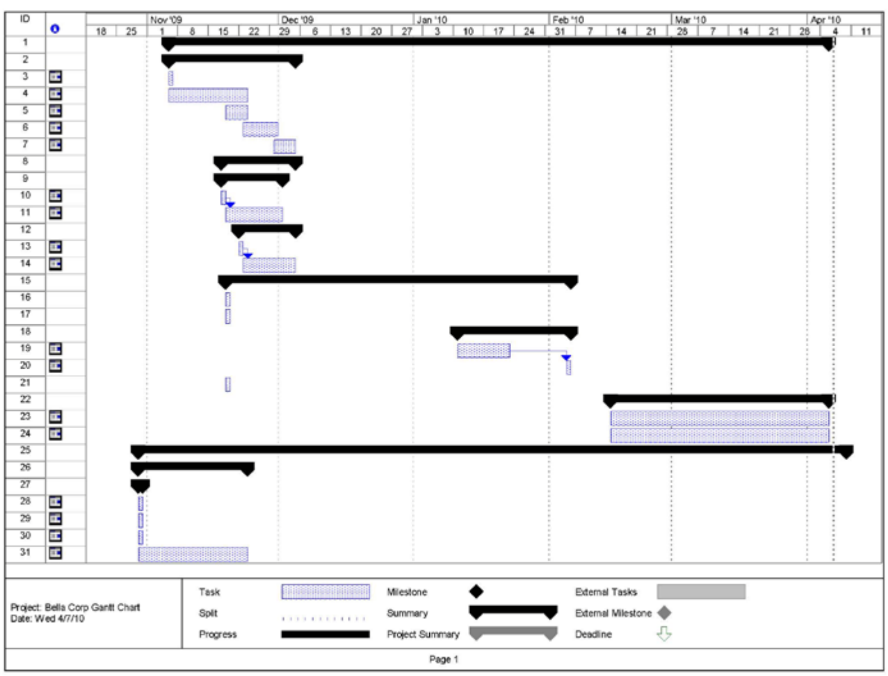


Figure 30. Gantt Chart, Page 1

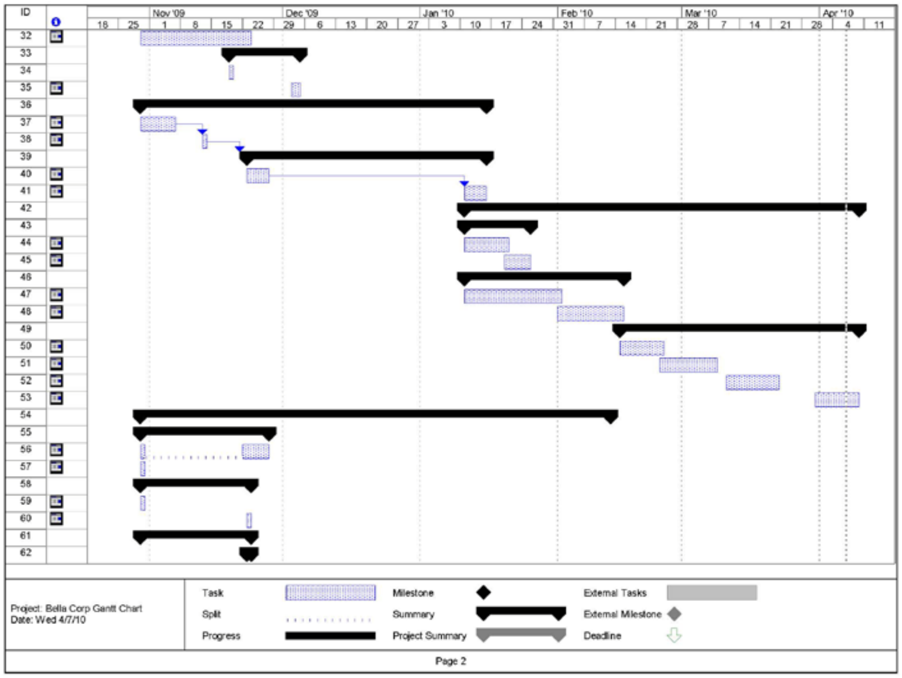


Figure 31. Gantt Chart, Page 2

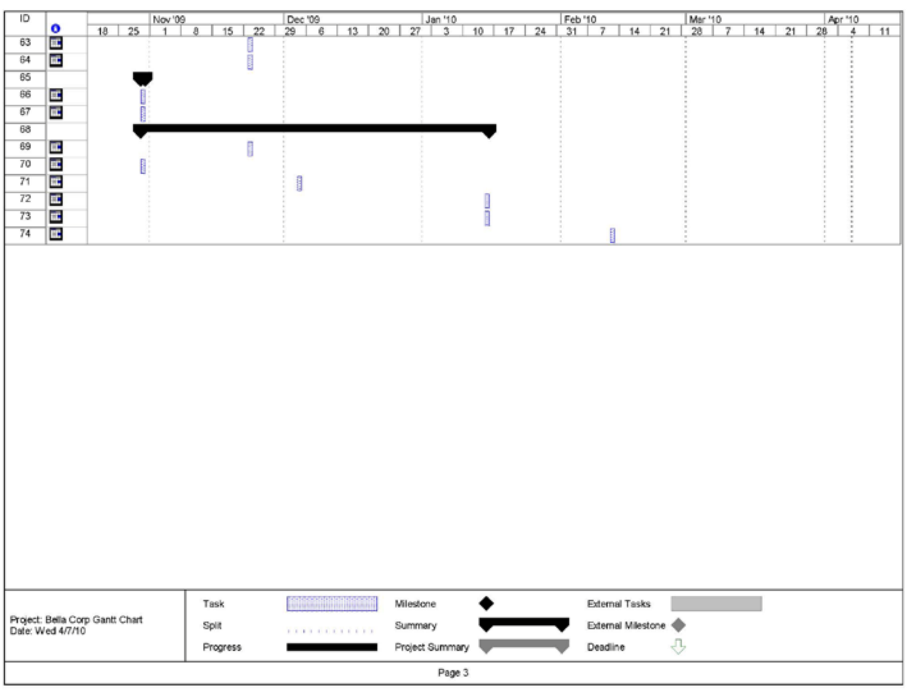


Figure 32. Gantt Chart, Page 3

Proposed Budget for Prototype

Costs of Prototype

The costs listed below are for the prototype that was built. The two scales that are used are not Food-grade and cannot be washed down. The prototype does include the large five inch caster wheels, and it is powder coated.

Prototype Cart Cost		
5 In. Caster Wheels	$	63.96
Angle Iron	$	22.00
Steel Tubing	$	63.36
Acculab Scale	$	312.00
Adam Equip. Scale	$	215.00
Total	**$**	**676.32**

Table 8. Prototype Cart Costs

Projected Costs of Food-grade Cart

Below are the projected costs for the cart if food-grade materials are used with wash-down scales. The prices for these scales are simply the prices for the scales that matched our criteria of being able to be wash-down capable, and have the ability to store data.

Projected Cart Cost for Food Grade Materials		
5 In. Caster Wheels	$	63.96
Angle Iron	$	22.00
Steel Tubing	$	63.36
Load Cell/Scale #1	$	1,200.00
Load Cell/Scale #2	$	2,200.00
Total	**$**	**3,549.32**

Table 9. Projected Cart Cost

It should be noted that while there is a substantial increase from the cost of the prototype to the cost of the food-grade, wash-down capable cart, the capabilities and cost saving potential of the food-grade, wash-down capable cart are greater. The complete set of capabilities for this cart are listed in the engineering section on page 34. The reason for the increase in cost savings is due to the reduction of CPM stations required since the cart will now be able to store data and work as its own CPM station.

Estimated Savings for Prototype Cart

The two graphs shown below are the estimated per pound production costs for a pound of mushrooms for the current production process and the estimated per pound production costs if J-M were to use the proposed cart.

Per Pound Cost for Current Process						
	Process	lbs Picked per day	Price per Pound		Total Amount	Price per pound
1	Picker	80	$1.50		$120.00	$1.50
	Process	# of Trips	Cost Per Trip		Total Amount	
2	Hauling	1	$150.00		$150.00	$0.06
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
3	Unload to Fridge	1	$12.00	0.5	$6.00	$0.0025
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
4	Move to CPM	1	$12.00	0.5	$6.00	$0.0025
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
5	CPM	1	$12.00	1	$12.00	$0.01
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
6	Move to Fridge	1	$12.00	0.5	$6.00	$0.0025
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
7	Move to Packing	1	$12.00	0.5	$6.00	$0.0025
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
8	Packaging	4	$12.00	2	$96.00	$0.04
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
9	Move to Fridge	1	$12.00	0.5	$6.00	$0.0025
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
10	Move to Truck	1	$12.00	0.5	$6.00	$0.0025
					Total	$ 1.62

Figure 10. Cost Per Pound for Current Process.

Projected Per Pound Cost for Proposed Production Process						
	Process	lbs Picked per day	Price per Pound		Total Amount	Price per Pound
1	Picker	75	$1.55		$116.25	$1.55
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
4	Move to CPM	1	$12.00	0.5	$6.00	$0.0025
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
5	CPM	1	$12.00	1	$12.00	$0.01
	Process	# of Employees	Hourly Wage	# Hours	Total Amount	
10	Move to Truck	1	$12.00	0.5	$6.00	$0.0025
					Total:	$1.56

Figure 11. Projected Per Pound Cost for Proposed Production Process

In the table above, it is shown that the savings is $0.06 per pound of mushroom that is produced using the new cart. The processes that were not included were 2,3,6,7,8 and 9. Though the exclusion of these processes total a reduction that is more than the $0.06 per pound, the picker is now getting paid more to compensate for the decrease in productivity due to their increased responsibilities. It should be noted that these are estimated costs and do not include a reduction in overhead costs.

Works Cited

All Business <http://www.allbusiness.com>

Amycel/spawnmate. <http://www.amycel.com/spawnmate.htm>

C P Yeatman & sons. <http://www.organicmushrooms.com/about.html>

Citrus and vegetable. 2009. 15 October 2009. <http://www.citrusandvegetable.com>

Citrus and vegetable. 2009. 20 October 2009. <http://thepacker.com/>

Company profile. <http://www.allbusiness.com/companyprofile/J-M_Farms_Inc/F2AEFBE73033412DBB40834BBF346057-1.html>

Computing scale system. United States Patent # 4,091,449. <http://www.google.com/patents?id=_9QvAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Creekside mushrooms. <http://www.creeksidemushrooms.com/productlist.htm>

Digital electronic scale. United States Patent # 4,153,125. <http://www.google.com/patents?id=UxcvAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Electronic scale printer. United States Patent # 4,700,791. <http://www.google.com/patents?id=8cg5AAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Method and container for the improved packing and cooling of produce. United States

Mushroom and tomato production in the U.S. 2009. 15 October 2009. <www.ibisworld.com>

Mushroom consumers are changing. 2004. Mushroom Council, 15 October 2009. < http://mushroomcouncil.org/ConsumerResearch/>

Mushroom consumer panel research. 2005. Mushroom Council. 15 October 2009. < http://mushroomcouncil.org/ConsumerResearch/>

Network address management for a wired network supporting wireless communication to a plurality of mobile users. United States Patent # 5,159,592. <http://www.google.com/patents?id=MiAhAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Package closing label. United States Patent # 5,866,183. <http://www.google.com/patents?id=cQ8XAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Patent # 5,738,890. <http://www.google.com/patents?id=VwMdAAAAEBAJ&zoom=4&pg=PA1#v=onepage&q=&f=false>

Phillips mushroom farms. <http://www.phillipsmushroomfarms.com/>

Portable electronic scale of minimal thickness and weight. United States Patent # 4,800,973. <http://www.google.com/patents?id=qK42AAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Tray for the improved packing and cooling of produce. United States Patent # 6,007,85. <http://www.google.com/patents?id=UC0YAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Wireless local area network communications system. United States Patent # 5,276,703. <http://www.google.com/patents?id=-qQgAAAAEBAJ&zoom=4&pg=PA1#v=onepage&q=&f=false>

Appendix

A. Consumer Research
B. Consumer Analysis
C. Scientific Articles
D. Patents
E. Design Drawings
F. Media Materials

r² rose research

FRESH MUSHROOM ATTITUDE & USAGE TRACKING STUDY FINDINGS

May, 2008

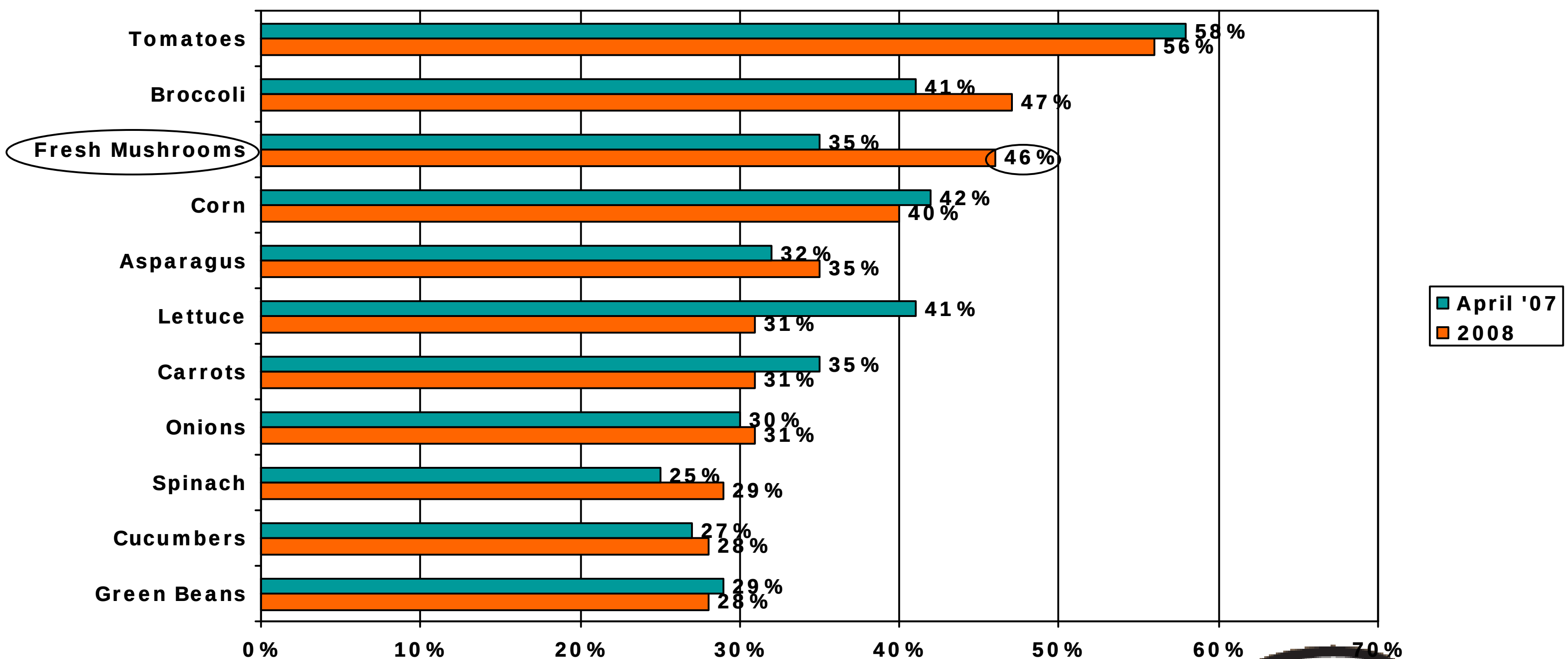
fresh Mushrooms
Nature's Hidden Treasure

METHODOLOGY

- A total of 500 interviews were completed via the internet among primary household grocery shoppers (female & male).
  - Respondents were screened to ensure that they have purchased fresh mushrooms within the past year.
  - Results will be compared to previous studies (where applicable) and tracked going forward.

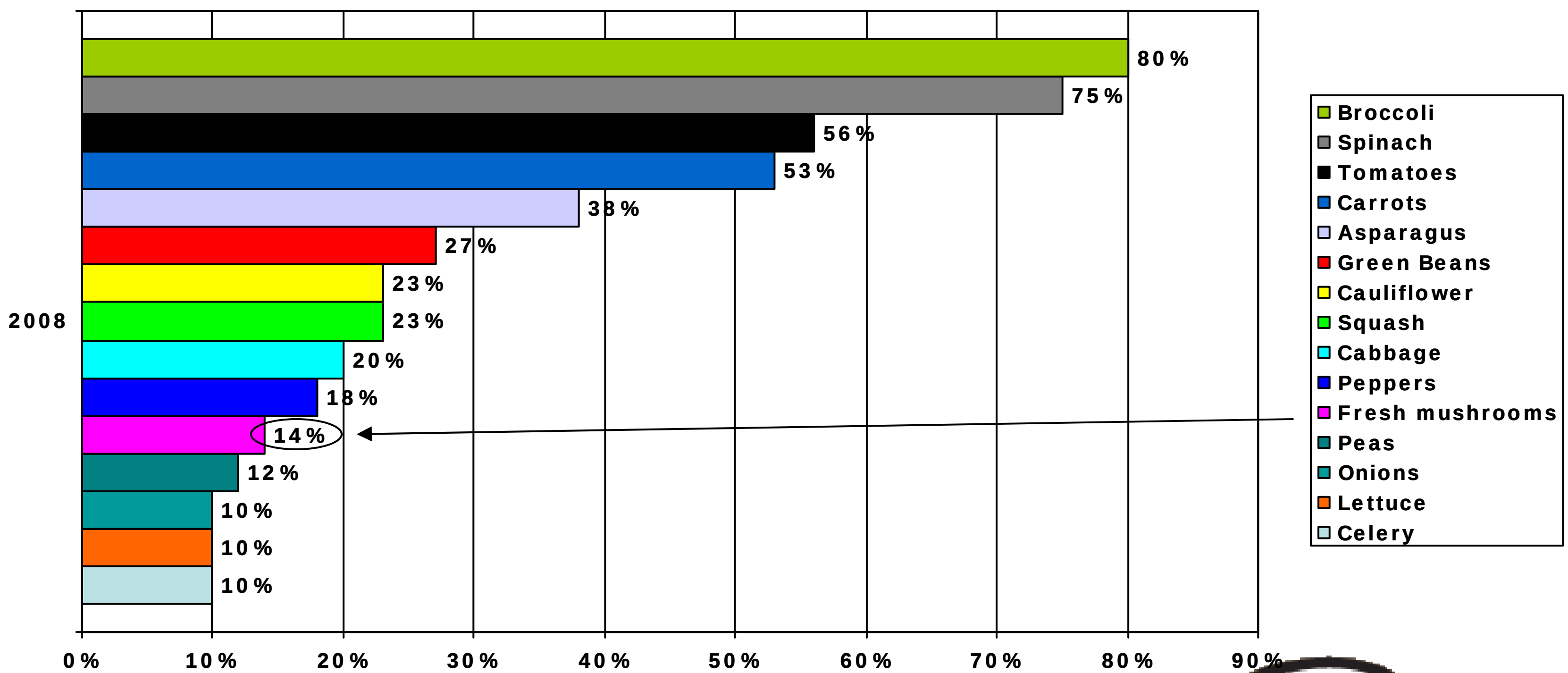
TOP-5 FAVORITE FRESH VEGETABLES

- Fresh mushrooms are third in overall popularity…



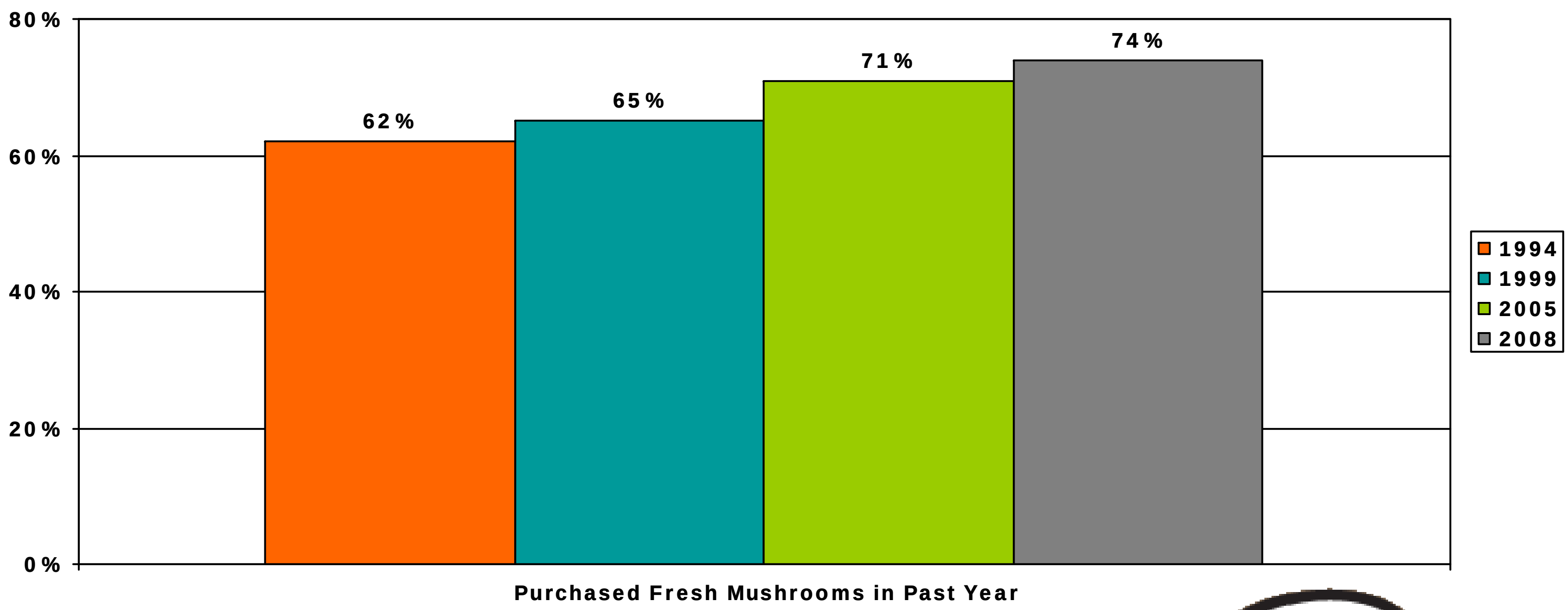
TOP-5 MOST HEALTHY FRESH VEGETABLES

- However, further consumer education is warranted…



OVERALL INCIDENCE OF PURCHASING FRESH MUSHROOMS

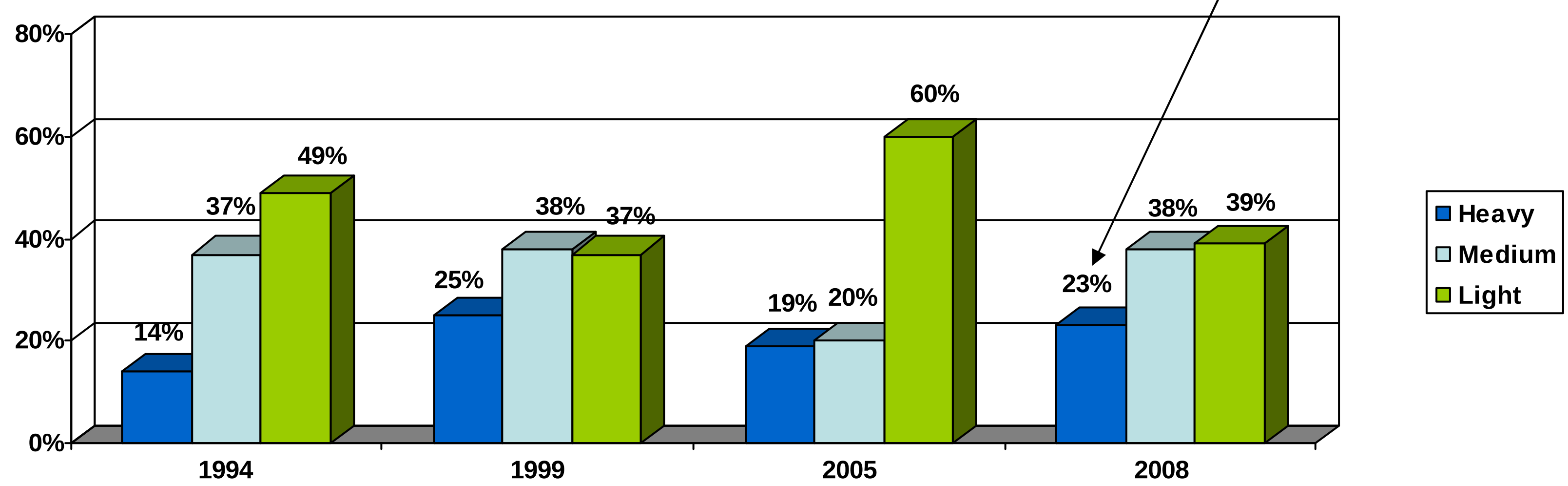
- The percentage of households who have purchased fresh mushrooms in the past year continues to climb…



HEAVY VS. MEDIUM VS. LIGHT USERS

- Most consumers are defined as either medium or light purchasers…

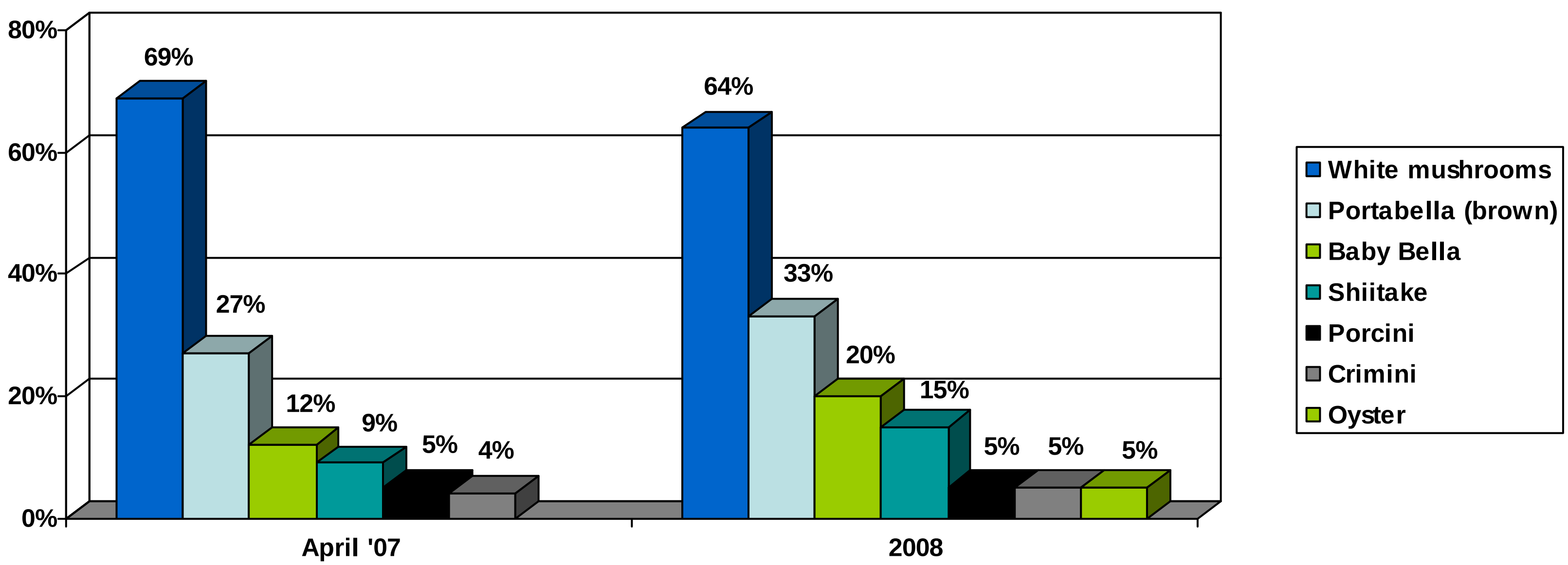
How do we convert them to heavy users?



rose research

TYPE OF MUSHROOM PURCHASED MOST RECENTLY

- Findings are more or less in line with last year, as White mushrooms are by far the most popular variety…

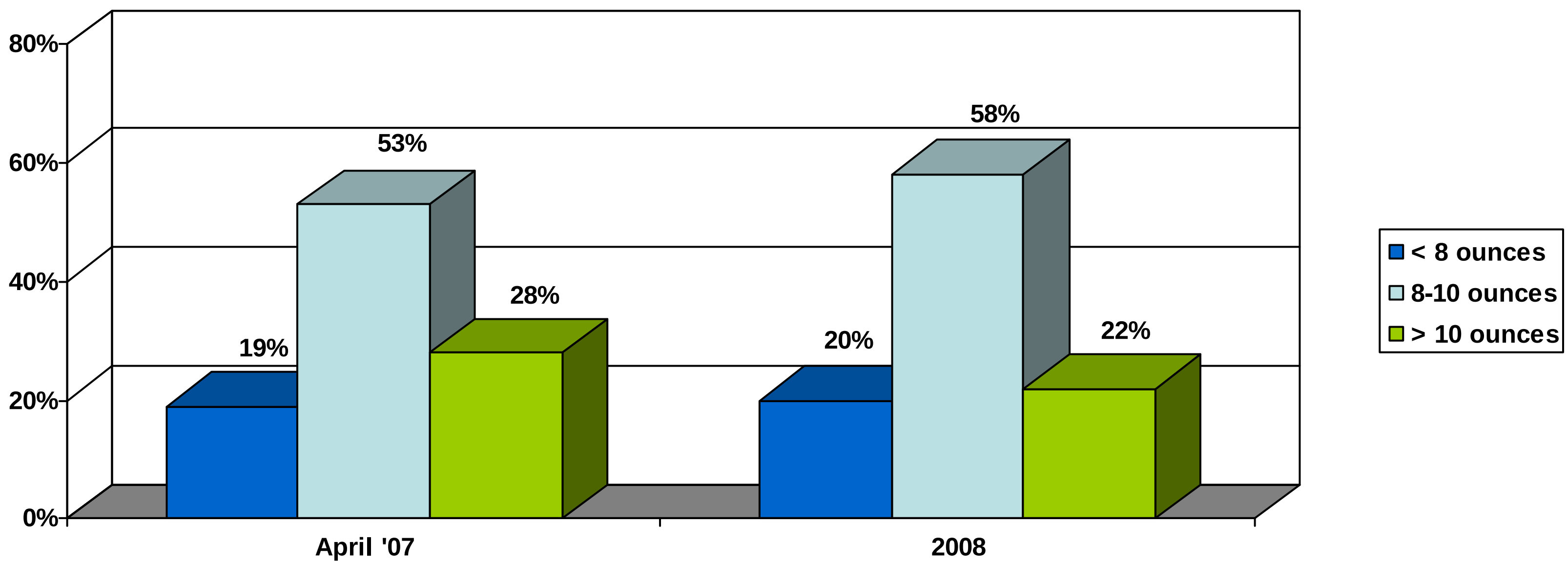


fresh Mushrooms
Nature's Hidden Treasure

rose research

QUANTITY OF LAST MUSHROOM PURCHASE

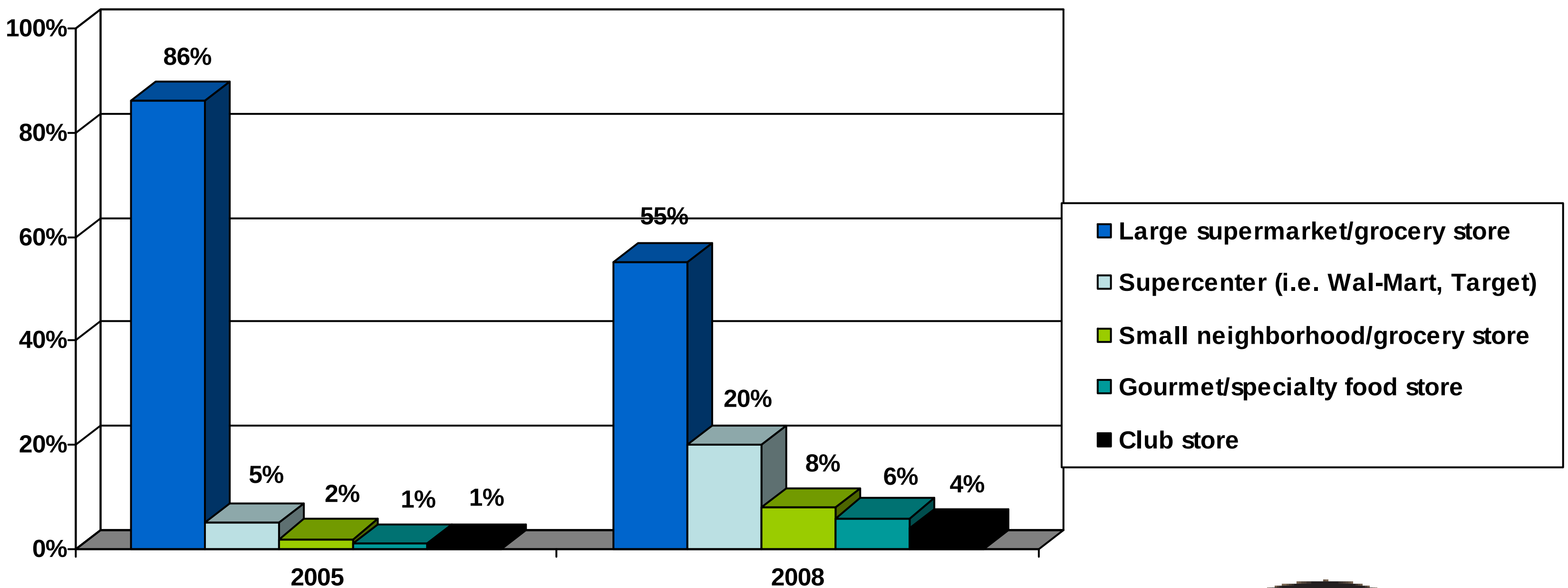
- Also in line with last year, most of the shoppers purchased between 8 and 10 ounces of mushrooms…



fresh Mushrooms
Nature's Hidden Treasure

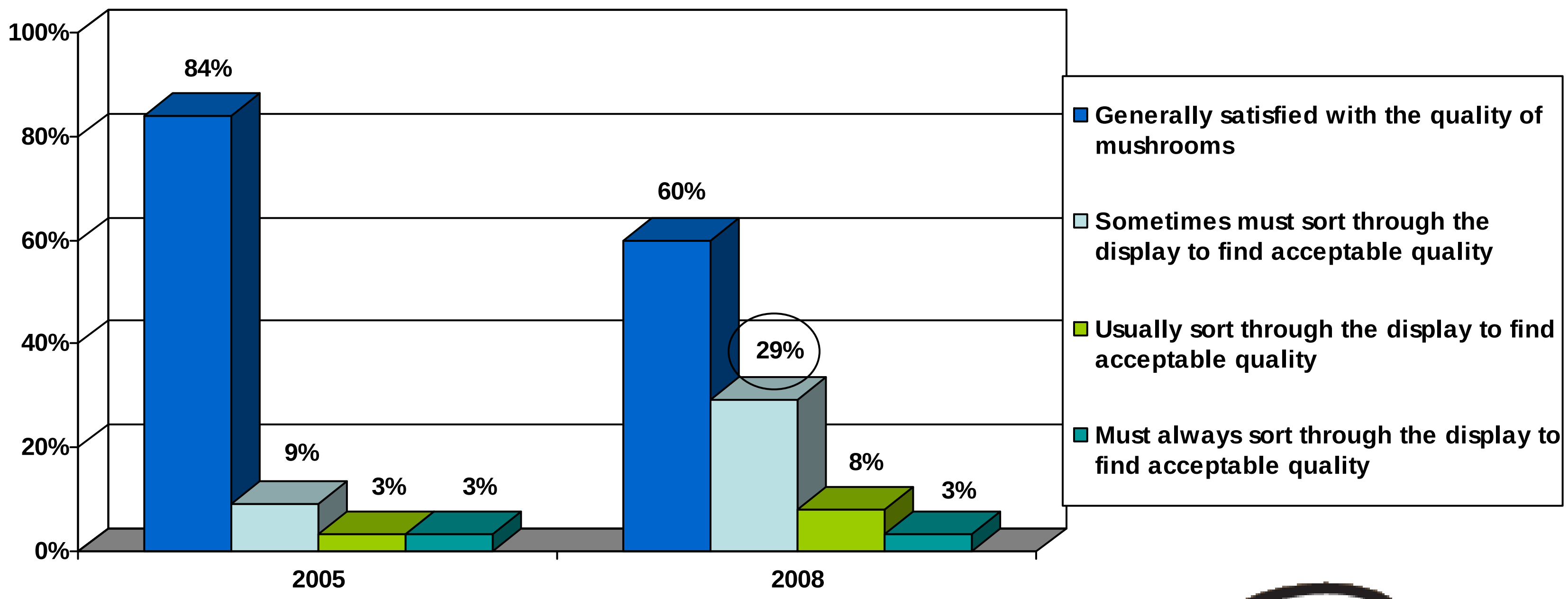
WHERE MUSHROOMS ARE PURCHASED MOST OFTEN

- While supermarkets have lost share of wallet, incidence of purchasing mushrooms at other outlets increased significantly…



OVERALL SATISFACTION WITH QUALITY OF MUSHROOMS AVAILABLE

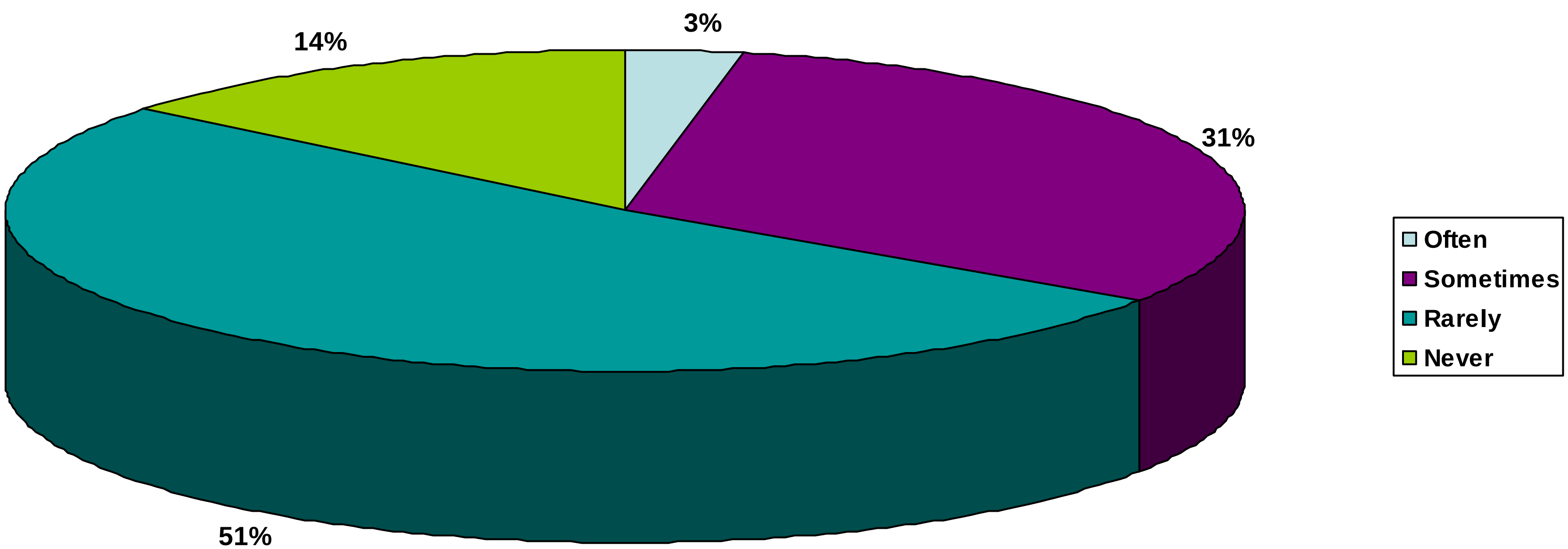
- Shoppers have become more savvy – with many indicating that they sort through the display to find good mushrooms versus 2005…



rose research

FREQUENCY OF NOT PURCHASING MUSHROOMS DUE TO QUALITY

- Despite having to look through the display, most indicate that they either “rarely” or “never” not purchase mushrooms for quality reasons…

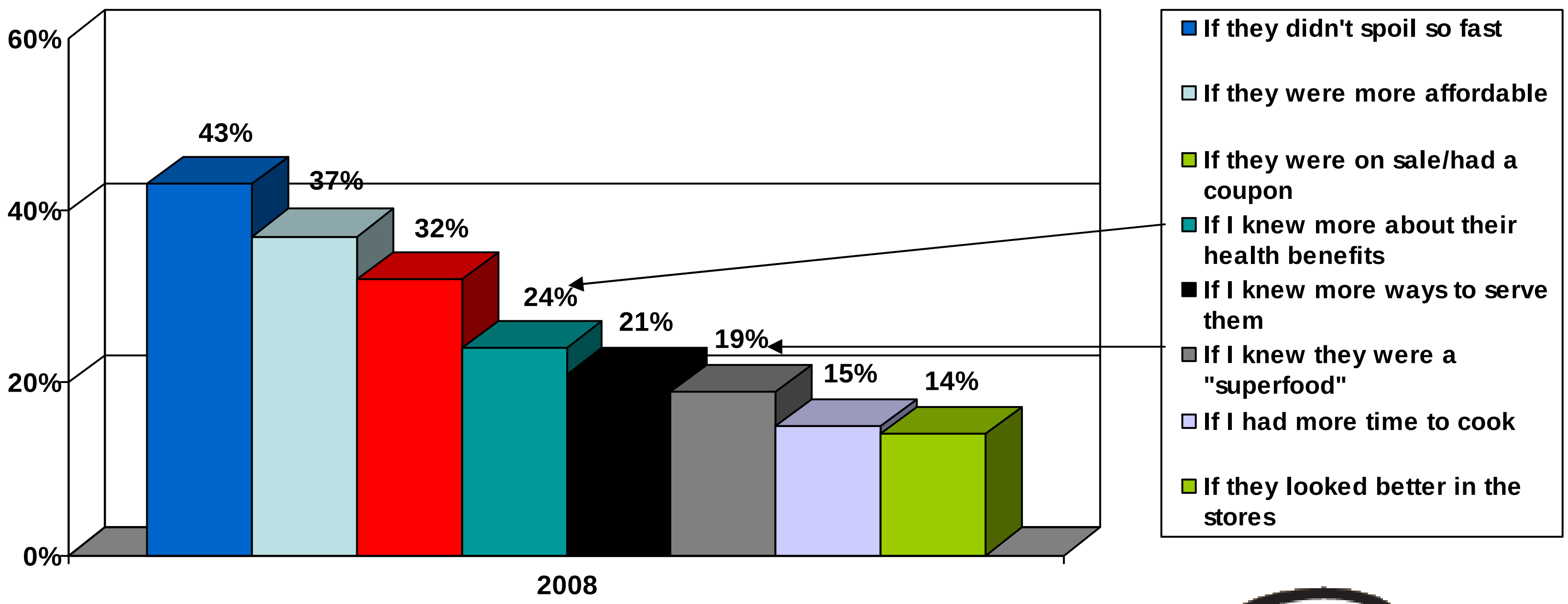


fresh Mushrooms
Nature's Hidden Treasure

rose research

ENTICEMENTS TO PURCHASE MORE MUSHROOMS – TOP-3 CHOICES

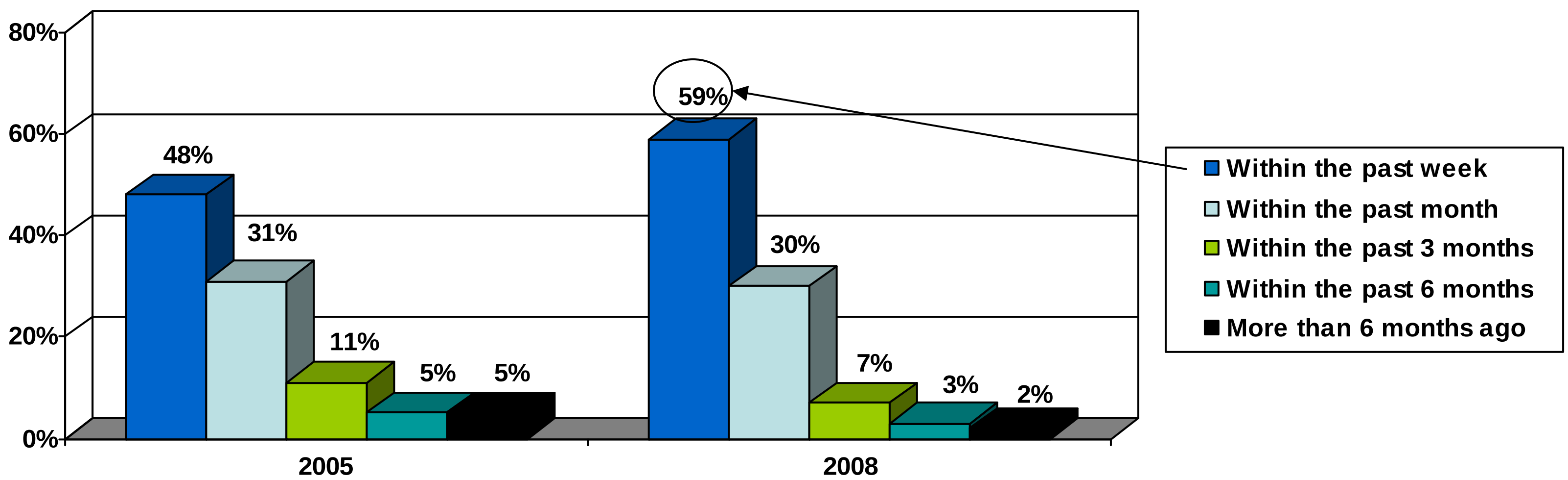
- In addition to quality and price, health is also a motivating factor…



fresh Mushrooms
Nature's Hidden Treasure

LAST TIME MUSHROOMS WERE CONSUMED

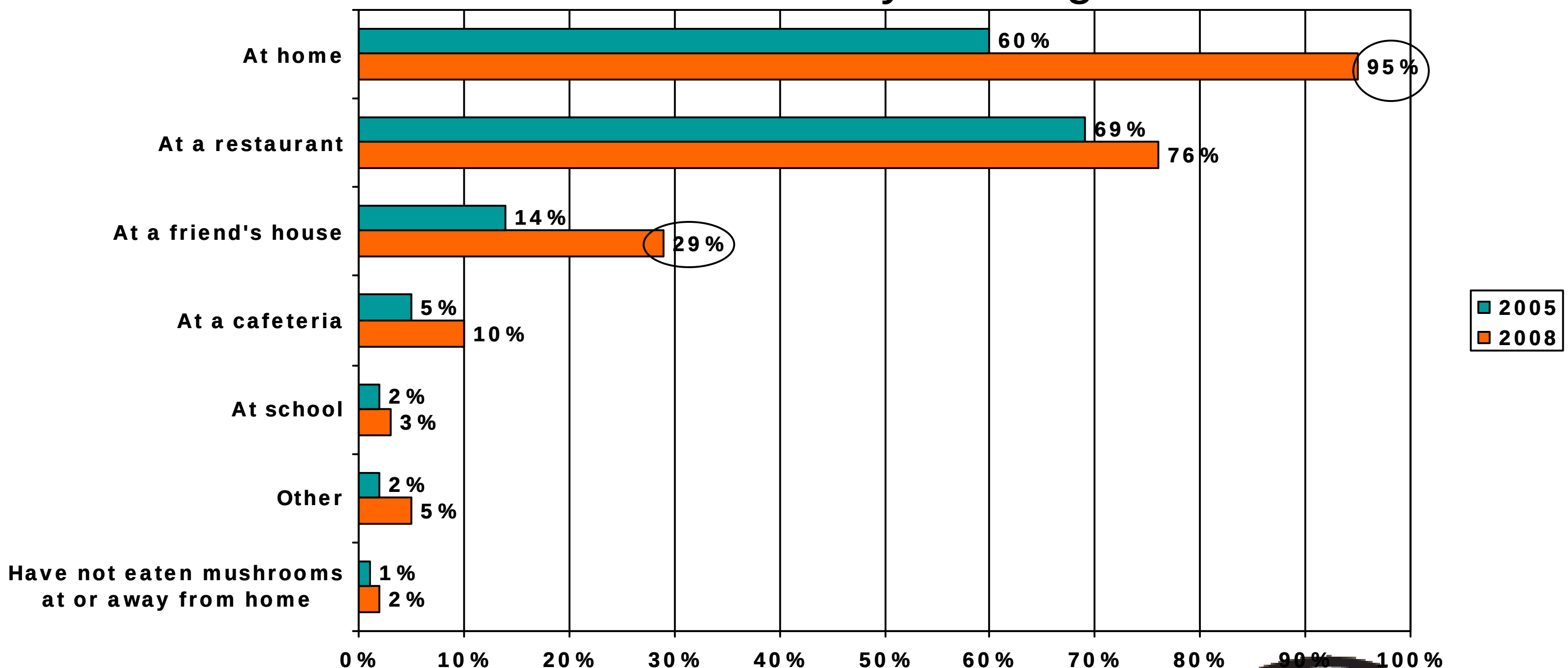
- Mushroom consumption has also increased vis-à-vis 2005, with nearly 6 in 10 having eaten them within the past week…



rose research

WHERE FRESH MUSHROOMS HAVE BEEN CONSUMED (PAST YEAR)

- Fresh mushrooms are significantly more likely to be consumed in the home versus 3 years ago…

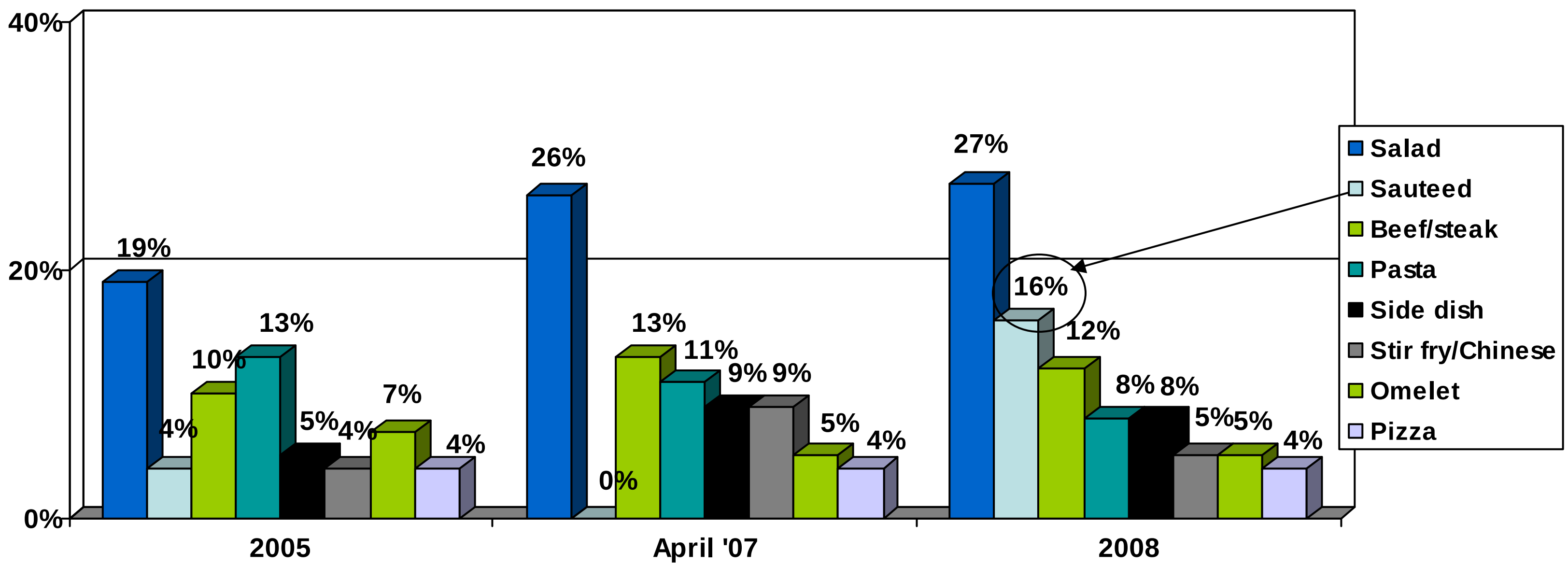


fresh Mushrooms
Nature's Hidden Treasure

r² rose research

DISH EATEN MOST OFTEN W/MUSHROOMS

- While overall findings are similar to previous years, more consumers are sauteeing mushrooms in 2008 than in previous years…

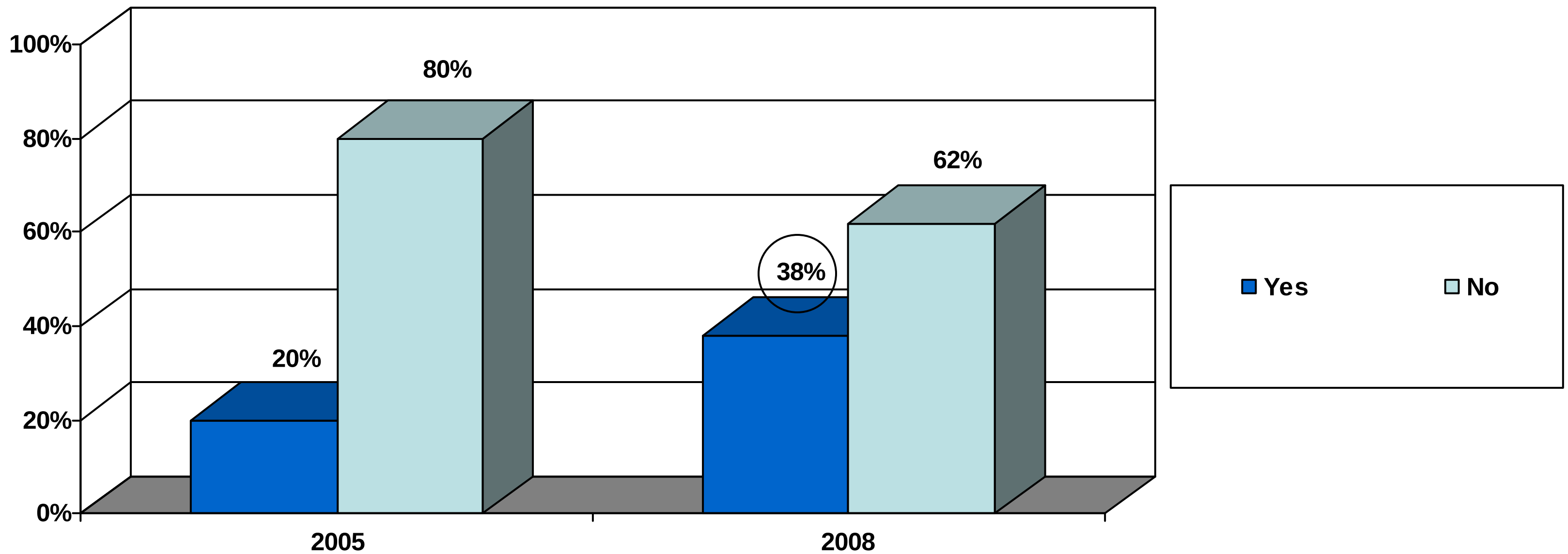


fresh Mushrooms Nature's Hidden Treasure

r² rose research

INCIDENCE OF USING NEW RECIPES (PAST 6 MOS.)

- Along these lines, more respondents are trying out new recipes including mushrooms…

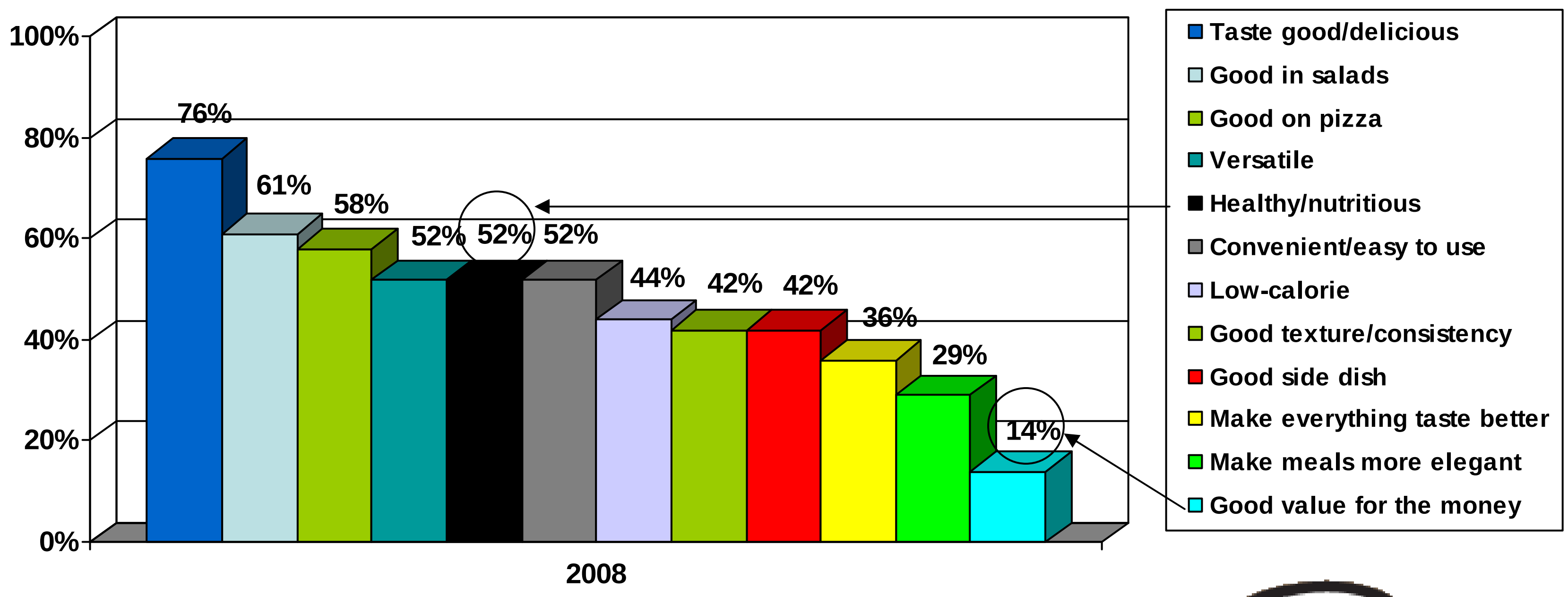


fresh Mushrooms Nature's Hidden Treasure

rose research

FRESH MUSHROOM LIKES

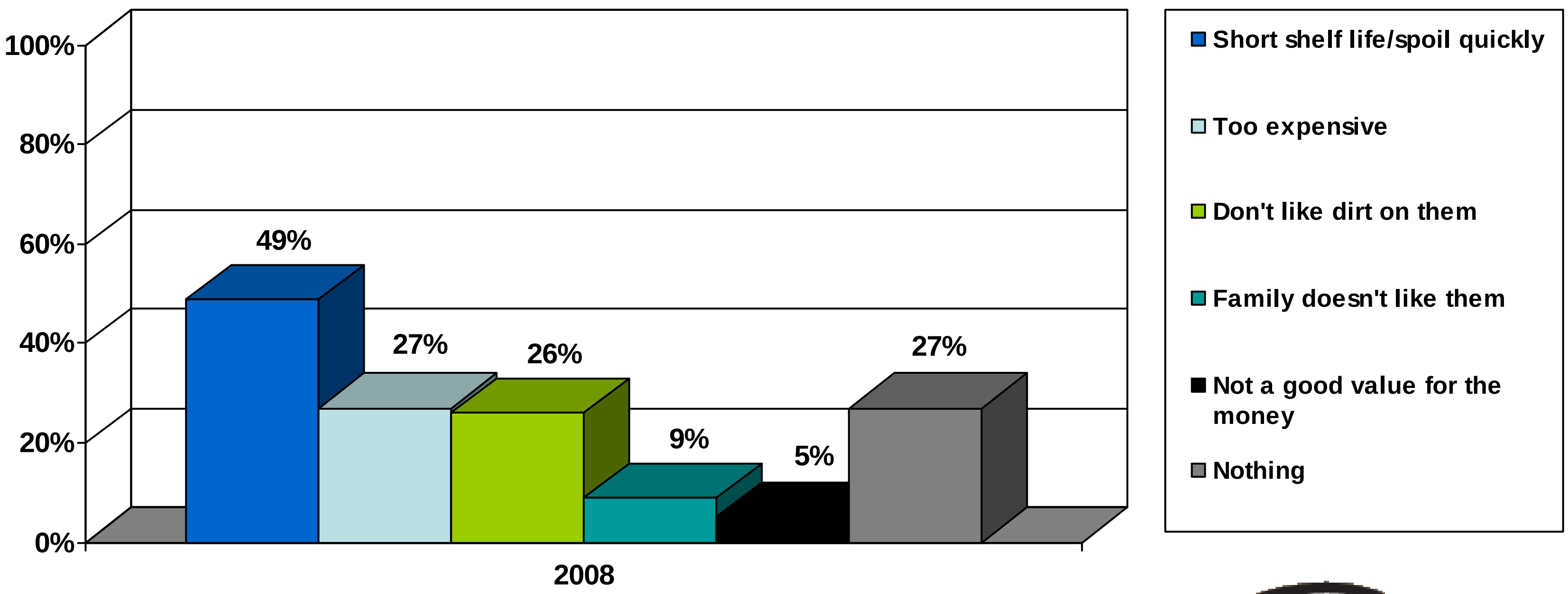
- Mushrooms are credited for their taste and versatility, however, health and value are not inherent strengths…



fresh Mushrooms
Nature's Hidden Treasure

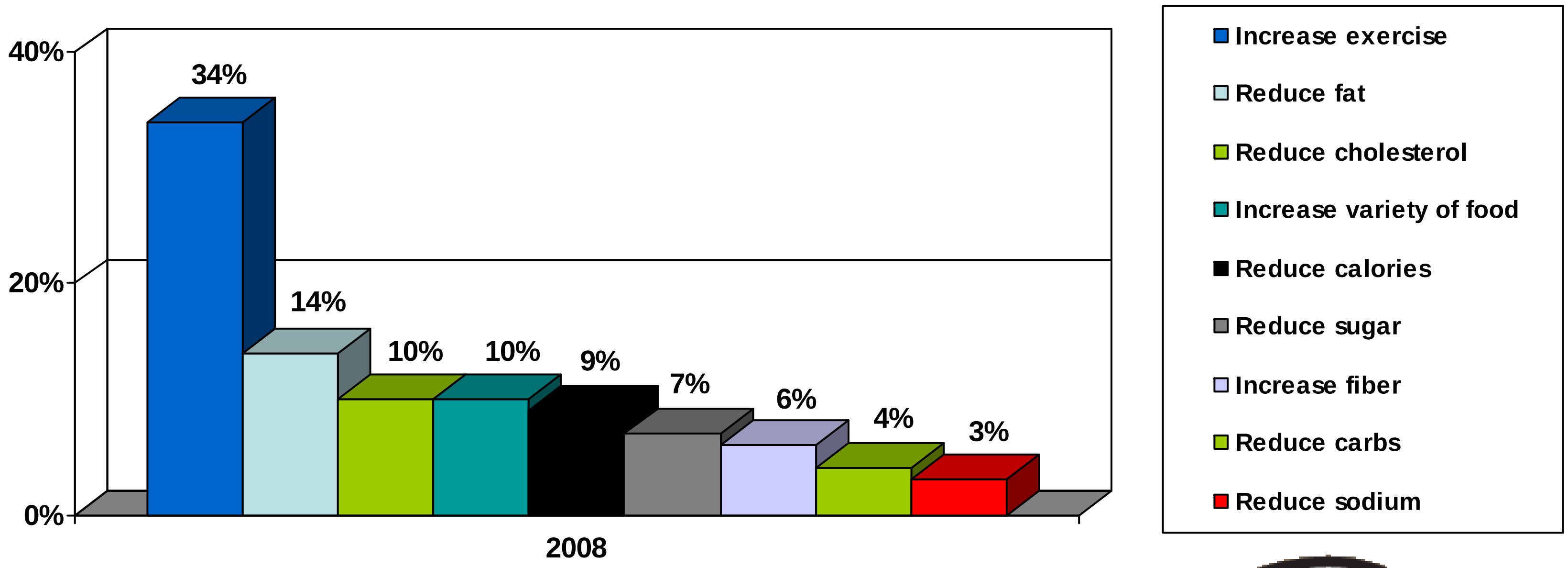
FRESH MUSHROOM DISLIKES

- In line with previous findings, spoilage concerns and price are some of the major complaints consumers have with fresh mushrooms…



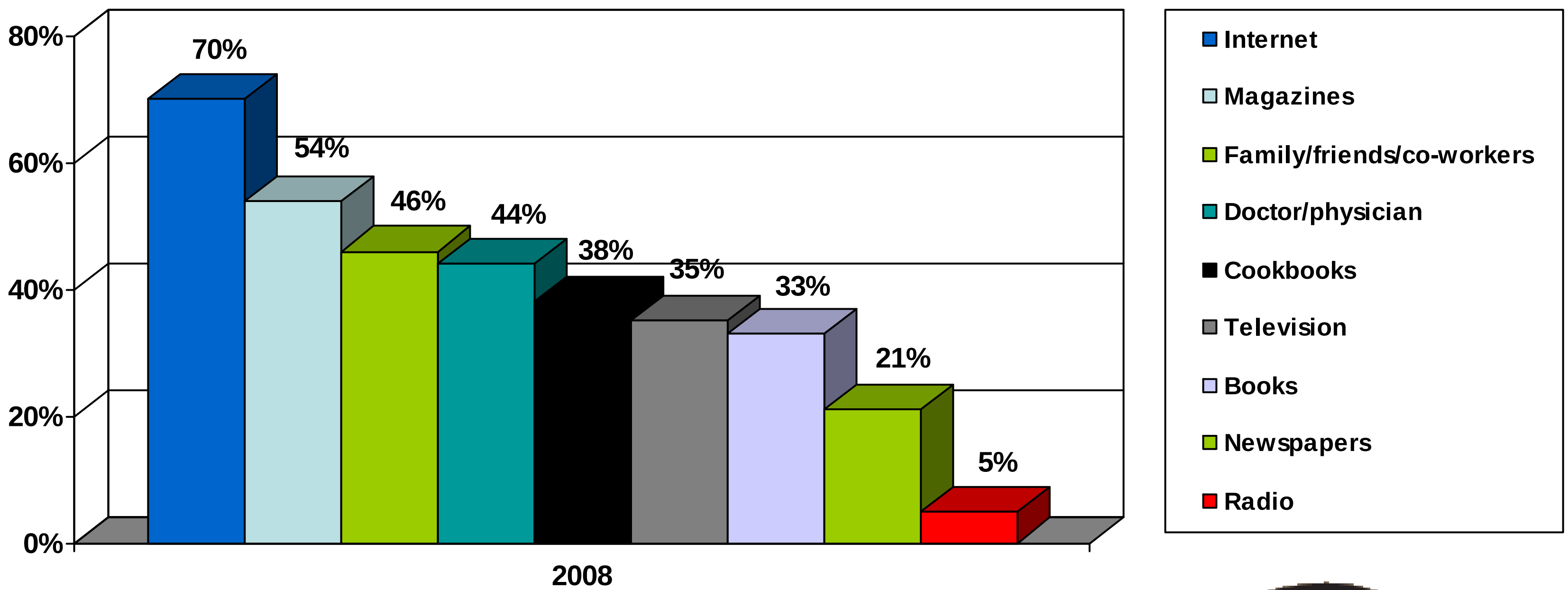
MOST IMPORTANT ACTION TO EAT/LIVE HEALTHIER

- While most consumers indicate that they're eating healthier compared to a couple of years ago, increasing exercise is perceived to be the most important thing they can do for themselves...



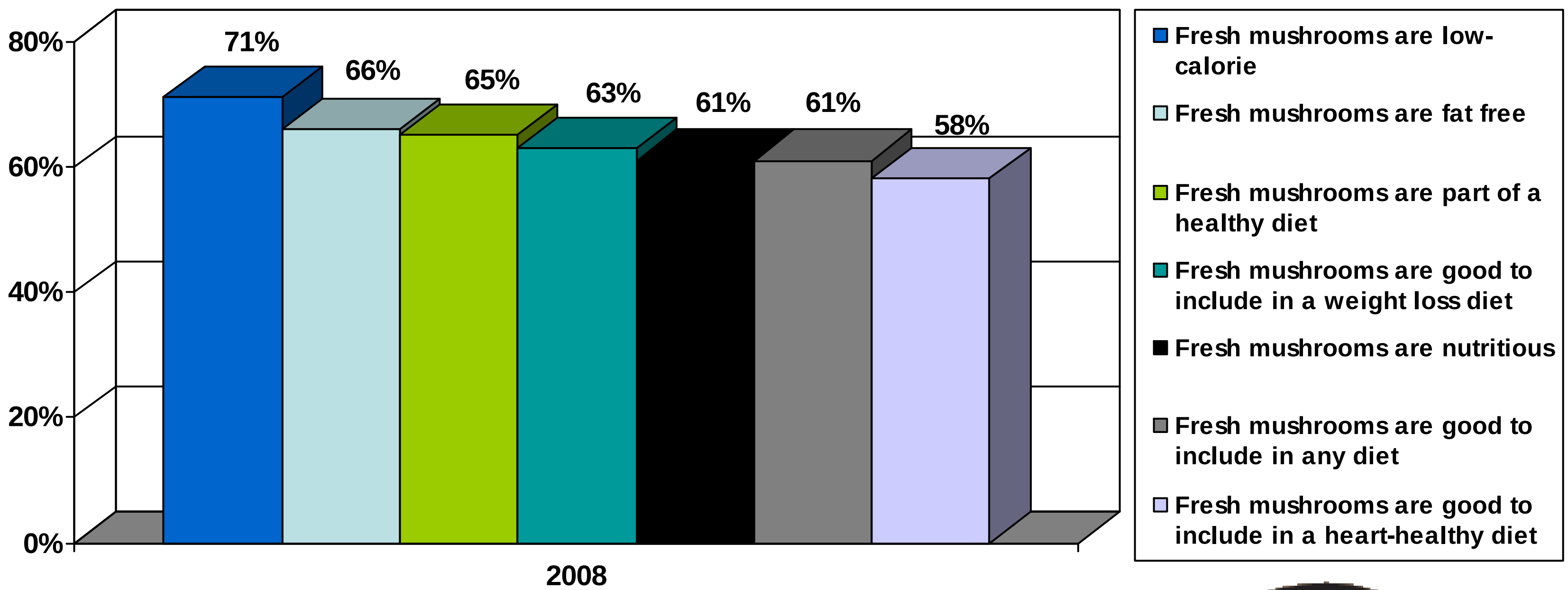
SOURCES FOR HEALTHY EATING INFORMATION

- Most consumers look to the Internet for information regarding healthy eating…



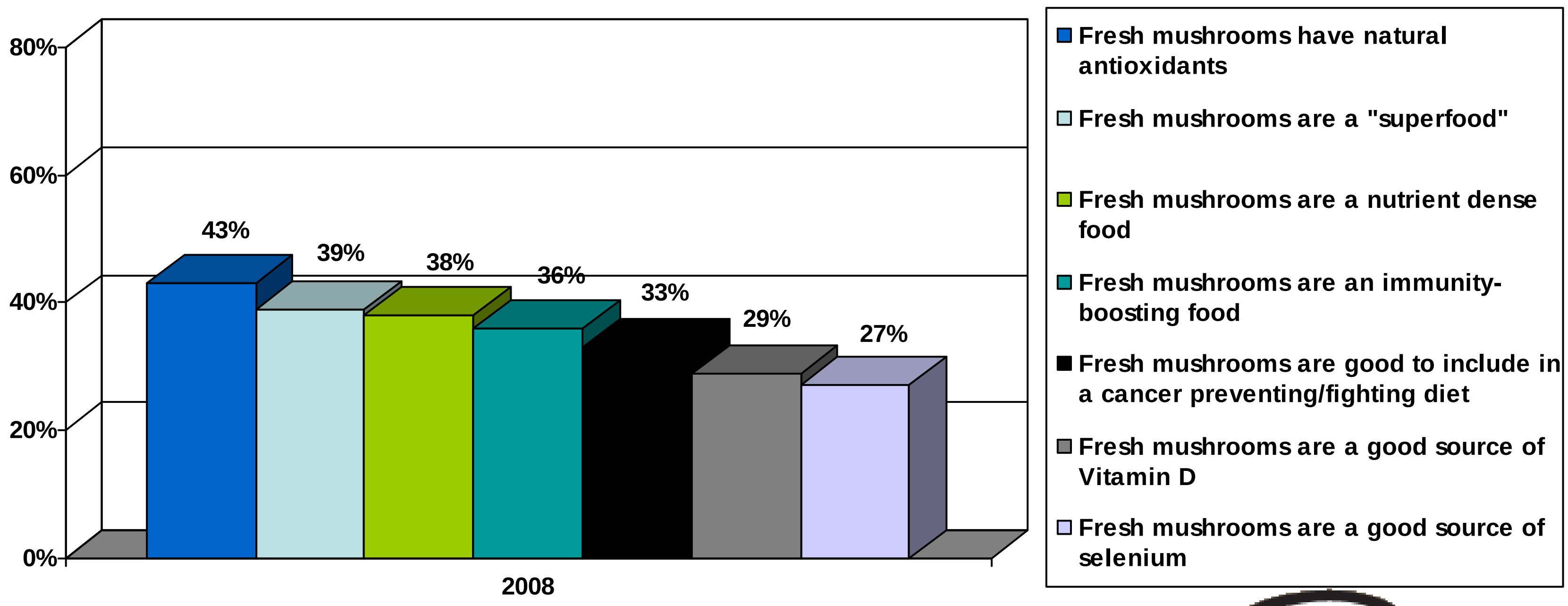
FRESH MUSHROOM HEALTH PERCEPTIONS

- In general, consumers perceive fresh mushrooms to be healthy/good for the diet…



FRESH MUSHROOM HEALTH PERCEPTIONS

- However, most are not aware of the specific health benefits provided by fresh mushrooms…



r² rose research

CONCLUSIONS

- While incidence of fresh mushroom purchasing continues to be strong and is becoming more of a mainstream product, there is room for additional growth.

  – About three-quarters have bought them in the past year – up from 62% in 1994

  – 95% of households have consumed fresh mushrooms at home in 2008 – versus 60% in 2005

fresh Mushrooms Nature's Hidden Treasure

CONCLUSIONS

- The key challenge continues to be converting medium and light purchasers to heavy ones.
  - Consumer education should continue to stress:
    - Storage/spoilage information
    - Specific health benefits

$$$BETTER VALUE FOR THE MONEY$$$

rose research

CONCLUSIONS

- In addition, the wide variety of fresh mushroom choices should be communicated – offering consumers more choice.

- Along these lines, fresh mushroom versatility should also be integrated into the marketing strategy via new recipes, as shoppers are very receptive to new uses.

- The Internet should be utilized as much as possible, as it is the medium where consumers get most of their information about healthy eating/foods.

fresh Mushrooms Nature's Hidden Treasure

Consumers are Changing

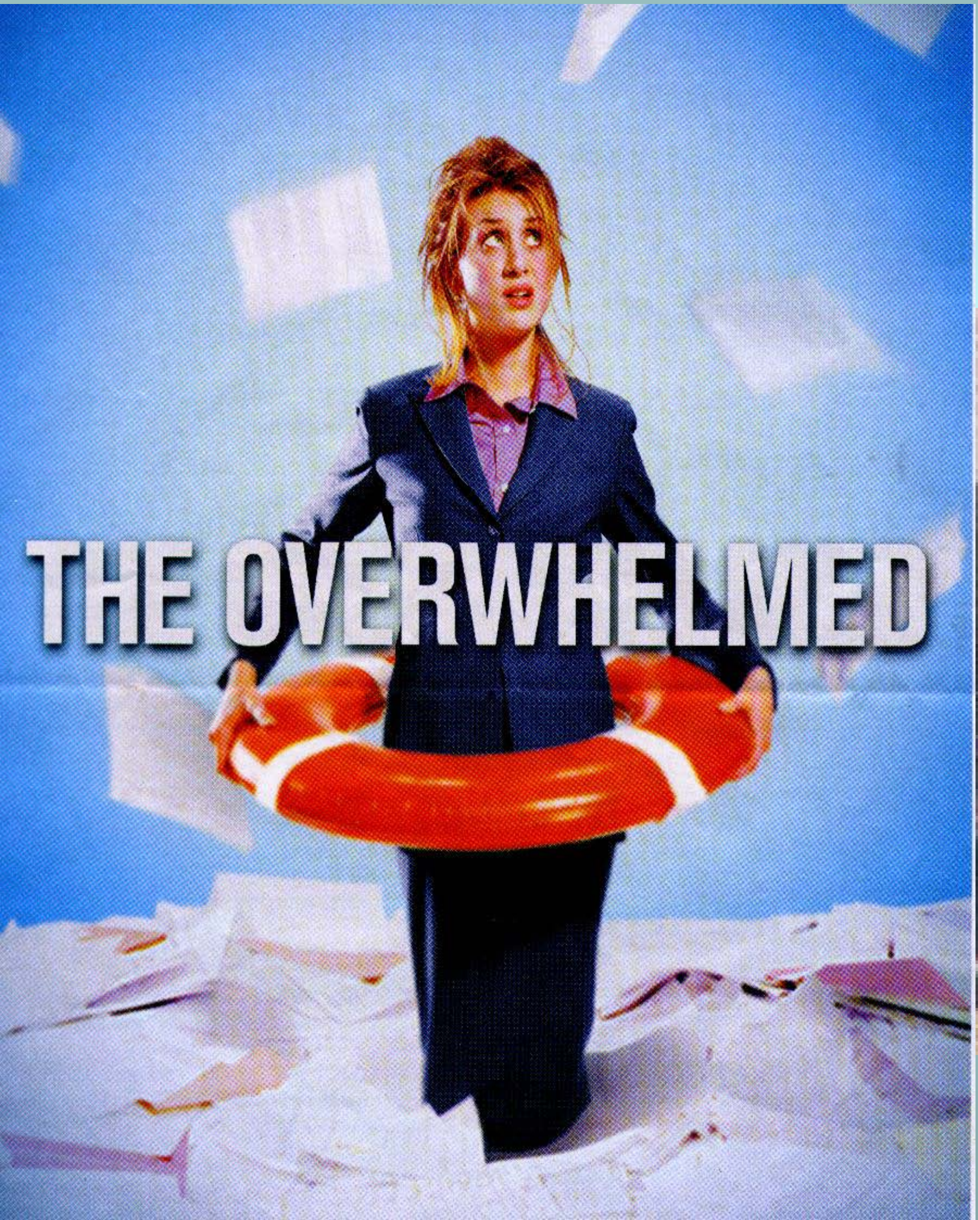
By Dr. John L. Stanton
Department of Food Marketing
Saint Joseph's University
www.johnlstanton.com
jstanton@sju.edu

Another way to say it is:

“Shift happens”

The single biggest change in consumer buying habits has been the quest for convenience

Women are in the midst of a Time Famine



Time Starved Consumers

- Almost 80% of adult women work outside the home
- Average work week getting longer (163 more hours/year than the 1960s)
- Perception of time poverty increases

According to Tyson research today's cooks want to cook *15 minutes or less*

versus 30 minutes in the '80s; versus 2.5 hours in the '50s

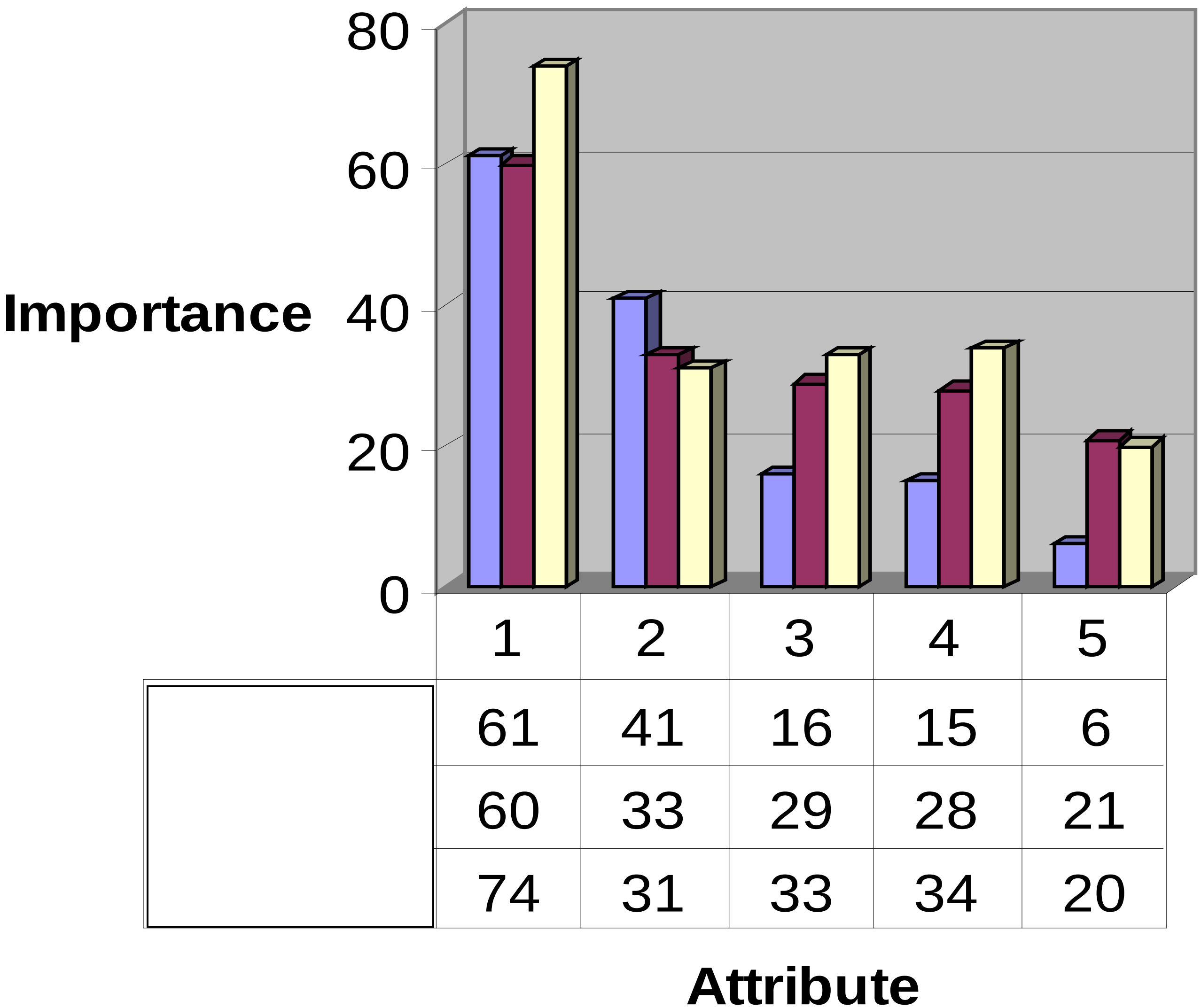
Some involvement is still important in meal preparation

- According to Stouffer’s, women ages 25-50 have time concerns but they also want to feel like they have done something to make the meal.
- 80% of women believe “stove top” preparation is closer to homemade.


Norman
Rockwell

Food Attributes

1. Ease of Preparation
2. Low price
3. Speed of Consumption
4. R-T-E/no prep
5. Portability



	1	2	3	4	5
	61	41	16	15	6
	60	33	29	28	21
	74	31	33	34	20

"Consumers are seeking simplification in their lives. Any product or service that responds to that need will receive acceptance."

— Donald Sokolnicki
Vice President
National Accounts
Nestlé USA

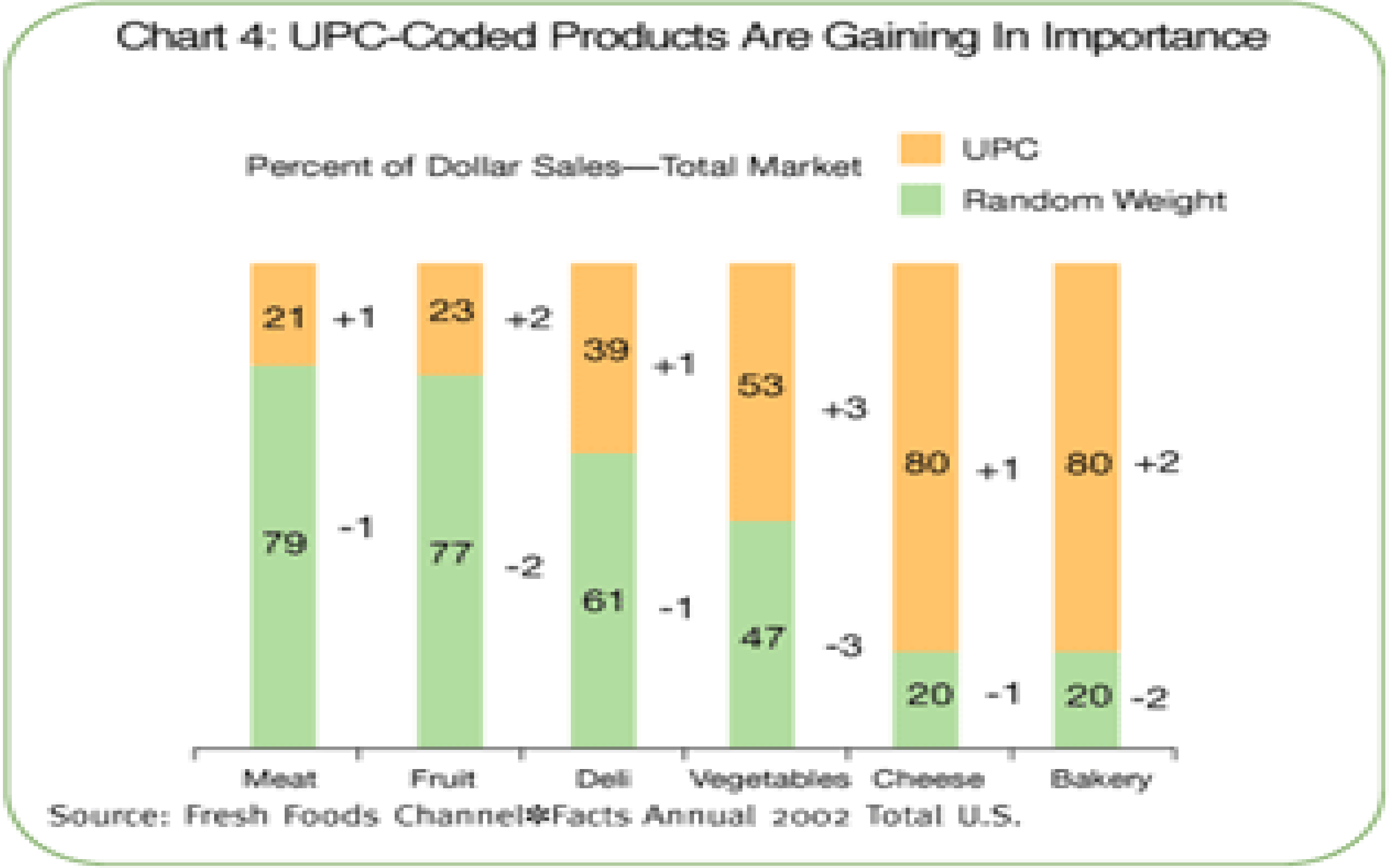
It has affected almost every section of the grocery store as well as the stores themselves

Convenient Solutions Skyrocketing

	\$ Sales (Millions)	% Growth
Precut Fresh Salad Mix	2,083	12
Refrigerated Entrees	1,061	21
Breakfast Bars	414	28
Polishing/Cleaning Cloths	248	8
Frozen Biscuits/Rolls/Muffins	213	43
Shelf-Stable Entrees	211	50
Pre-Moistened Cleaning Towels	151	48
Refrigerated Meal Starters	18	304

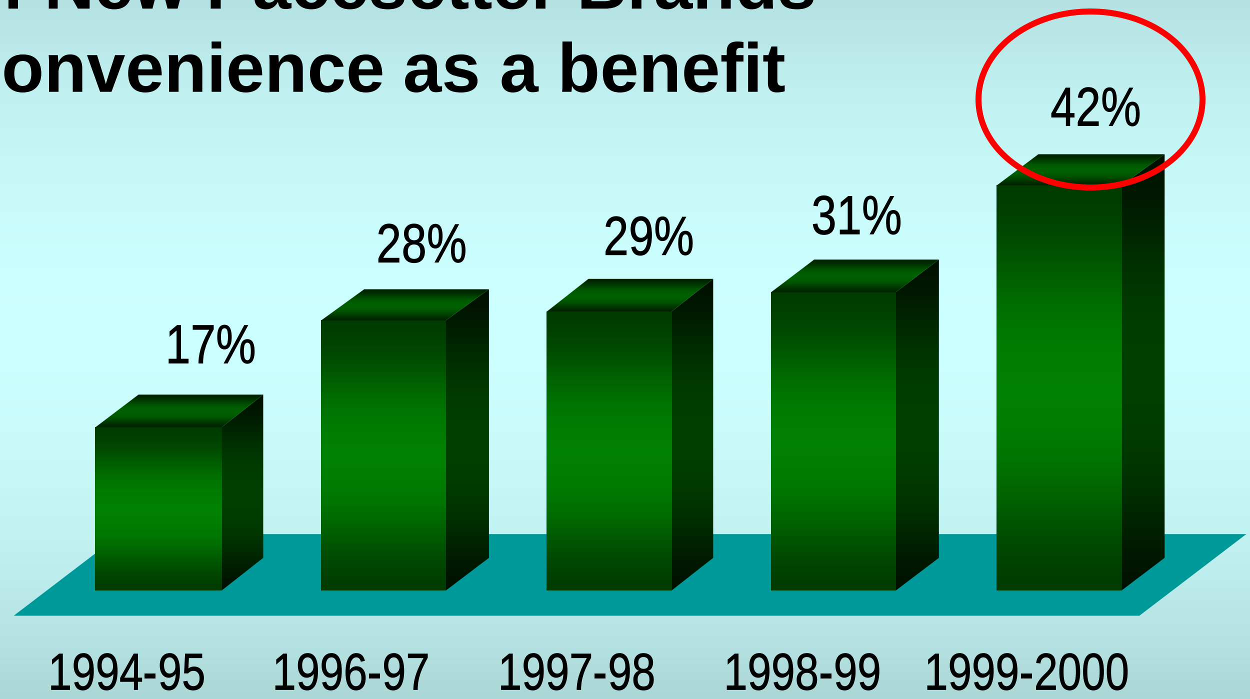
Source: ACNielsen Strategic Planner F/D/M (Ex WM) - 2002.

UPC coded vegetables are up!



Increasing trend toward convenience

Percent of New Pacesetter Brands offering convenience as a benefit



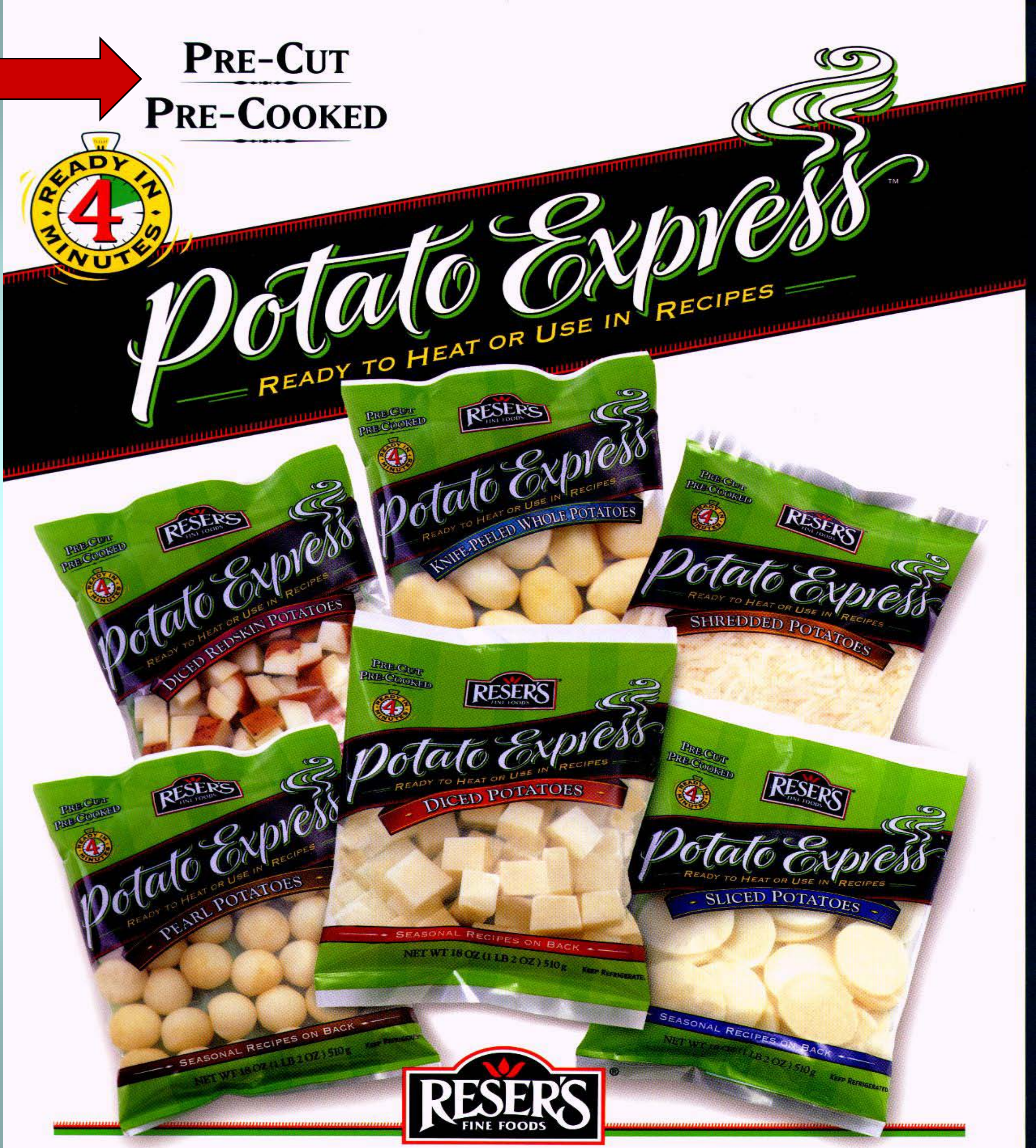
Number of Pacesetters	**102**	**87**	**91**	**95**	**120**

Pacesetters: top 200 or so new brands with year-one sales +7.5 mm

Ready-to-heat and ingredients are where the action is!

The supermarket’s new role will be as the “family’s sous chef.”

Here's another example

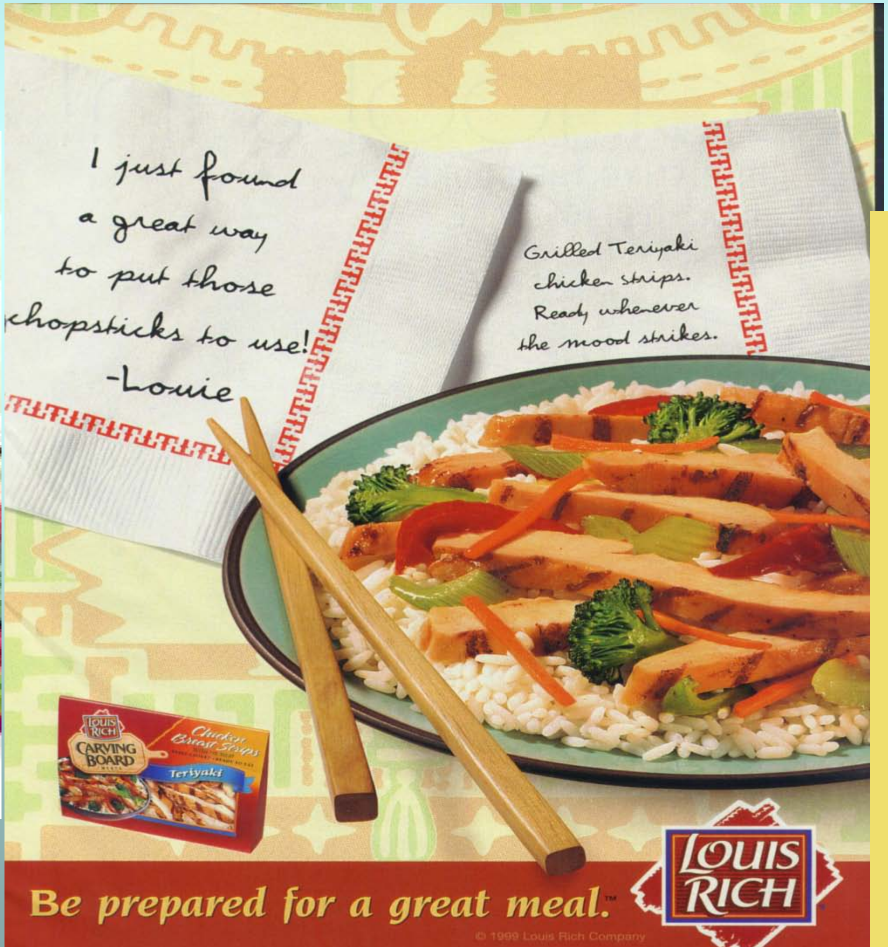


This is merchandised in the MEAT Aisle

What else is in the meat aisle?

- Produce such as
  - Stir fry vegetables near the steak
  - Refrigerated mashed potatoes
  - Vegetable soup mixes near the chuck and beef bones
- To name but a few
- What is missing?

Some companies are providing food that can be easily made into a meal such as a chicken Caesar



How About Bacon, Lettuce and Tomato Merchandised Together!

Fresh Cut Fruit is more convenient and more profitable!

This is not news; A.C. Nielsen* wrote this about the produce section:

Make these categories more accessible and leverage them as impulse purchases in other store sections to enhance meal occasion trips.

*A.C. Nielsen insight magazine 12/15/03

How does the future fare for mushrooms?

- They are very easy to cook
- They are very very fast to cook
- They are low carb
- They are low fat
- They go with most every thing from pizza to beef stroganoff
- They are available all year
- They come in many varieties

My God man, They are perfect

But what must be done to get consumers to buy more

- Follow the advice of Robert Sokolnicki:
- Make it easier and more convenient to use mushrooms.

- Find out what are the obstacles to using mushrooms and remove them.

The obstacles are simple to understand

- I don’t like or have time to get them ready
- I forget to buy them
- I don’t know how to use them
- I don’t know how to store them

My presentation tomorrow will talk about the products and labels that can overcome these obstacles

As Phil Mickelson said about Golf:

- It’s simple it just isn't easy. Nor will overcoming the consumer obstacles about mushrooms be easy.
- It will require a change of grower attitude about how you go to market.
- Some of you just won’t be able to do it.

In one case a wholesaler provided a retailer with 10 hanging racks for Parmesan cheese. They were put in all the sections where cheese could be used.

When the wholesaler returned to the store all the racks were in the storeroom (empty). ***"We took the damn things out, we couldn't keep them filled,"*** the retailer said.

- In a fast changing world, what worked yesterday probably doesn’t work today.

    »Peter Drucker, 1998

“Complacency is something confectionery manufacturers, retailers and wholesalers cannot indulge in.”

Joe Viviano

Vice Chairman

Hershey Foods Corp.

Words of Darwin

- In the struggle for survival, the fittest win out at the expense of their rivals *because they succeed in adapting themselves best to their environment.*

- *Survival is about adaptation!*

  - **Charles Darwin (1809 - 1882), The Origin of Species 1859**

Mushroom growers can heed the words of Darwin

- Adapt or die away!
- Adapt and flourish

- But unlike the animals you have a choice.

Choose today!

PERISHABLES GROUP™

Keeping Your Business Fresh®
www.perishablesgroup.com

Mushroom Consumer Panel Research

Prepared for:

MUSHROOM COUNCIL

August 2005

ACNielsen

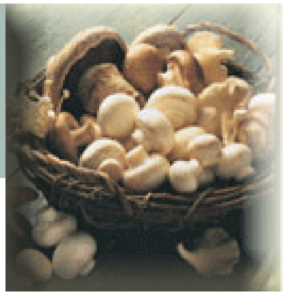
homescan
THE AUTHORITY ON CONSUMER BEHAVIOR

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Contents



FRESH MUSHROOMS *what a good idea*

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Background

ACNielsen Homescan Fresh Foods consumer panel provides the data to document consumer purchasing behavior across fresh food categories and retail channels.

- **The consumer panel consists of roughly 10,000 households. The purchasing behavior of these panelists, in aggregate, accurately reflects (projects to) all households in their region and the rest of the country.**
  - ***Channel*Facts allows comparisons of basic shopping measures across category buyers within key channels and accounts.***
  - ***Consumer*Facts provides household purchasing behavior and demographic profiles.***

FRESH MUSHROOMS what a good idea

Background

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

UPC Purchases

FF / RW Purchases

Consumer Panel

Fresh Foods Consumer*Facts

How do consumers shop fresh foods and my category? Who are the consumers of this category?

Fresh Foods Channel*Facts

How do consumers shop and buy the category in a particular channel?

FRESH MUSHROOMS *what a good idea*

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Research Project Objectives

Gain insight into the mushroom consumer across regions and markets.

HOW are consumers purchasing the mushroom category:

- **Category Purchase Components – evaluate dollar worth and size of category buyers, buy rate, purchase frequency, purchase size, dealing activity, basket size, and buyer conversion.**
- **Opportunity Assessment – mushroom sales opportunities across regions and markets.**

WHO are the mushroom consumers:

- **Demographic Profile – identify who mushroom buyers are (by income, HH size, heads of households, presence of kids, etc.). Demonstrate the value of buyers according to their demographic profile.**
- **Regional Comparisons – assess how consumers vary by geographic region.**

FRESH MUSHROOMS what a good idea

Perishables Group™

Keeping Your Business Fresh®

www.perishablesgroup.com

Key Findings & Implications

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Key Findings

- **Penetration of mushrooms is relatively low, but the spend rate on the category is among the highest, trailing only potatoes and tomatoes.**
  - ***Mushrooms are a large portion of the vegetable consumer's annual spend, and is a higher ring category.***
  - ***The mushroom consumer makes an average of 5 trips per year on mushrooms, and the average transaction size is among the highest of all vegetables.***
- **Majority of mushroom sales are in packages (UPC). The spend rate of UPC mushrooms is nearly double that of RW mushrooms.**
- **Mushroom buyers are evenly distributed nationally. There are distinct differences in mushroom type preferences across the country.**
  - ***The Central region is slightly more developed than other regions. RW mushrooms have a strong presence in West, where the region captures 44% of buyers.***

FRESH MUSHROOMS what a good idea

Source: ACNielsen Homescan Panel Data, 2004

Key Findings

- **Penetration is highest in major markets – San Francisco, Los Angeles and Chicago.**
  - ***Particularly in San Francisco, 50% of all households are buying the category. Interestingly, deal activity is among the lowest in San Francisco. Purchase behavior in SF is independent of any deal incentive.***
- **Buy rate is second highest in Atlanta.**
  - ***There is a group of core buyers in Atlanta that are either buying mushrooms at a high price point, buying a significant amount or making frequent trips.***
- **San Francisco is a top performing market, with significantly higher penetration and buy rate than other markets.**
- **Atlanta is a market of opportunity, where spend rate is high but penetration is the lowest.**
  - ***Further research is recommended to examine usage patterns of these core mushroom buyers in Atlanta.***

Source: ACNielsen Homescan Panel Data, 2004

Key Findings

- **The South region dominates in total sales, but the East region has heavier category buyers that are spending more and make the most category trips per year.**
- **Deal activity varies widely across regions, and is lowest in the West, where only 20% of total dollars were associated with promotion/discounting.**
- **Consumers are shopping mushrooms primarily through traditional grocery stores.**
  - ***Compared to produce and vegetables, mushroom buyers shopping alternative formats (Mass, Club) is minimal with the exception of Super Centers, where 16% of mushroom buyers are shopping the category.***
  - ***A portion of RW mushrooms buyers are shopping fruit stands.***
- **Repeat purchase level of the category is generally high (70% nationally), and is highest in the Central and East regions where deal activity is also more prominent.**

Source: ACNielsen Homescan Panel Data, 2004

Key Findings

- **Households that purchase mushrooms tend to be more affluent 2 person households.**
  - ***The category also exhibits strong skews towards Asian households.***
  - ***Households in the West tend to be affluent, smaller households that are Empty Nesters or Childless Younger Couples.***
  - ***In the East and South, however, households tend to be larger with children.***
- **The main differences between the average vegetable and average mushroom consumer is that mushroom households tend to be slightly more affluent, educated and have strong skews towards Asian households.**
  - ***The category also attracts more childless younger couples, and fewer older singles. This younger, highly educated demographic that may be open to targeted programs on usage and preparation. In store demos and POS material with usage (recipes) are recommended to boost penetration.***

Key Findings

- **Mushroom shoppers are valuable to retailers. The average shopping basket with mushrooms is more than double the value of a shopping basket without mushrooms.**
- **Dairy products and specific produce items are most likely to be purchased along with mushrooms:**
  - ***Fresh carrots, packaged salads, lettuce and fresh potatoes are the produce items most likely to be purchased along with mushrooms.***
  - ***Sour cream, shredded cheese, yogurt and fresh eggs are the dairy items most likely to be purchased along with mushrooms.***
  - ***Spaghetti/marinara sauce, canned soup and margarine/spreads are the grocery items most likely to be purchased with fresh mushrooms.***

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Research Implications

- **The low levels of repeat purchases, trips per year (in South) and especially penetration indicate that consumers are shopping the category for specific purchase occasions.**
  - ***When consumers are purchasing the category they spend significant dollars relative to the rest of the produce department. However, a general lack of mushroom usage/preparation knowledge may be hurting category performance.***
- **Current mushroom consumers may need to be presented with additional eating occasions and usage options.**
  - ***Summer grilling recipes/themes and holiday tie-ins are two examples.***
- **The low penetration, across all regions, strongly suggests that new consumers will need information and education on usage and preparation.**
  - ***In store demos and POS material with usage (recipes) and handling/storage suggestions are critical to increasing penetration in underdeveloped markets. If this can be accomplished the data indicates that once consumers begin to use mushrooms they may spend more on the category than most other significant produce categories.***

FRESH MUSHROOMS what a good idea

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Research Implications

- **POS materials (including recipes) should be produced and distributed with Hispanic and Asian consumers in mind.**
  - ***Regardless of region, particular attention should be given to Asian markets/chains as they are heavy buyers.***
  - ***In the Central and South regions the Hispanic consumer exhibits a propensity to purchase mushrooms.***
- **The household panel data indicates that marketing resources may be more efficiently applied to the traditional retail channel as this is where a disproportionate percentage of purchases occur.**
  - ***However, the lack of successive years of data eliminates trending to reveal if mushroom purchases in Supercenters are consistent with the growth of this overall channel.***
- **The data indicates that promotions are important for driving repeat purchases and increasing trip occasions for the category.**
  - ***Promotions should be used to drive eating/purchase occasions but discount depths should be limited as it appears consumers are willing to spend more on this category relative to the rest of produce.***
  - ***In addition the mushroom consumer is very affluent. This again reinforces the notion that the industry should make every effort to trade up consumers from white to browns and etc.***

FRESH MUSHROOMS what a good idea

Source: ACNielsen Homescan Panel Data, 2004

Research Implications

- **Practices impacting penetration in the Central region should be identified and utilized across other regions.**
  - ***Penetration in the Central region is relatively high. More consumers, per capita, shop the category in this region than any other region. This does not appear to be the result of dealing. The Central region is on par with respect to the percent of category sold on deal vs. the other regions and Total US.***
- **The data indicates that, by region, the following mix/positioning of mushrooms relative to the primary consumer demographics is recommended:**
  - ***West – Bulk items or smaller package sizes. Position as high end, perhaps part of a gourmet meal solution. Asian recipes for POS materials.***
  - ***Central – Maintain bulk offering while displaying a strong proportion of packaged items . Position as high end, perhaps part of a gourmet meal solution. Hispanic recipes for POS materials.***
  - ***South – Offer larger package sizes. Position as high end, perhaps part of a gourmet meal solution.***
  - ***East – Some bulk with moderate package sizes. Position as high end, perhaps part of a gourmet meal solution. Asian and Hispanic recipes for POS materials.***

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Research Implications

- **Mushrooms are not only valuable to supermarkets in driving overall transaction size, but specific items, especially in produce, appear to be highly complimentary. As a result, retailers should be encouraged to utilize primary displays and/or secondary displays designed leverage the likelihood of these complimentary purchases.**
  - ***Fresh Carrots and packaged salads are eight times more likely to be purchased in conjunction with mushrooms.***
  - ***Bulk lettuce is 6 times more likely to be purchased in conjunction with mushrooms. Fresh potatoes are purchased with mushrooms by a factor of 5.***
- **Fresh mushrooms appear to be utilized as a primary ingredient in cooking by consumers. Secondary retail displays to support the tendancy by consumers to purchase mushrooms as part of meal planning are likely to be successful in driving incremental sales.**
  - ***Shredded cheese and sour cream purchases are more than 5 times more likely to be purchased in conjunction with fresh mushrooms.***
  - ***Spaghetti sauce/marinara buyers are nearly five times more likely to buy fresh mushrooms.***
  - ***Egg buyers and canned soup buyers are nearly four times more likely to make a fresh mushroom purchase.***

FRESH MUSHROOMS *what a good idea*

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Consumer Panel Data
Shopping Behavior

ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

Consumer Shopping Behavior

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Shopper Components

Total Mushroom Dollar Sales =

Buyer Base
(HH Penetration)

Buying/Spend Rate
(Dollars per Buyer)

Purchase Rate
(Dollars per Trip)

How much per trip?

Purchase Frequency
(Trips per Buyer)

How many trips?

FRESH MUSHROOMS what a good idea

Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

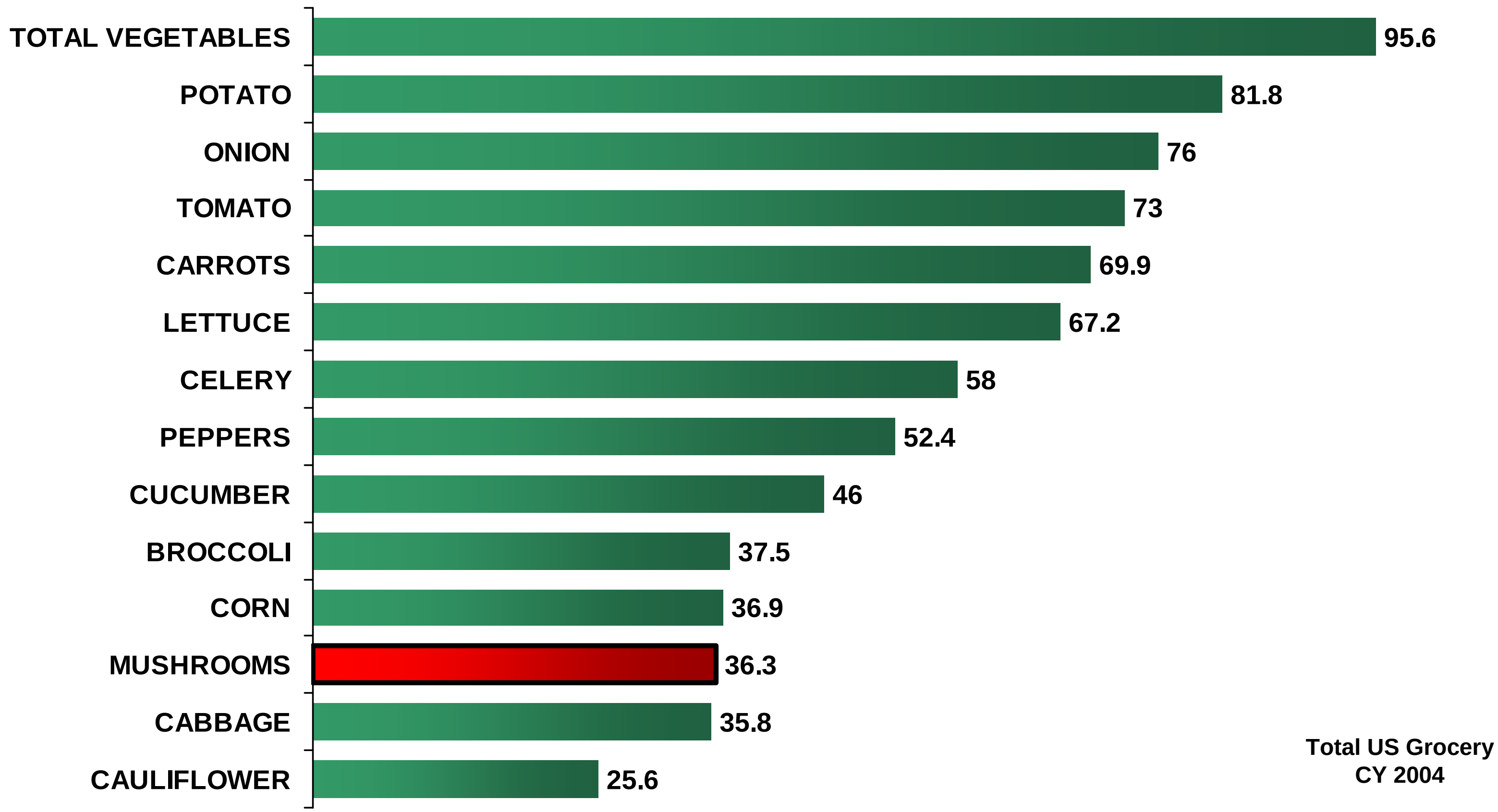
PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

- **Benchmarking penetration across vegetable categories**
  - ***Penetration of mushrooms is relatively low compared to other vegetables, at 36%. One out of 3 households are purchasing the mushroom category.***

VEGETABLE PENETRATION



Penetration = % of HHs that purchases the product atleast once.

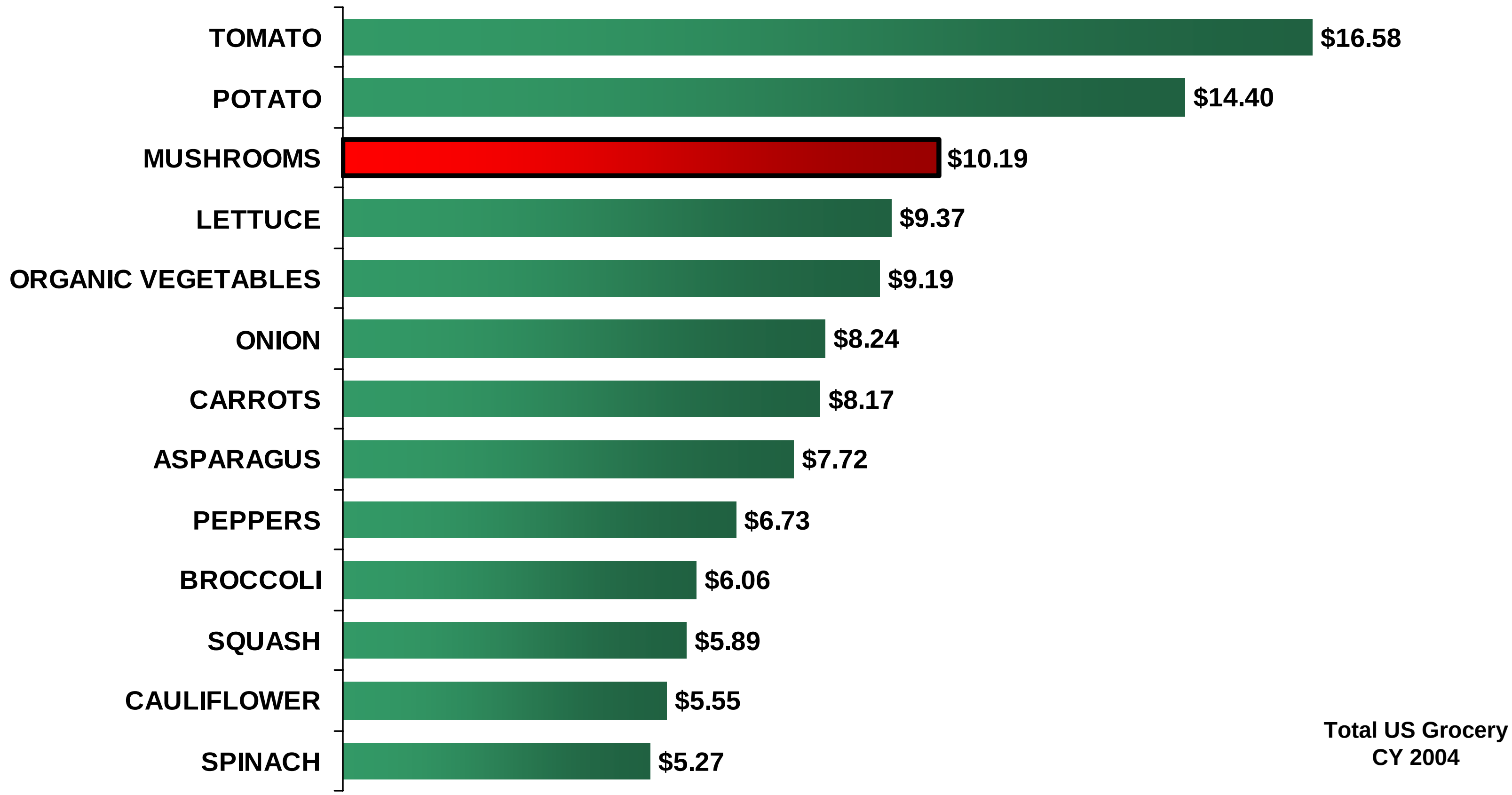
Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

- **Benchmarking buy rate across produce categories**
  - ***The buying rate of mushrooms is one of the highest of all vegetables. The annual spend per buyer on the category is $10.***

VEGETABLE BUYING RATE (SPEND RATE)



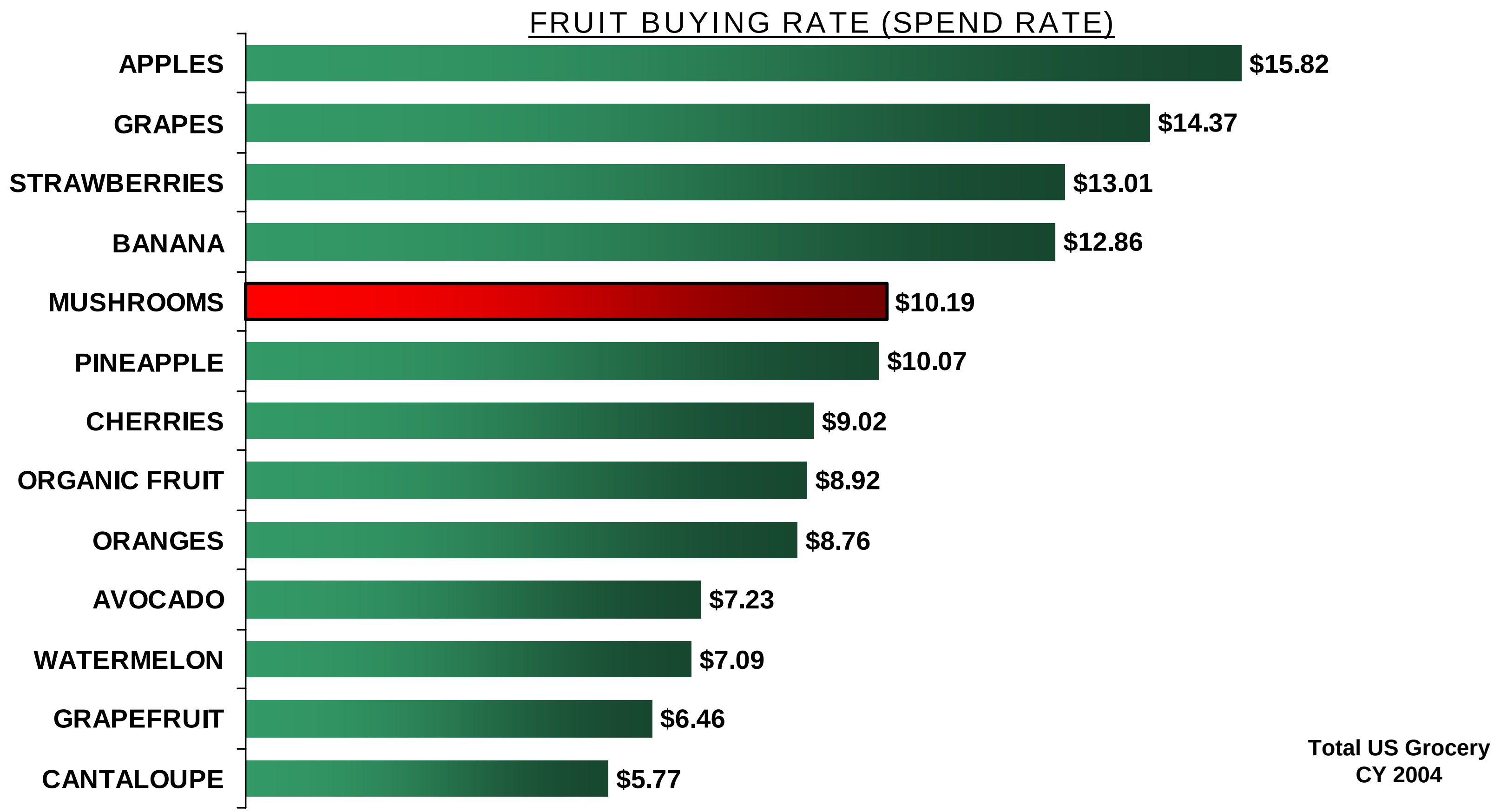
Buy Rate = The average dollars spent per buyer.

Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

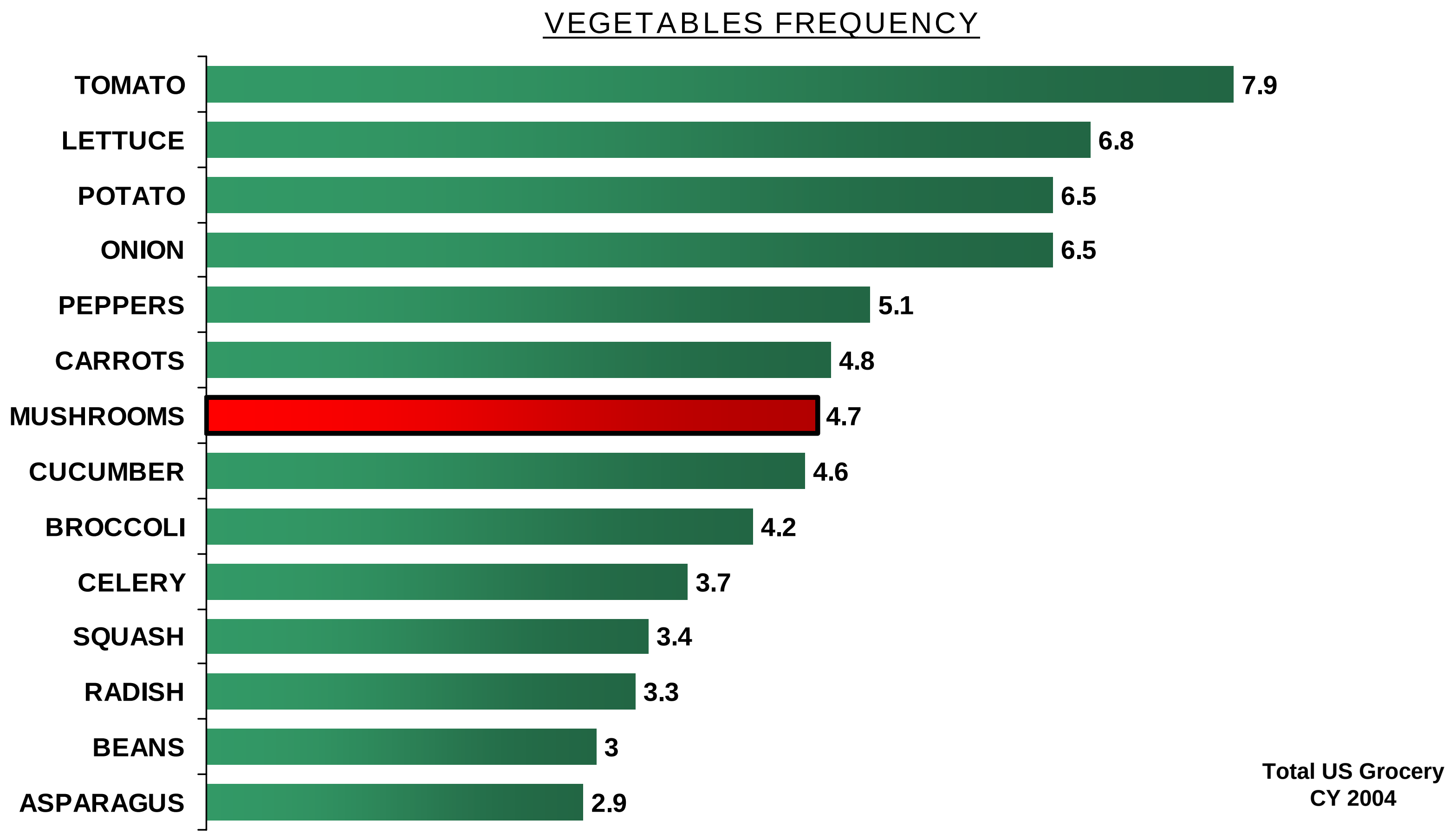
- **Benchmarking buy rate across fruit categories**
  - ***The buying rate of mushrooms exceeds several fruit categories. Consumers are spending nearly the same amount on mushrooms as several traditional mainstream fruits, such as cherries, oranges and pineapple.***



Buy Rate = The average dollars spent per buyer.

Consumer Shopping Behavior

- **Benchmarking frequency across produce categories**
  - ***Mushroom buyers are making roughly 4-5 trips per year.***



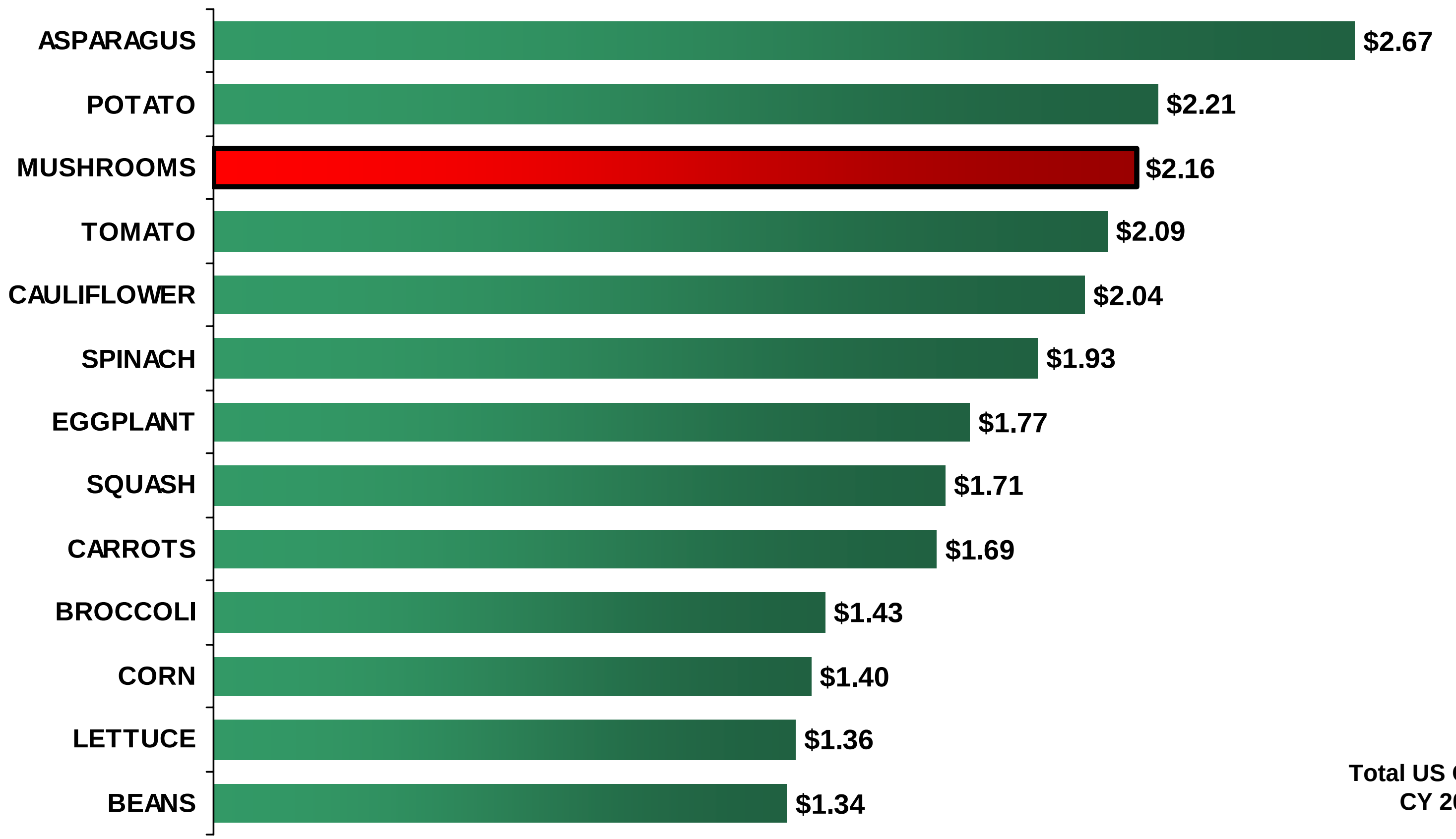
Frequency = The average annual number of product purchase occasions.

Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

- **Benchmarking transaction size across produce categories**
  - ***The average mushroom consumer spends $2.16 per trip, among the highest of all vegetables.***

VEGETABLES TRANSACTION SIZE



Total US Grocery
CY 2004

Dollars per Trip = The average dollars spent per product purchase occasion.

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

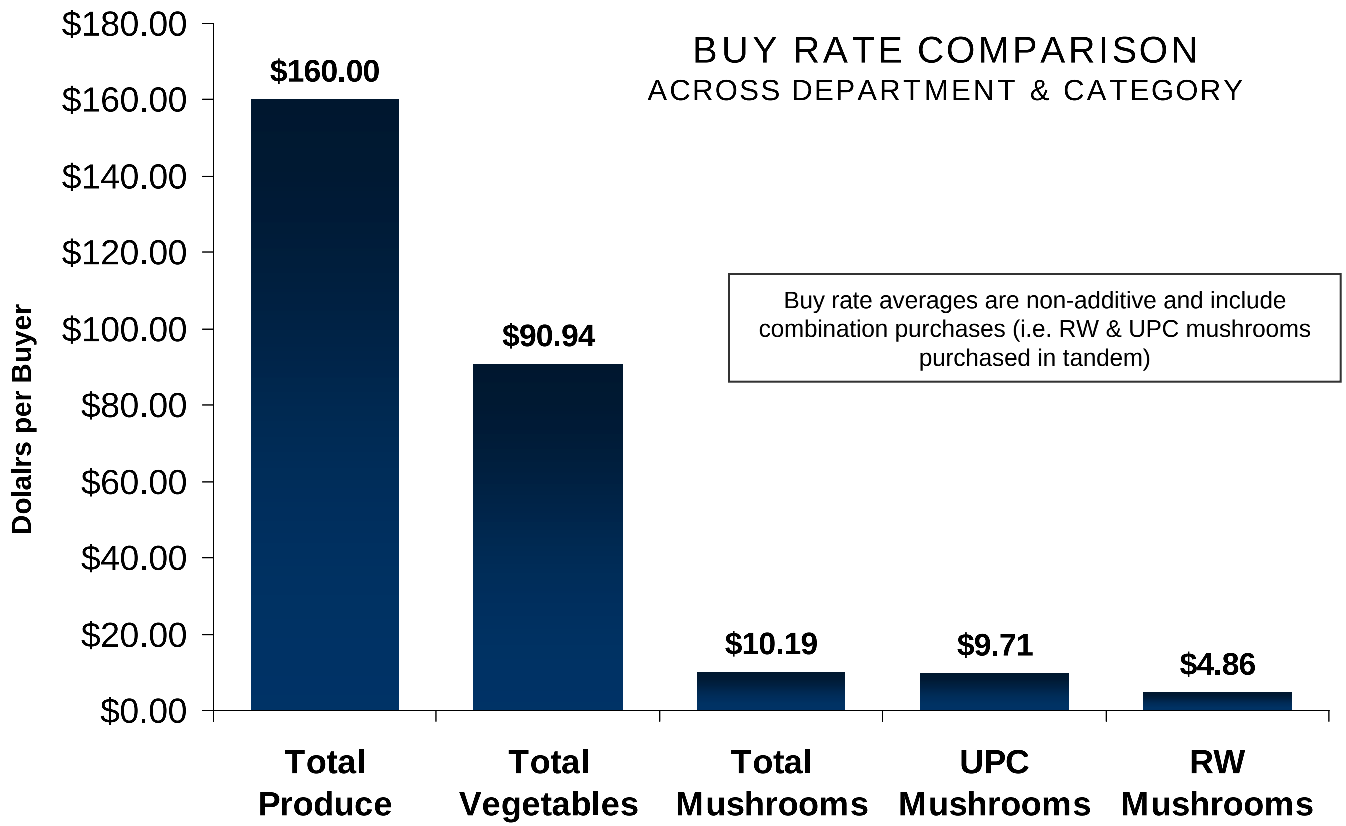
Keeping Your Business Fresh®

www.perishablesgroup.com

Consumer Shopping Behavior

Buy Rate Comparison

- ***The average consumer spends $160 per year on produce. $90 of those dollars are towards vegetable purchases, and $10 are spent on mushrooms. The spend rate of UPC (packaged) mushrooms is nearly double that of RW (bulk) mushrooms.***



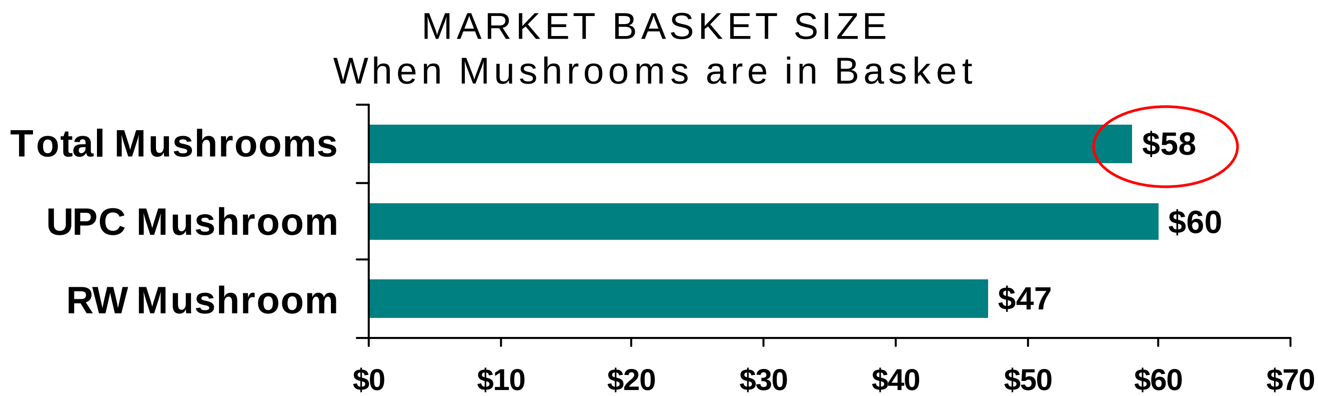
Source: ACNielsen Homescan Panel Data, 2004

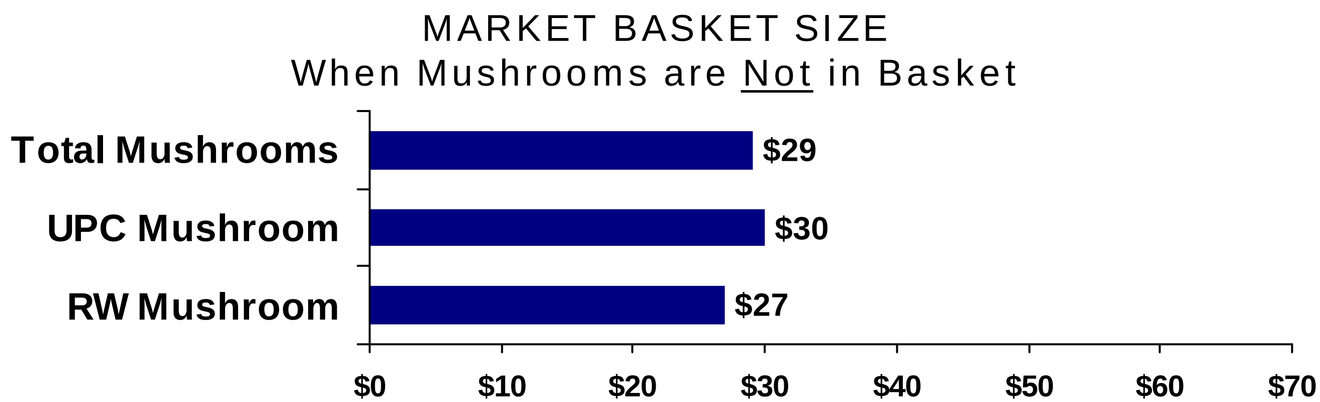
PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

Consumer Shopping Behavior

Market Basket Size

- ***The average dollar value of the shopping basket is $58 when mushrooms were included. This is double the basket when when mushrooms were absent. Mushrooms add significant additional shopping basket spending dollars to the retailer.***



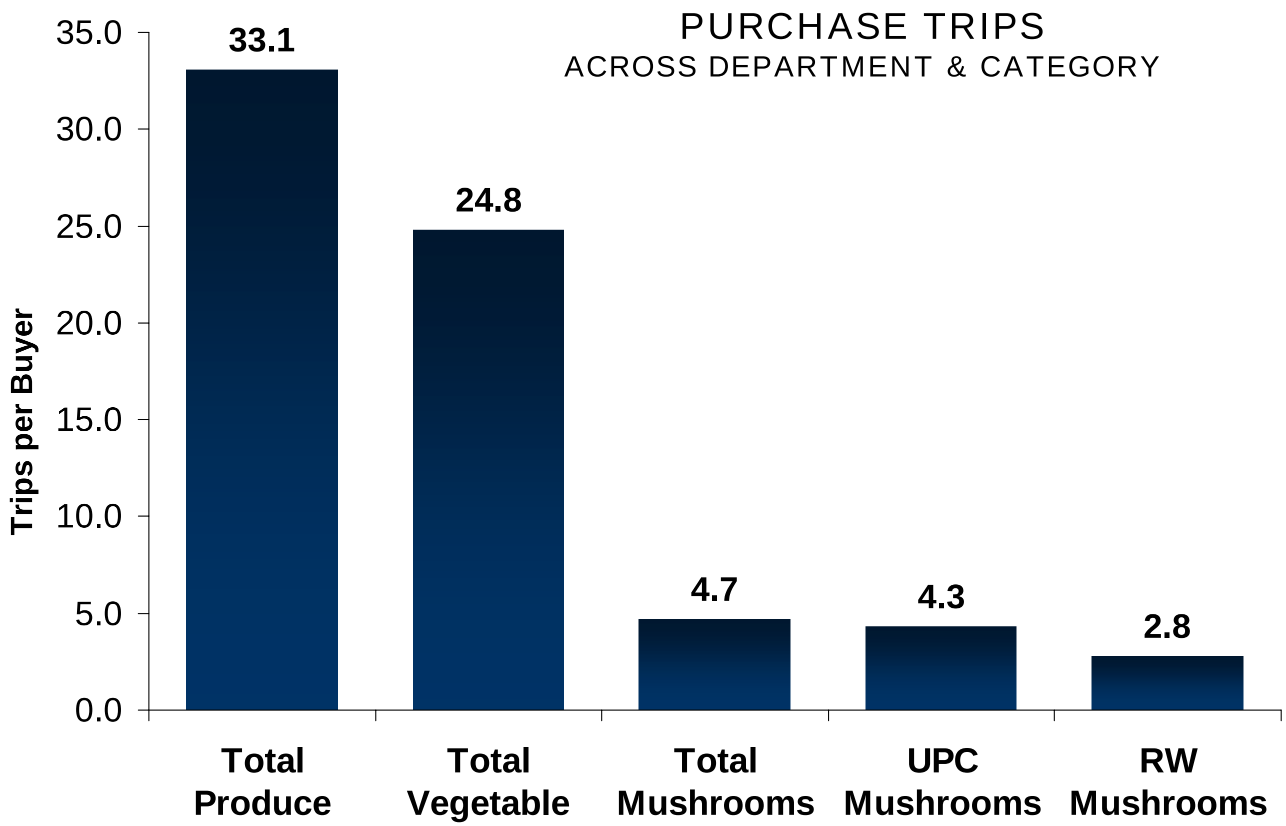


FRESH MUSHROOMS *what a good idea*

Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

- **Purchase Frequency Comparison**
  - ***The average consumer makes 33 trips per year for produce. 22 of those trips are for vegetable, and 4 trips are for mushroom purchases.***



Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

PERISHABLES GROUP™

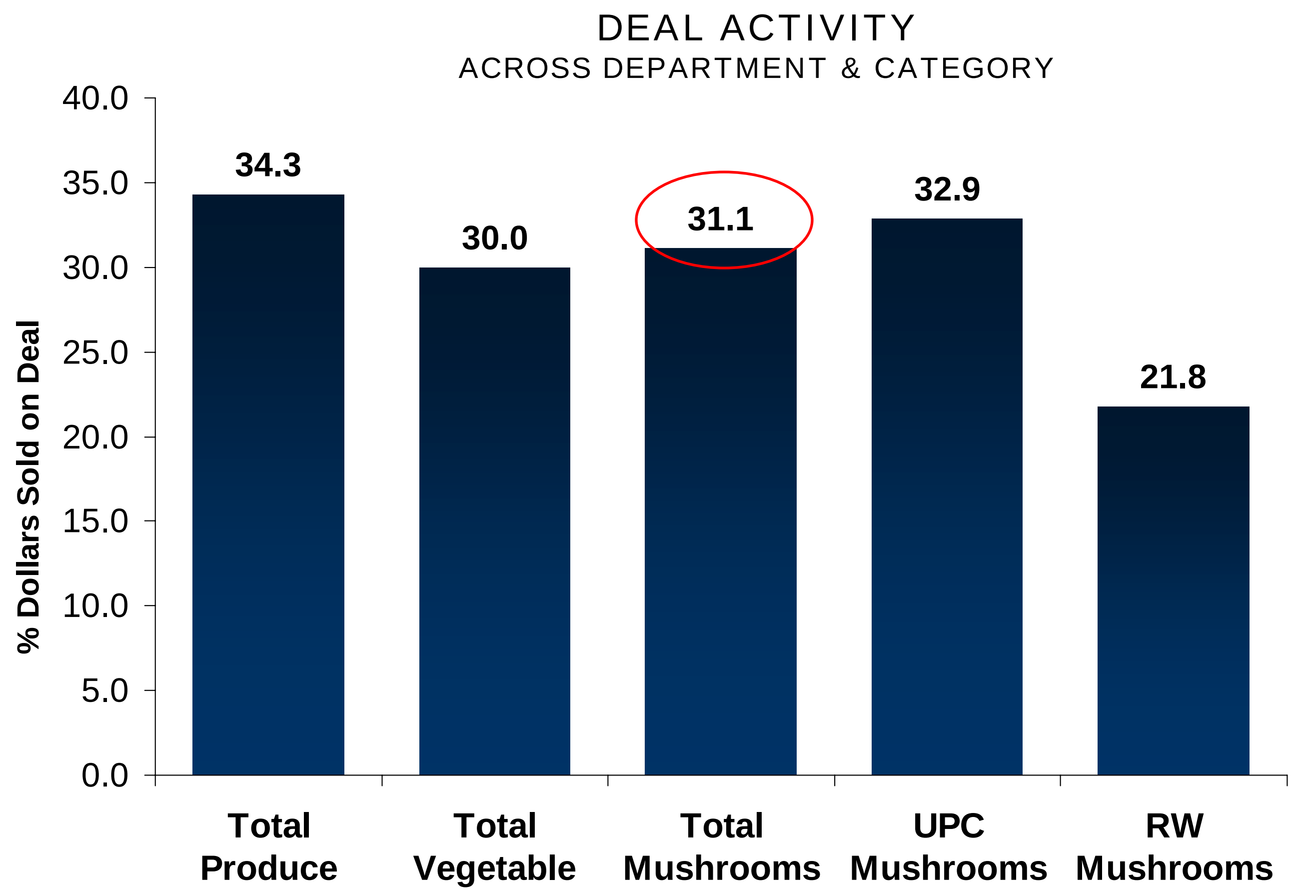
Keeping Your Business Fresh®

www.perishablesgroup.com

Deals are defined as features, displays, store coupons, manufacturer coupons, and other deals such as price packs or bonus packs.

Deal Activity Comparison

- ***A greater percentage of mushroom dollars is sold on deal than vegetables. Furthermore, nearly a third of all UPC mushroom sales is associated with deal.***



FRESH MUSHROOMS what a good idea

Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

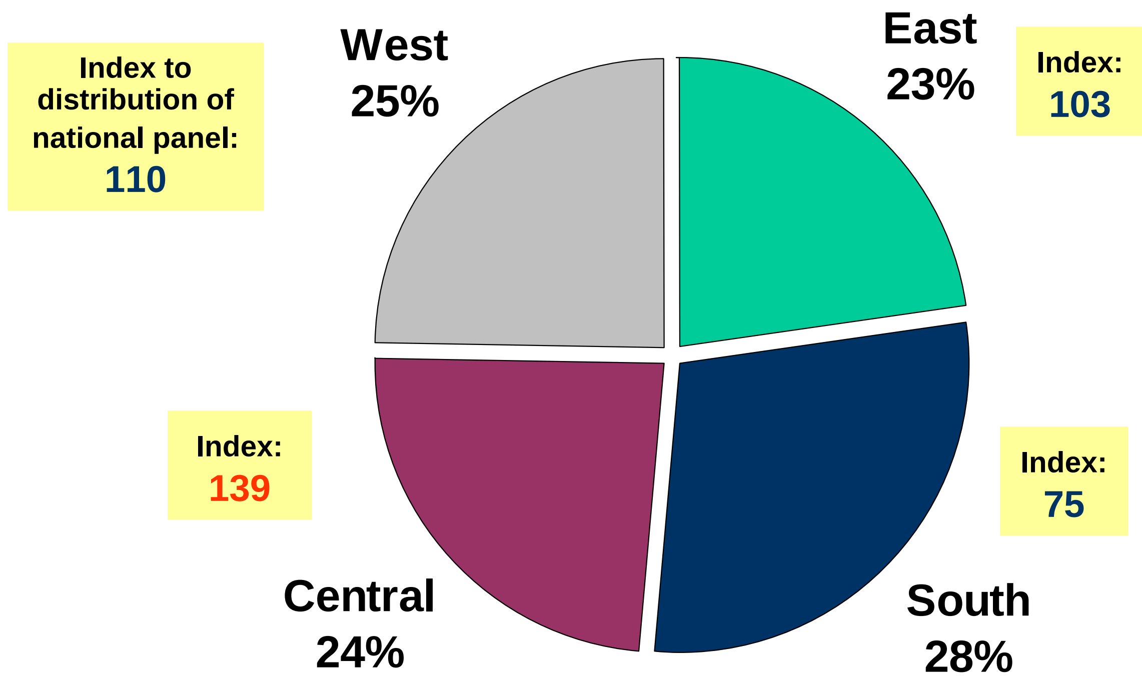
SAMPLE SIZE:
Total US HHs buying mushroom category: 3,532

East: 832 HHs
South: 1,198 HHs
Central: 592 HHs
West: 910 HHs

Buyer Distribution

- ***Mushroom buyers are evenly distributed across geographic regions. The South is under-developed, while there are more buyers than expected in the Central region.***

BUYER DISTRIBUTION
BY REGION



Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

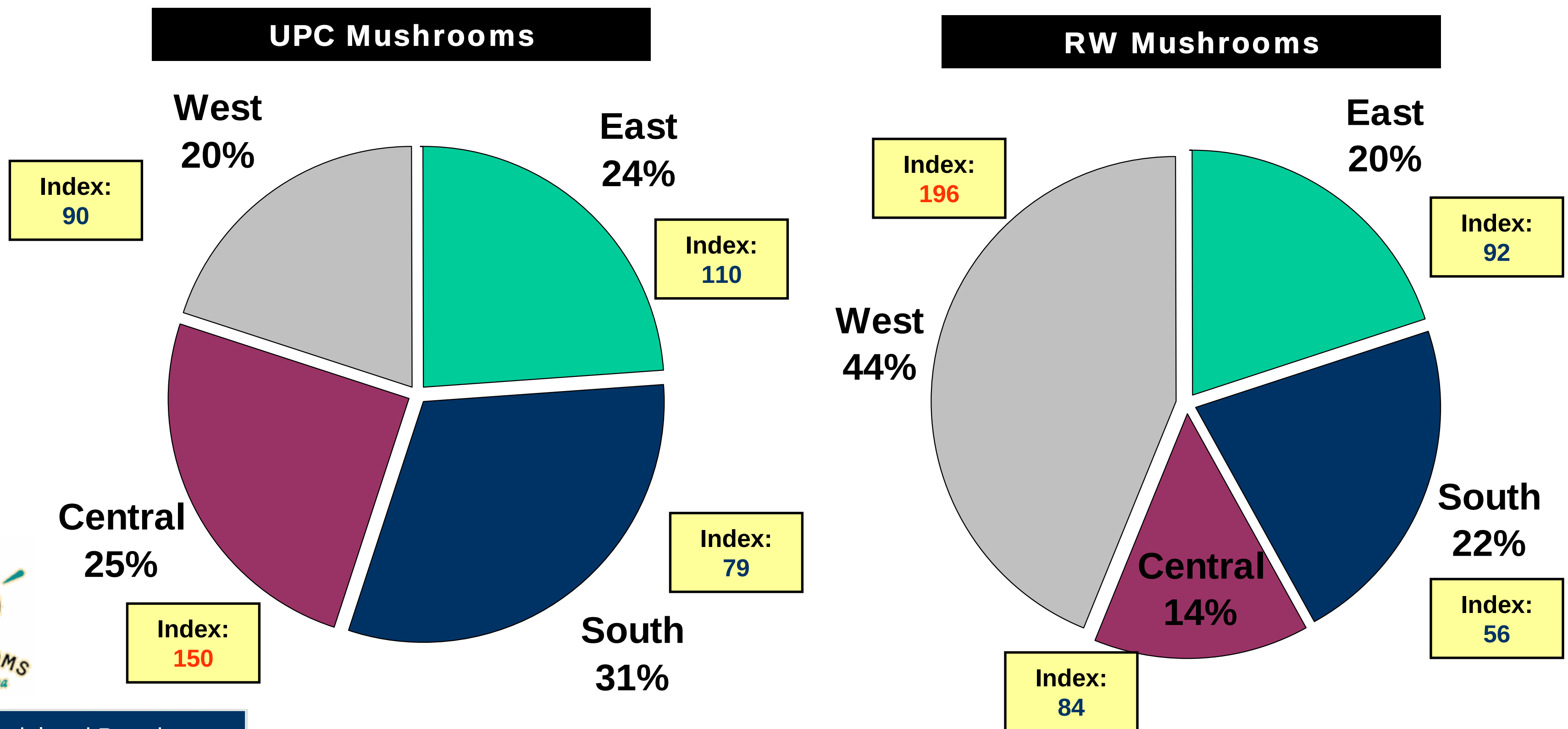
PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

- **Buyer Distribution (cont.)**
  - ***There are clear differences in mushroom type preferences across geographic regions. RW mushrooms have a strong presence in the West, and is somewhat under developed in other regions.***

BUYER DISTRIBUTION
BY MUSHROOM TYPE

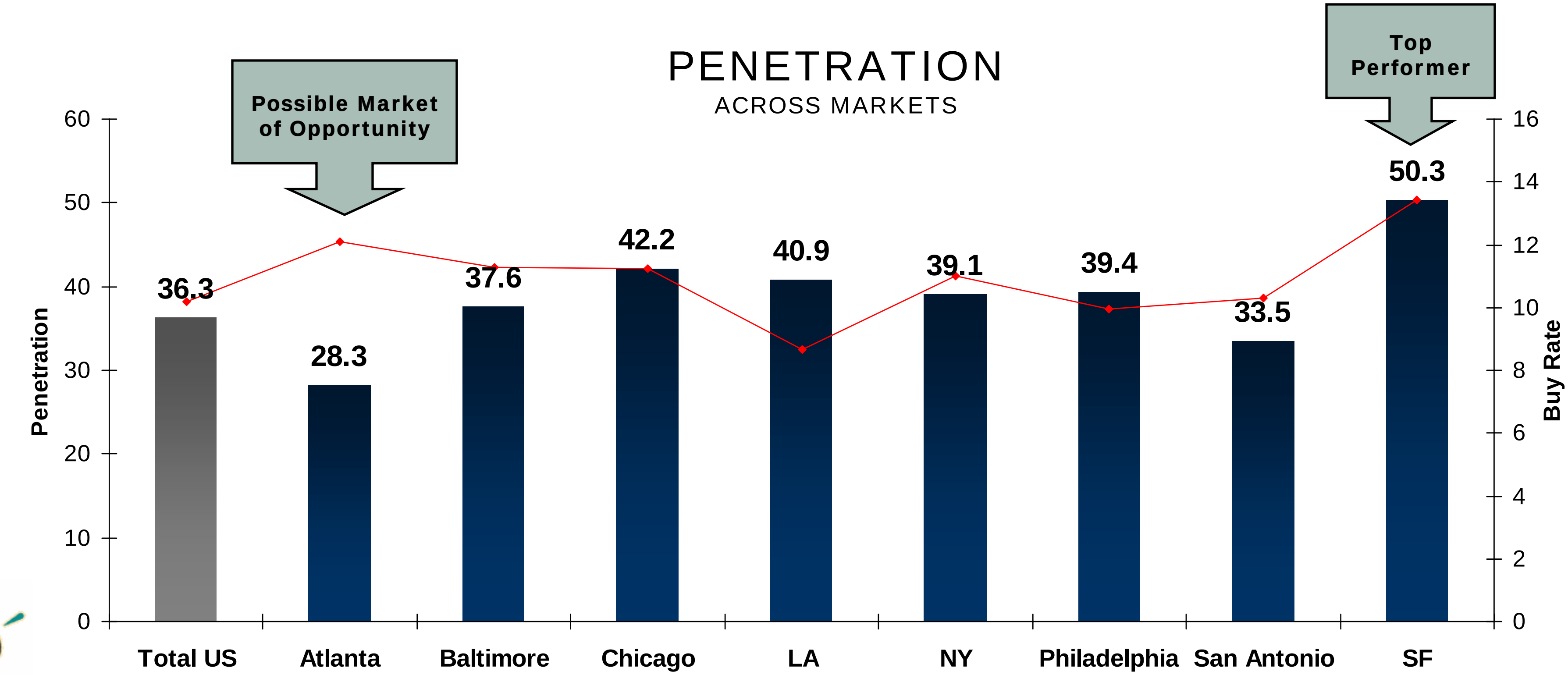


FRESH MUSHROOMS what a good idea

Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

- **Penetration & Buy Rate by Market**
  - ***Penetration is highest among the SF, LA and Chicago markets. Spend rate, however, is second highest in Atlanta, where the average mushroom buyer spends $12 per year on the category.***

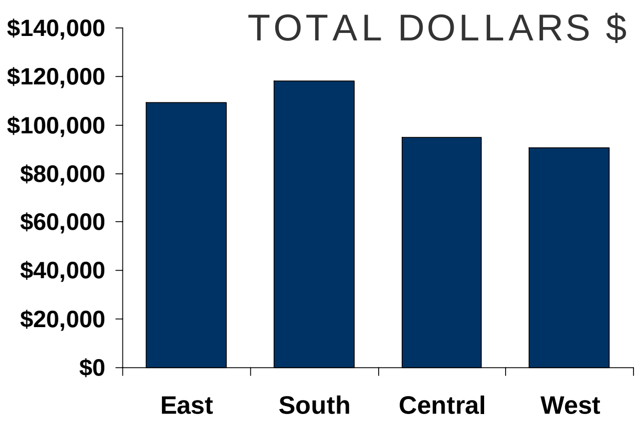


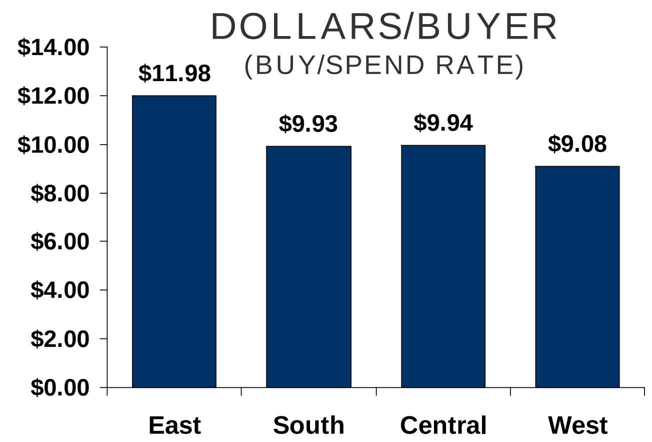
Note: Due to small sample sizes, use data directionally.

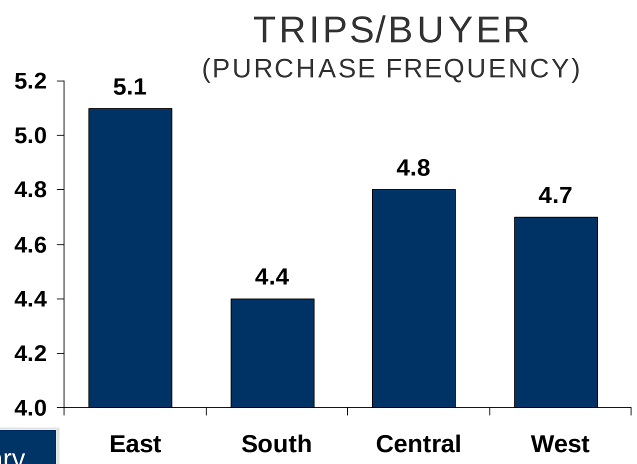
Source: ACNielsen Homescan Panel Data, 2004

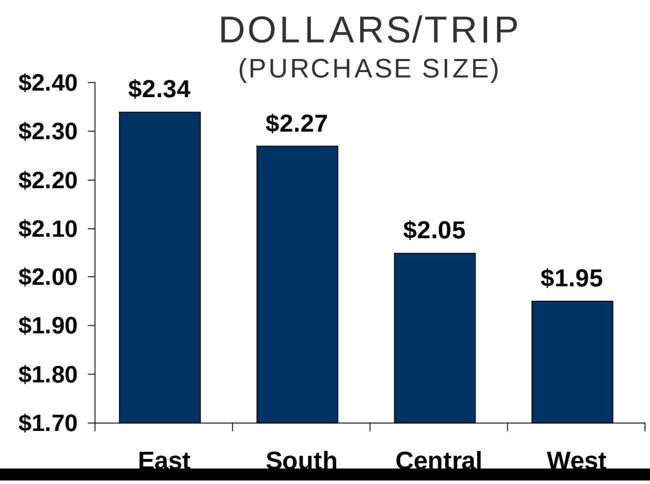
Consumer Shopping Behavior

- **Total Mushrooms Regional Comparison**
  - ***Although the South Region dominates in total sales, the East Region has heavier category buyers that have high spend rate and make the most trips per year.***









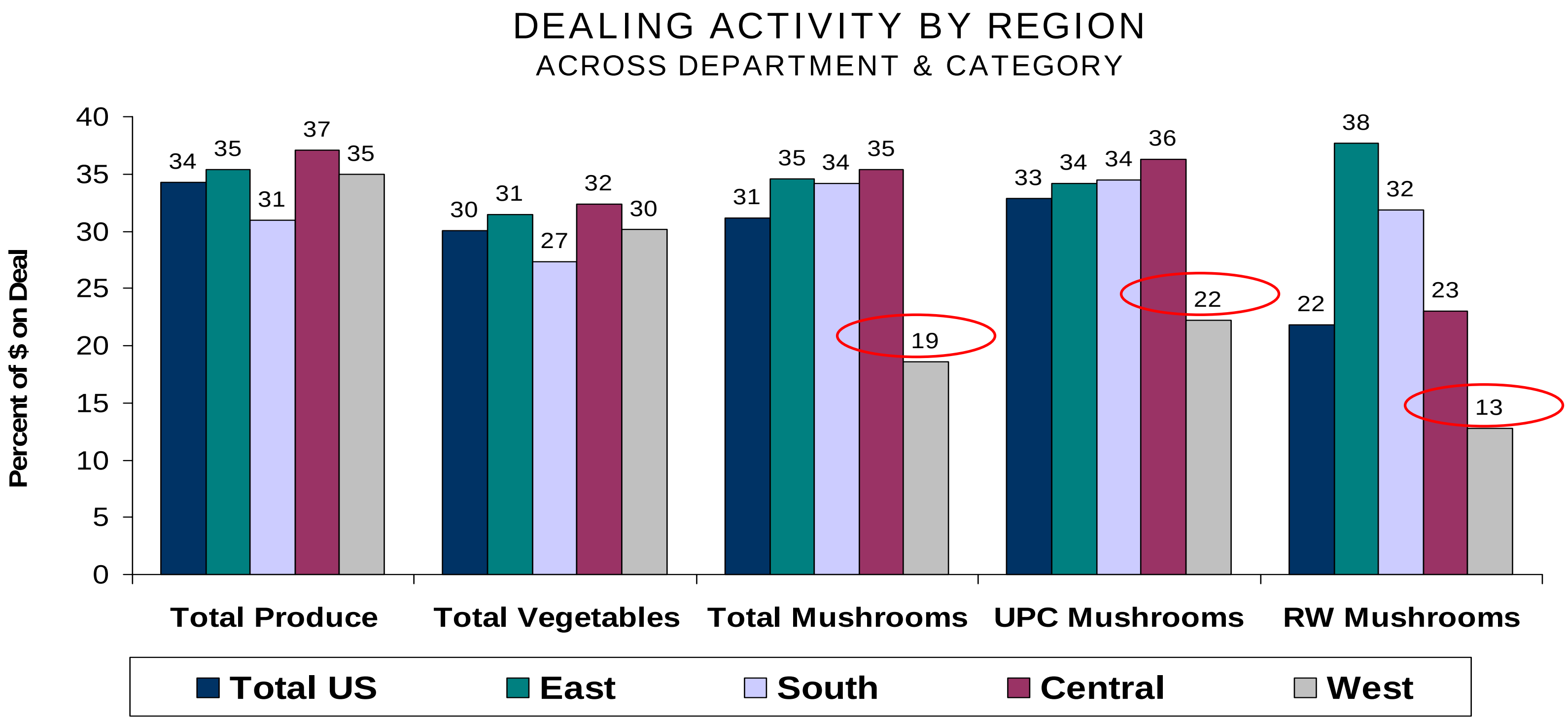
Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

Dealing Activity by Region

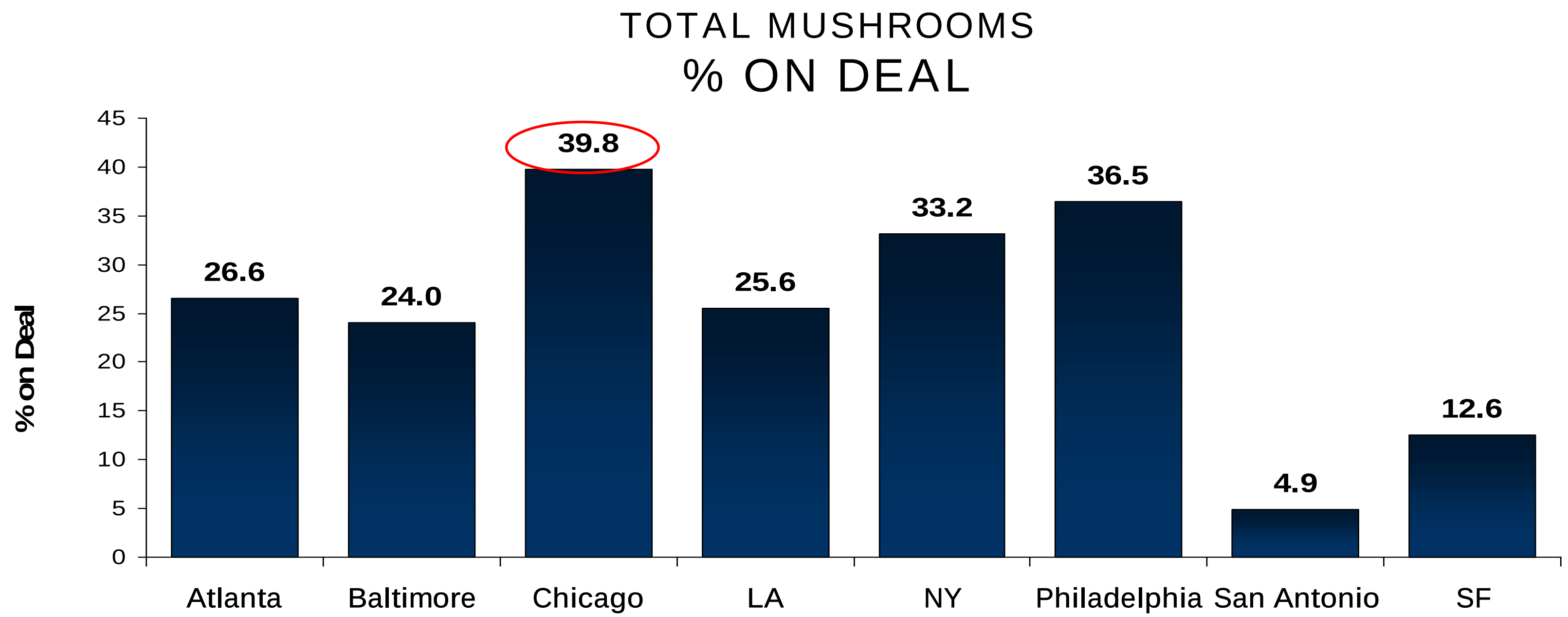
- ***Approximately one-third of produce and vegetable purchases are associated with retail promotion/discounting. Deal activity for mushrooms varies widely across geographic regions. Deal activity is at the lowest level in the West.***



Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

- **Dealing Activity by Market**
  - ***Deal percentages vary significantly by market. Chicago and Philadelphia have the highest level of promotion/discounting.***



Note: Due to small sample sizes, use data directionally.

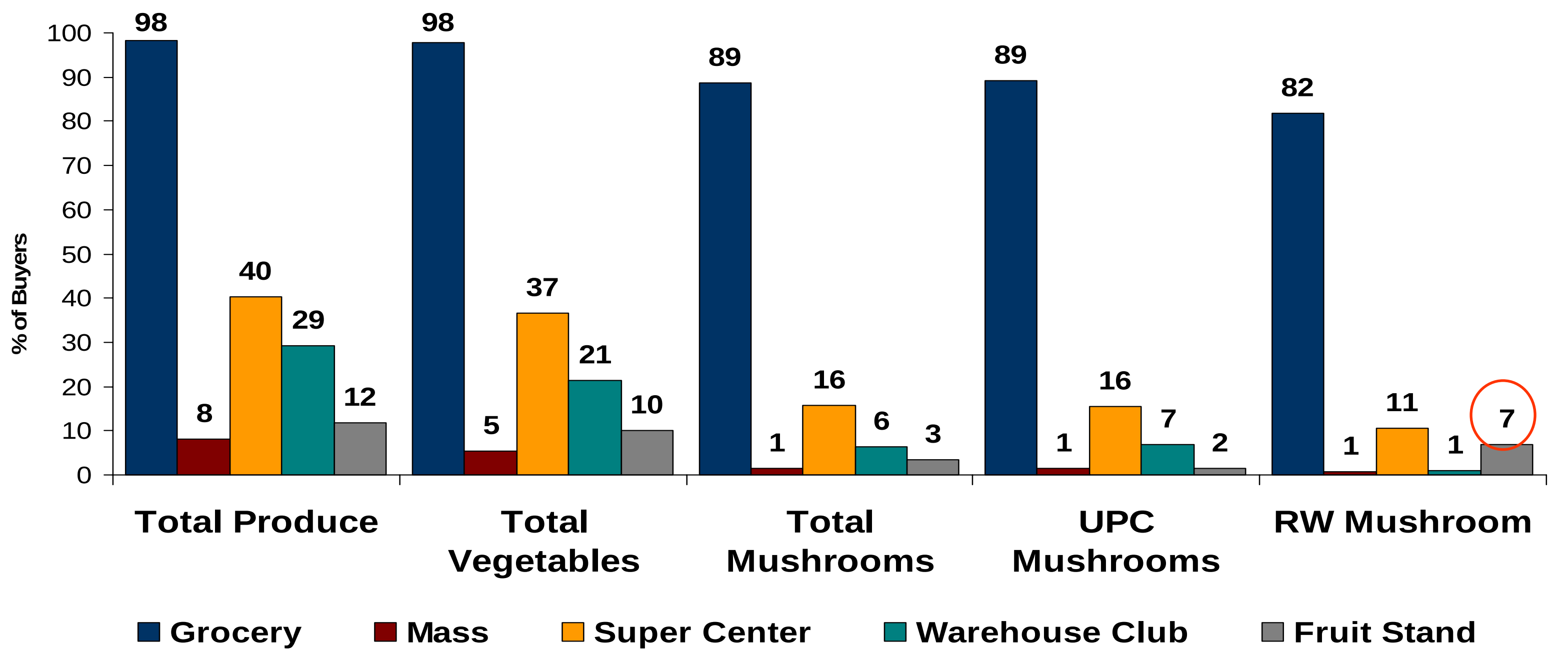
Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

Percent of Buyers by Channel

- ***Mushroom buyers are shopping primarily in traditional grocery stores. Fewer mushroom buyers are shopping in Mass, SC and club than consumers of vegetables & produce. A portion of RW mushroom consumers are buying through vegetable stands (7%).***

PERCENT OF BUYERS BY CHANNEL *

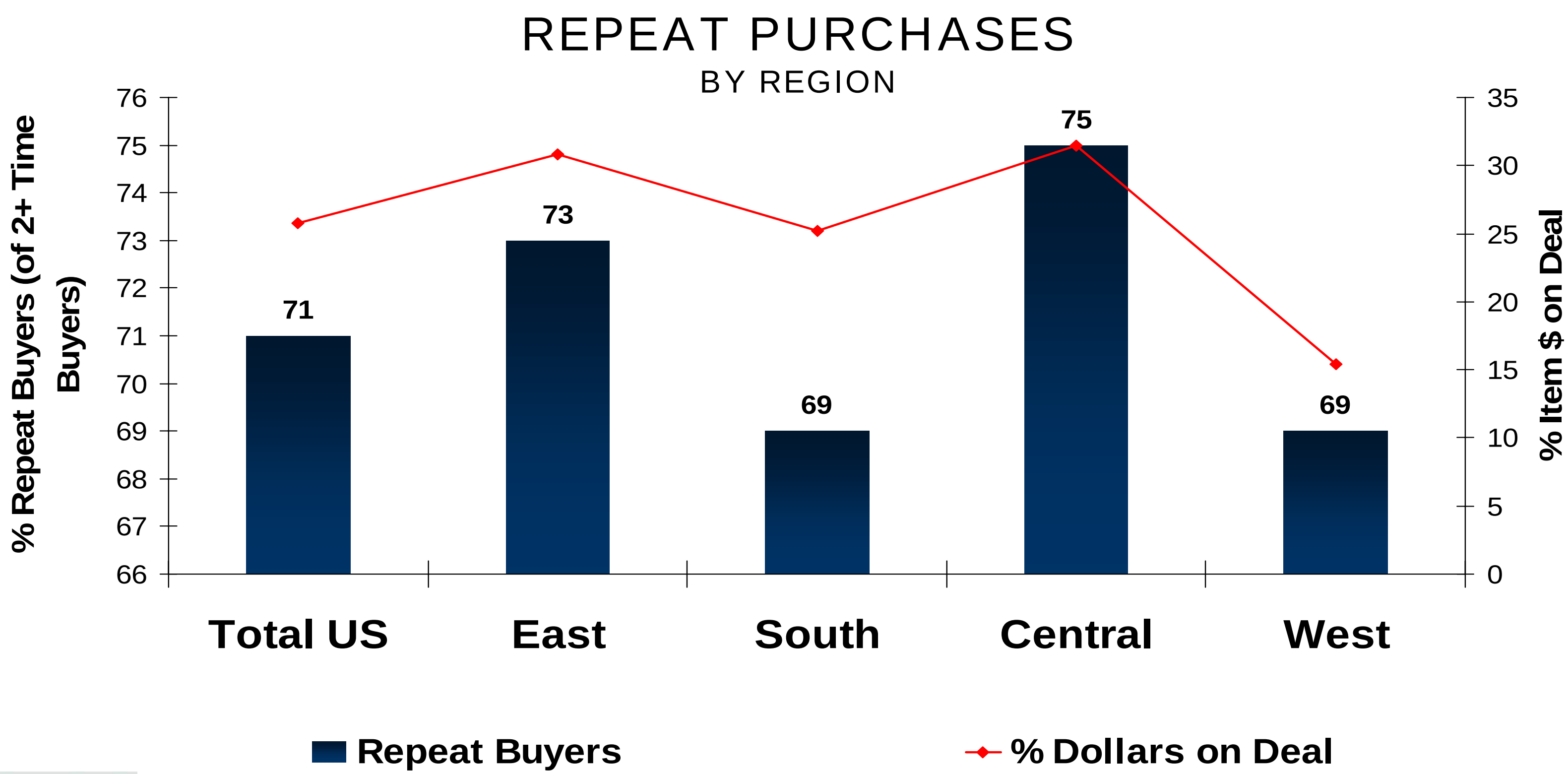


* Percentages also reflect buyers shopping multiple channels (percentages are not additive).

Source: ACNielsen Homescan Panel Data, 2004

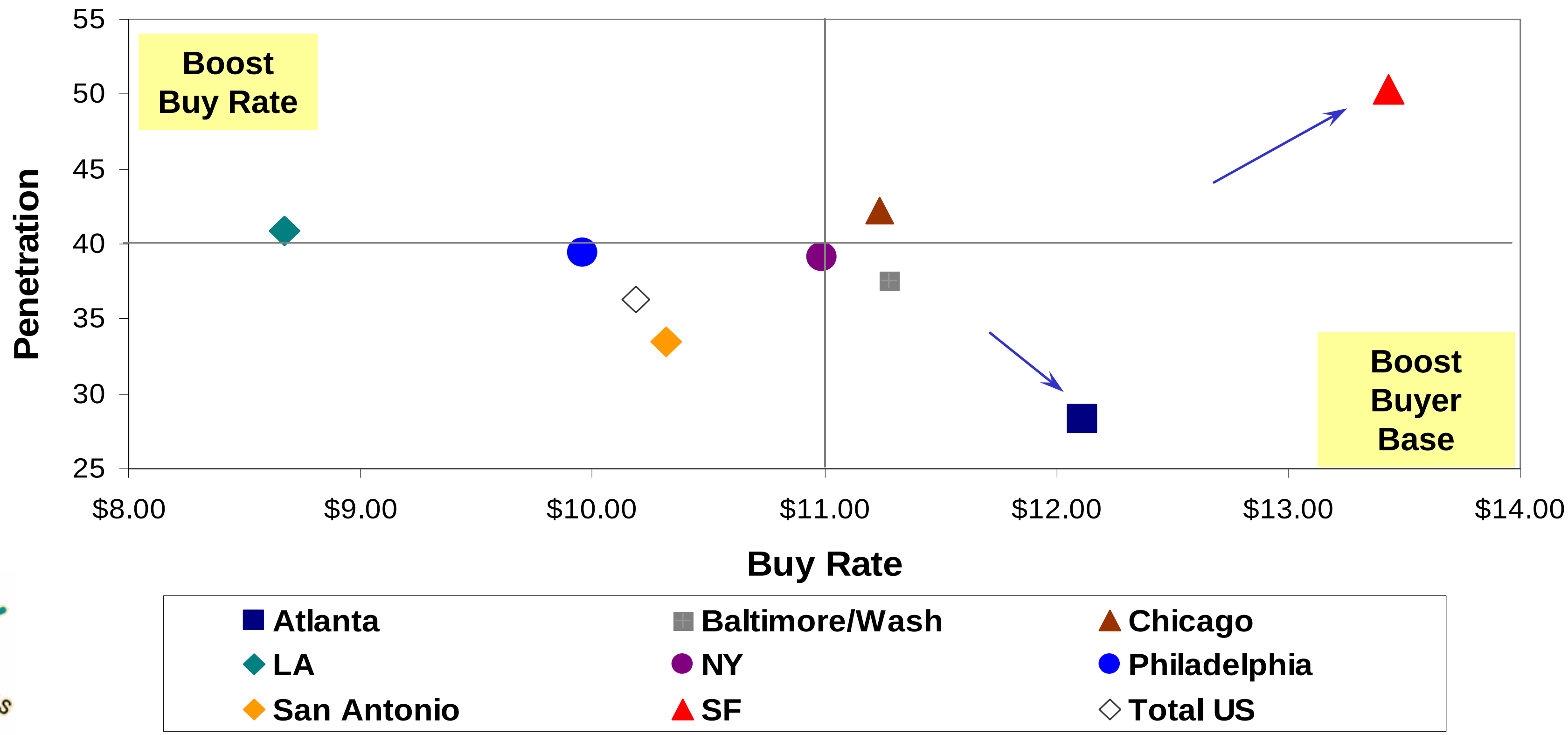
Consumer Shopping Behavior

- **Repeat Levels by Region**
  - ***Repeat level is highest in the Central region, where 75% of 2+ time buyers bought again.***



Consumer Shopping Behavior

- **Market Opportunity Growth**
  - ***SF is a top performing market, with high penetration and significantly higher buy rate. Atlanta is a high potential market with high buy rate, but remains one of the lowest in penetration.***



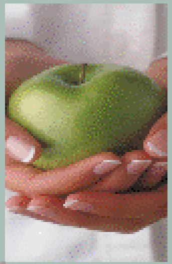
Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Consumer Demographic Profile



ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

Demographic Profile

Mushroom Consumer Profile Summary

GROUPS REPRESENTING
MAJORITY OF MUSHROOM DOLLARS

HH Income Level
Higher Income $70k+ (30% of dollars)

HH Size
2 Members (39%)

Presence of Children
No Children less than 18 years old (48%)

Lifestage
Empty Nesters (19%)

Race
Caucasian (68%)

Source: ACNielsen Homescan Panel Data, 2004

Demographic Profile

Mushroom Consumer Profile Summary

- **High indices towards more affluent, 2 member households; strong index towards Asian households**

<u>HIGH INDEXING GROUPS</u> *

HH Income Level

Higher income $70k+ (157 index)

HH Size

2 Members (119)

Presence of Children

(No skew)

Lifestage

Childless Younger Couples (128), Empty Nesters Living Comfortably (130), New Families (124)

Race

Asian (186)

* Groups exhibiting strongest skews, i.e. representing more than their “fair share” of category dollars.

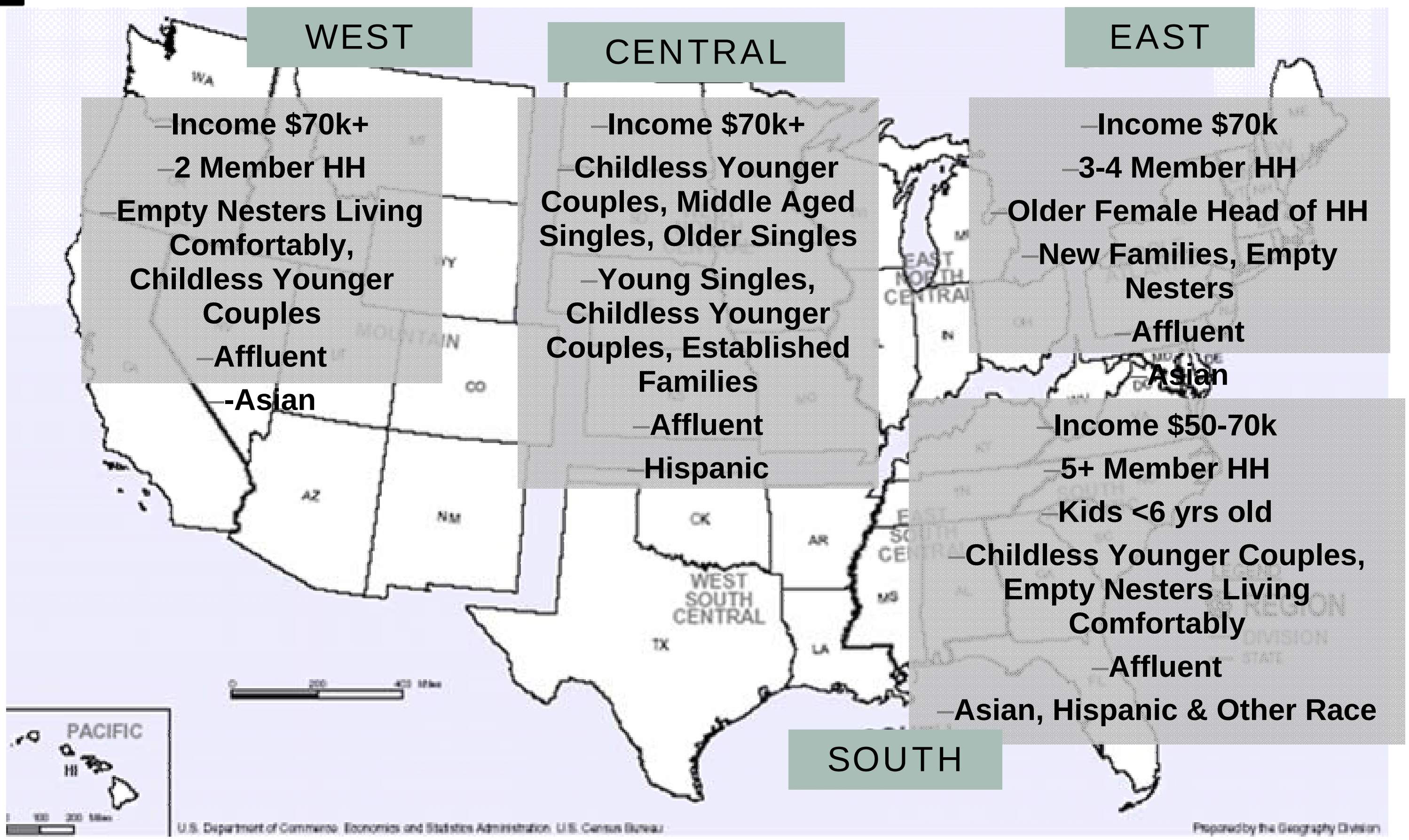
PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Demographic Profile

Who are your mushroom consumers? *



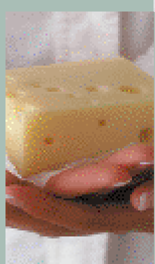
FRESH MUSHROOMS *what a good idea*

* Groups exhibiting strongest skews, i.e. representing more than their “fair share” of category dollars.

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com



Consumer Demographic Profile

Total Vegetable vs. Mushroom

ACNielsen

homescan

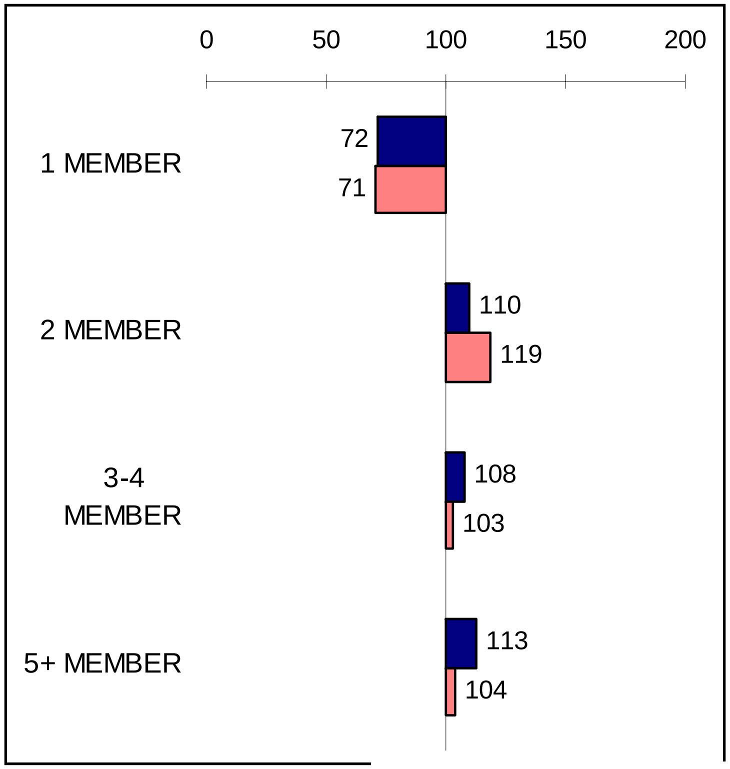
THE AUTHORITY ON CONSUMER BEHAVIOR

Demographic Profile

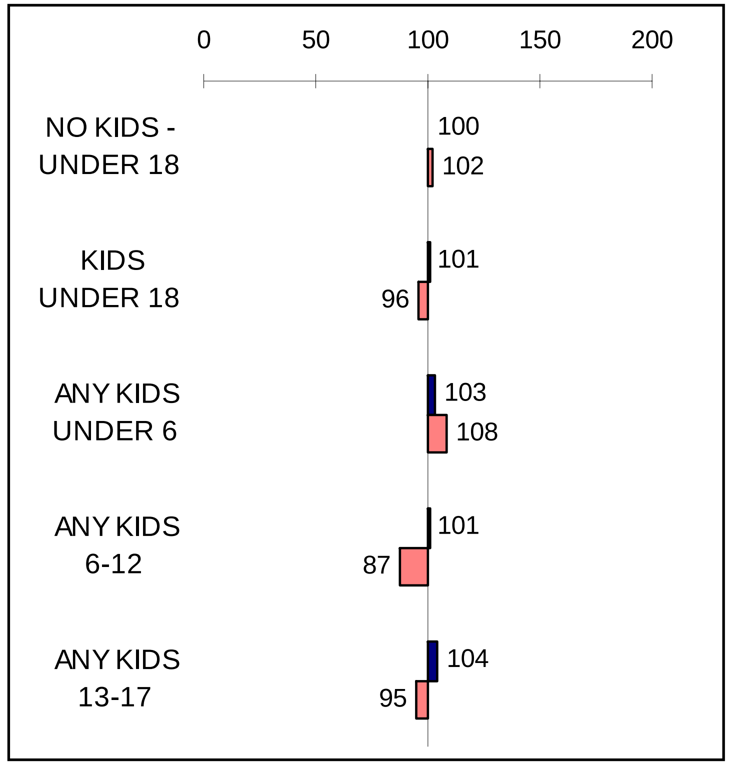
Index of 120 or greater indicates the group purchases more than expected.

- **Vegetable Consumers vs. Mushroom Consumers**
  - ***Mushroom households tend to be larger (5+ members) and have young kids.***

HH SIZE



AGE/PRESENCE OF KIDS



Total Vegetables   Total Mushrooms

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

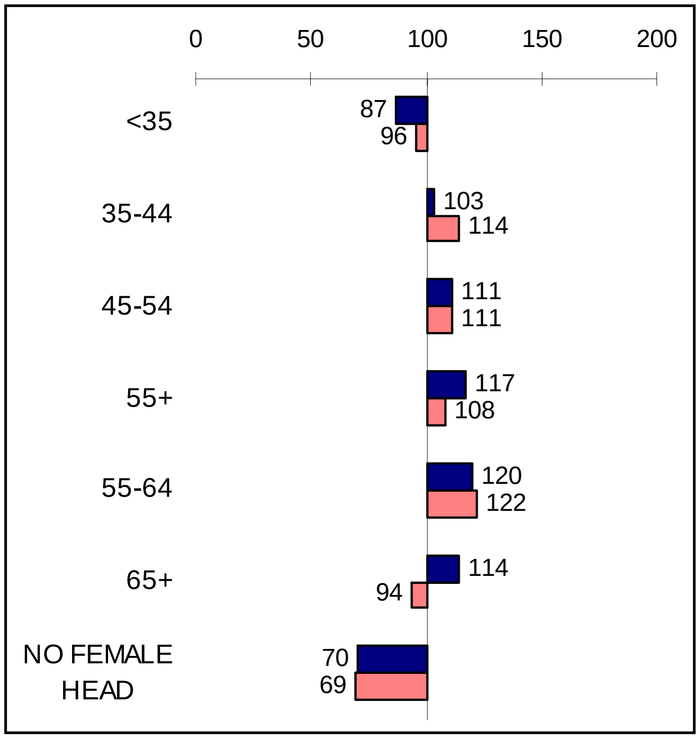
www.perishablesgroup.com

Demographic Profile

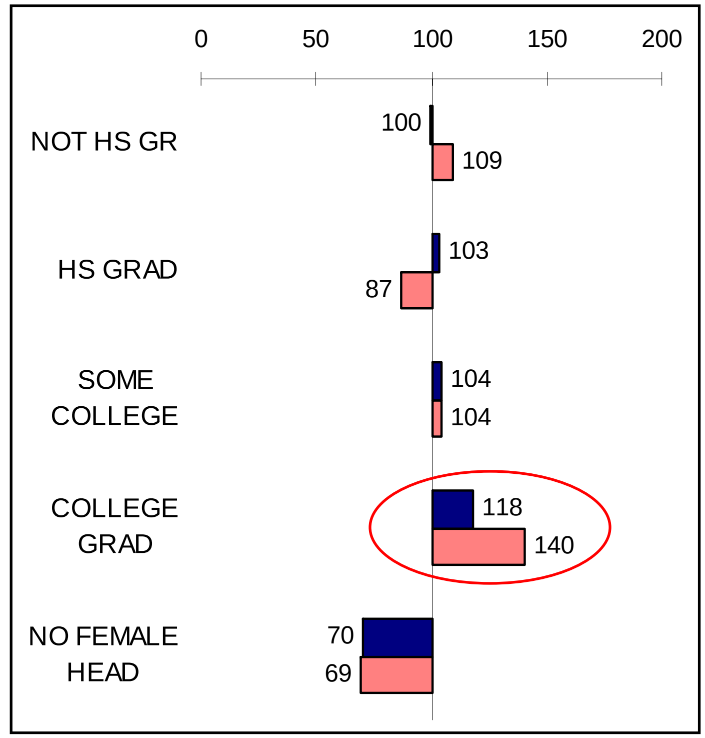
Index of 120 or greater indicates the group purchases more than expected.

- **Vegetable Consumers vs. Mushroom Consumers**
  - ***The female head age tends to be slightly older (65+) for mushroom households (65+), with skews in both the educated and uneducated groups, while the general vegetable category attracts female head ages of 55-65.***

FEMALE HEAD AGE



FEMALE HEAD EDUCATION



■ Total Vegetables ■ Total Mushrooms

FRESH MUSHROOMS *what a good idea*

Source: ACNielsen Homescan Panel Data, 2004

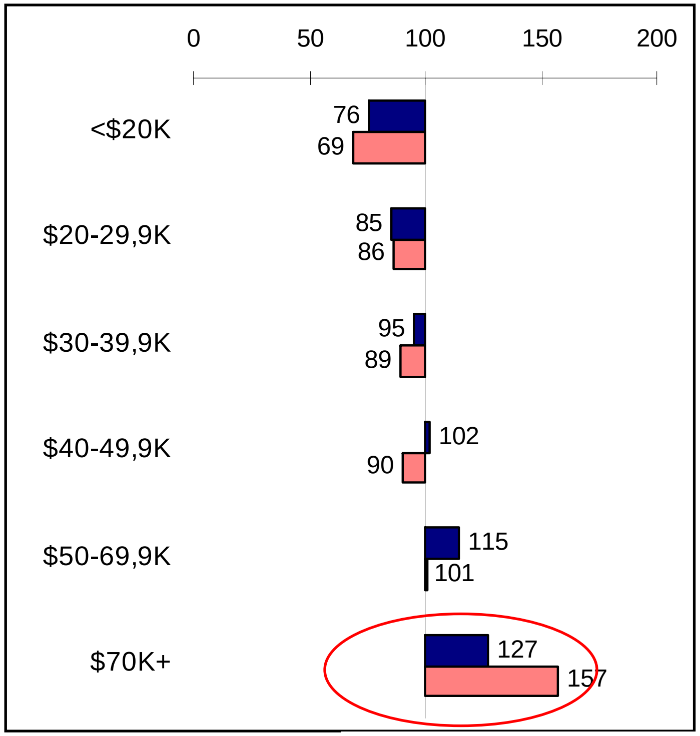
Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

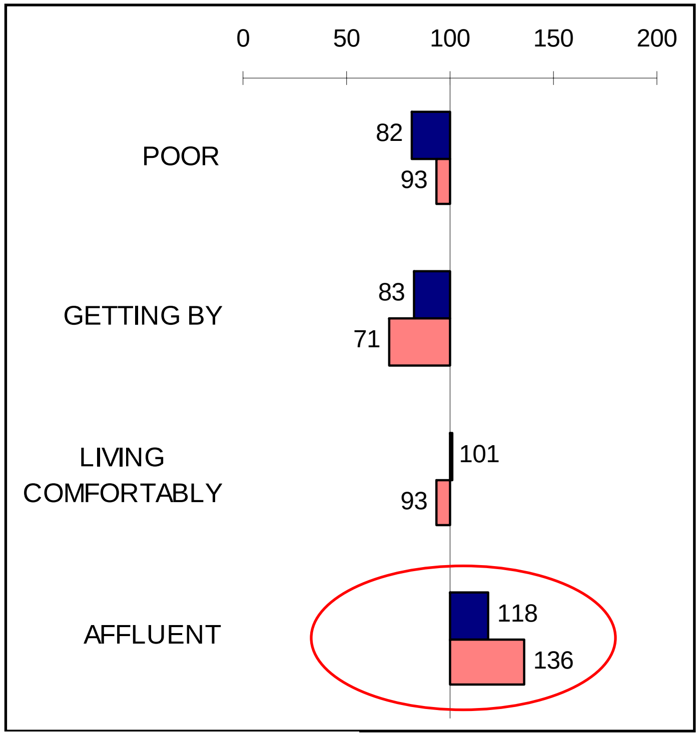
Vegetable Consumers vs. Mushroom Consumers

- ***Mushroom consumers tend to be just as affluent as the average vegetable buyer.***

HH INCOME



HH AFFLUENCY



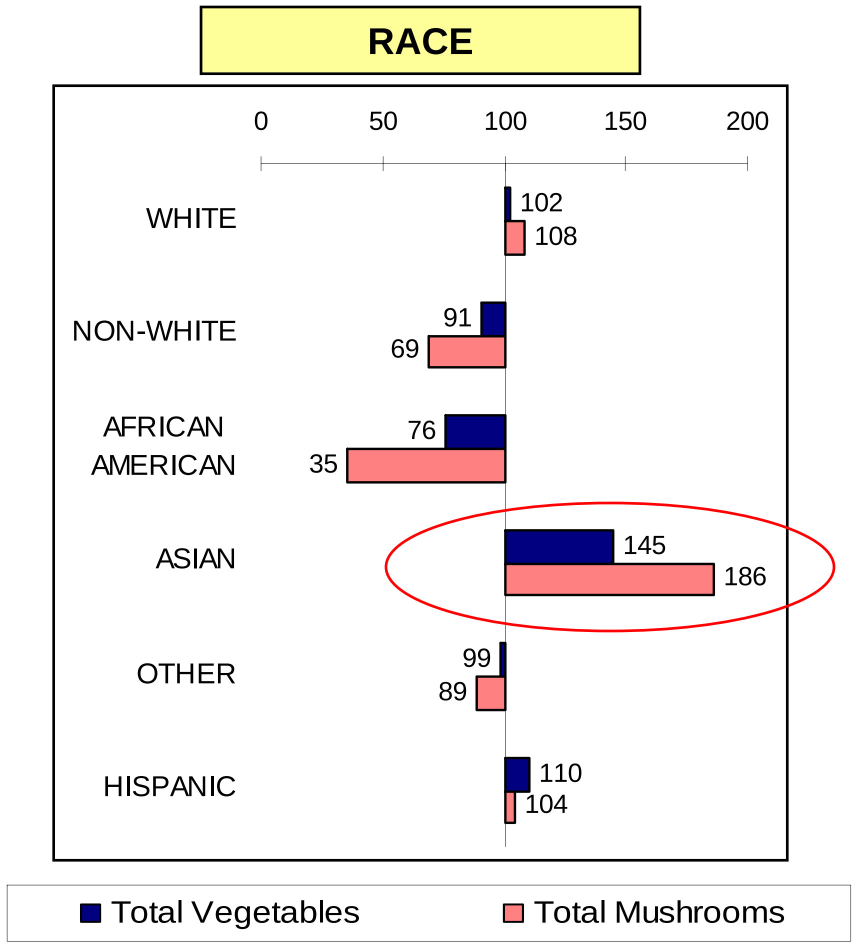
Total Vegetables   Total Mushrooms

Source: ACNielsen Homescan Panel Data, 2004

Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

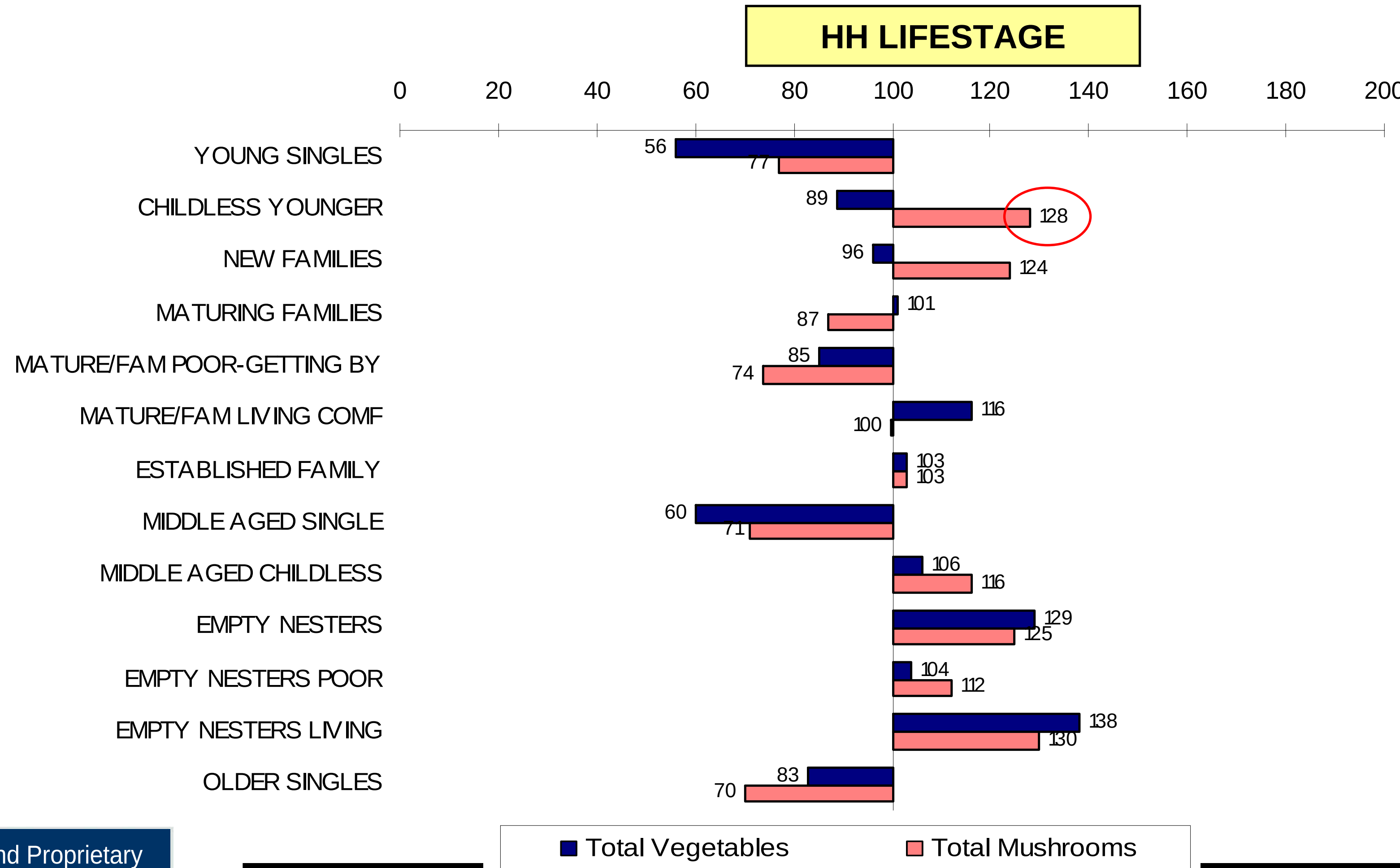
- **Vegetable Consumers vs. Mushroom Consumers**
  - ***Total vegetable and mushrooms both over-index in Asian households***



Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

- **Vegetable Consumers vs. Mushroom Consumers**
  - ***Mushroom consumers exhibit high indices towards Childless Younger and New Families, while average vegetable consumers are Empty Nesters.***



PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Consumer Demographic Profile

UPC vs RW Mushroom

ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

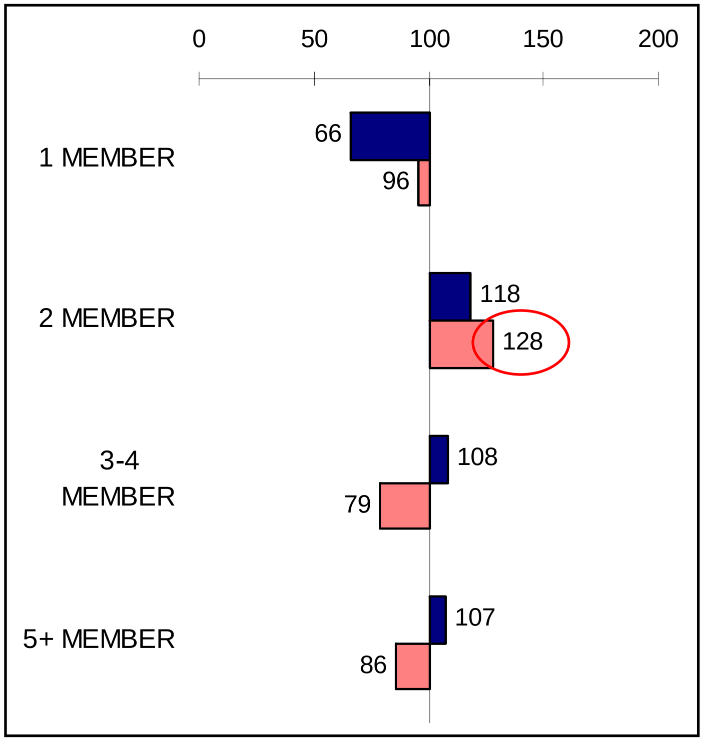
Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

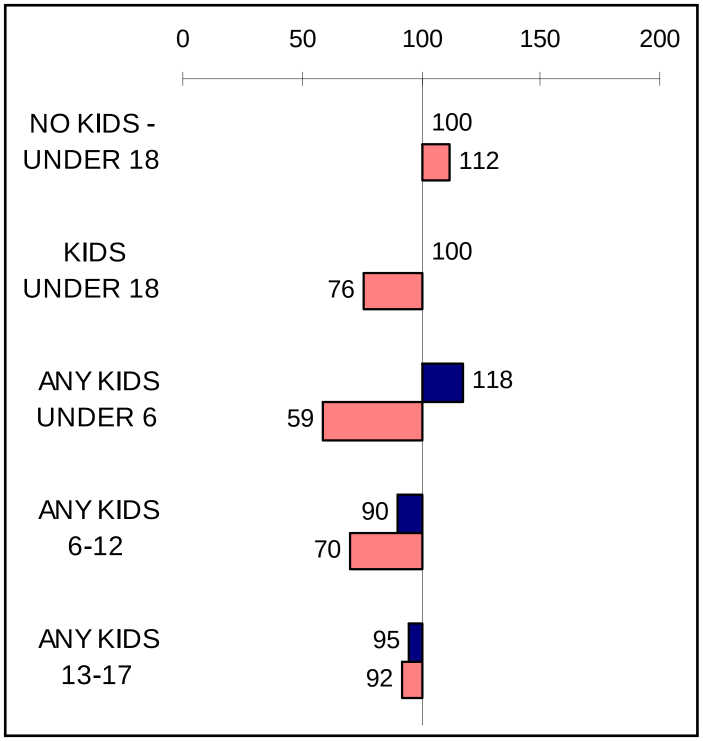
UPC vs. RW Mushroom

- ***RW Mushroom consumers tend to fall in 2 member households.***

HH SIZE



AGE/PRESENCE OF KIDS



UPC Mushrooms RW Mushrooms

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

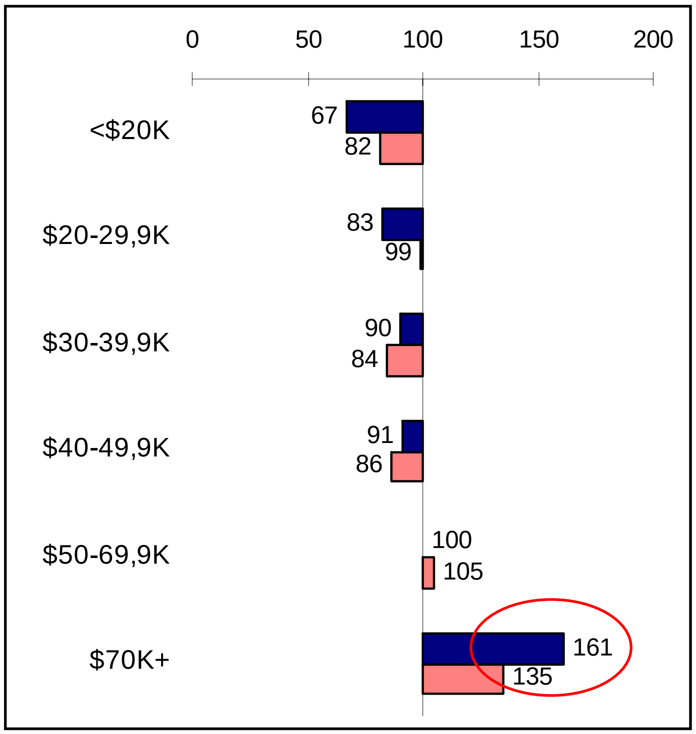
Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

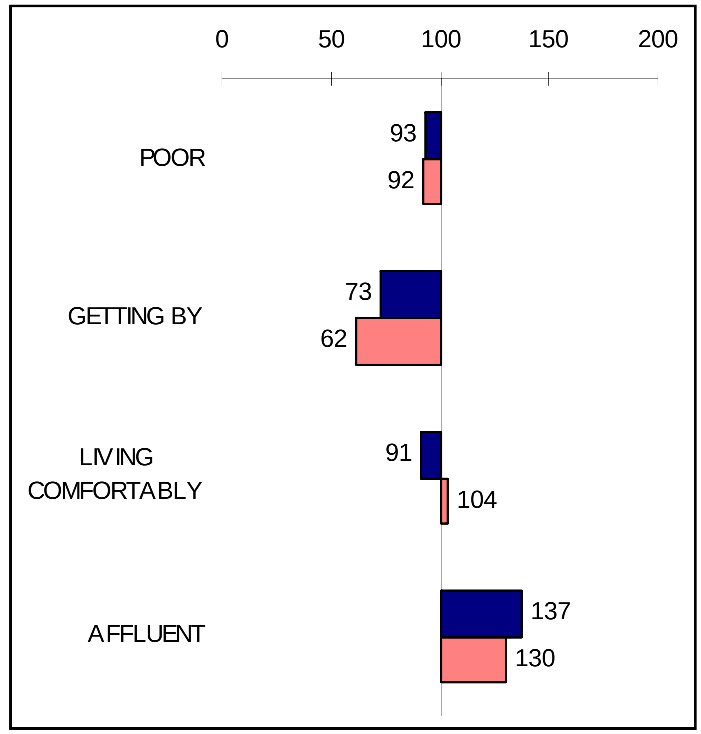
UPC vs. RW Mushroom

- ***UPC Mushroom households tend to be slightly more affluent.***

HH INCOME



AFFLUENCY



■ UPC Mushrooms ■ RW Mushrooms

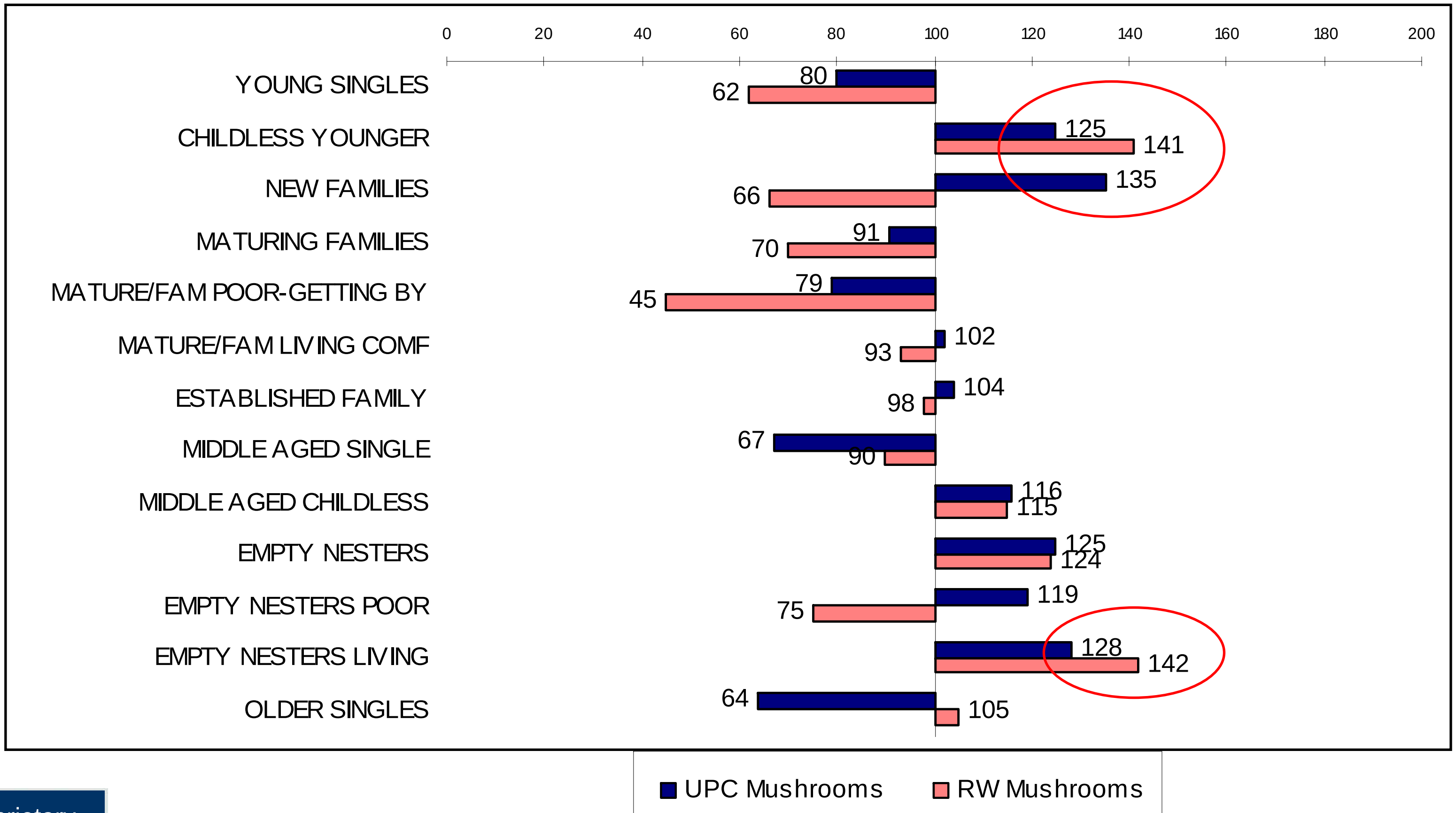
Source: ACNielsen Homescan Panel Data, 2004

Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

- **UPC vs. RW Mushroom**
  - ***More childless younger couples and older singles purchase RW mushrooms than UPC mushrooms.***

LIFESTAGE

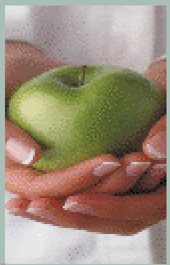


Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com



Market Basket Data

ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

Market Basket

Trips Per Shopper

Items purchased with mushrooms in more than 2 shopping trips per year:

Dairy Department:
Butter & Margarine (2)
Cheese (3)
Cottage Cheese/Sour Cream (2)
Shredded Cheese (2)
Eggs (2)
Milk (3)
Yogurt (3)

Meat Department:
Fresh Meat (2)
Packaged Meat/Deli (3)

Shelf Stable Department:
Canned Shrimp (3)
Toppings (Liquid & Dry) (3)

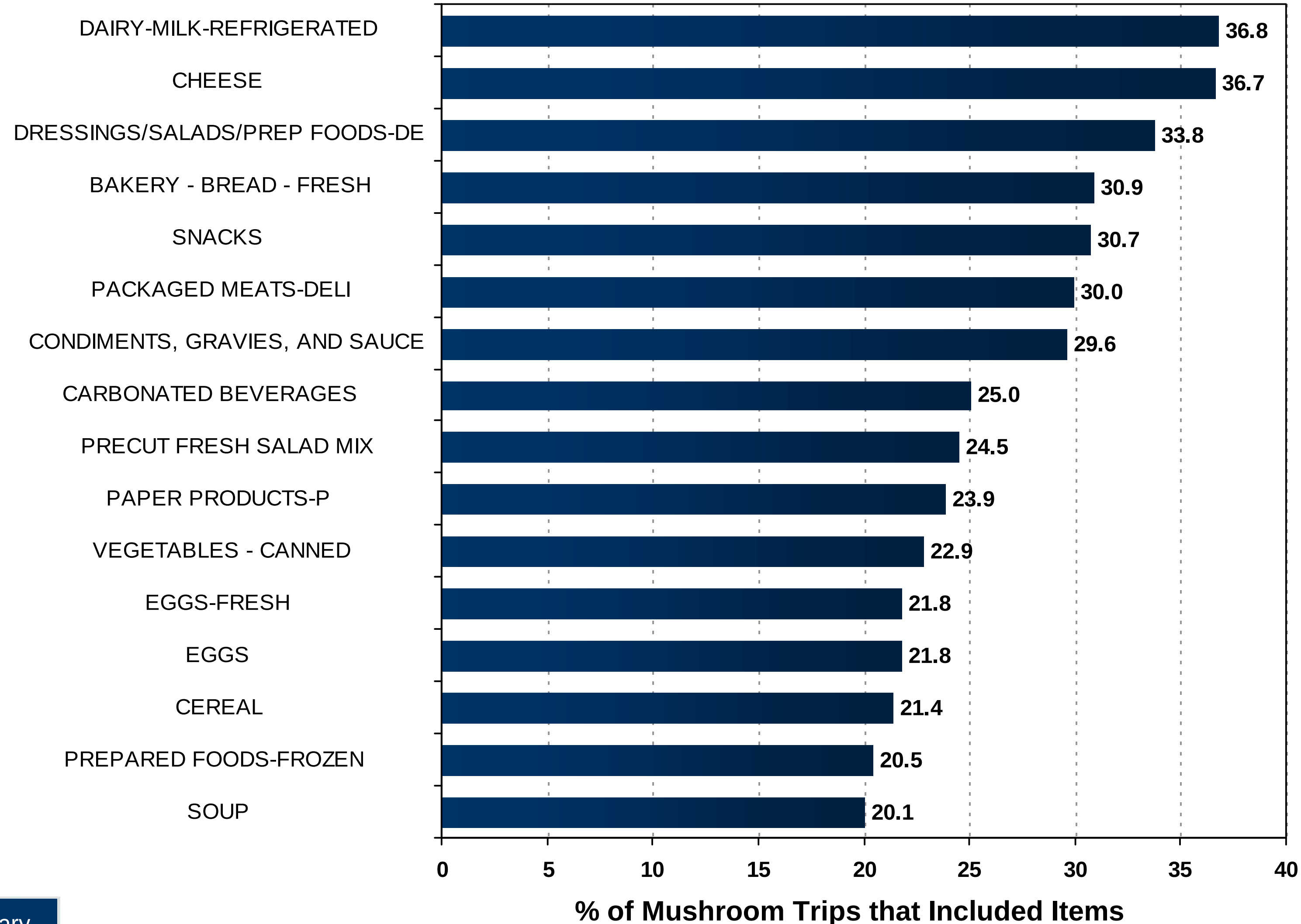
Refrigerated/Produce:
Precut/Fresh Salad Mix (3)
Fresh Lettuce (3)

FRESH MUSHROOMS what a good idea

Source: ACNielsen Homescan Panel Data, 2004

Market Basket

% of Trips With Mushrooms

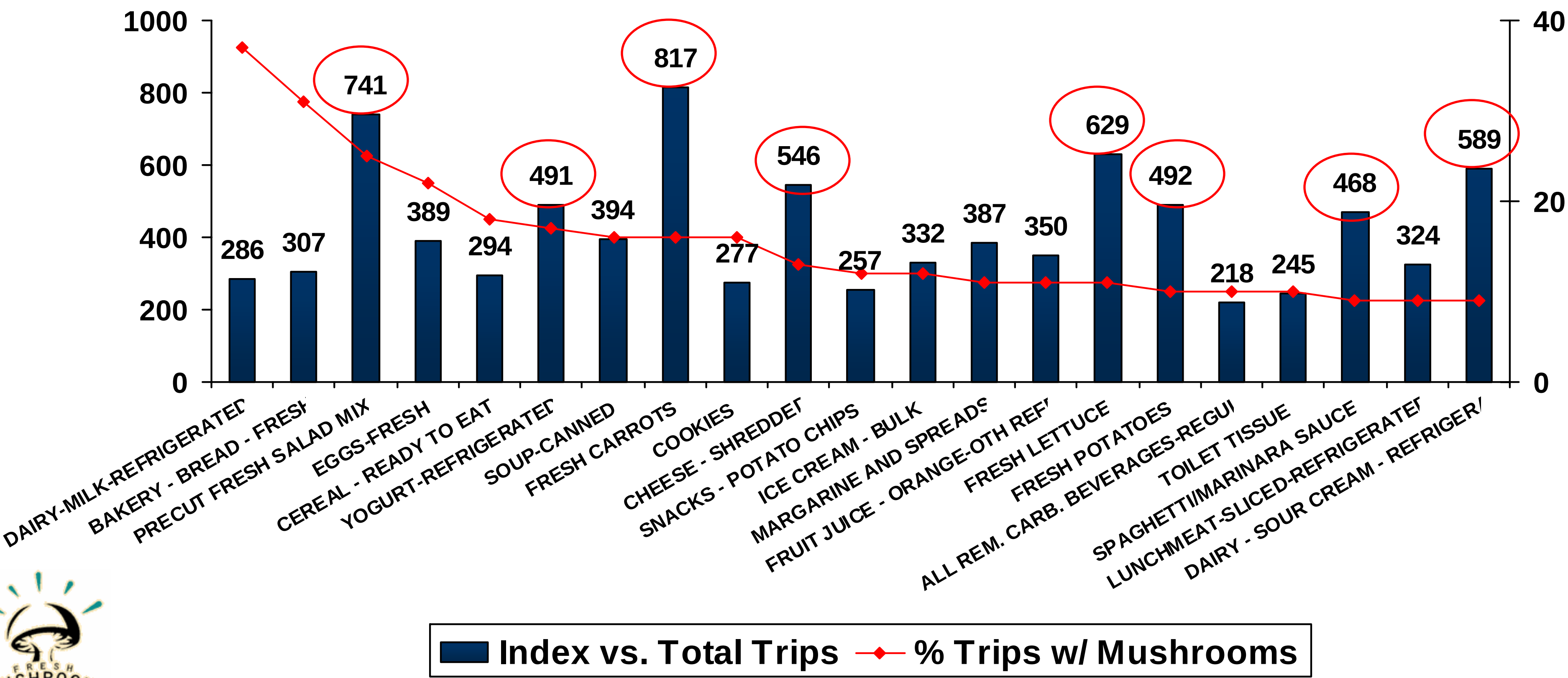


Source: ACNielsen Homescan Panel Data, 2004

Market Basket

% of Trips with Mushrooms vs. Trip Index

Higher index indicates higher likelihood of being in basket when mushrooms are purchased



Source: ACNielsen Homescan Panel Data, 2004


Norman
Rockwell

Scientific Literature Review Appendix

List of Scientific Articles

- "Analysis of Automatic Weight-Fill Bagging Machinery for Fresh Citrus"
- "Analysis of the Factors Implied in the Fruit to Fruit Impacts on Packing Lines"
- "Analysis of the Mechanical Aggressiveness of Three Orange Packing Systems: Packing Table, Box Filler and Net Filler"
- "Apple Impact Damage Thresholds"
- "Apple Packing Line Damage Reduction"
- "Assessment of Apple Damage on Packing Lines"
- "Design of a Shitake Mushroom Packing Line"
- "Fruit Damage Assessment in Peach Packing Lines"
- "Fruit and Vegetable Bruise Threshold Prediction Using Theory of Elasticity and Failure Tissue Properties"
- "Grading of Mushrooms using Machine Vision System"
- "Impact Bruise Estimates for Onion Packing Lines"
- "Impacts Recorded on Avacado, Papaya, and Pineapple Packing Lines"
- "Instrumented Sphere Impact Analysis of Tomato and Bell Pepper Packing Line"
- "Mechanical Harvesting System for Burley Tobacco"
- "Multi Purpose, Vegetable Production Machine Investigation"
- "Packing Line Bruise Evaluation for 'Walla Walla' Summer Sweet Onions"
- "Peach Physical Characteristics for Orientation"
- "A Procedure for Testing Padding Materials In Fruit Packing Lines Using Multiple Logistic Regression"
- "Reduction of Mechanical Damage to Apples in Packing Lines Using Mechanical Devices"
- "Sorting Table Illumination on Stonefruit Packing Lines in California"
- "Suspended Tray Package for Shipping Soft Fruit"

"Analysis of Automatic Weight-Fill Bagging Machinery for Fresh Citrus"
Citation: Applied Engineering in Agriculture. 2(2): 252-256. @1986
Authors: W. M. Miller, R. P. Muraro, W. F. Wardowski
Keywords: Automation, Citrus packing, Fruit production
Abstract – "AUTOMATIC bagging machines which minimize weight overfill have been introduced to pack fresh citrus in Florida. At a commercial packinghouse, a machine was analyzed in bagging K-early tangelos (large fruit, low count/bag) and Robinson tangerines (small fruit, large count/bag). A non-parametric statistical computer program was developed to analyze automatic bagging machinery performance. Iterations in the weight-fill mode of operation were analyzed as an inferential indicator of potential product damage through recycling. Mixing of dimensional sizes was investigated to reduce search iterations."
Available at - http://asae.frymulti.com/abstract.asp?aid=26751&t=1

"Analysis of the Factors Implied in the Fruit to Fruit Impacts on Packing Lines"

Citation: Applied Engineering in Agriculture. Vol. 20(5): 671-675. @2004
Authors: F. J. García-Ramos, J. Ortiz-Cañavate, M. Ruiz-Altisent
Keywords: Fruit-to-fruit impact, Bruise, Instrumented sphere, Powered decelerator
Abstract – "The problem of fruit-to-fruit impacts on packing lines was analyzed in an experimental fruit packing line. Different factors were considered including fruit susceptibility to damage, fruit flow in the line, and characteristics of the transfer points between elements on the line. Tests were performed using "Golden" apples and IS 100 instrumented spheres. Most of the fruit-to-fruit impacts occurred at angled transfer points. A powered decelerator was developed and installed in the packing line that significantly minimized the number and intensity of fruit-to-fruit impacts at transfer points with a 90 degree angle between two transporting belts."
Available at - http://asae.frymulti.com/abstract.asp?aid=17447&t=1

"Analysis of the Mechanical Aggressiveness of Three Orange Packing Systems: Packing Table, Box Filler and Net Filler"
Citation: Applied Engineering in Agriculture. Vol. 20(6): 827-832. @2004
Authors: F. J. García-Ramos, C. Valero, M. Ruiz-Altisent, J. Ortiz-Cañavate
Keywords: Packing systems, Orange, Impact detection, Damage
Abstract – "Three different types of orange packing systems (packing table, box filler, and net filler) were analyzed using an instrumented sphere IS 100 (7 cm.) in four orange packing lines in the region of Levante (Spain). Four packing tables, three box fillers, and three net fillers were tested by analyzing impacts inflicted to fruit at the entrance and outlet transfer points of the machine. In general, entrance transfer points were more aggressive than outlet transfer points. Box filler was the least aggressive machine."
Available at - http://asae.frymulti.com/abstract.asp?aid=17716&t=1

"Apple Impact Damage Thresholds"
Citation: Applied Engineering in Agriculture. 8(1): 55-60. @1992
Authors: N. L. Schulte, G. K. Brown, E. J. Timm
Keywords: Bruising, Fruit, Quality, Packing lines
Abstract – "Drop tests were conducted using an Instrumented Sphere (IS) and four varieties of apples to determine the impact conditions which initiate bruising. 'McIntosh' apples were found to be the most sensitive of the apple varieties. Bruising was initiated at an estimated 2.0 mm (0.08 in.) drop onto steel for large 'McIntosh' apples, the day after harvest. The IS recorded a 20 peak G impact for this drop condition. Bruise threshold response lines for 'McIntosh' were developed and combined with IS impact response lines for typical surfaces used on apple packing lines. This information was incorporated into the IS software, allowing the analysis of impact data based on the probability of occurrence of apple bruises. These estimates can be used to develop conservative design estimates for apple packing line changes, as well as the practical application and choice of cushioning for hard surfaces."
Available at - http://asae.frymulti.com/abstract.asp?aid=26033&t=1

"Apple Packing Line Damage Reduction"

Citation: Applied Engineering in Agriculture. 6(6): 759-764. @1990
Authors: G. K. Brown, N. L. Schulte Pason, E. J. Timm, C. L. Burton, D. E. Marshall
Keywords: Acceleration, Fruit damage, Fruit handling, Fruit quality, Instrumented sphere
Abstract – "Mechanical equipment and operations used on apple packing lines often bruise the apples. These bruises are caused by impacts with hard surfaces or other apples. An Instrumented Sphere (IS) was used to evaluate commercial packing lines and identify areas where damaging impacts occur. Damage free apples were also used on some lines to provide a direct indication of damage. A few lines were changed to reduce impacts and damage, and then were re-evaluated. Impacts exceeding 20 g* (summation of all peak g) and total bruise damage were directly related, and both were significantly reduced using relatively inexpensive line changes. When installing new lines, traditional use of large elevation changes and hard instead of cushioned surfaces between line components must be avoided. Manufacturers, installers and owners can work together to make low handling damage a reality."
Available at - http://asae.frymulti.com/abstract.asp?aid=26460&t=1

"Assessment of Apple Damage on Packing Lines"
Citation: Applied Engineering in Agriculture. 5(4): 475-484. @1989
Authors: G. K. Brown, C. L. Burton, S. A. Sargent, N. L. Schulte Pason, E. J. Timm, D. E. Marshall
Keywords: Fruit damage, Fruit handling, Fruit marketing, Orchard management
Abstract – "Apples for fresh market can incur physical damage during packinghouse operations. During the 1986 packing season, eight different packing lines were studied by placing essentially bruise-free 'Golden Delicious' apples in the lines to quantify the amount of damage (bruises, cuts, punctures), to identify the cause of damage and to suggest ways of reducing damage. The results are summarized in terms of cumulative damage magnitude and bruises/fruit for each operation. Laboratory tests were conducted to define conditions that should help minimize bruising and to estimate the effect of bruising on subsequent decay development. Improvements in methods and equipment to reduce such damage are both needed and feasible."
Available at - http://asae.frymulti.com/abstract.asp?aid=26547&t=1

"Design of a Shitake Mushroom Packing Line"
Citation: Applied Engineering in Agriculture. 5(3): 405-411. @1989
Authors: W. F. Wilcke, C. G. Haugh, K. C. Diehl, C.W. Coale
Keywords: Packing material, Produce handling, Produce marketing

Abstract – "This paper describes design and testing of a packing line for shiitake mushrooms. Because the mushroom marketing cooperative that used the packing line had limited resources, the design minimized equipment costs. In the final design, seven workers could pack three hundred 99-g (3.5-oz) containers per hour, with variable costs for packing materials and labor of $0.42 per container."

Available at - http://asae.frymulti.com/abstract.asp?aid=26535&t=1

“Fruit Damage Assessment in Peach Packing Lines”
Citation: Applied Engineering in Agriculture. Vol. 17(1): 57-62. @2001
Authors: A. Berardinelli, A. Guarnieri, J. Phuntsho, L. Ragni
Keywords: Peach, Mechanical damage, Fruit packing line, Instrumented sphere
Abstract – “In order to assess the effects of mechanical handling on peaches, the impacts measured in Italian packing lines using an instrumented sphere were emulated in the laboratory by means of a simple drop-test device. Samples of Big Top, Caldesi 2000, Centry, and Rich Lady peaches were subjected to impacts representative of the conditions observed at the critical points in packing lines: the drop onto the conveyor belt from the dry bin dumper, the entrance into the counter-basket filler, and at the beginning of the filling of the mini-bin. A test was also carried out to assess the effects on the damages of repeated drops onto the same point of the surface of the fruits. At the highest impact level (180 g, 2.20 m/s), at the beginning of the filling of the mini-bin, damaged fruit did not exceed 18% and the average dimension of the flesh damages did not exceed 10 mm in diameter (Big Top) and 6 mm (Centry) in depth. In general, repeated drops did not seem to cause substantial additional damage. However, they did cause an increase in percentage of damaged fruits for Centry and for the dimension of the alterations for Rich Lady. Considering the severity of the test, the low number of fruits subjected to high impacts by the mini-bin filler and the kind of the damages, the packing lines studied in the present research should not produce an appreciable commercial damage to the ready-to-eat fresh peaches.”
Available at - http://asae.frymulti.com/abstract.asp?aid=1922&t=1

“Fruit and Vegetable Bruise Threshold Prediction Using Theory of Elasticity and Failure Tissue Properties “
Citation: Paper number 016139, 2001 ASAE Annual Meeting. @2001
Authors: J. Varith, G. M. Hyde, A. L. Baritelle, T. Sattabongkot
Keywords: Bruise threshold, fruit and vegetable bruising, tissue failure, tissue properties, dynamic axial compression, paired-increasing height multiple impacting

Abstract – “Determining bruise threshold (drop height at which bruising just begins) from tissue failure properties and whole specimen mass and shape has the advantages of speed and the ability to predict threshold change from failure property changes. Conditioning in turn can influence failure properties; with the result that bruise threshold can be controlled to some degree by commodity conditioning. This work compared bruise threshold prediction using theory of elasticity, tissue failure stress and strain determined by dynamic axial compression (DAC), Poisson’s ratio, and specimen mass and radius of curvature, with results of paired increasing-height multiple-impacting (PIHMI), a whole specimen technique that has proven reliable for determining bruise threshold in apples. The results show that DAC prediction agreed with PIHMI results with a standard error of 1.7 mm for bruise thresholds up to 16 mm grouped by hydration level, DAC and PIHMI bruise thresholds were not significantly different ($p>0.05$) using a paired t-test.”
Available at - http://asae.frymulti.com/abstract.asp?aid=7517&t=1

“Grading of Mushrooms using Machine Vision System”

Citation: Transactions of the ASAE. 37(5): 1671-1677. @1994
Authors: P. H. Heinemann, R. Hughes, C. T. Morrow, H. J. Sommer, III, R. B. Beelman, P. J. Wuest
Keywords: Mushrooms, Machine Vision System, Grading
Abstract – "The quality features of the common white Agaricus bisporus mushroom were quantified using image analysis in order to inspect and grade the mushrooms by an automated system. The features considered were color, shape, stem cut, and cap veil opening. Two human inspectors evaluated samples which were divided into training and test sets. The vision system was trained to classify mushrooms into two quality grades using thresholding. The human inspection results were compared with each other as well as the computer vision system results. Misclassification by the vision system ranged from 8 to 56% depending upon the quality feature evaluated, but averaged about 20%. The disagreement between inspectors ranged from 14 to 36%."
Available at - http://asae.frymulti.com/abstract.asp?aid=28255&t=1

"Impact Bruise Estimates for Onion Packing Lines"
Citation: Applied Engineering in Agriculture. 7(5): 571-576. @1991
Authors: E. J. Timm, G. K. Brown, R. C. Brook, N. L. Schulte, C. L. Burton
Keywords: Impact, Bruising, Onion, Packing line, Instrumented sphere
Abstract – "The common dry onion (Allium cepa) is grown throughout the United States. Most of these are cured (dried) and held in long term storage before being mechanically cleaned, trimmed, sorted, sized, and bagged for marketing. The mechanical operations can cause bruise, cut and puncture damage, due mainly to impacts against hard surfaces. The Instrumented Sphere (IS), an impact recorder, was handled along with onions in packing line operations to record the impacts caused by the lines. In the laboratory, impact tests using the IS and both freshly harvested and cured 'Spartan Banner 80' onions were conducted to estimate the impact conditions which initiate bruising. Bruising initiated at a 10 mm (0.39 in.) drop onto steel for the freshly harvested onions compared to 6 mm (0.24 in.) for the cured onions. The IS recorded 85 and 56 peak G for these respective drops. Many impacts on hard surfaces exceeding these G levels were recorded on the packing lines. It is yet unknown what amount of bruising will result in discoloration, decay, or a reduction in shelf life after storage. But, improvements of packing line handling operations would reduce the impact levels and related bruising determined from this research."
Available at - http://asae.frymulti.com/abstract.asp?aid=26271&t=1

"Impacts Recorded on Avacado, Papaya, and Pineapple Packing Lines"
Citation: Applied Engineering in Agriculture. 7(4): 418-422. @1991
Authors: E. J. Timm, G. K. Brown
Keywords: Impact, Bruising, Instrumented sphere, Avocado, Papaya, Pineapple
Abstract – "Mechanical equipment and operations used in avocado, papaya, and pineapple packing lines can cause bruise damage resulting in post-harvest losses. An Instrumented Sphere (IS) was used to record impacts occurring in commercial packing lines for these fruit. The IS was able to identify transfers that caused high impacts in each line. Impacts from each packing line were also classified relative to impacts on known surfaces. Improvements in all of these lines can be made by adding cushioning

to bare steel surfaces, replacing worn cushioning, reducing elevation changes between components, and controlling fruit flow at each transfer. Impact tests to establish bruise damage thresholds with each fruit are needed to determine impact and fruit conditions which result in bruise damage. Improved handling conditions can then be identified to maintain fruit quality.”
Available at - http://asae.frymulti.com/abstract.asp?aid=26259&t=1

“Instrumented Sphere Impact Analysis of Tomato and Bell Pepper Packing Lines”
Citation: Applied Engineering in Agriculture. 8(1): 76-83. @1992
Authors: S. A. Sargent, J. K. Brecht, J. J. Zoellner
Keywords: Lycopersicon esculentum, Capsicum annuum, Postharvest handling, Quality control, Mechanical injury, Mechanical damage, Bruising, Vegetable packinghouses
Abstract – “Transfer points with potential to cause mechanical injury were identified in 11 tomato packing lines (5 packing green tomatoes, 5 packing tomatoes showing red color, 1 repacker); 3 bell pepper packing lines; and 2 mobile field pack units for peppers. Average maximum impact levels for the lines packing tomatoes with red color were higher than those packing green tomatoes. Field pack units for peppers had significantly fewer numbers of impacts than the pepper packing lines. Modifications to some transfer points resulted in over 50% reduction in impact levels.”
Available at - http://asae.frymulti.com/abstract.asp?aid=26036&t=1

“Mechanical Harvesting System for Burley Tobacco”
Citation: Applied Engineering in Agriculture. 3(1): 95-98. @1987
Authors: J. H. Casada, M. J. Bader, L. R. Walton, L. D. Swetnam, M. E. Fiedeldey
Keywords: Mechanical harvester, Tobacco harvesting, Tobacco production
Abstract – “A harvesting-handling system for burley tobacco was modified and field tested to evaluate its performance. The system utilizes a semi-mounted harvester to cut the plants, notch their stalks and convey them to a trailing wagon where workers hang the notched plants on wire-strung portable frames. A grasping chain conveyor was added at the front of the harvest to positively control the plants in the cutting and notching zone. An adjustable frame holder was added to the wagon which allowed the frame to be repositioned to provide working space for completely filling the frame. A quickly adjustable wagon tongue was provided which facilitated turning the machine at end of row. Test results showed that 94.7% of plants were successfully harvested and hung while 2.2% were lost from the conveyors and 3.1% were not properly notched for hanging. Leaves lost amounted to 18.7% and harvest rate was 40.5 plants/min.”
Available at - http://asae.frymulti.com/abstract.asp?aid=26653&t=1

“Multi Purpose, Vegetable Production Machine Investigation”

Citation: Applied Engineering in Agriculture. 6(6): 691-696. @1990
Authors: C. E. Hood, Y. Alper, R. E. Williamson
Keywords: Controlled-traffic production, Field packing, Harvesting, Materials handling, Mechanization

Abstract – “Two multi-purpose, vegetable production vehicles with 3-m (10-ft) spans have been developed by retrofitting commercial high-clearance power units. Bi-directional and movable operator stations were designed to allow the operator to view critical field operations. Dual three-point hitch systems were incorporated into the design to allow multiple field operations in a single pass. The prototype vehicles have successfully performed tillage, bed shaping, planting, cultivating, spraying, and harvesting operations.”
Available at - http://asae.frymulti.com/abstract.asp?aid=26449&t=1

“Packing Line Bruise Evaluation for ‘Walla Walla’ Summer Sweet Onions”
Citation: Transactions of the ASAE. 38(4): 1167-1171. @1995
Authors: R. W. Bajema, G. M. Hyde
Keywords: Onion, Bruise resistance, instrumented sphere, packing lines
Abstract – “An instrumented sphere (IS) was used to analyze the handling impact characteristics of five eastern Washington State summer sweet onion packing lines. Bruise probability curves were developed for the onions by dropping them from known heights, using a pendulum, onto three reference surfaces. The IS was then used to characterize the surfaces and onion bruise thresholds were determined. Recommendations, based on the impact characteristics of the packing lines and the bruise threshold results, were made to the packing line management on how to reduce bruise damage. A dramatic reduction in impact levels was verified in the packing lines that used the evaluation to improve their equipment’s handling characteristics. The bruise threshold results should be useful throughout the sweet onion industry.”
Available at - http://asae.frymulti.com/abstract.asp?aid=27936&t=1

“Peach Physical Characteristics for Orientation”
Citation: Transactions of the ASAE. 39(4): 1493-1497. @1996
Authors: M. P. Rigney, G. H. Brusewitz, M. L. Stone
Keywords: Fruit, Packing lines, Property, Shape
Abstract – “Packing line sorting equipment utilizing an electronic quality sensor usually requires oriented fruit for reliable measurements. The performance of mechanisms using the rolling behavior of peaches to achieve orientation is dependent on the fruit’s physical characteristics. The focus of this study was to determine the effect of peach physical characteristics (shape and mass) on orientation potential. Starting completely out of orientation, peaches became oriented within 43 cm of travel, on the average, and always within 105 cm. Starting with the peaches properly oriented (the stem-to-blossom axis horizontal), 75% remained so oriented while being rolled 1.4 m. Thinner peaches (cheek diameter, D, less than stem-blossom height, H) like Harmony stayed oriented 88% of the time while only 57% of spherical-shaped fruit like ‘Red Haven’ stayed oriented for 1.4 m. Peaches with diameter/height ratio (D/H) greater than 1.0 had the greatest variability in orienting behavior. Knowing a peach’s shape enables a prediction of orientation probability for a given travel distance.”
Available at - http://asae.frymulti.com/abstract.asp?aid=27643&t=1

“A Procedure for Testing Padding Materials in Fruit Packing Lines Using Multiple Logistic Regression”

Citation: Transactions of the ASAE. Vol. 45(3): 751–757. @2002
Authors: F. J. García–Ramos, P. Barreiro, M. Ruiz–Altisent, J. Ortiz–Cañavate, J. Gil–Sierra, I. Homer
Keywords: Padding material, Packing line, Impact tester, Instrumented sphere, Bruises, Logistic regression, Fruit
Abstract – "Padding materials are commonly used in fruit packing lines with the objective of diminishing impact damage in post–harvest handling. Two sensors (IS 100 instrumented sphere and UC–LPF impact tester) were compared to analyze the performance of six different padding materials used in Spanish fruit packing lines. Padding materials tested were classified according to their capability to decrease impact intensities inflicted on fruit in packing lines. A statistical procedure to test padding materials was tested for Golden Delicious apples. Its basis is a multiple logistic regression to predict bruise probability in fruit. The model combines two groups of parameters: padding material parameters measured with the IS, and fruit properties."
Available at – http://asae.frymulti.com/abstract.asp?aid=8846&t=1

"Reduction of Mechanical Damage to Apples in Packing Lines Using Mechanical Devices"
Citation: Applied Engineering in Agriculture. Vol. 19(6): 703-707. @2003
Authors: F. J. García-Ramos, J. Ortiz-Cañavate, M. Ruiz-Altisent
Keywords: Instrumented sphere, Bruise, Transfer points, Fruit quality, packing lines
Abstract – "Fresh fruits and vegetables experience impacts as they are mechanically handled in commercial packing lines. Impacts commonly occur when the product is transferred between successive unit operations (transfer point) along the line. Mechanical devices can be used at transfer points to decrease the mechanical damage to fruit.

Bruise onset is induced when the failure stress or the maximum deformation for the product tissue are exceeded (depending upon the damage mechanism). Bruise onset and its magnitude depend on different factors: height of the transfer points, working velocity, hardness of the surfaces, curvature of the surfaces, and fruit characteristics (mass, curvature, temperature, humidity, and firmness).

To analyze the effectiveness of mechanical devices (cushioned rollers, powered brush, and padding materials) to reduce mechanical damage to "Golden" apples, three standard transfer points (transporting belt – rollers transporter; rollers transporter – singularize; and transporting belt – transporting belt) of a experimental packing line were studied using instrumented spheres (IS 100). The efficiency of the solutions was analyzed using "Golden" apples and measuring the presence of external bruises during the handling.

Solutions tested reduced the acceleration values under 50 g, which is commonly a safe level to avoid the mechanical damage in apples. Once the transfer points were improved, apples were handled, and values around 100% of fruit were EC Grade I.

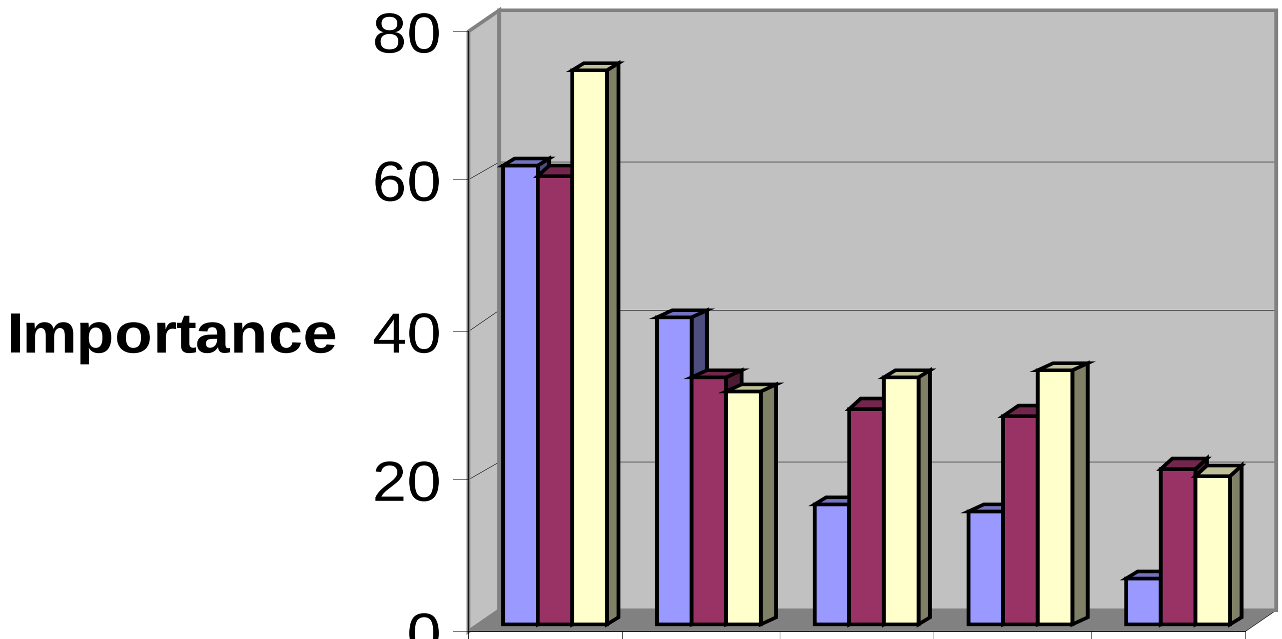
Tests carried out showed that mechanical devices are useful to reduce mechanical

damage in “Golden” apples, but must be correctly regulated to obtain optimum results (fruit without bruises). This regulation can be carried out using instrumented spheres (IS 100) and fresh fruit.”
Available at - http://asae.frymulti.com/abstract.asp?aid=15653&t=1

“Sorting Table Illumination on Stonefruit Packing Lines in California”
Citation: Applied Engineering in Agriculture. 9(6): 539-543. @1993
Authors: M. J. Delwiche, J. F. Thompson, R. S. Johnson
Keywords: Lighting, Grading, Inspection
Abstract – “Sorting table illumination was evaluated in nine stonefruit packing houses, including table configuration, light intensity, uniformity, and spectral quality. Typical sorting tables had two sorting lanes with a cull lane running between, and the fruit were moved by roller conveyor made from white PVC pipe. Luminaires with two fluorescent lamps were usually centered above and along each sorting lane section. Correlated color temperatures of the lamps varied from 3600 to 5000° K, and color rendering indices varied from 62 to 90. Illuminance at the center of each sorting lane ranged from 920 to 4080 lx (85 to 379 fc), with a mean value of 2170 lx (202 fc). Light intensity was relatively uniform over the entire surface of the sorting lane. Luminance ratios between the white roller conveyors and darker fruits exceeded the 3:1 industry recommendation and could be improved by using darker rollers. The majority of packing lines used “cool-white” fluorescent lamps. Color rendering might be improved with lamps having higher correlated color temperatures and color rendering indices, thereby more closely approximating daylight. Defect recognition might be enhanced with lamps having more energy in the red region of the spectrum.”
Available at - http://asae.frymulti.com/abstract.asp?aid=26019&t=1

“Suspended Tray Package for Shipping Soft Fruit”
Citation: Paper number 066188, 2006 ASAE Annual Meeting. @2006
Authors: J.F. Thompson, D.C. Slaughter, M.L. Arpaia
Keywords: packaging, vibration damage, quality, transportation, pear, avocado
Abstract – “A new suspended fruit packaging system for damage-free transport of soft fruit was developed and tested. Transit vibration tests simulating a continental USA cross-country trip of approximately 4,500 km (2,800 mi) showed that this suspended fruit system prevents nearly all transport vibration damage to pears when used with a plastic clamshell package and to avocados when used with a plastic clamshell or corrugated fiberboard master container. Comparative damage data are reported for simulated shipment (American Standards Testing Materials D4169-94 assurance level I) of Hass avocados and Bartlett pears ripened to varying firmness levels.”
Available at - http://asae.frymulti.com/abstract.asp?aid=21535&t=1

Food Attributes



	1	2	3	4	5
	61	41	16	15	6
	60	33	29	28	21
	74	31	33	34	20

Attribute

1. Ease of Preparation
2. Low price
3. Speed of Consumption
4. R-T-E/no prep
5. Portability

Breakfast
Lunch
Dinner

United States Patent [19]
Iwasaki et al.

[11] **Patent Number: 4,700,791**
[45] **Date of Patent: Oct. 20, 1987**

[54] **ELECTRONIC SCALE PRINTER**

[75] Inventors: **Yoshitaka Iwasaki; Kunio Mori; Yoshio Tanabe**, all of Tokyo, Japan

[73] Assignee: **Teraoka Seiko Co., Ltd.**, Tokyo, Japan

[21] Appl. No.: **852,642**

[22] Filed: **Apr. 16, 1986**

Related U.S. Application Data

[63] Continuation of Ser. No. 705,533, Feb. 26, 1985, Pat. No. 4,598,780.

[30] **Foreign Application Priority Data**

Mar. 2, 1984	[JP]	Japan	59-39844
Mar. 2, 1984	[JP]	Japan	59-39845
Mar. 8, 1984	[JP]	Japan	59-44876
Mar. 8, 1984	[JP]	Japan	59-33898[U]
Dec. 28, 1984	[JP]	Japan	59-278899

[51] **Int. Cl.**^{4} **G01G 23/38;** G01D 9/00; G01D 15/34; B41J 7/00

[52] **U.S. Cl.** **177/2;** 346/9; 346/136; 400/61; 400/613; 400/708

[58] **Field of Search** 177/1-13; 346/9-12, 136; 400/61, 76, 613, 708

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,717,881	2/1973	Bunning	346/136
4,027,590	6/1977	Seidl et al.	400/613 X
4,101,366	7/1978	Teraoka et al. .	
4,158,205	6/1979	Jenkins, Jr. .	
4,301,878	11/1981	Soe .	
4,440,248	4/1984	Teraoka .	
4,531,851	7/1985	Kondo et al.	400/708 X
4,564,302	1/1986	Hatazawa	400/76

FOREIGN PATENT DOCUMENTS

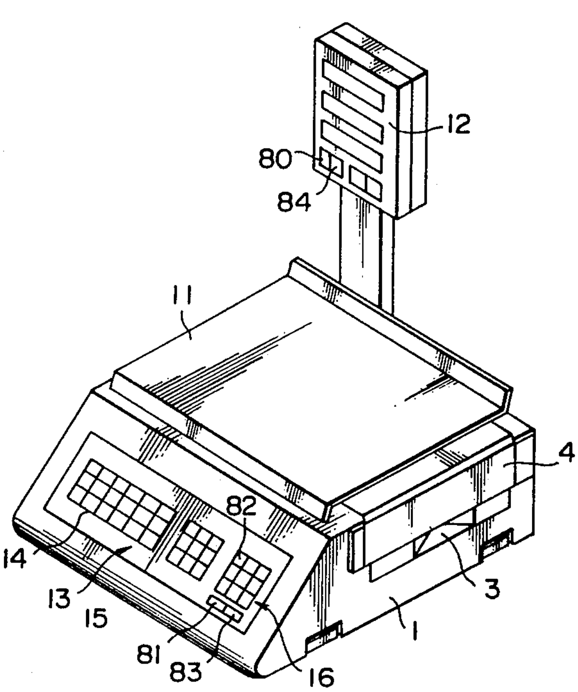
0052848	11/1981	European Pat. Off.	400/61
57-8190	1/1982	Japan	400/76
58-175671	10/1983	Japan	400/61

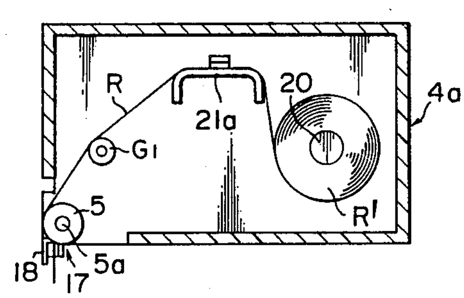
Primary Examiner—George H. Miller, Jr.
Attorney, Agent, or Firm—Sandler & Greenblum

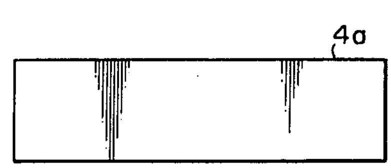
[57] **ABSTRACT**

This invention provides an electronic scale printer, and more particularly an electronic scale printer in which a printer is connected electrically to the electronic scale used in a department store or supermarket etc., and required data are printed on a printing sheet under an instruction from the electronic scale and issued from the printer. The invention provides a printer capable of issuing both a label and a receipt through one printing means and more particularly an electronic scale printer in which either a label or a receipt corresponding to the kind of printing sheet stored in a cassette is printed and issued under proper replacement of the cassette having printing sheet for label stored therein with a cassette having a printing sheet for receipt stored therein.

33 Claims, 53 Drawing Figures







US006007854A

United States Patent [19]

Cadiente et al.

[11] **Patent Number: 6,007,854**

[45] **Date of Patent: *Dec. 28, 1999**

[54] **TRAY FOR THE IMPROVED PACKING AND COOLING OF PRODUCE**

[75] Inventors: **Anthony Cadiente**, Salinas; **William Sambrailo**, Aptos; **Mark Sambrailo**, Watsonville, all of Calif.

[73] Assignee: **Plexiform Company**, Watsonville, Calif.

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **09/060,452**

[22] Filed: **Apr. 14, 1998**

Related U.S. Application Data

[63] Continuation-in-part of application No. 08/591,000, Jan. 24, 1996, Pat. No. 5,738,890.

[51] **Int. Cl.**^{6} **B65D 21/032**; B65D 85/34

[52] **U.S. Cl.** **426/106**; 206/501; 206/564; 229/120

[58] **Field of Search** 426/106; 206/501, 206/564; 229/120

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,652,335	9/1953	Conti	426/106
2,660,529	11/1953	Bloom	426/106
2,684,907	7/1954	Brunsing	426/392

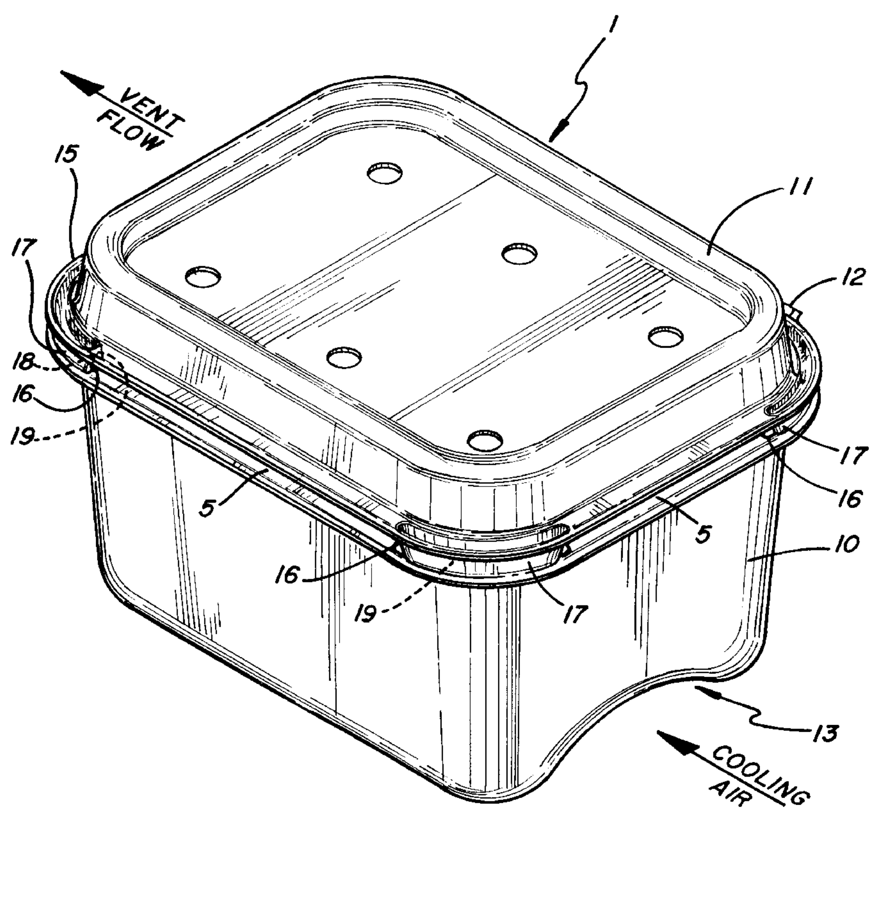
Primary Examiner—Leo B. Tentoni

Attorney, Agent, or Firm—Morton & Associates; Howard E. Morton

[57] **ABSTRACT**

Method for improved packing and cooling of produce by improving the flow of ventilation air to the produce, and apparatus to practice the method. According to the present invention, baskets for the packing of fruit are provided with ventilation channels disposed upon a lower surface of the basket. Vent apertures communicate between the ventilation channels and the produce stored in the baskets. After packing the baskets with produce, they are loaded into trays. The trays may be provided with tray vents which align with the ventilation channels. Alternatively, the trays may be formed without tray vents to improve some cooling regimes. In this manner, entire pallets of produce-filled baskets can be efficiently chilled by introducing a flow of cooling air into the baskets and thence through the produce packed inside. The trays and baskets are sized so as to occupy all of the surface area of a standard shipping pallet, and to minimize the movement of the baskets within the trays, and of the trays with respect to one another.

10 Claims, 17 Drawing Sheets



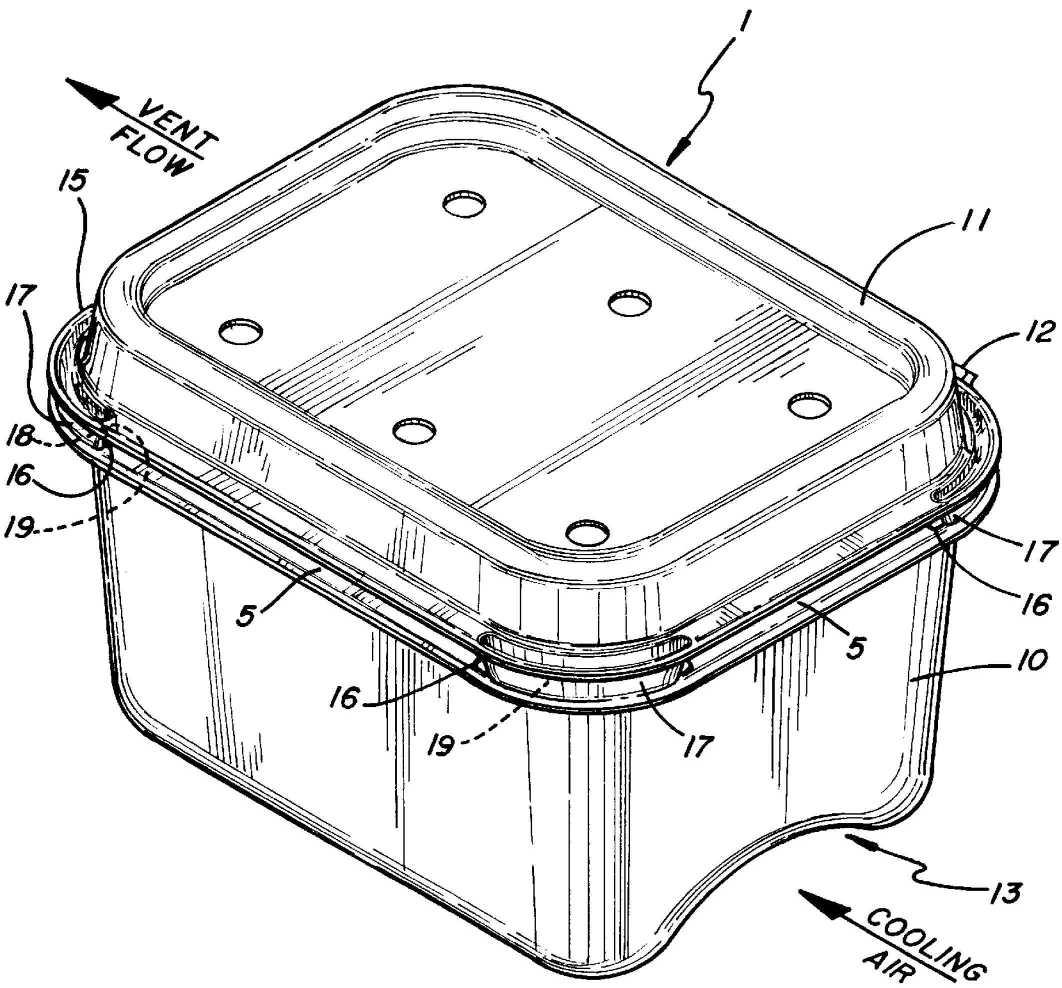


FIG. 1

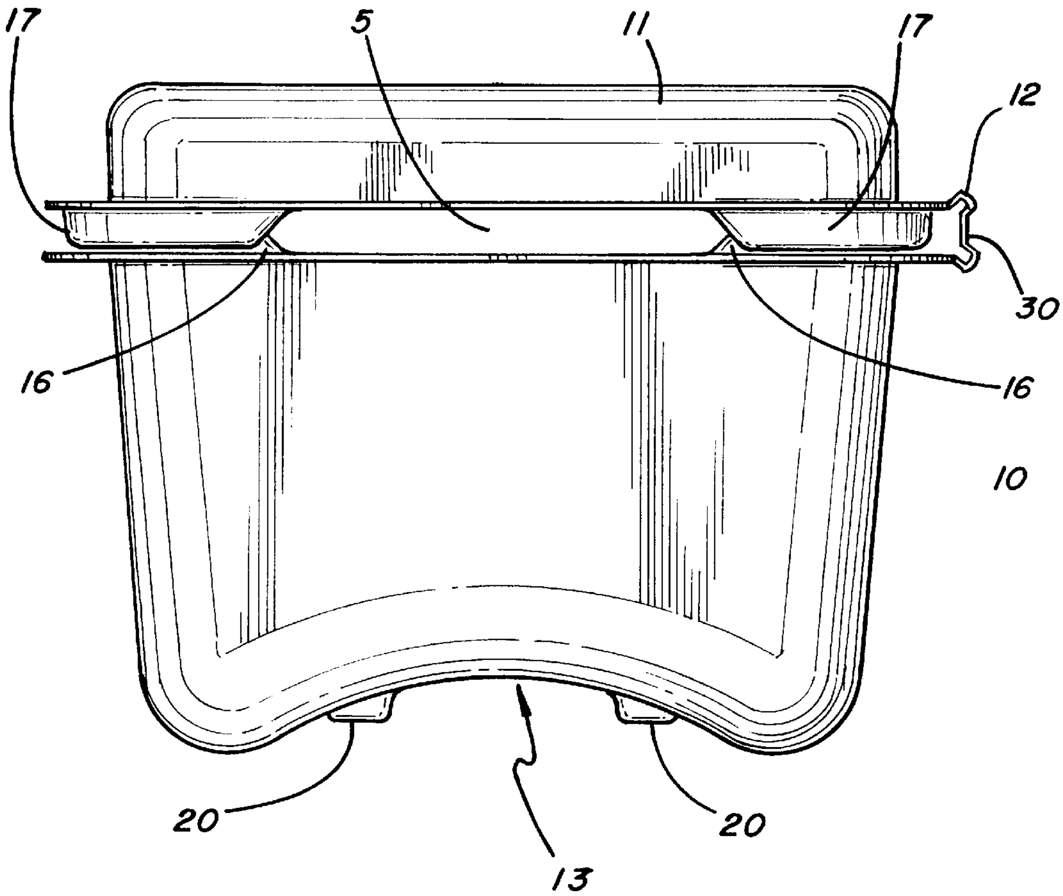


FIG. 2

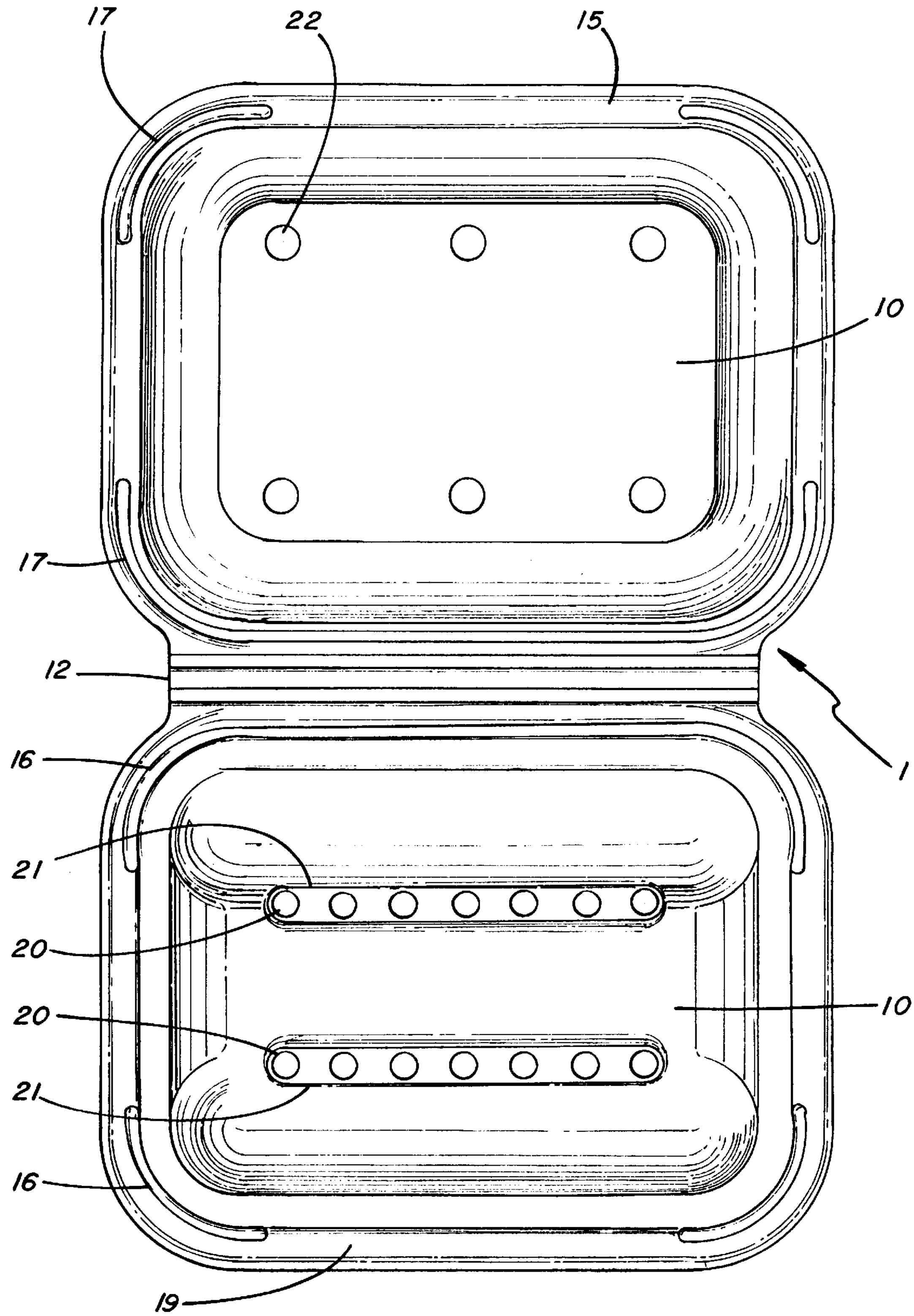


FIG. 3

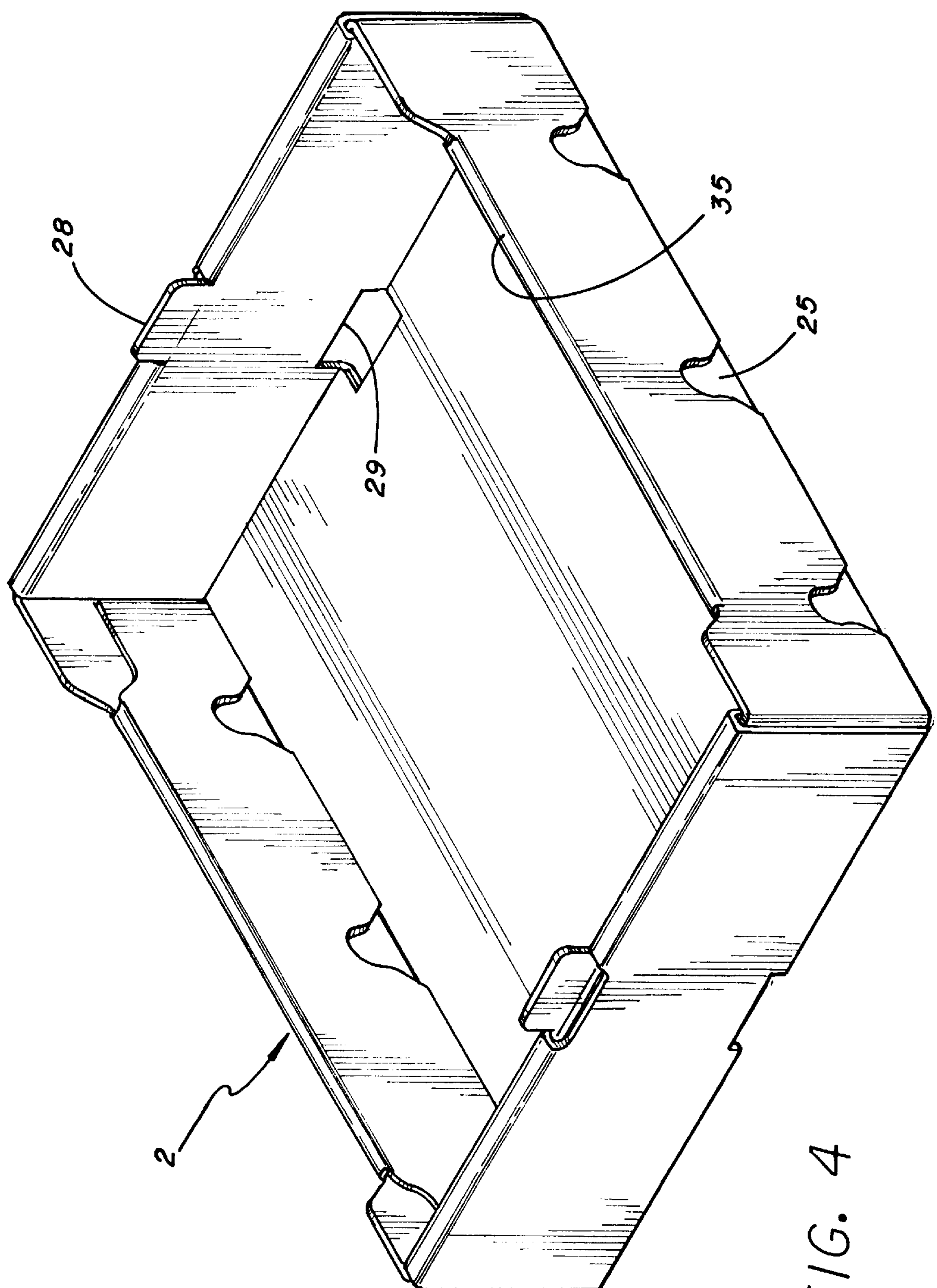


FIG. 4

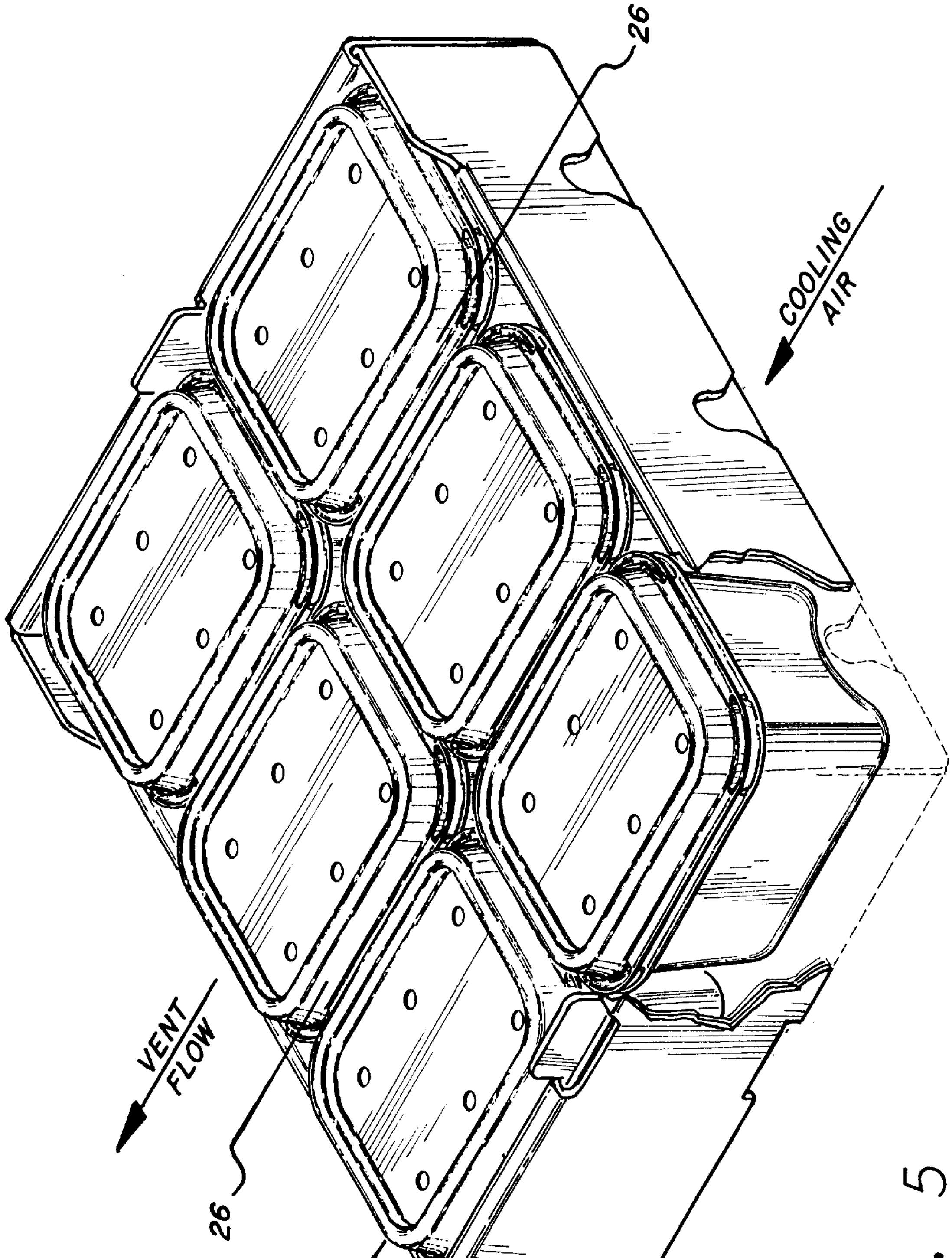


FIG. 5

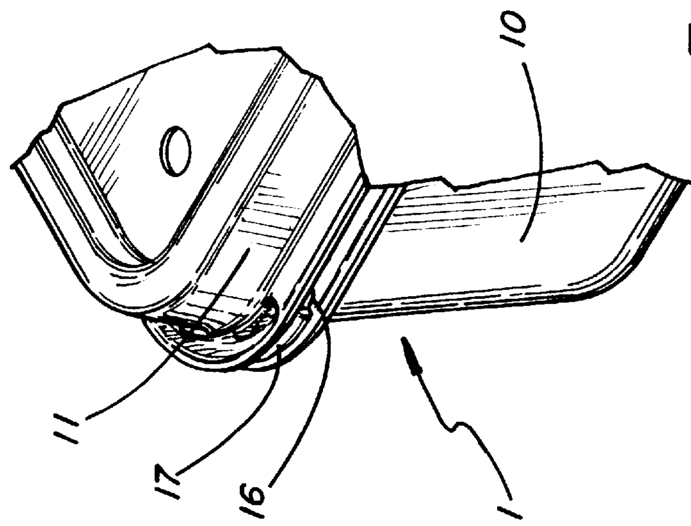


FIG. 7

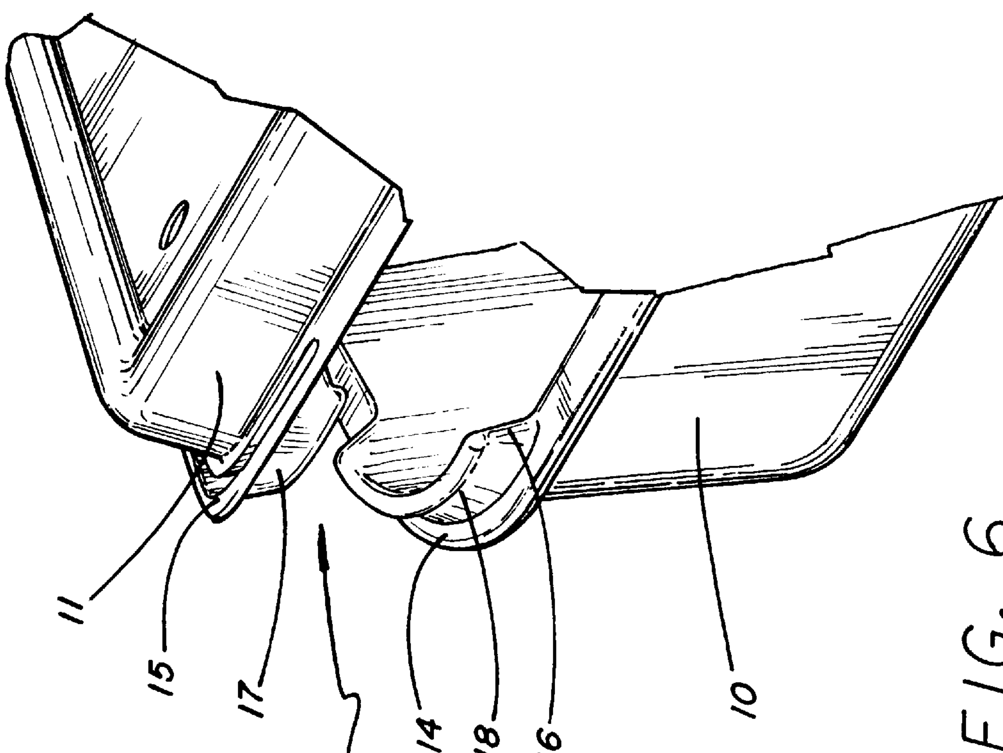


FIG. 6

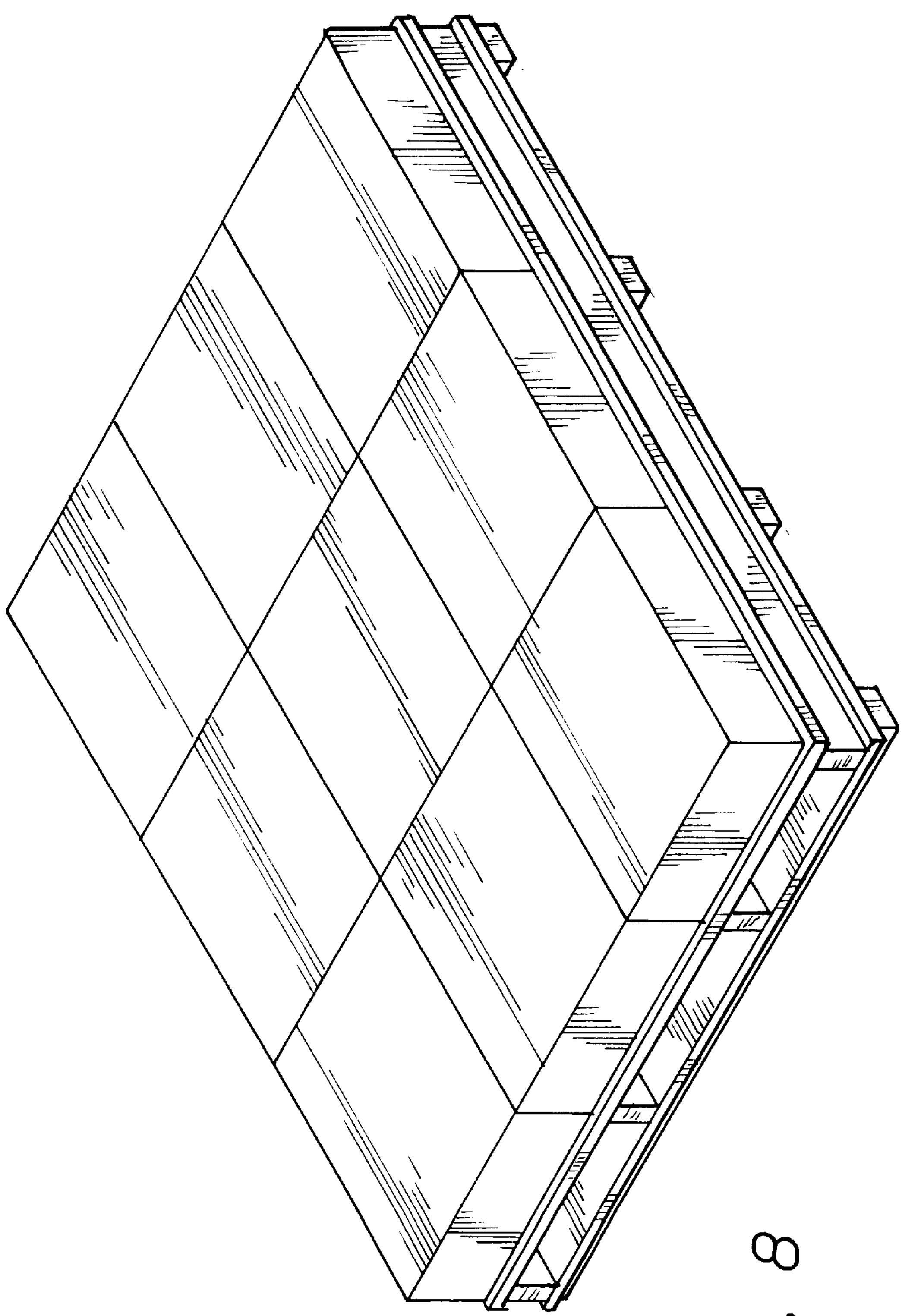


FIG. 8

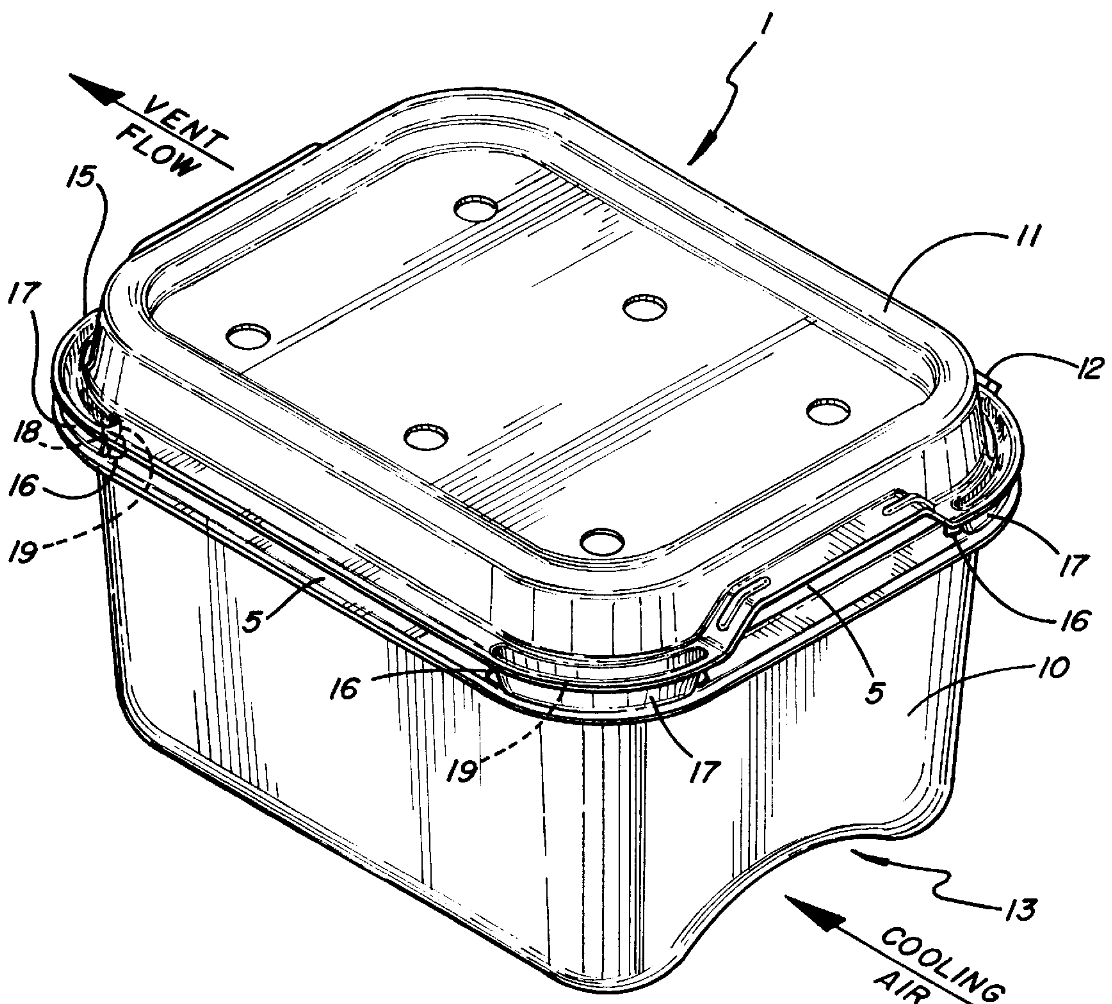


FIG. 9

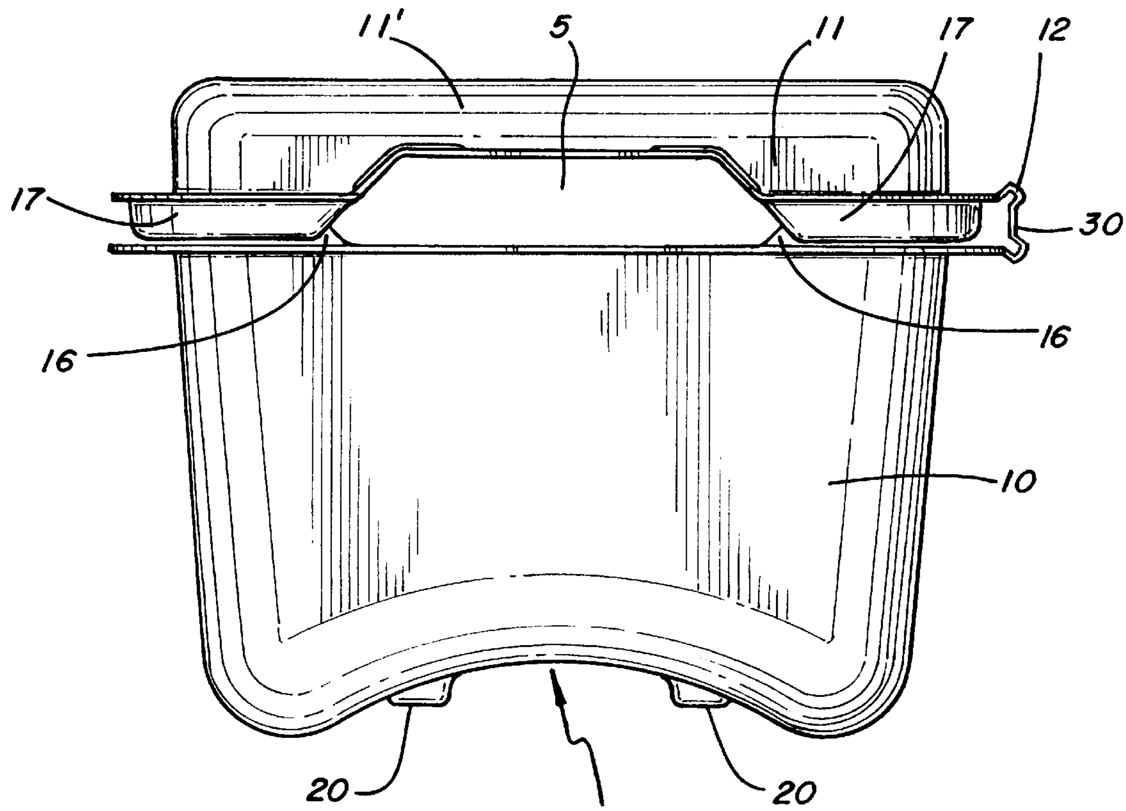


FIG. 10

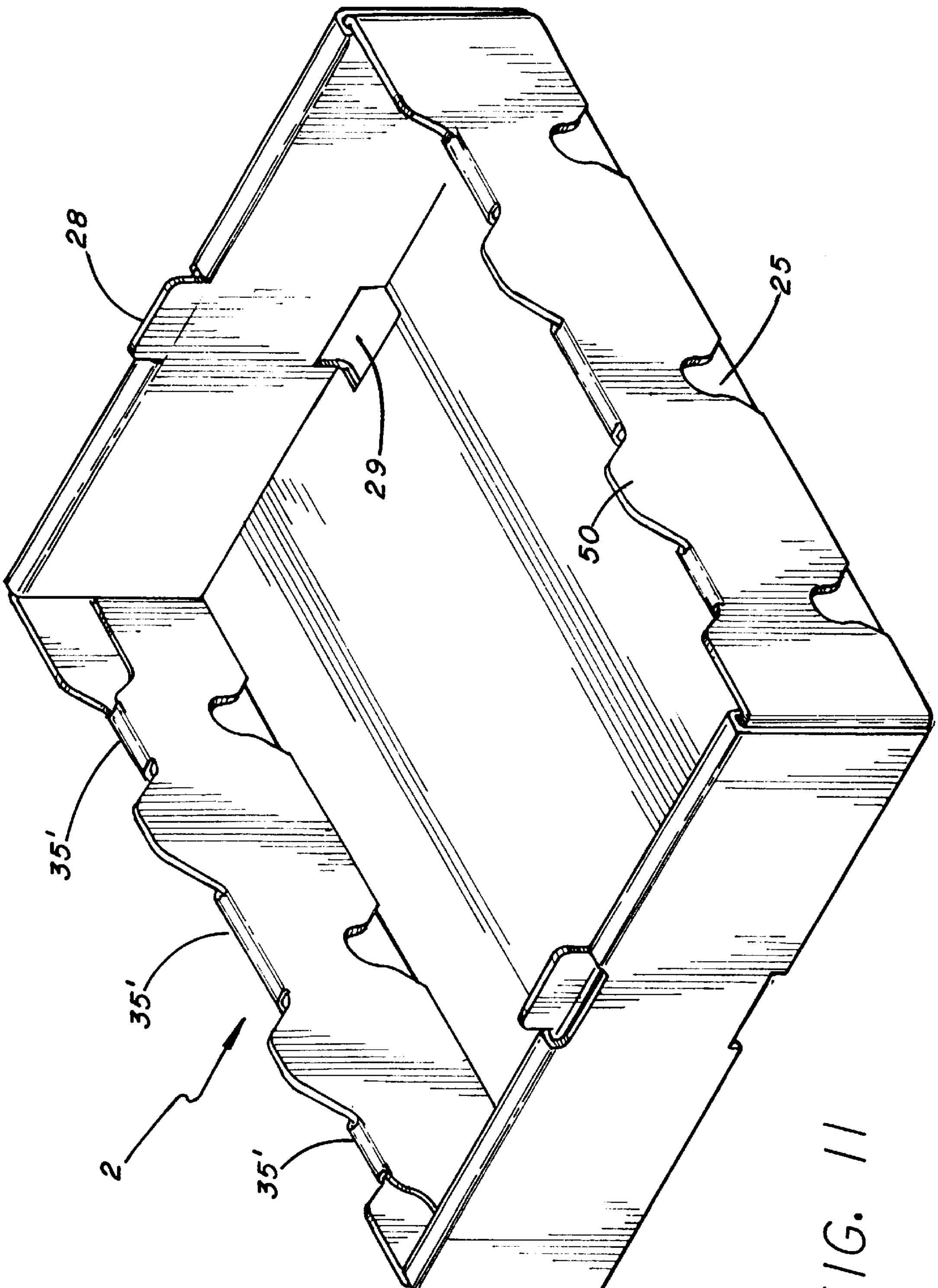


FIG. 11

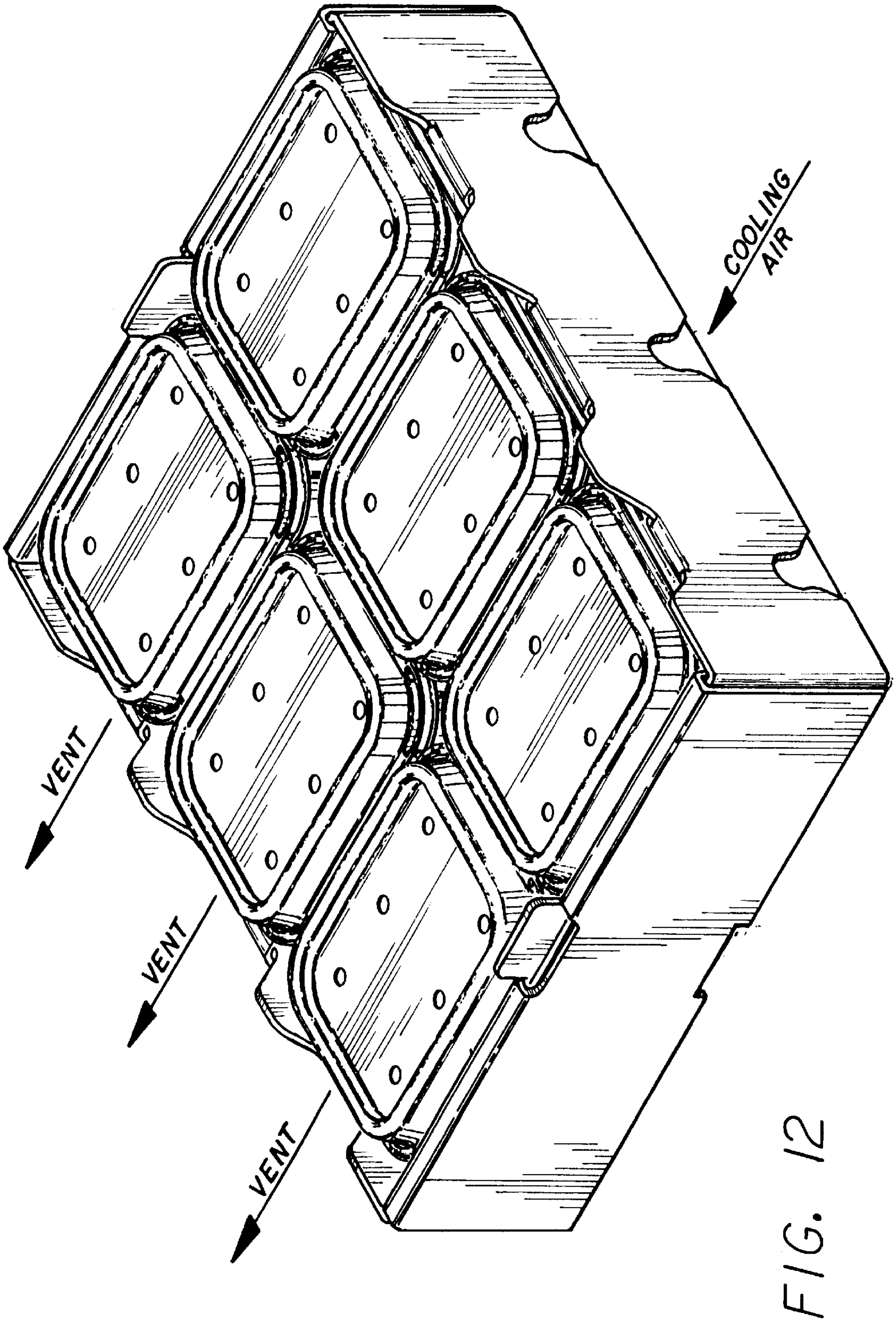


FIG. 12

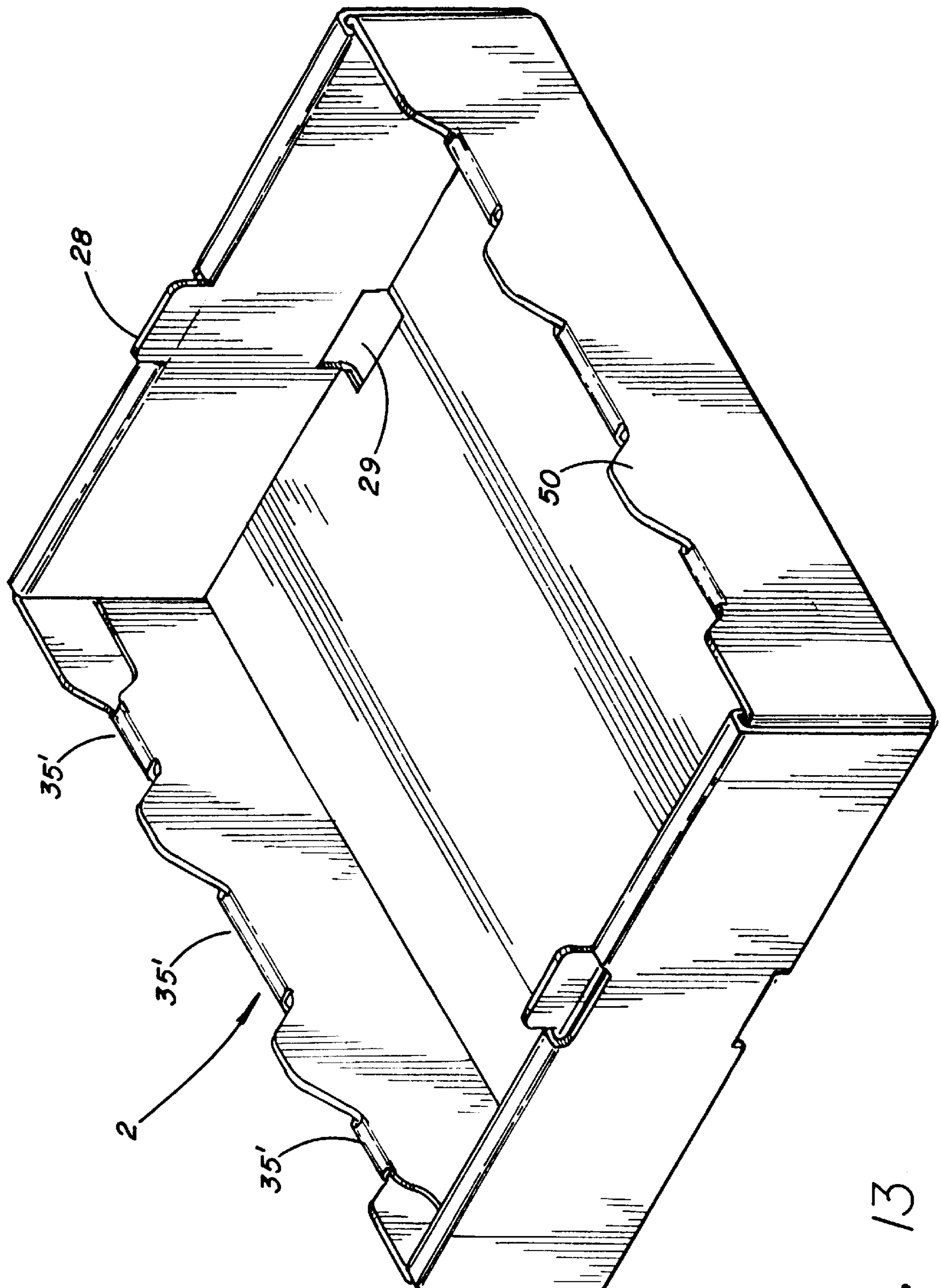


FIG. 13

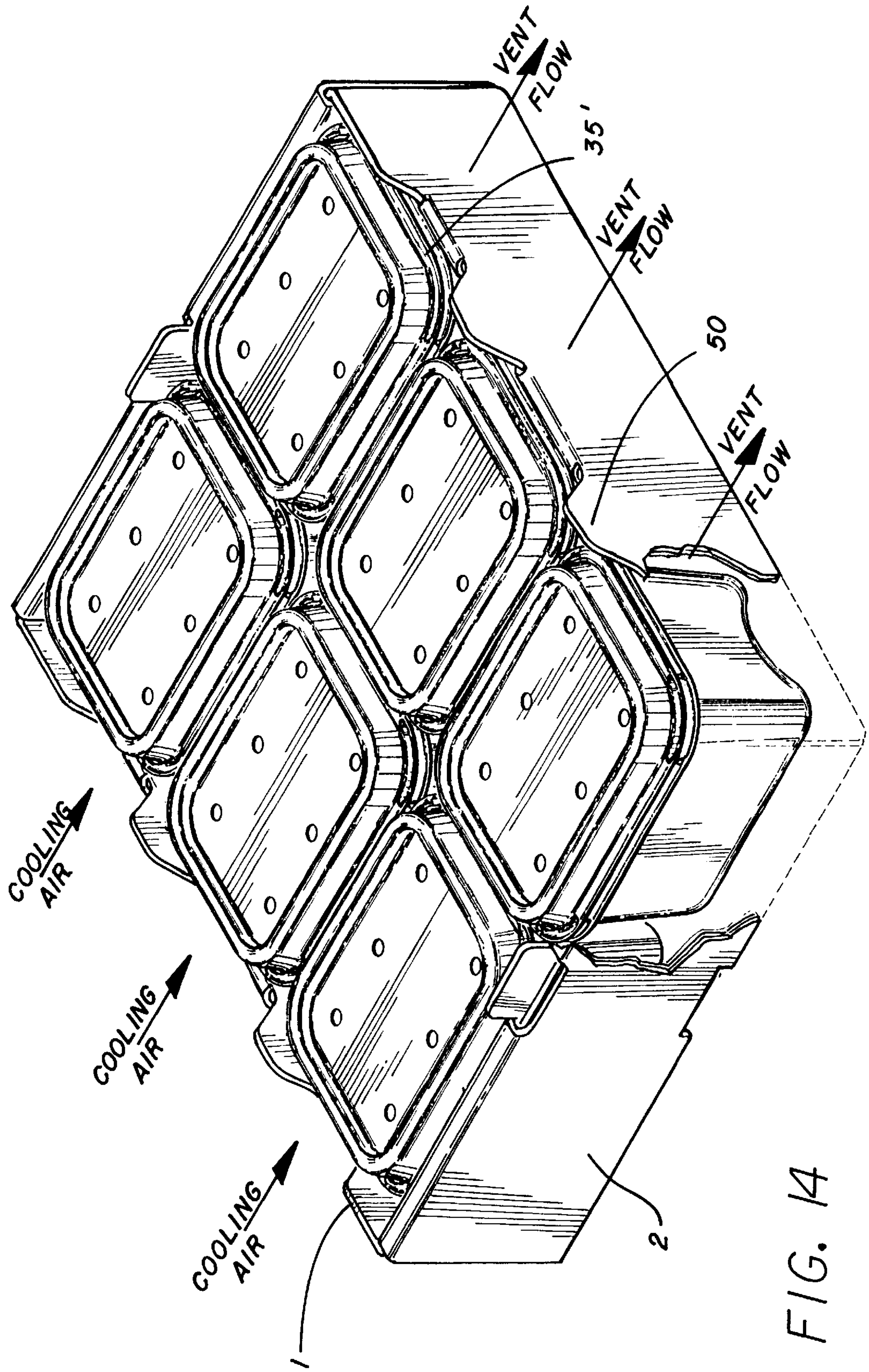

VENT FLOW
35'
VENT FLOW
50
VENT FLOW
COOLING AIR
COOLING AIR
COOLING AIR
1
2

FIG. 14

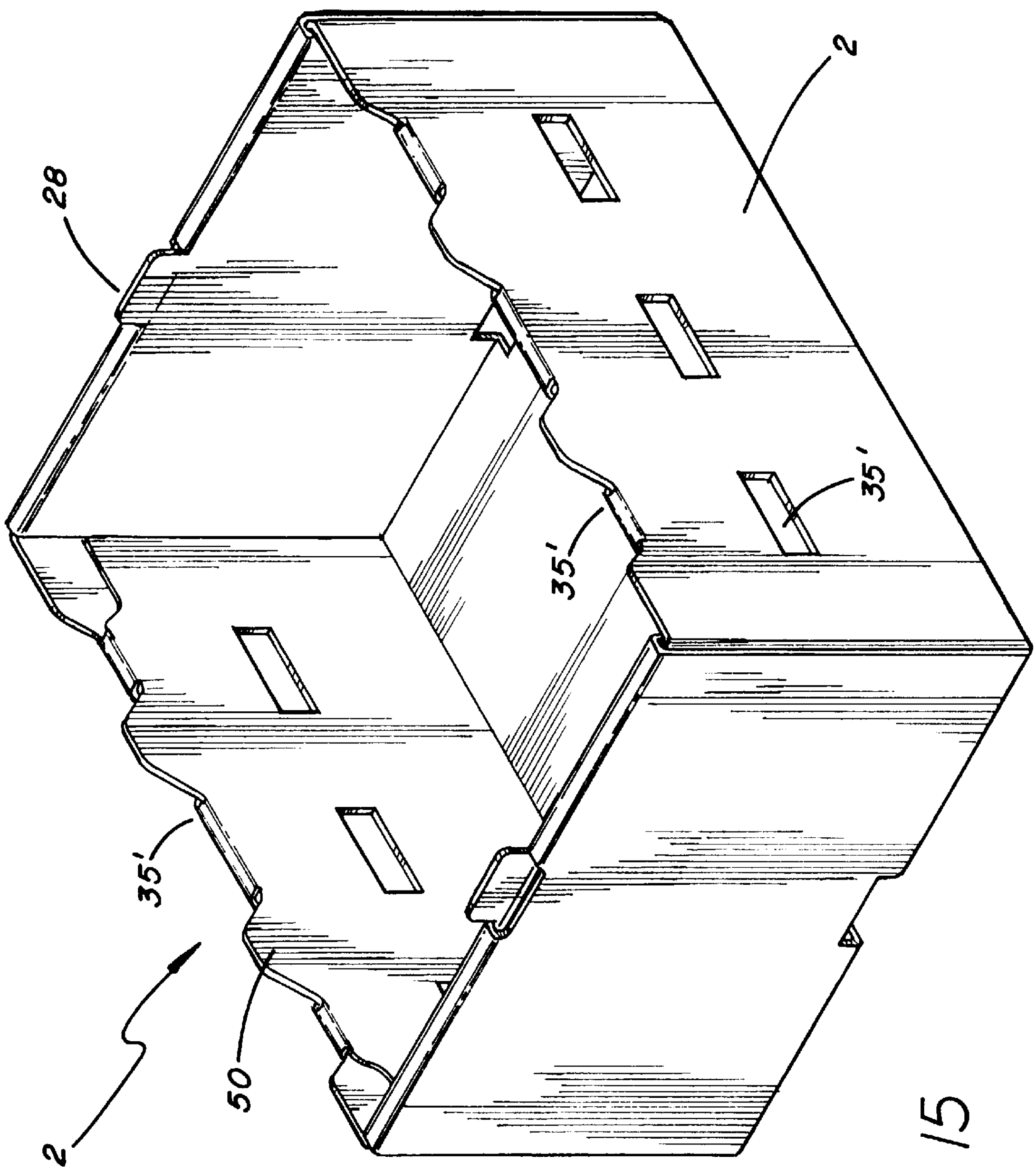


FIG. 15

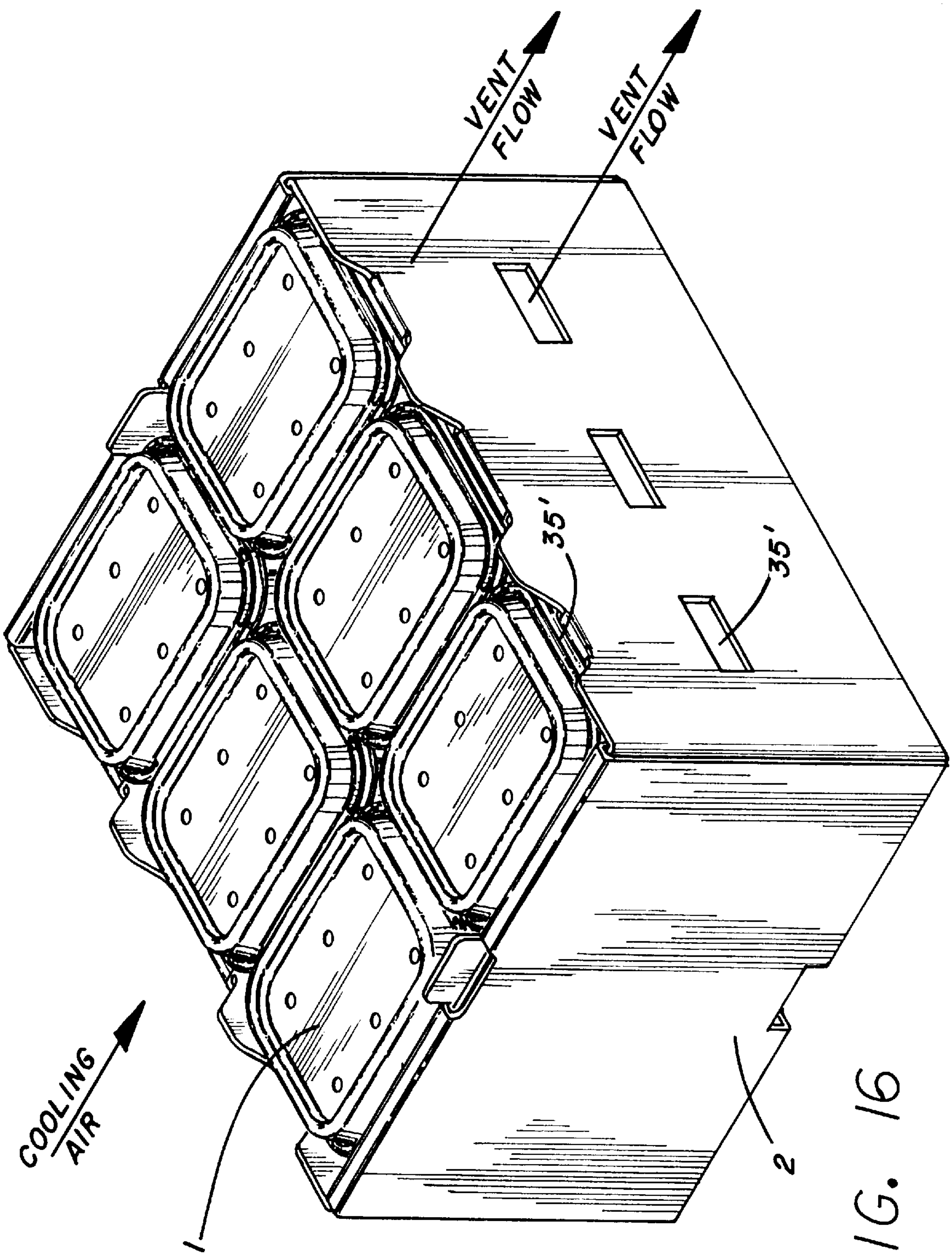


FIG. 16

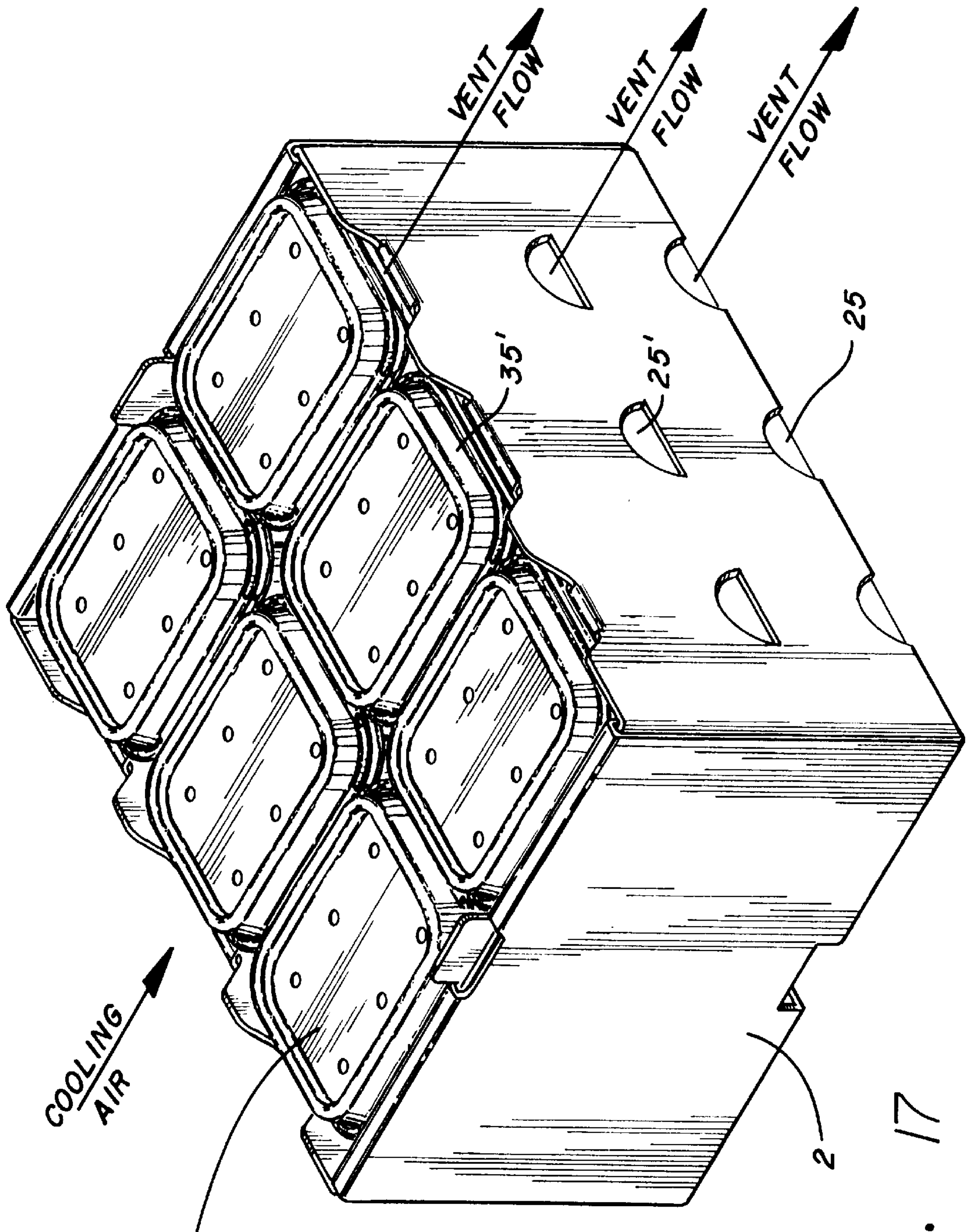


FIG. 17

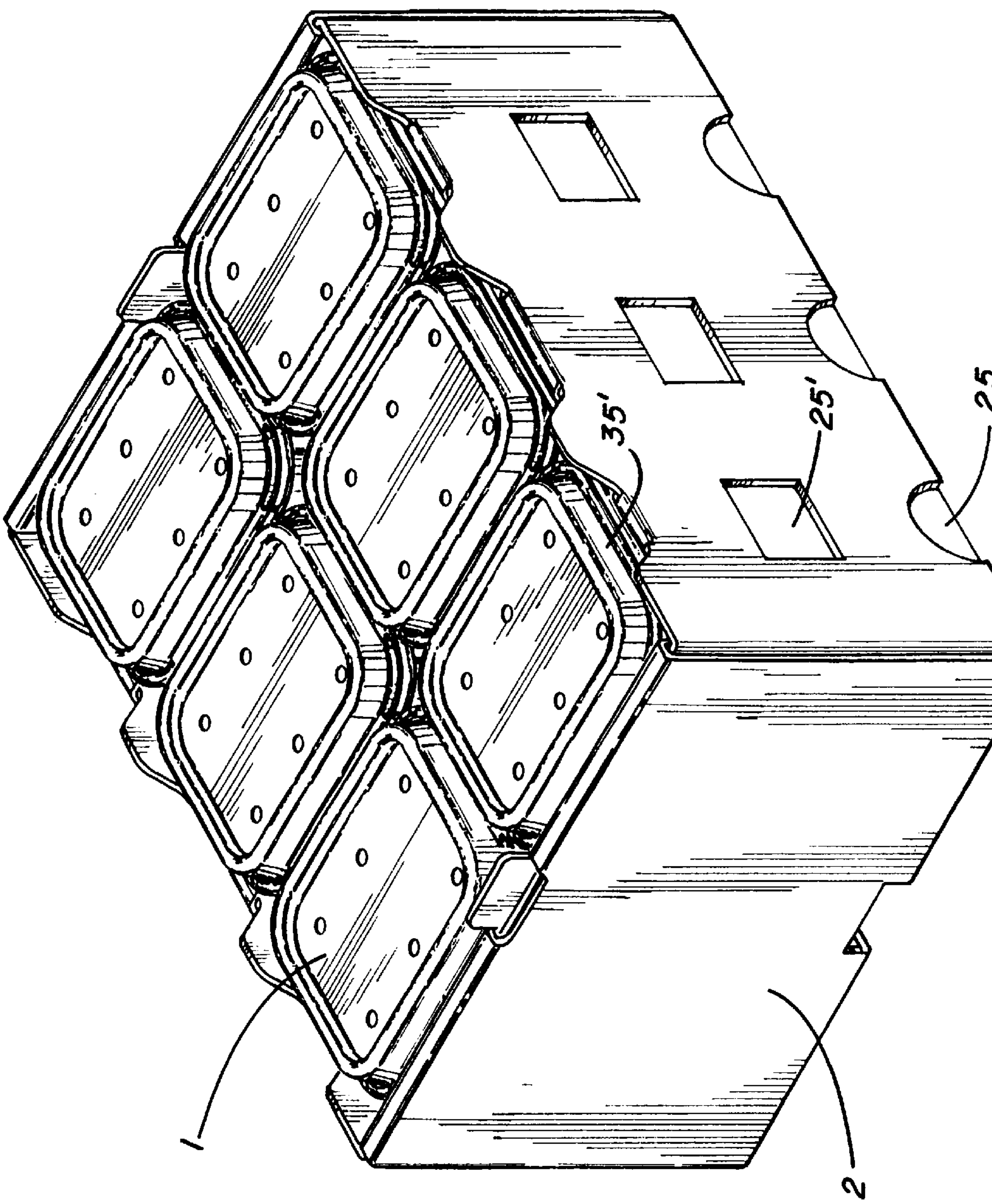


FIG. 18

TRAY FOR THE IMPROVED PACKING AND COOLING OF PRODUCE

CROSS-REFERENCE TO RELATED PATENTS

This application is a continuation-in-part of Ser. No. 08/591,000, now U.S. Pat. No. 5,738,890, issued Apr. 14, 1998.

TECHNICAL FIELD

The present invention relates to an improved basket for the improved packing, cooling, storage, and shipping of produce. More particularly, the present invention is an improved container system comprising vacuum formed fruit containers received into and in operative combination with an improved tray design for optimizing the cooling and shipping of fruit, particularly of berries.

BACKGROUND ART

Many produce products are harvested and packed in the field into containers which are ultimately purchased by the end consumer. Examples of such produce items include, but are not limited to, tomatoes, berries, grapes, mushrooms, radishes and broccoli florets. Many of these produce items require substantial post-harvest cooling in order to enable shipping over long distances and to prolong shelf life.

In use, a grower's harvesting crew harvests produce items of the type previously discussed directly from the plant in the field into the container. The containers are then loaded into trays, which contain a specific number of individual containers and the trays, when filled, are loaded onto pallets. The most common pallet used in the produce industry is the forty by forty-eight inch (40'×48') wooden pallet, and the vast majority of produce handling, storage and shipping equipment is designed around pallets of this size.

After the pallets have been filled and loaded in the field, they are transported to shippers who perform a variety of post-harvest processes to enhance the marketability of the produce itself. For many types of produce, including berries, a significant packing evolution is the post-harvest cooling of the packed fruit. Indeed, berry shippers are often referred to as "coolers". The process of cooling berries typically includes injecting a stream of cooling air into one side of a tray and thence through the individual baskets and around the berries stored therein. As the air cools the berries, it picks up heat therefrom which is exhausted from apertures on the opposite side of the tray.

Packages for use by berry coolers have undergone a systematic process of evolution to improve the storing and cooling of the fruit while reducing packaging costs. While early berry packaging products included the use or folded wood or chipboard containers, a common package for the marketing of strawberries for instance, is a one pound vacuum formed plastic basket developed in conjunction with Michigan State University. This one piece package, hereinafter referred to for brevity as a "Michigan basket", includes a basket body formed with an integral hinged lid which, after the basket is filled with fruit, is folded over and locked in place with respect to the basket body. The lid is retained in position by means of a detent, which engages an edge flange of the basket body. Disposed at or near the substantially flat bottom of the basket body are a plurality of apertures, typically elongate slots, to provide air flow through the body of the packed fruit in the basket. This air flow continues through a similar series of apertures formed in the lid. In the case of the strawberry package, typically, eight (8) sixteen ounce (16 oz) baskets are loaded into a formed and folded corrugated cardboard tray.

The tray developed for use with the Michigan basket has one or more openings along either of its short ends to enable air flow through the tray. From the previous discussion on berry cooling, it will be appreciated that in the typically formed strawberry package system in current use, the two individual baskets within the tray which are immediately adjacent to the air intake apertures formed in the ends of the tray receive substantially more cooling from air inflow than do the two packages at the discharge end of the tray. To overcome this deficiency in air flow, berry coolers are currently required to utilize substantial amounts of cooling energy to ensure that fruit packed at the discharge side of the tray receives sufficient cooling to prolong its shelf life, while precluding the freezing of berries at the intake side of the tray.

The previously discussed problem is due to the fact that the one pound strawberry baskets and the tray which contains it were developed separately. Specifically, the design of the previously discussed one pound strawberry basket was finalized prior to the design of the tray which ultimately receives eight of these baskets therein. The previously discussed one pound strawberry containers in current use measure approximately four and three quarter inches by seven and one quarter inches (4¾'×7¼') and are three and one half inches (3½') tall with the top secured. As a result, the commonly used eight basket tray measures approximately fifteen and one-half inches by nineteen and three quarters inches (15½'×19¾'). This tray size is to some extent mandated by the size of the baskets it contains. While no great difficulty was likely encountered in forming a tray to fit a given number of the baskets, the area or "footprint" of the resultant tray was not given sufficient consideration in the design of the baskets. This has given rise to a significant inefficiency of packaging.

Because the current eight—one pound strawberry trays, and the baskets shipped therein are not fitted together properly, the package does not fully utilize the surface area of a forty by forty eight inch pallet, therefore shipping of those pallets is not optimized. Specifically, using current basket technology, a layer of strawberries comprises six (6) trays per layer on the pallet. With eight (8) one pound baskets per tray, this means that forty eight pounds of fruit can be packed per layer on a standard 40 inch by 48 inch pallet. Because there is no way with current use packages to completely fill the pallet with trays, a significant portion of the pallet remains unused. This of course forms a further inefficiency of shipping.

Another problem with current use plastic produce baskets is that they are usually formed with vertical stiffening ribs. This is done to maximize the resistance of the relatively thin basket to deformation. These ribs also provide salient intrusions into the body of the basket. Where a pulpy fruit, such as berries, are packed in the basket, handling shock to the packed fruit, combined with its own weight turns these intrusions into sites where significant bruising of the packed fruit occurs. This loss of fruit quality results in higher costs the shipper, transporter, retailer and consumer alike.

The previous discussion has centered on the specific case of the one pound whole strawberry container preferred by consumers. It should be noted, however, that while strawberries comprise the bulk of all U.S. berry consumption, other berry crops also enjoy a significant position in the marketplace. Each of these berry crops has, to a certain extent, given rise to preferred packaging embodiments therefor. By way of illustration but not limitation, while strawberries are typically sold in eight ounce or one pound containers, blueberries are typically sold by volume, specifically, consumers tend to prefer the one pint package of blueberries. Raspberries, on the other hand, are typically marketed in small five or six ounce trays.

The trays into which each of these differing types of berry baskets are ultimately installed have not been designed with a view to integrating them with other berry or indeed other produce crops. This presents a problem to the small-to-medium sized grocery establishment which may not order berries in multiple pallet lots but may prefer, for various reasons, to mix quantities of berries on one pallet. Because the trays used in the several aspects of the berry industry are not integrated one with another this capability is, at present, not realized. Accordingly, smaller lots of berries as commonly shipped to small-to-medium sized grocers must typically be sold at a premium cost in order to compensate the grower, shipper and transporter for the packing and shipping inefficiencies occasioned by the lack of packaging design cohesion.

Another problem with the previously discussed Michigan basket is the latch which retains the lid in the closed position with respect to the body. The Michigan basket uses a single detent formed in the lip of the lid to engage the edge of the basket body lip. This latch arrangement has proven troublesome in that it is difficult to quickly and securely close in the field while being prone to unwanted opening during packing, shipping and while on the grocer's shelves.

Other workers in the packaging arts have attempted to solve the previously discussed latch deficiencies by means of forming snap fasteners in the edge material of the plastic baskets which they produce. The results obtained by this design are mixed. While the snap fasteners may be slightly more secure than the previously discussed edge latch, they are at least as difficult to align properly by pickers in the field as the Michigan basket latch.

The trays currently available for use with Michigan baskets designed for one pound strawberry packing are not generally well suited for the baskets in that the baskets are allowed considerable freedom of movement within the trays. This results in an increased incidence of shifting of the baskets within the trays, which causes an increase in bruising of the fruit stored in the baskets.

The final problem not contemplated by the prior art is that different quantities, types, and external forms of produce a require different cooling air flow regimes. Some combinations of fruit types and quantities benefit from the relatively laminar flow provided by the invention of U.S. patent application Ser. No. 08/591,000. Further research has shown that some combinations of produce quantity and type benefit from a relatively turbulent air flow through the basket during the cooling process.

What is clearly needed is an improved berry packing system which will significantly reduce the cooling time and cooling expense for the fruit contained in the baskets. To make such an improved system feasible, it must interface with commonly used and preferred materials handling apparatus, specifically the previously discussed forty by forty eight inch pallets in current use in the grocery industry.

The baskets of such a system should be capable of being formed in the preferred size or quantity configuration preferred by the end consumer, while simultaneously maximizing their footprint on existing pallet technology. The baskets should be formed to minimize bruising and other damage to the fruit packed therein. Furthermore, such a system should provide for the mixing of lots of different types, quantities and sizes of produce on a single pallet without substantial losses of packaging efficiency occasioned by differing types of misaligned trays.

The basket should possess a lid latch capable of being quickly and securely fastened in the field. The same lid should be capable of being repeatedly opened and closed during packing, while on the grocer's shelves and ultimately by the end consumer.

The packaging system should enable the packaging of one layer, or a plurality of layers of filled baskets therein.

Finally, the several components of the packaging system should be capable of providing cooling air flow regimes relatively optimal for the type and quantity of produce to be stored in the baskets.

If possible, the system should be formed utilizing existing equipment and machinery from materials of the same or lesser cost than currently available fruit packages.

DISCLOSURE OF INVENTION

The present invention, available as the Mixim™ packaging from Sambrailo Packaging of Watsonville, Calif., comprises an improved berry packing system which matches trays with baskets to significantly reduce cooling time and expense for the fruit contained in the baskets. This is done by several means. First, cooling channels are formed in base of the individual baskets. These channels may be aligned with apertures formed in the sides of the trays into which the baskets are loaded. Second, the lid, when closed over the basket body defines at least one, and preferably a plurality of horizontal slots. These slots, in combination with other apertures formed in both the basket body and lid significantly improve air flow through the basket. The size, number and extent of the horizontal slots and their respective vertical positions on the basket may be arranged to optimize cooling for the type and quantity of produce for which the basket is formed. Thus, the combination of basket horizontal slots, apertures and the cooling channels aligned with tray apertures provides a significantly improved flow of cooling air flow through the berries. This improved air flow results in improved cooling efficiency and hence lower packing cost, resulting in a better quality berry, having a longer shelf life, and delivered to the consumer at a lower cost.

The cooling air flow provided by the several embodiments of the present invention may be optimized for generally laminar cooling air flow, relatively turbulent air flow, or some combination thereof. This is accomplished by selecting cooling slot geometries and tray configurations which provide the desired air flow regime.

The packing system of the present invention interfaces with commonly used and preferred materials handling apparatus, specifically the forty by forty-eight inch pallets in standard use in the grocery industry. The trays of the present invention are designed to completely fill such a standard pallet. This results in significant improvements in shipping efficiencies, again lowering costs to the consumer.

The baskets of such a system are capable of being formed in the preferred size or quantity configuration preferred by the end consumer, while simultaneously maximizing their footprint on standard pallets. Thus, the system provides for the mixing of lots of different types, quantities and sizes of produce on a single pallet without any of the substantial losses of packaging efficiency occasioned by packing differing types of misaligned trays. This advantage is accomplished by utilizing trays of the same area, but which may differ in their vertical dimension. The different trays required for different fruits, as taught by the present invention, not only possess the same footprint, but the same lug configuration as well. Accordingly, the present invention provides for the intermixing of different capacity trays on the same pallet. The only requirement is that trays in a given layer should all possess similar heights.

The baskets taught herein are formed to minimize bruising and other damage to the fruit. This is accomplished by designing the baskets without vertical stiffening ribs or other salient intrusions into the basket, but with gentle curves on substantially all those surfaces which come into contact with the fruit packed within. This further minimizes costs and losses to the grower, shipper, transporter and retailer.

The baskets possess a lid latch capable of being quickly and securely fastened in the field. The same lid is capable of being repeatedly opened and closed during packing, while on the grocer's shelves and ultimately by the end consumer.

The system is capable of being formed utilizing existing equipment and machinery, and generally from materials of the same or lesser cost than currently available fruit packages.

Other features of the present invention are disclosed or apparent in the section entitled: "BEST MODE FOR CARRYING OUT THE INVENTION."

BRIEF DESCRIPTION OF DRAWINGS

For fuller understanding of the present invention, reference is made to the accompanying drawing in the following detailed description of the Best Mode of Carrying Out the Present Invention. In the drawing:

FIG. **1** is a perspective view of a closed produce basket according to the principles of the present invention.

FIG. **2** is an end view of this closed produce basket.

FIG. **3** is plan view of an open produce basket according to the principles of the present invention.

FIG. **4** is a perspective view of a tray as taught by the present invention.

FIG. **5** is a perspective view of a plurality of closed produce baskets loaded into trays as taught by the present invention.

FIG. **6** is a detail of the lid detent of the produce basket posed prior to closing the lid over the basket body.

FIG. **7** is a detail of the lid detent of the produce basket after closing the lid over the basket body.

FIG. **8** is a perspective view of a plurality of trays of the present invention shown loaded on a pallet.

FIG. **9** is a perspective view of a closed first alternative produce basket formed according to the principles of the present invention.

FIG. **10** is an end view of the closed first alternative produce basket.

FIG. **11** is a perspective view of a first alternative tray incorporating flow restriction tabs.

FIG. **12** is a perspective view of a plurality of closed produce baskets loaded into the first alternative tray.

FIG. **13** is a perspective view of a second alternative tray incorporating flow restriction tabs, and optimized for producing turbulent flow.

FIG. **14** is a perspective view of a plurality of closed produce baskets loaded into the second alternative tray.

FIG. **15** is a perspective view of a third alternative tray incorporating flow restriction tabs, the tray further optimized for producing turbulent flow, and for receiving therein a plurality of layers of baskets.

FIG. **16** is a perspective view of a plurality of closed produce baskets loaded into the third alternative tray formed to receive therein a plurality of layers of baskets, the tray being optimized for producing turbulent flow.

FIG. **17** is a perspective view of a plurality of closed produce baskets loaded into a fourth alternative tray formed to receive therein a plurality of layers of baskets, the tray for providing relatively laminar air flow.

FIG. **18** is a perspective view of a plurality of closed produce baskets loaded into a fifth alternative tray formed to receive therein a plurality of layers of baskets, the tray for providing relatively laminar flow of cooling air.

Reference numbers refer to the same or equivalent parts of the present invention throughout the several figures of the drawing.

BEST MODE FOR CARRYING OUT THE INVENTION

Having reference to FIG. **1**, a first preferred embodiment of the produce basket **1** of the present invention is shown. Produce basket **1** is a one-piece structure incorporating both basket body **10** and lid **11**. That portion of produce basket **1** joining basket body **10** and lid **11** is formed as a hinge, **12**. Basket body **10** is further defines a transverse concavity defining channel **13**. While a first preferred embodiment is a vacuum formed plastic structure, the principles of the present invention are equally applicable to alternative materials and manufacturing technologies. In a first preferred embodiment of the present invention, the basket is formed of Kodapak® PET Copolyester 9921, available from Eastman Kodak. Alternative materials include, but are not limited to various polymeric and monomeric plastics including but not limited to styrenes, polyethylenes including HDPE and LPDE, polyesters and polyurethanes; metals and foils thereof; paper products including chipboard, pressboard, and flakeboard; wood and combinations of the foregoing. Alternative manufacturing technologies include, but are again not limited to thermocasting; casting, including die-casting; thermosetting; extrusion; sintering; lamination; the use of built-up structures and other processes well known to those of ordinary skill in the art.

Continuing with this first preferred embodiment, and referring now to FIGS. **6** and **7**, each of basket body **10** and lid **11** has formed about the periphery thereof a lip, **14** and **15** respectively. In a first preferred embodiment shown in FIG. **1**, lid **11** is held in the closed position by at least one set of paired, mating detent latches **16** and **17**. Latches **16** and **17** are formed as substantially vertically protruding members from lips **14** and **15** respectively. Latches **16** and **17** include teeth **18** and **19**. When lid **11** is closed over body **10**, tooth **18** of latch **16** engages tooth **19** of latch **17**, and maintains lid **11** secured in the closed position with respect to body **10**. Teeth **18** and **19** are maintained in the latched condition by the elastic deformation of latches **16** and **17**. In a first preferred embodiment, a pair of latches **16** and **17** are disposed about each of the front corners of basket **1**. A third pair of latches **16** and **17** is disposed about the rear edge of basket **1**. In this manner, lid **11** is secured to body **10** by three pairs of latches, acting in compressive opposition. This arrangement provides a lid closure which is at once more easily effected under field conditions, more secure and may be more easily opened and resealed than previous fruit basket latches.

Having reference to FIG. **2**, some of the improved ventilation features of this first preferred embodiment of the present invention are shown. Lateral ventilation channel **13** is formed at a substantially lower portion of body **10**. Channel **13** is disposed on body **10** to provide an improved flow of cooling air and ventilation through the lower portion of body **10**. To accomplish this, at least one, and preferably a plurality of vent apertures (not shown) are defined within vent bosses **20**. In order to provide a similarly improved flow of cooling air and ventilation through the upper portion of body **10**, vent slot **5** is defined when lid **11** and body **10** are secured together. Slot **5** is maintained at a fixed distance by paired detent latches **16** and **17**. The flow of cooling air through the basket is further improved by at least one, and again preferably a plurality of vent apertures (not shown) in the upper surface of lid **11**.

The upper and lower vent apertures, **22** and **21** are clearly shown in FIG. **3**. Also shown in this figure are the general arrangement of detent latches **16** and **17**. In a first preferred embodiment, lower latches **16** are disposed about a substantially inner portion of lower lip **14**, while upper latches **17** are disposed about a substantially outer portion of upper lip **15**. In this manner, when lid **11** is secured to body **10**, lower latches **16** are substantially captured within upper latches **17**, and maintained in an engages configuration by the elastic deformation of latches **16** and **17** in operative combination with teeth **18** and **19** (not shown). Furthermore, lateral movement and potential disengagement of lid **11** from body **10** is substantially precluded by latches **16** and **17** disposed about the portions of body **10** and lid **11** immediately adjacent to hinge **12**. This pair of latches, in a preferred embodiment, is disposed upon the entire width of body **10** and lid **11** respectively.

With continued reference to FIG. **3**., it will be apparent that in closing lid **11** onto body **10**, latches **16** and **17** disposed about the portions of body **10** and lid **11** immediately adjacent to hinge **12** will be the first to engage as lid **11** is closed. After teeth **18** and **19** (not shown) of this latch pair engage, the act of closing lid **11** continues, and latches **16** and **17** at the front end of basket **1** are engaged. The operator, by applying further closing pressure, elastically deforms to some degree at least some of latches **16** and **17**, engaging teeth **18** and **19** (not shown) and thereby securing lid **11** onto body **10**.

While the preceding discussion regarding a first preferred embodiment has centered on a one piece basket incorporating the basket body and lid joined by a hinge, it will be immediately apparent to those of ordinary skill in the art that the principles of the present invention may with equal facility be embodied in a two piece implementation utilizing a separate body and lid. This embodiment is specifically contemplated by the teachings of the present invention.

The preceding discussion details a first cooling regime wherein cooling air is actively urged towards both channel **13** and vent slot **5**. It is thought that this cooling regime may result in a more laminar flow of cooling air about produce contained within basket **1**. For some combinations of produce type and quantity however, a different cooling regime results in superior cooling. To produce this cooling regime, cooling air is actively urged only towards vent slot **13**. It is thought that this results in a more turbulent flow of cooling air about the enclosed produce, and that cooled air exits both through vent channel **13** and the opposite end of vent slot **5**. This alternative cooling regime is provided by use of alternative tray designs, as described below, and may be accentuated by certain modifications to the basket design itself.

Continued research into produce cooling has shown that some produce type/quantity combinations require different velocities of cooling air to achieve optimal cooling. This can be attained by altering the size of slot **5** in the following manner: in the second preferred embodiment of the present invention shown in FIGS. **9** and **10**, the vertical extent of slot **5** is substantially increased upwardly from the embodiment shown in FIGS. **1** and **2**. This is accomplished by extending the cut out portion **11'** in a substantially upward direction. This extension will often exceed one half of the lid portion of basket **1**.

Having reference now to FIGS. **4** and **5** a first preferred tray, **2**, formed according to the principles of the present invention is shown. Tray **2** is sized to hold at least one and preferably a plurality of baskets (not shown in this figure). In one preferred embodiment of the present invention, tray **2** holds six baskets **1**. A particular feature of tray **2** is the plurality of tray vents **25**. As shown in FIG. **5**, tray vents **25** align with the previously discussed vent channels formed in the bottom of baskets **1**. In this manner, a direct path is created from the ambient atmosphere to the bottom surface of each basket **1** loaded into tray **2**. Trays **2** are formed such that when stacked a lateral vent slot **26** is formed between each pair of trays **2**. Air vented from baskets **1** is vented from tray **2** at vent slots **27**. This means of tray ventilation, together with the previously described improvements in basket ventilation combine to ensure that all berries in the tray receive significantly greater cooling ventilation than any previous fruit cooling and packaging system, thereby creating significant reductions in cooling energy requirements. Indeed, preliminary testing indicates that the improved cooling afforded by the ventilation arrangement of the present invention may cut cooling costs for some strawberry packing operations by as much as 25%.

With continued reference to FIG. **4**, tray **2** is further formed with at least one cutaway section, **35**, which aligns with the horizontal ventilation slot of basket **1**, when loaded into tray **2**. This provides for improved flow of cooling air towards the top of basket **1** when loaded in tray **2**.

Having reference now to FIGS. **11** and **12**, cutaway section **35** may be formed into a further plurality of sections **35'**, separated by divider tabs **50**. Sections **35'** serve to direct the flow of cooling air only into horizontal slot **5** of basket **1** (not shown). In this manner, cooling efficiency is improved. The flow of cooling and vent air provided by this embodiment is shown in FIG. **12**.

With continued reference to FIG. **4**, trays **2** are formed to minimize lateral movement of one tray with respect to another by means of at least one tab **28** formed at an upper edge of tray **2** in operative combination with at least one receptacle **29** similarly formed on a substantially lower edge of the corresponding side. In this manner, when a plurality of trays **2** are loaded, for instance onto a pallet, tab **28** of a lower tray is received into receptacle **29** of the tray loaded onto it. Tab **28** may be formed to accept therein stacking wires (not shown), in accordance with generally accepted container design practice. These stacking wires generally take the form of an elongated U-shaped member which are inserted through tab **28** of one tray and thence through corresponding tabs **28** of one or more trays stacked thereon. Stacking wires thus utilized not only reduce lateral movement of one tray with respect to another, but can also form a handle for the facile handling of a plurality of trays at one time.

Having reference now to FIG. **8**, a significant savings in shipping costs is realized by sizing baskets **1** and trays **2** as a system to maximize the area or shipping footprint of a layer of trays on a pallet. As previously discussed, the 40 inch by 48 inch pallet is the preferred standard size in the grocery business. Current Michigan baskets measure approximately 4¾" by 7¼' by 3½' tall when closed and are loaded eight per tray.. This tray measures approximately 19¾ inches by 15¾ inches. A maximum of six such trays constitute a layer on a 40 inch by 48 inch pallet. Where the trays are loaded with one pound strawberry baskets, a maximum of 48 pounds of fruit may thus be loaded in each layer. In contrast, baskets of the present invention designed to receive therein one pound of strawberries are sized approximately 6⅜"×5"×3¾ high, when closed. Tray **2** of the present invention is sized at approximately 16"×13¼". This size maximizes the footprint on a standard pallet. This means that nine such trays can be loaded as a layer on the previously described pallet, for a total of 54 pounds of fruit per layer. This represents an increase of 6 pounds, or 16 percent per layer over the Michigan basket. Since the shipper is not paying for wasted shipping volume his shipping costs are reduced, which can result in further savings to the consumer.

The vertical mating surface of the Michigan trays, that portion of the baskets which abut one another when loaded into trays, comprises little more than the mated edges of two thin sheets of plastic. Accordingly, because those mating surfaces protrude, and due to the thin nature of their vertical aspect, the mating surfaces of the Michigan basket are very much prone to over-riding one another. This allows the baskets to shift markedly inside the tray, which is a significant factor in the bruising of fruit stored in the baskets. Referring again to FIG. **2**, it will be appreciated that to overcome this limitation, the baskets of the present invention further comprise an edge mating surface **30** formed by hinge **12** and latches **17**. This edge mating surface is relatively broad in comparison to the Michigan baskets described herein. The combination of this relatively broad mating surface with a properly sized basket/tray combination has been shown to be especially effective in the reduction of damage to fruit stored therein.

The preceding discussion of a first preferred embodiment of the present invention has focused on one specific berry package design. It will be immediately obvious to those of ordinary skill in the art that the principles set forth herein are also applicable to a wide range of produce package sizes and utilizations. By way of illustration but not limitation, the present invention specifically contemplates the forming of 1 pint and ½ pint (also referred to 8 oz. or 250 g.) berry baskets, as well as baskets configured to receive therein specific produce shapes, types and counts. An example of the latter is the "long stem pack" used in the berry industry for shipping specific package counts of large, premium berries. Furthermore, while the discussion of the principles set forth herein has centered on packages for the berry industry, it is recognized that these principles may be applied with equal facility to the packaging of a broad range of materials including other foodstuffs or any item which would benefit from the advantages set forth herein. Such applications are specifically contemplated. These principles include the use of a family of trays, having fixed "footprints" or lengths and widths, but with whose heights are varied to accommodate baskets having different heights and/or counts per tray. By maintaining the footprint at a constant value, the advantages of minimizing lateral movement between individual trays and between layers of trays are attained because the trays of one layer interlock with the layer of trays above or below it. This is true even where adjacent tray layers contain significantly differing sizes of baskets, holding the same or different produce items.

Where the tray is designed to receive one pound strawberry baskets as previously discussed, the height of the tray is approximately 3-¾ inches. Where other berries, or indeed other produce products are shipped, the length and width of the tray do not change, but remain at the previously defined optimal size. Changes in tray volume necessary to accommodate differing numbers and volumes of baskets are accommodated by altering the height of the tray. In similar fashion, baskets designed for use in the present system are sized to fit within the previously discussed tray. In this manner, baskets suitable for substantially any size basket designed for consumer use, as well as many baskets sized for the food service industry, may be accommodated by the present invention. This presents the previously described advantage of enabling the shipment of a mixed pallet of differing produce by loading trays optimized for each type of produce onto separate, compatible layers.

Moreover, tray **2** may be formed to receive therein a plurality of layers of filled baskets **1**. Examples of such embodiments are shown in FIGS. **15–18** Having reference now to FIGS. **17** and **18**, one embodiment of the present invention designed to hold two layers of the filled baskets is shown. In this embodiment, the first described cooling air regime is selected, and both tray vents **25** and horizontal cutaway sections **35'** are employed. Moreover, at least one pair of modified tray vents, **25'** is formed on opposite sides of tray **2** to perform the functions of tray vent **25** for the upper layer of baskets **1**, and cutaway sections **35'** for the lower layer of baskets **1**. Modified tray vents **25'** may be formed with a number of geometries. Two such are shown in FIGS. **17** and **18**.

With continued reference to FIG. **4**, tray **2** in a first preferred embodiment is formed of cut and folded corrugated cardboard formed in a manner well known to those of skill in the art. One such corrugated cardboard is Georgia-Pacific USP120-33sml-USP120, although any number of packaging materials well known to those of ordinary skill in the art could, with equal facility, be used. Such alternative materials include, but are not limited to various cardboards, pressboards, flakeboards, fiberboards, plastics, metals and metal foils. In some embodiments of tray **2**, it may further be advantageous to incorporate a gluing, adhesive or fastening step in fabrication of the tray, again in accordance with generally accepted practices in container design and fabrication.

Because of the smaller size of the trays of the present invention, a lighter grade of corrugated board is may be used for their manufacture than are trays required to support the greater weight and greater area of the Michigan baskets previously described. This lighter weight not only minimizes shipping costs, but can significantly reduce packaging costs for the shipper, again lowering consumer costs. While the tray of a first preferred embodiment is formed of corrugated cardboard, the principles of the present invention may with equal facility be implemented on a variety of alternative tray materials. Such alternative materials include, but are not limited to various polymeric and monomeric plastics again including but not limited to styrenes, polyethylenes including HDPE and LPDE, polyesters and polyurethanes; metals and foils thereof; paper products including chipboard, pressboard, and flakeboard; wood; wire; and combinations of the foregoing.

A second preferred embodiment of the present invention, implementing an alternative cooling air regime, can be provided by altering the ventilation provided by tray **2**. In this general class of embodiments, shown in FIGS. **13–16**, tray vents **25** or **25'** of the previously discussed embodiments are eliminated, and substantially all cooling air is directed to horizontal slots **5** of baskets **1** through cutaway sections **35** or **35'** of tray **2**. An example of such a tray, formed to receive therein a single layer of baskets **1**, is shown in FIGS. **13** and **14**. Another such tray, formed to receive therein a plurality of layers of baskets **1** is shown in FIGS. **15** and **16**. Each of trays **2** shown in FIGS. **13–16** are shown as employing divider tabs **50**. In studying the principles of the present invention, those having ordinary skill in the art will note that this second cooling air regime may, with equal facility, be implemented without recourse to divider tabs **50**.

The present invention has been particularly shown and described with respect to certain preferred embodiments and features thereof. However, it should be readily apparent to those of ordinary skill in the art that various changes and modifications in form and detail may be made without departing from the spirit and scope of the inventions as set forth in the appended claims. In particular, the use of alternative basket forming technologies, tray forming technologies, basket and tray materials and specifications, basket shapes and sizes to conform to differing produce requirements, and vent configurations are all contemplated by the principles of the present invention. The inventions illustratively disclosed herein may be practiced without any element which is not specifically disclosed herein.

We claim:

1. A produce tray for receiving there a produce basket, the produce basket defining a horizontal ventilation slot, said produce tray comprising in operative combination:

a tray body for receiving therein said produce basket; and

said tray body defining a cutaway portion, said cutaway portion disposed so as to align with said horizontal ventilation slot of said produce basket when said produce basket is received into said produce tray.

2. The produce tray of claim **1** further applied to said produce basket further including a ventilation channel formed on a lower surface thereof, said produce tray further defining a tray vent aperture disposed on said tray body so as to align with said ventilation channel when said produce basket is received into said produce tray.

3. The produce tray of claim **1** further for receiving therein a plurality of produce baskets, at least some number or said plurality of said produce baskets being arrayed vertically one above the other, said produce tray further defining a plurality of said cutaway portions, at least some number of said plurality of said cutaway portions arrayed vertically and further disposed to align with the horizontal ventilation slot of each of said produce baskets when said produce baskets are received in said produce tray.

4. The produce tray of claim **1** further for receiving therein a plurality of produce baskets, at least some number or said plurality of said produce baskets being arrayed vertically one above the other when received in said produce tray, each of said plurality of said produce baskets further including a ventilation channel formed on a lower surface thereof, said produce tray further defining a plurality of tray vent apertures, at least some number of said plurality of said tray vent apertures arrayed vertically and further disposed to align with said each said ventilation channel of said plurality of produce baskets when said produce baskets are received in said produce tray.

5. The produce tray of claim **1** further comprising:

a bottom;

first and second ends; and

first and second sides.

6. The produce tray of claim **1** further comprising a tab formed in an upper portion of at least one of said first and second ends.

7. The produce tray of claim **1**, sized such that nine of said trays define a layer which completely covers a forty by forty-eight inch pallet.

8. The produce tray of claim **1**, wherein said produce tray is sized in the range of 15 to 17 inches by 12¼ to 14¼ inches.

9. The produce tray of claim **8**, wherein said produce tray is sized in the range of 15½ to 16½ inches by 12¾ to 13¾ inches.

10. The produce tray of claim **9**, wherein said produce tray is sized 16 inches by 13¼ inches.

* * * * *

US005738890A

United States Patent [19]

Cadiente et al.

[11] Patent Number: 5,738,890

[45] Date of Patent: Apr. 14, 1998

[54] METHOD AND CONTAINER FOR THE IMPROVED PACKING AND COOLING OF PRODUCE

[75] Inventors: **Anthony Cadiente**, Salinas; **William Sambrailo**, Aptos, both of Calif.

[73] Assignee: **Plexiform Company**, Watsonville, Calif.

[21] Appl. No.: **591,000**

[22] Filed: **Jan. 24, 1996**

[51] **Int. Cl.**^{6} **B29C 49/00**; B65D 21/032; B65D 85/34

[52] **U.S. Cl.** **426/106**; 264/544; 426/392

[58] **Field of Search** 426/106, 392; 206/509, 560; 229/120; 264/544

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,652,335	9/1953	Conti	426/106
2,660,529	11/1953	Bloom	426/106
2,684,907	7/1954	Brunsing	426/392

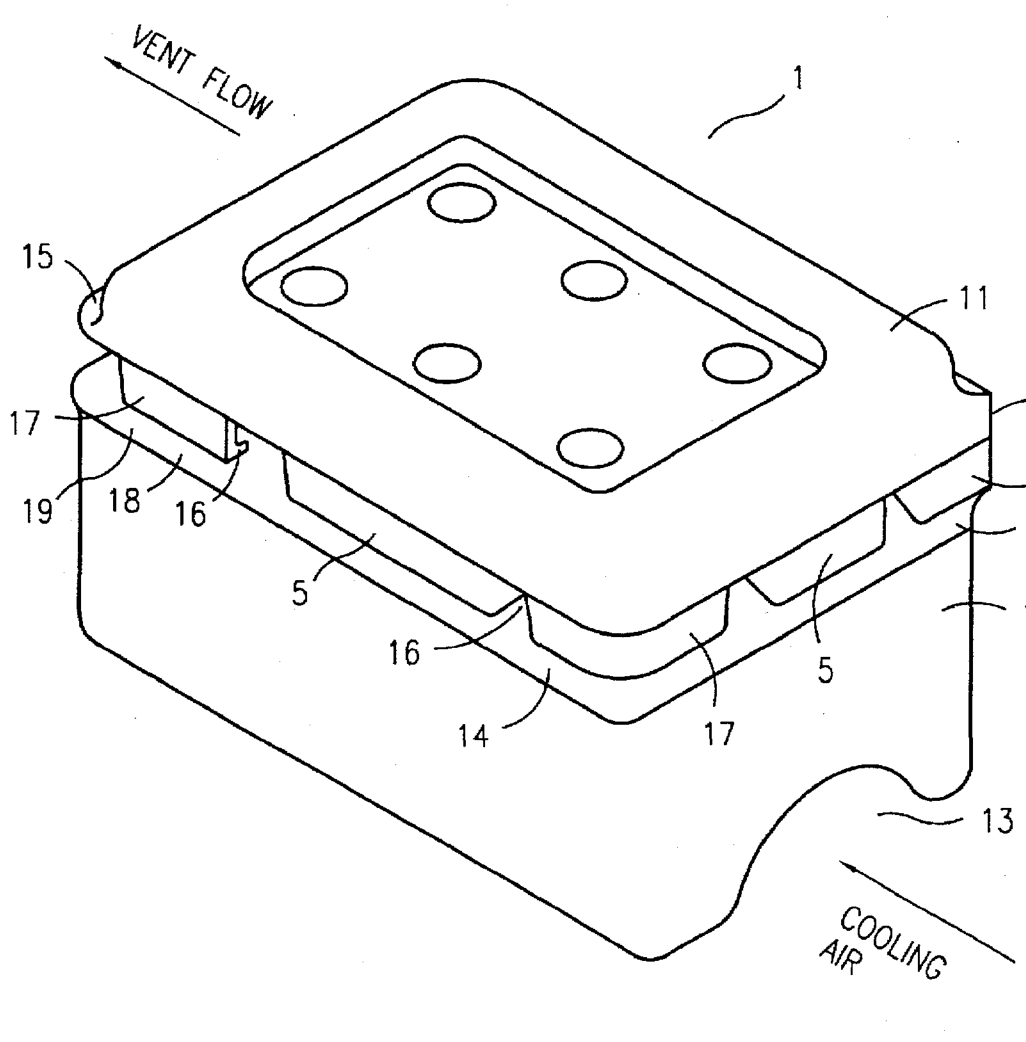
Primary Examiner—Leo B. Tentoni

Attorney, Agent, or Firm—LaRiviere, Grubman & Payne

[57] **ABSTRACT**

Method for improved packing and cooling of produce by improving the flow of ventilation air to the produce, and apparatus to practice the method. According to the present invention, baskets for the packing of fruit are provided with ventilation channels disposed upon a lower surface of the basket. Vent apertures communicate between the ventilation channels and the produce stored in the baskets. After packing the baskets with produce, they are loaded into trays. The trays are provided with tray vents which align with the ventilation channels. In this manner, entire pallets of produce-filled baskets can be efficiently chilled by introducing a flow of cooling air into the tray vents, through the ventilation channels and thence through the produce packed inside. The trays and baskets are sized so as to occupy all of the surface area of a standard shipping pallet, and to minimize the movement of the baskets within the trays, and of the trays with respect to one another.

21 Claims, 7 Drawing Sheets



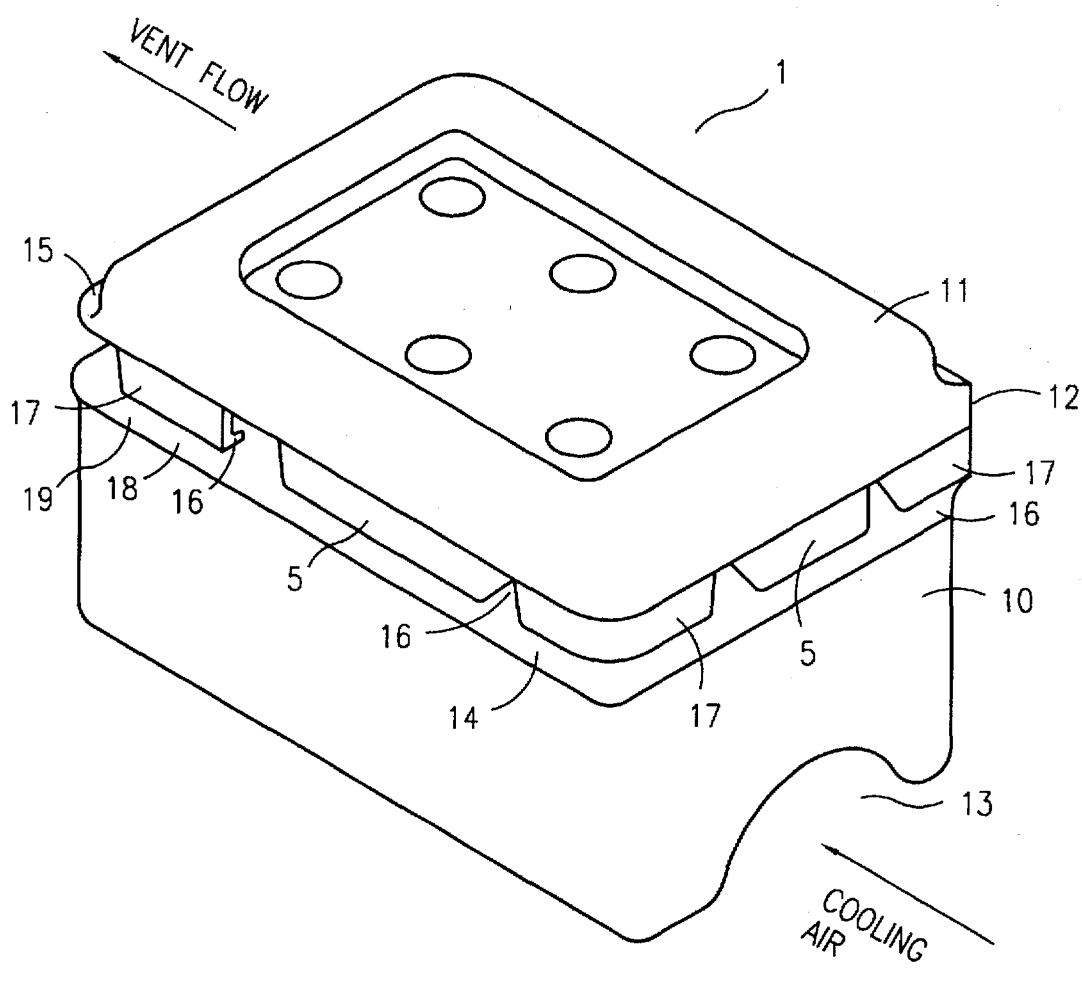


FIG. 1

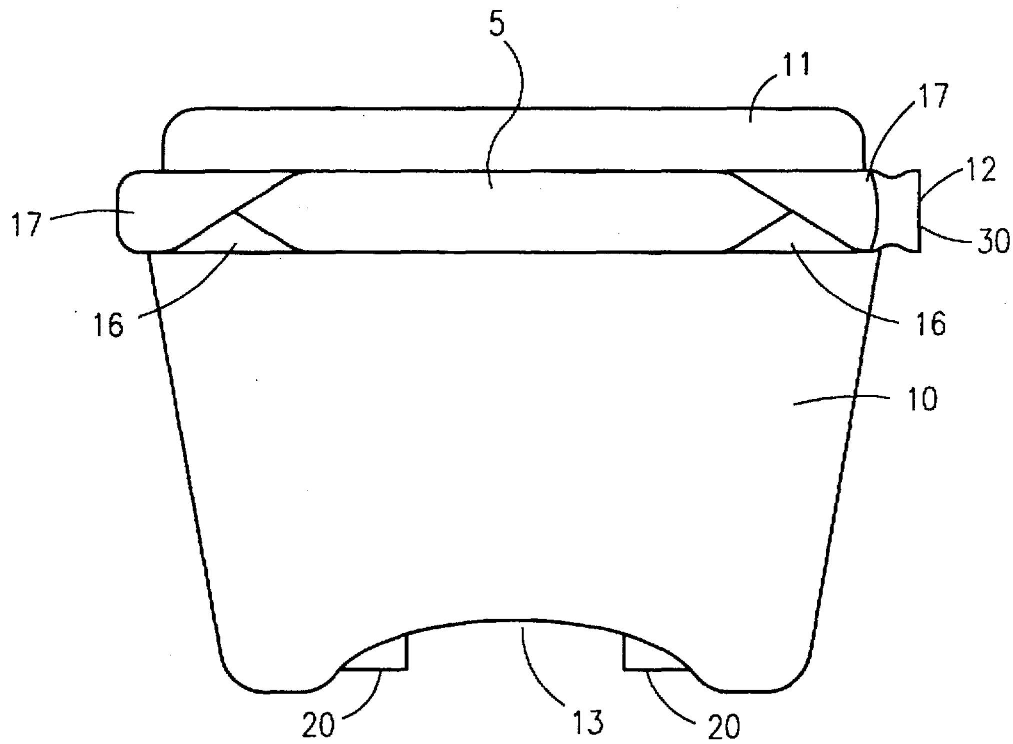


FIG. 2

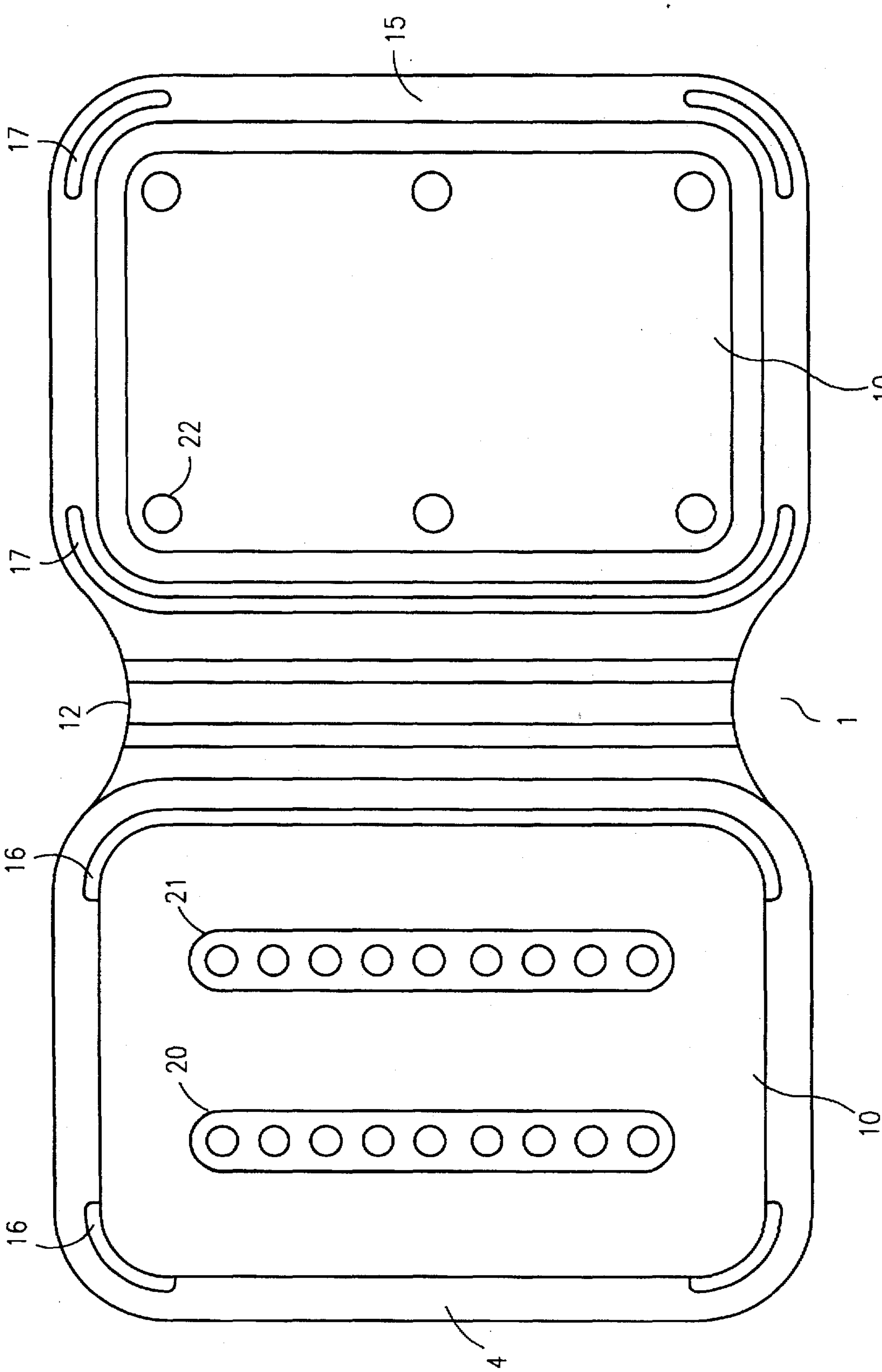


FIG. 3

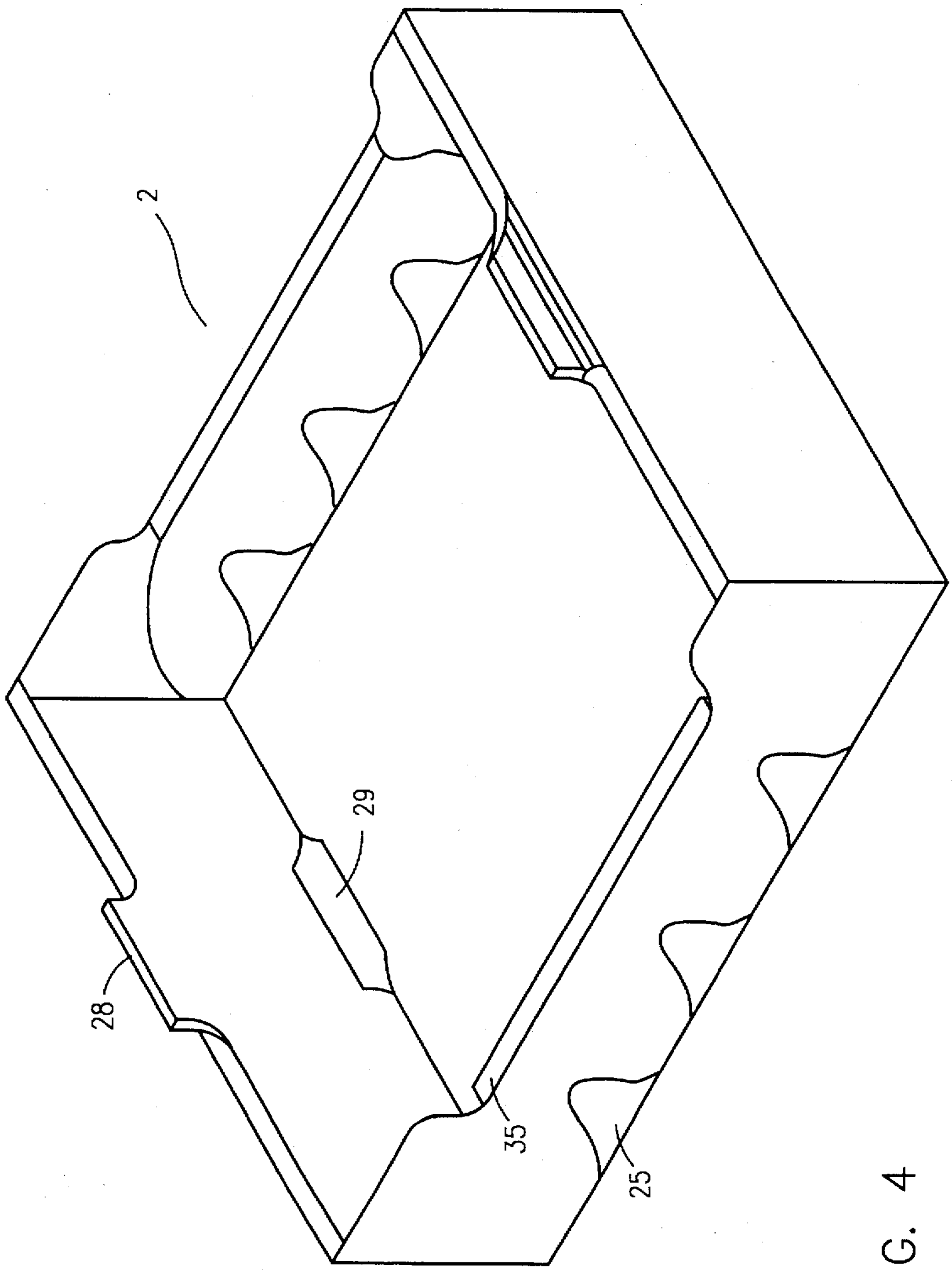


FIG. 4

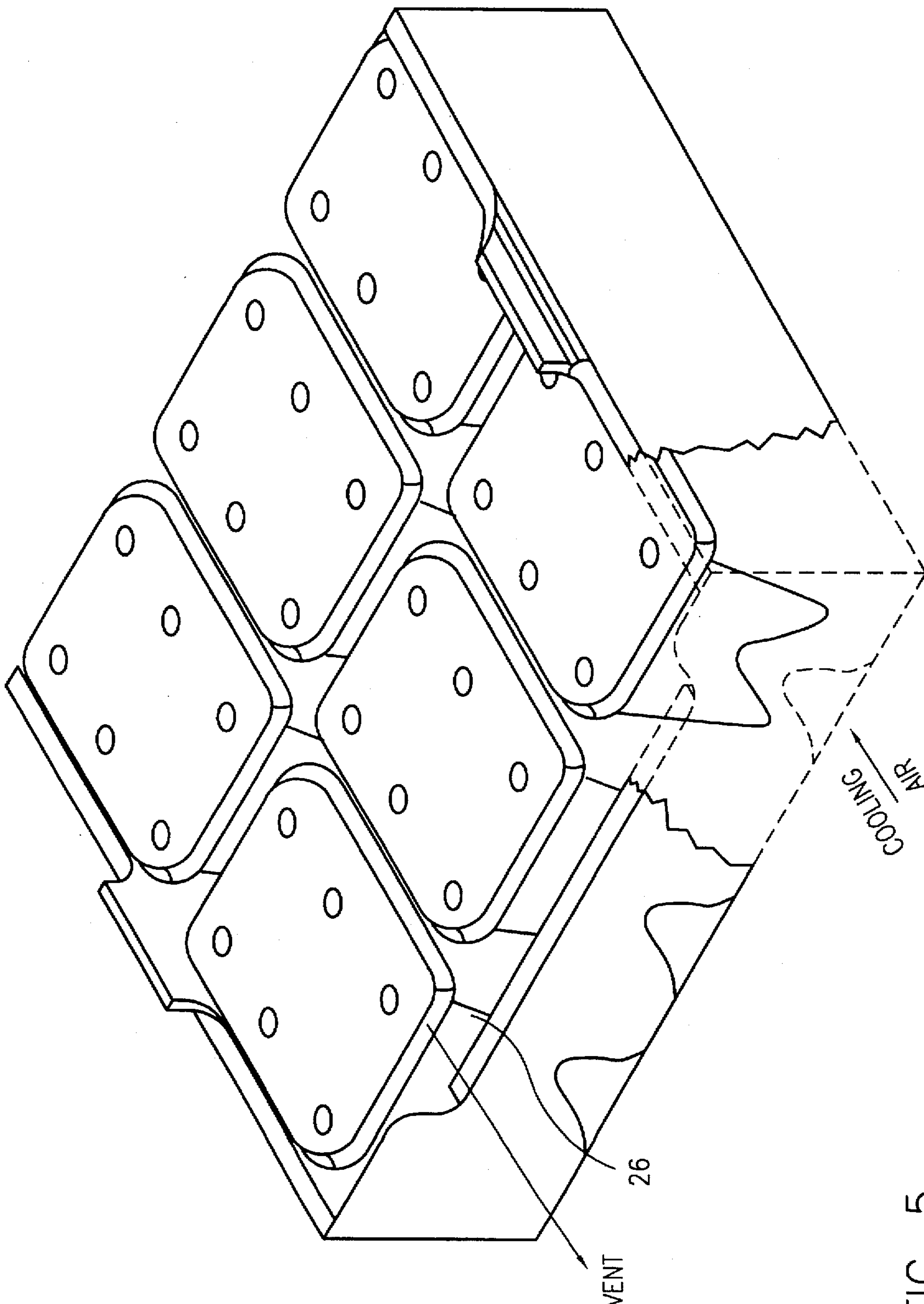


FIG. 5

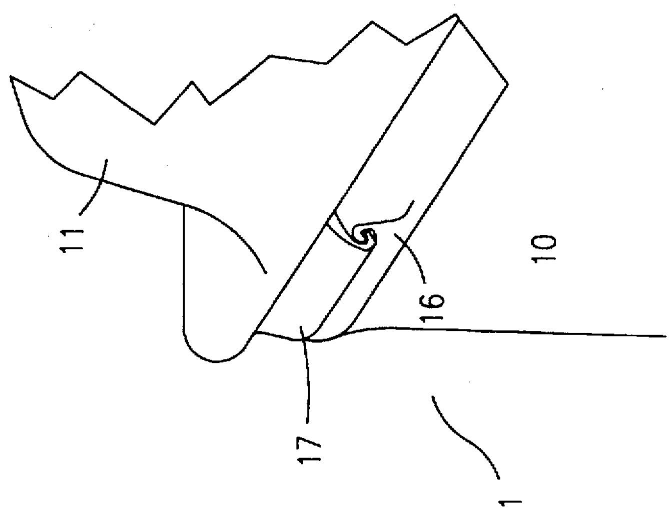


FIG. 7

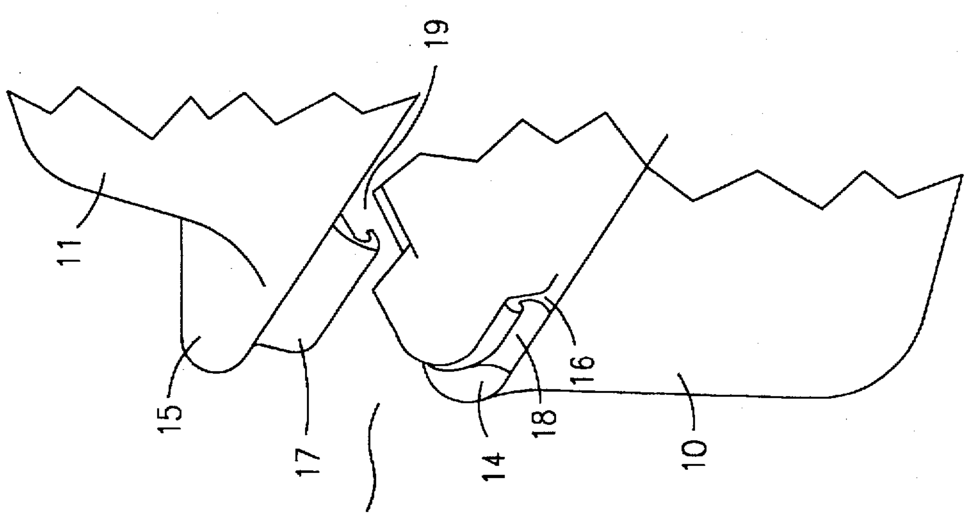


FIG. 6

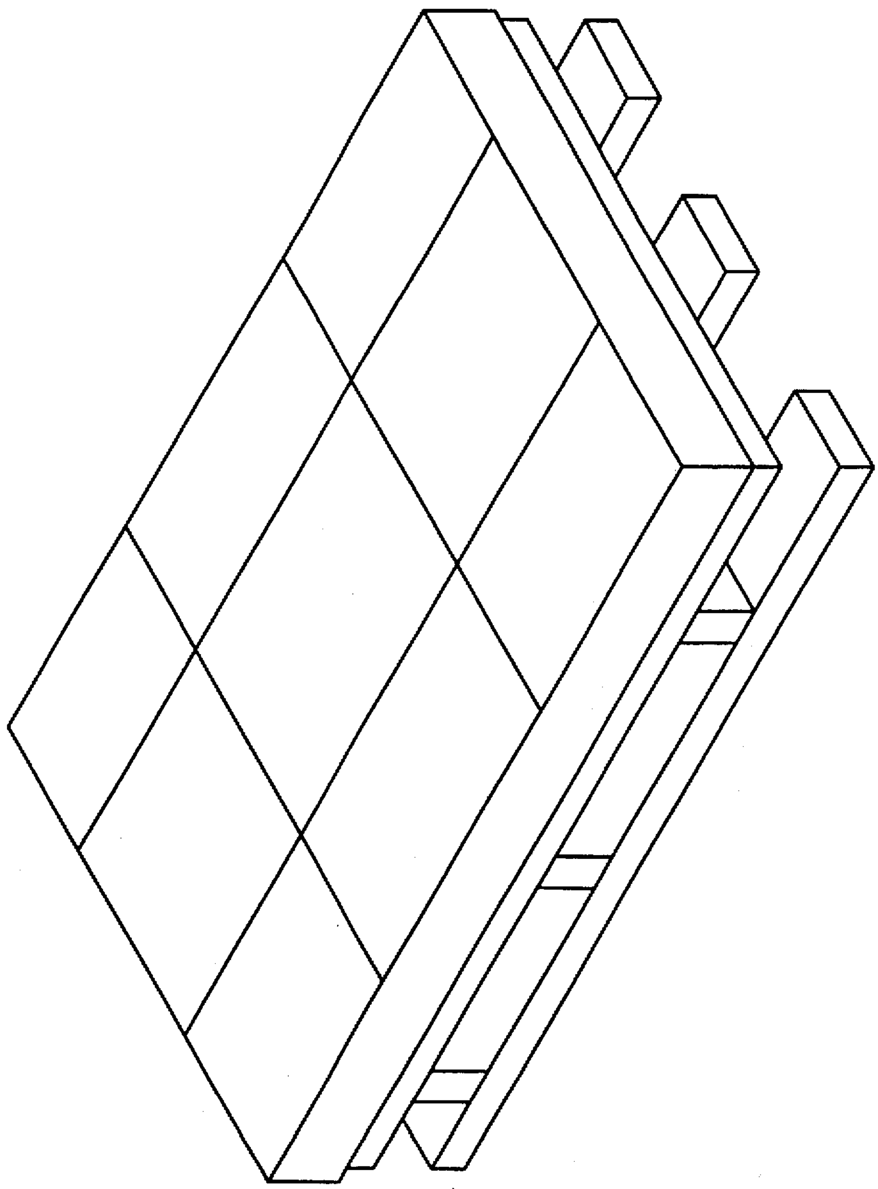


FIG. 8

METHOD AND CONTAINER FOR THE IMPROVED PACKING AND COOLING OF PRODUCE

TECHNICAL FIELD

The present invention relates to a method for the improved packing, cooling, storage, and shipping of produce items, and apparatus to perform the method. More particularly, the present invention is an improved container system comprising vacuum formed fruit containers received into and in operative combination with an improved tray design for optimizing the cooling and shipping of fruit, particularly of berries.

BACKGROUND ART

Many produce products are harvested and packed in the field into containers which are ultimately purchased by the end consumer. Examples of such produce items include, but are not limited to, tomatoes, berries, grapes, mushrooms, radishes and broccoli florets. Many of these produce items require substantial post-harvest cooling in order to enable shipping over long distances and to prolong shelf life

In use, a grower's harvesting crew harvests produce items of the type previously discussed directly from the plant in the field into the container. The containers are then loaded into trays, which contain a specific number of individual containers and the trays, when filled, are loaded onto pallets. The most common pallet used in the produce industry is the forty by forty-eight inch (40"×48") wooden pallet, and the vast majority of produce handling, storage and shipping equipment is designed around pallets of this size.

After the pallets have been filled and loaded in the field, they are transported to shippers who perform a variety of post-harvest processes to enhance the marketability of the produce itself. For many types of produce, including berries, a significant packing evolution is the post-harvest cooling of the packed fruit. Indeed, berry shippers are often referred to as "coolers". The process of cooling berries typically includes injecting a stream of cooling air into one side of a tray and thence through the individual baskets and around the berries stored therein. As the air cools the berries, it picks up heat therefrom which is exhausted from apertures on the opposite side of the tray.

Packages for use by berry coolers have undergone a systematic process of evolution to improve the storing and cooling of the fruit while reducing packaging costs. While early berry packaging products included the use or folded wood or chipboard containers, a common package for the marketing of strawberries for instance, is a one pound vacuum formed plastic basket developed in conjunction with Michigan State University. This one piece package, hereinafter referred to for brevity as a "Michigan basket", includes a basket body formed with an integral hinged lid which, after the basket is filled with fruit, is folded over and locked in place with respect to the basket body. The lid is retained in position by means of a detent, which engages an edge flange of the basket body. Disposed at or near the substantially flat bottom of the basket body are a plurality of apertures, typically elongate slots, to provide air flow through the body of the packed fruit in the basket. This air flow continues through a similar series of apertures formed in the lid. In the case of the strawberry package, typically, eight (8) sixteen ounce (16 oz) baskets are loaded into a formed and folded corrugated cardboard tray.

The tray developed for use with the Michigan basket has one or more openings along either of its short ends to enable air flow through the tray. From the previous discussion on berry cooling, it will be appreciated that in the typically formed strawberry package system in current use, the two individual baskets within the tray which are immediately adjacent to the air intake apertures formed in the ends of the tray receive substantially more cooling from air inflow than do the two packages at the discharge end of the tray. To overcome this deficiency in air flow, berry coolers are currently required to utilize substantial amounts of cooling energy to ensure that fruit packed at the discharge side of the tray receives sufficient cooling to prolong its shelf life, while precluding the freezing of berries at the intake side of the tray.

The previously discussed problem is due to the fact that the one pound strawberry baskets and the tray which contains it were developed separately. Specifically, the design of the previously discussed one pound strawberry basket was finalized prior to the design of the tray which ultimately receives eight of these baskets therein. The previously discussed one pound strawberry containers in current use measure approximately four and three quarter inches by seven and one quarter inches (4¾×7¼") and are three and one half inches (3½") tall with the top secured. As a result, the commonly used eight basket tray measures approximately fifteen and one-half inches by nineteen and three quarters inches (15½"×19¾"). This tray size is to some extent mandated by the size of the baskets it contains. While no great difficulty was likely encountered in forming a tray to fit a given number of the baskets, the area or "footprint" of the resultant tray was not given sufficient consideration in the design of the baskets. This has given rise to a significant inefficiency of packaging.

Because the current eight—one pound strawberry trays, and the baskets shipped therein are not fitted together properly, the package does not fully utilize the surface area of a forty by forty eight inch pallet, therefore shipping of those pallets is not optimized. Specifically, using current basket technology, a layer of strawberries comprises six (6) trays per layer on the pallet. With eight (8) one pound baskets per tray, this means that forty eight pounds of fruit can be packed per layer on a standard 40 inch by 48 inch pallet. Because there is no way with current use packages to completely fill the pallet with trays, a significant portion of the pallet remains unused. This of course forms a further inefficiency of shipping.

Another problem with current use plastic produce baskets is that they are usually formed with vertical stiffening ribs. This is done to maximize the resistance of the relatively thin basket to deformation. These ribs also provide salient intrusions into the body of the basket. Where a pulpy fruit, such as berries, are packed in the basket, handling shock to the packed fruit, combined with its own weight turns these intrusions into sites where significant bruising of the packed fruit occurs. This loss of fruit quality results in higher costs the shipper, transporter, retailer and consumer alike.

The previous discussion has centered on the specific case of the one pound whole strawberry container preferred by consumers. It should be noted, however, that while strawberries comprise the bulk of all U.S. berry consumption, other berry crops also enjoy a significant position in the marketplace. Each of these berry crops has, to a certain extent, given rise to preferred packaging embodiments therefor. By way of illustration but not limitation, while strawberries are typically sold in eight ounce or one pound containers, blueberries are typically sold by volume, specifically, consumers tend to prefer the one pint package of blueberries. Raspberries, on the other hand, are typically marketed in small five or six ounce trays.

The trays into which each of these differing types of berry baskets are ultimately installed have not been designed with a view to integrating them with other berry or indeed other produce crops. This presents a problem to the small-to-medium sized grocery establishment which may not order berries in multiple pallet lots but may prefer, for various reasons, to mix quantities of berries on one pallet. Because the trays used in the several aspects of the berry industry are not integrated one with another this capability is, at present, not realized. Accordingly, smaller lots of berries as commonly shipped to small-to-medium sized grocers must typically be sold at a premium cost in order to compensate the grower, shipper and transporter for the packing and shipping inefficiencies occasioned by the lack of packaging design cohesion.

Another problem with the previously discussed Michigan basket is the latch which retains the lid in the closed position with respect to the body. The Michigan basket uses a single detent formed in the lip of the lid to engage the edge of the basket body lip. This latch arrangement has proven troublesome in that it is difficult to quickly and securely close in the field while being prone to unwanted opening during packing, shipping and while on the grocer's shelves.

Other workers in the packaging arts have attempted to solve the previously discussed latch deficiencies by means of forming snap fasteners in the edge material of the plastic baskets which they produce. The results obtained by this design are mixed. While the snap fasteners may be slightly more secure than the previously discussed edge latch, they are at least as difficult to align properly by pickers in the field as the Michigan basket latch.

Finally, the trays currently available for use with Michigan baskets designed for one pound strawberry packing are not generally well suited for the baskets in that the baskets are allowed considerable freedom of movement within the trays. This results in an increased incidence of shifting of the baskets within the trays, which causes an increase in bruising of the fruit stored in the baskets.

What is clearly needed is an improved berry packing system which will significantly reduce the cooling time and cooling expense for the fruit contained in the baskets. To make such an improved system feasible, it must interface with commonly used and preferred materials handling apparatus, specifically the previously discussed forty by forty eight inch pallets in current use in the grocery industry.

The baskets of such a system should be capable of being formed in the preferred size or quantity configuration preferred by the end consumer, while simultaneously maximizing their footprint on existing pallet technology. The baskets should be formed to minimize bruising and other damage to the fruit packed therein. Furthermore, such a system should provide for the mixing of lots of different types, quantities and sizes of produce on a single pallet without substantial losses of packaging efficiency occasioned by differing types of misaligned trays.

The basket should possess a lid latch capable of being quickly and securely fastened in the field. The same lid should be capable of being repeatedly opened and closed during packing, while on the grocer's shelves and ultimately by the end consumer.

If possible, the system should be formed utilizing existing equipment and machinery from materials of the same or lesser cost than currently available fruit packages.

DISCLOSURE OF INVENTION

The present invention comprises an improved berry packing system which matches trays with baskets to significantly reduce cooling time and expense for the fruit contained in the baskets. This is done by several means. First, cooling channels are formed in base of the individual baskets. These channels are aligned with apertures formed in the sides of the trays into which the baskets are loaded. Second, the lid, when closed over the basket body defines at least one, and preferably a plurality of horizontal slots. These slots, in combination with other apertures formed in both the basket body and lid significantly improve air flow through the basket. Thus, the combination of basket horizontal slots, apertures and the cooling channels aligned with tray apertures and provides a significantly improved flow of cooling air flow through the berries. This improved air flow results in improved cooling efficiency and hence lower packing cost, resulting in a better quality berry, having a longer shelf life, and delivered to the consumer at a lower cost.

The packing system of the present invention interfaces with commonly used and preferred materials handling apparatus, specifically the forty by forty eight inch pallets in standard use in the grocery industry. The trays of the present invention are designed to completely fill such a standard pallet. This results in significant improvements in shipping efficiencies, again lowering costs to the consumer.

The baskets of such a system are capable of being formed in the preferred size or quantity configuration preferred by the end consumer, while simultaneously maximizing their footprint on standard pallets. Thus, the system provides for the mixing of lots of different types, quantities and sizes of produce on a single pallet without any of the substantial losses of packaging efficiency occasioned by packing differing types of misaligned trays. This is accomplished by utilizing trays of the same area, but which may differ in their vertical dimension. The different trays required for different fruits, as taught by the present invention, not only possess the same footprint, but the same lug configuration as well.

The baskets taught herein are formed to minimize bruising and other damage to the fruit packed therein. This is accomplished by designing the baskets without vertical stiffening ribs or other salient intrusions into the basket, but with gentle curves on substantially all surfaces which come into contact with the fruit packed within. This further minimizes costs and losses to the grower, shipper, transporter and retailer.

The baskets possess a lid latch capable of being quickly and securely fastened in the field. The same lid is capable of being repeatedly opened and closed during packing, while on the grocer's shelves and ultimately by the end consumer.

The system is capable of being formed utilizing existing equipment and machinery, and generally from materials of the same or lesser cost than currently available fruit packages.

Other features of the present invention are disclosed or apparent in the section entitled: "BEST MODE FOR CARRYING OUT THE INVENTION."

BRIEF DESCRIPTION OF DRAWINGS

For fuller understanding of the present invention, reference is made to the accompanying drawing in the following detailed description of the Best Mode of Carrying Out the Present Invention. In the drawing:

FIG. 1 is a perspective view of a closed produce basket according to the principles of the present invention.

FIG. 2 is an end view of this closed produce basket.

FIG. 3 is plan view of an open produce basket according to the principles of the present invention.

FIG. **4** is a perspective view of a tray as taught by the present invention.

FIG. **5** is a perspective view of a plurality of closed produce baskets loaded into trays as taught by the present invention.

FIG. **6** is a detail of the lid detent of the produce basket posed prior to closing the lid over the basket body.

FIG. **7** is detail of the lid detent of the produce basket after closing the lid over the basket body.

FIG. **8** is perspective view of a pallet supporting a plurality of trays according to the present invention, and displaying the improved shipping efficiencies enabled by the present invention.

Reference numbers refer to the same or equivalent parts of the present invention throughout the several figures of the drawing.

BEST MODE FOR CARRYING OUT THE INVENTION

Having reference to FIG. **1**, a preferred embodiment of the produce basket **1** of the present invention is shown. Produce basket **1** is a one-piece structure incorporating both basket body **10** and lid **11**. That portion of produce basket **1** joining basket body **10** and lid **11** is formed as a hinge, **12**. Basket body **10** is further defines a transverse concavity defining channel **13**. While a preferred embodiment is a vacuum formed plastic structure, the principles of the present invention are equally applicable to alternative materials and manufacturing technologies. In a preferred embodiment of the present invention, the basket is formed of KODAPAK polyethylene terephthalate (PET) Copolyester 9921, available from Eastman Kodak. Alternative materials include, but are not limited to various polymeric and monomeric plastics including but not limited to styrenes, polyethylenes including HDPE and LPDE, polyesters and polyurethanes; metals and foils thereof; paper products including chipboard, pressboard, and flakeboard; wood and combinations of the foregoing. Alternative manufacturing technologies include, but are again not limited to casting, including die-casting; extrusion; sintering; lamination; the use of built-up structures and other processes well known to those of ordinary skill in the art.

Referring now to FIGS. **6** and **7**, each of basket body **10** and lid **11** has formed about the periphery thereof a lip, **14** and **15** respectively. In a preferred embodiment shown in FIG. **1**, lid **11** is held in the closed position by at least one set of paired, mating detent latches **16** and **17**. Latches **16** and **17** are formed as substantially vertically protruding members from lips **14** and **15** respectively. Latches **16** and **17** include teeth **18** and **19**. When lid **11** is closed over body **10**, tooth **18** of latch **16** engages tooth **19** of latch **17**, and maintains lid **11** secured in the closed position with respect to body **10**. Teeth **18** and **19** are maintained in the latched condition by the elastic deformation of latches **16** and **17**. In a preferred embodiment, a pair of latches **16** and **17** are disposed about each of the front corners of basket **1**. A third pair of latches **16** and **17** is disposed about the rear edge of basket **1**. In this manner, lid **11** is secured to body **10** by three pairs of latches, acting in compressive opposition. This arrangement provides a lid closure which is at once more easily effected under field conditions, more secure and may be more easily opened and resealed than previous fruit basket latches.

Having reference to FIG. **2**, some of the improved ventilation features of the present invention are shown. Lateral ventilation channel **13** is formed at a substantially lower portion of body **10**. Channel **13** is disposed on body **10** to provide an improved flow of cooling air and ventilation through the lower portion of body **10**. To accomplish this, at least one, and preferably a plurality of vent apertures (not shown) are defined within vent bosses **20**. In order to provide a similarly improved flow of cooling air and ventilation through the upper portion of body **10**, horizontal ventilization slot **5** is defined when lid **11** and body **10** are secured together. Slot **5** is maintained at a fixed distance by paired detent latches **16** and **17**. The flow of cooling air through the basket is further improved by at least one, and again preferably a plurality of vent apertures (not shown) in the upper surface of lid **11**.

The upper and lower vent apertures, **22** and **21** are clearly shown in FIG. **3**. Also shown in this figure are the general arrangement of detent latches **16** and **17**. In a preferred embodiment, lower latches **16** are disposed about a substantially inner portion of lower lip **14**, while upper latches **17** are disposed about a substantially outer portion of upper lip **15**. In this manner, when lid **11** is secured to body **10**, lower latches **16** are substantially captured within upper latches **17**, and maintained in an engages configuration by the elastic deformation of latches **16** and **17** in operative combination with teeth **18** and **19** (not shown). Furthermore, lateral movement and potential disengagement of lid **11** from body **10** is substantially precluded by latches **16** and **17** disposed about the portions of body **10** and lid **11** immediately adjacent to hinge **12**. This pair of latches, in a preferred embodiment, is disposed upon the entire width of body **10** and lid **11** respectively.

With continued reference to FIG. **3**., it will be apparent that in closing lid **11** onto body **10**, latches **16** and **17** disposed about the portions of body **10** and lid **11** immediately adjacent to hinge **12** will be the first to engage as lid **11** is closed. After teeth **18** and **19** (not shown) of this latch pair engage, the act of closing lid **11** continues, and latches **16** and **17** at the front end of basket **1** are engaged. The operator, by applying further closing pressure, elastically deforms to some degree at least some of latches **16** and **17**, engaging teeth **18** and **19** (not shown) and thereby securing lid **11** onto body **10**.

While the preceding discussion regarding a preferred embodiment has centered on a one piece basket incorporating the basket body and lid joined by a hinge, it will be immediately apparent to those of ordinary skill in the art that the principles of the present invention may with equal facility be embodied in a two piece implementation utilizing a separate body and lid. This embodiment is specifically contemplated by the teachings of the present invention.

Having reference now to FIGS. **4** and **5** the tray, **2**, according to the present invention is shown. Tray **2** is sized to hold at least one and preferably a plurality of baskets (not shown). In a preferred embodiment of the present invention, tray **2** holds six baskets **1**. A particular feature of tray **2** is the plurality of tray vents **25**. As shown in FIG. **5**, tray vents **25** align with the previously discussed vent channels formed in the bottom of baskets **1**. In this manner, a direct path is created from the ambient atmosphere to the bottom surface of each basket **1** loaded into tray **2**. Trays **2** are formed such that when stacked a lateral vent slot **26** is formed between each pair of trays **2**. Air vented from baskets **1** is vented from tray **2** at lateral vent slots **26**. This means of tray ventilation, together with the previously described improvements in basket ventilation combine to ensure that all berries in the tray receive significantly greater cooling ventilation than any previous fruit cooling and packaging system, thereby creating significant reductions in cooling energy requirements.

Indeed, preliminary testing indicates that the improved cooling afforded by the ventilation arrangement of the present invention may cut cooling costs for some strawberry packing operations by as much as 25%.

With continued reference to FIG. **4**, tray **2** is further formed with at least one cutaway section, **35**, which aligns with the horizontal ventilation slot of basket **1**, when loaded into tray **2**. This provides for improved flow of cooling air towards the top of basket **1** when loaded in tray **2**, thereby defining the previously discussed lateral vent slot **26**.

With continued reference to FIG. **4**, trays **2** are formed to minimize lateral movement of one tray with respect to another by means of at least one tab **28** formed at an upper edge of tray **2** in operative combination with at least one receptacle **29** similarly formed on a substantially lower edge of the corresponding side. In this manner, when a plurality of trays **2** are loaded, for instance onto a pallet, tab **28** of a lower tray is received into receptacle **29** of the tray loaded onto it. Tab **28** may be formed to accept therein stacking wires (not shown), in accordance with generally accepted container design practice. These stacking wires generally take the form of an elongated U-shaped member which are inserted through tab **28** of one tray and thence through corresponding tabs **28** of one or more trays stacked thereon. Stacking wires thus utilized not only reduce lateral movement of one tray with respect to another, but can also form a handle for the facile handling of a plurality of trays at one time.

Having reference now to FIG. **8**, a significant savings in shipping costs is realized by sizing baskets **1** and trays **2** as a system to maximize the area or shipping footprint of a layer of trays on a pallet. As previously discussed, the 40 inch by 48 inch pallet is the preferred standard size in the grocery business. Current Michigan baskets measure approximately 4¾" by 7¼" by 3½" tall when closed and are loaded eight per tray. This tray measures approximately 19¾ inches by 15¾ inches. A maximum of six such trays constitute a layer on a 40 inch by 48 inch pallet. Where the trays are loaded with one pound strawberry baskets, a maximum of 48 pounds of fruit may thus be loaded in each layer. In contrast, baskets of the present invention designed to receive therein one pound of strawberries are sized approximately 6⅝"×5"×3¾ high, when closed. Tray **2** of the present invention is sized at approximately 16"×13¼". This size maximizes the footprint on a standard pallet. This means that nine such trays can be loaded as a layer on the previously described pallet, for a total of 54 pounds of fruit per layer. This represents an increase of 6 pounds, or 16 percent per layer over the Michigan basket. Since the shipper is not paying for wasted shipping volume his shipping costs are reduced, which can result in further savings to the consumer.

The vertical mating surface of the Michigan trays, that portion of the baskets which abut one another when loaded into trays, comprises little more than the mated edges of two thin sheets of plastic. Accordingly, because those mating surfaces protrude, and due to the thin nature of their vertical aspect, the mating surfaces of the Michigan basket are very much prone to over-riding one another. This allows the baskets to shift markedly inside the tray, which is a significant factor in the bruising of fruit stored in the baskets. Referring again to FIG. **2**, it will be appreciated that to overcome this limitation, the baskets of the present invention further comprise an edge mating surface **30** formed by hinge **12** and latches **17**. This edge mating surface is relatively broad in comparison to the Michigan baskets described herein. The combination of this relatively broad mating surface with a properly sized basket/tray combination has been shown to be especially effective in the reduction of damage to fruit stored therein.

The preceding discussion of a preferred embodiment of the present invention has focused on one specific berry package design. It will be immediately obvious to those of ordinary skill in the art that the principles set forth herein are also applicable to a wide range of produce package sizes and utilizations. By way of illustration but not limitation, the present invention specifically contemplates the forming of 1 pint and ½ pint (also referred to 8 oz. or 250 g.) berry baskets, as well as baskets configured to receive therein specific produce shapes, types and counts. An example of the latter is the "long stem pack" used in the berry industry for shipping specific package counts of large, premium berries. Furthermore, while the discussion of the principles set forth herein has centered on packages for the berry industry, it is recognized that these principles may be applied with equal facility to the packaging of a broad range of materials including other foodstuffs or any item which would benefit from the advantages set forth herein. Such applications are specifically contemplated. These principles include the use of a family of trays, having fixed "footprints" or lengths and widths, but with whose heights are varied to accommodate baskets having different heights and/or counts per tray. By maintaining the footprint at a constant value, the advantages of minimizing lateral movement between individual trays and between layers of trays are attained because the trays of one layer interlock with the layer of trays above or below it. This is true even where adjacent tray layers contain significantly differing sizes of baskets, holding the same or different produce items.

Where the tray is designed to receive one pound strawberry baskets as previously discussed, the height of the tray is approximately 3¾ inches. Where other berries, or indeed other produce products are shipped, the length and width of the tray do not change, but remain at the previously defined optimal size. Changes in tray volume necessary to accommodate differing numbers and volumes of baskets are accommodated by altering the height of the tray. In similar fashion, baskets designed for use in the present system are sized to fit within the previously discussed tray. In this manner, baskets suitable for substantially any size basket designed for consumer use, as well as many baskets sized for the food service industry, may be accommodated by the present invention. This presents the previously described advantage of enabling the shipment of a mixed pallet of differing produce by loading trays optimized for each type of produce onto separate, compatible layers.

With continued reference to FIG. **4**, tray **2** in a preferred embodiment is formed of cut and folded corrugated cardboard formed in a manner well known to those of skill in the art. One such corrugated cardboard is Georgia-Pacific USP120-33smi-USP120, although any number of packaging materials well known to those of ordinary skill in the art could, with equal facility, be used. Such alternative materials include, but are not limited to various cardboards, pressboards, flakeboards, fiberboards, plastics, metals and metal foils. In some embodiments of tray **2**, it may further be advantageous to incorporate a gluing, adhesive or fastening step in fabrication of the tray, again in accordance with generally accepted practices in container design and fabrication.

Because of the smaller size of the trays of the present invention, a lighter grade of corrugated board is may be used for their manufacture than are trays required to support the greater weight and greater area of the Michigan baskets previously described. This lighter weight not only minimizes shipping costs, but can significantly reduce packaging costs for the shipper, again lowering consumer costs. While the tray of a preferred embodiment is formed of corrugated cardboard, the principles of the present invention may with equal facility be implemented on a variety of alternative tray materials. Such alternative materials include, but are not limited to various polymeric and monomeric plastics again including but not limited to styrenes, polyethylenes including HDPE and LPDE, polyesters and polyurethanes; metals and foils thereof; paper products including chipboard, pressboard, and flakeboard; wood; wire; and combinations of the foregoing.

The present invention has been particularly shown and described with respect to certain preferred embodiments and features thereof. However, it should be readily apparent to those of ordinary skill in the art that various changes and modifications in form and detail may be made without departing from the spirit and scope of the inventions as set forth in the appended claims. In particular, the use of alternative basket forming technologies, tray forming technologies, basket and tray materials and specifications, basket shapes and sizes to conform to differing produce requirements, and vent configurations are all contemplated by the principles of the present invention. The inventions illustratively disclosed herein may be practiced without any element which is not specifically disclosed herein.

We claim:

1. A produce packaging system comprising in operative combination:

basket means including basket body means and lid means;

latch means for reversibly securing said lid means to said body means;

ventilation channel means formed in a lower surface of said basket body means;

a lower vent means further disposed on said lower surface of said basket body means in communication with said ventilation channel means; and

tray means for receiving therein said basket means, said tray means defining paired tray vent means disposed upon a lower portion of said tray means, said tray vent means disposed so as to align with said ventilation channel means when said basket means is installed in said tray means.

2. The packaging system of claim **1** wherein said basket means further comprises an upper vent means.

3. The packaging system of claim **2** wherein said upper vent means is disposed on a substantially upper surface of said lid means.

4. The packaging system of claim **1** wherein said body means and said lid means further define a horizontal ventilation slot.

5. The packaging system of claim **4** wherein said tray means further defines a cutaway portion, said cutaway portion disposed so as to align with said horizontal ventilation slot of said basket when said basket means is installed in said tray means.

6. A produce packaging system comprising in operative combination:

a basket including a basket body and a lid;

latch means for reversibly securing said lid to said body and for maintaining said lid in the secured position with respect to said body;

said basket body and said lid defining, when said lid is positioned in said secured position with respect to said body, a horizontal ventilation slot;

a lateral ventilation channel formed in a lower surface of said basket body;

a lower vent aperture further disposed on said lower surface of said basket body and in communication with said lateral ventilation channel;

an upper vent aperture disposed on a substantially upper surface of said lid;

a tray for receiving therein said basket, said tray defining paired tray vents disposed upon a lower portion of said tray, said tray vents disposed so as to align with said ventilation channel of said basket when said basket is installed in said tray; and

said tray further defining a cutaway portion, said cutaway portion disposed so as to align with said horizontal ventilation slot of said basket when said basket is installed in said tray.

7. The produce packaging system of claim **6** wherein said latch means further comprises a pair of toothed vertically mating latches including a first engageable tooth disposed upon said basket body and a second engageable tooth disposed upon said lid.

8. The produce packaging system of claim **7** wherein said latch means further comprises a plurality of pairs of toothed vertically mating latches.

9. The produce packaging system of claim **7** wherein said basket is a one-piece structure, said basket defining both said basket body and said lid as an integral unit.

10. The produce packaging system of claim **9** wherein said basket further defines a flexible hinge joining said basket body and said lid.

11. The produce packaging system of claim **7** wherein said tray further comprises a bottom, first and second ends and first and second sides.

12. The produce packaging system of claim **11** further comprising a tab formed in an upper portion of at least one of said first and second ends.

13. The produce packaging system of claim **11** further comprising a receptacle formed in a lower portion of at least one of said first and second ends, said receptacle for receiving therein said tab formed in a second tray.

14. The produce packaging system of claim **7** wherein said trays are sized such that nine of said trays define a layer which completely covers a forty by forty-eight inch shipping pallet.

15. The produce packaging system of claim **14** wherein said trays are sized in the range of 15 to 17 inches by 12¼ to 14¼ inches.

16. The produce packaging system of claim **15** wherein said trays are further sized in the range of 15½ to 16½ inches by 12¾ to 13¾ inches.

17. The produce packaging system of claim **16** wherein said trays are further sized 16 inches by 13¼ inches.

18. A method for the improved packing, cooling and shipment of produce comprising the steps of:

packing said produce in a basket means including basket body means and lid means, said body means including ventilation channel means formed in a lower surface thereof, and lower vent means further disposed on said lower surface of said basket body means and in communication with said ventilation channel means;

securing said lid means to said body means using latch means;

loading said basket containing said produce into a tray means, said tray means including tray vent means disposed upon a lower portion thereof and disposed so as to align with said ventilation channel means of said basket means when said basket means is installed in said tray means; and cooling said produce by means of introducing a flow of cooling air through said tray vent means, thence through said ventilation channel means and said lower vent means and about said produce.

19. A method for the manufacture of an improved packing, cooling and shipping system for produce, said method comprising the steps of:

forming a basket means including basket body means and lid means, said body means including ventilation channel means formed in a lower surface thereof, and lower vent means further disposed on said lower surface of said basket body means and in communication with said ventilation channel means, said basket means further including latch means for reversibly securing said lid means to said basket body means; and

forming a tray means for receiving therein at least one of said basket means, said tray means including tray vent means disposed upon a lower portion thereof and disposed so as to align with said ventilation channel means of said basket means when said basket means is received in said tray means.

20. The produce packaging system of claim 7 wherein said basket body further comprises a bottom, first and second ends and first and second sides, said bottom, said first and second ends and said first and second sides forming a substantial whole article defining said basket body, said first and second ends and said first and second sides further being substantially smooth structures, free of reinforcing ribs.

21. A produce packaging system comprising in operative combination:

a one-piece basket, said basket defining both a basket body and an integral lid joined by a flexible hinge, said basket body including a bottom, first and second ends and first and second sides, said bottom, said first and second ends and said first and second sides forming a substantial whole article defining said basket body, said first and second ends and said first and second sides further being substantially smooth structures, free of reinforcing fibs;

three sets of paired, toothed vertically mating detent latches, each of said sets of latches including a first engageable tooth disposed upon said basket body and a second engageable tooth disposed upon said lid, said latches for reversibly securing said lid to said body and for maintaining said lid in the secured position with respect to said body by the elastic deformation of said first and said second teeth;

a horizontal ventilation slot, said slot formed by edges of said basket body and said lid when said lid is positioned in said secured position with respect to said body; a lateral ventilation channel formed in a lower surface of said basket body;

a vent boss disposed on said ventilation channel, said boss further defining a

lower vent apertures in communication with said lateral ventilation channel;

an upper vent aperture disposed on a substantially upper surface of said lid;

a tray for receiving therein basket, said tray comprising a bottom, first and second ends and first and second sides, and defining paired tray vents disposed upon a lower portion of at least one of said sides, said tray vents disposed so as to align with said ventilation channel of said basket when said basket is installed in said tray, said tray sized such that nine of said trays define a layer which completely covers a forty by forty-eight inch shipping pallet;

at least one of said first and said second sides of said tray forming a cutaway portion, said cutaway portion disposed so as to align with said horizontal ventilation slot of said basket when said basket is installed in said tray;

a tab formed in an upper portion of at least one of said first and second ends; and

a receptacle formed in a lower portion of at least one of said first and second ends, said receptacle for receiving therein said tab formed in a second tray.

* * * * *

US005866183A

United States Patent [19]

Small

[11] **Patent Number: 5,866,183**

[45] **Date of Patent: Feb. 2, 1999**

[54] **PACKAGE CLOSING LABEL**

[75] Inventor: **Tobby Lynn Small**, St. Petersburg, Fla.

[73] Assignee: **Moore Business Forms, Inc.**, Grand Island, N.Y.

[21] Appl. No.: **908,079**

[22] Filed: **Aug. 11, 1997**

Related U.S. Application Data

[62] Division of Ser. No. 566,918, Dec. 4, 1995, Pat. No. 5,704,649.

[51] **Int. Cl.**[6] **B65D 85/72**

[52] **U.S. Cl.** **426/383**; 426/87; 426/106; 426/392; 426/396; 426/397; 206/459.5; 206/807; 220/315; 53/415; 53/416; 53/419

[58] **Field of Search** 426/87, 106, 118, 426/119, 120, 123, 397, 383, 392, 395, 396; 206/459.5, 807; 220/315; 53/415, 416, 419

[56] **References Cited**

U.S. PATENT DOCUMENTS

1,849,774	3/1932	Taylor	426/87
2,255,810	9/1941	Replogle	426/87
2,692,723	10/1954	Elsman	426/87 X
5,405,009	4/1995	Hackenbracht	426/119 X

FOREIGN PATENT DOCUMENTS

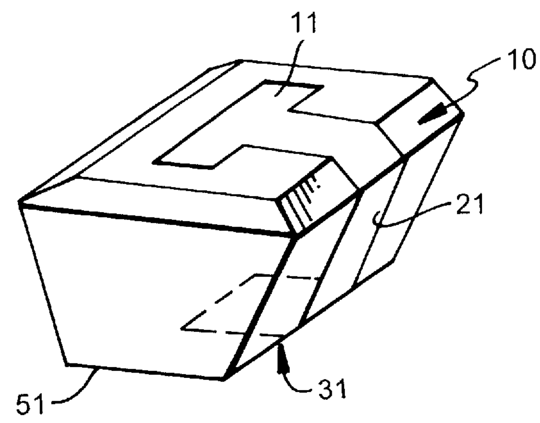
0380	8/1990	European Pat. Off.	206/807
3289465	12/1991	Japan	206/807
2236100	3/1991	United Kingdom	206/807

Primary Examiner—Milton Cano
Attorney, Agent, or Firm—Nixon & Vanderhye, P.C.

[57] **ABSTRACT**

A packaging label includes a first portion with permanent pressure sensitive adhesive on its bottom face and a second portion substantially perpendicular to the first portion and having permanent pressure sensitive adhesive on the bottom face remote from the first portion. The second portion typically includes nutritional information and bar coding since the label is typically used with clam shell plastic packages for fruits or other food items. The first portion of the label is adhesively secured to the lid of a clam shell container and after the container is filled with food items, the lid is closed, the second portion of the label is unfolded from a compact position which facilitates stacking and transportation, and the adhesive on the second portion is secured to the bottom of the container, holding the lid closed. The bar coding is preferably on the top face of the second portion opposite the adhesive so that it can be scanned merely by dragging the bottom of the container over a scanner (e.g. in a grocery store).

20 Claims, 4 Drawing Sheets



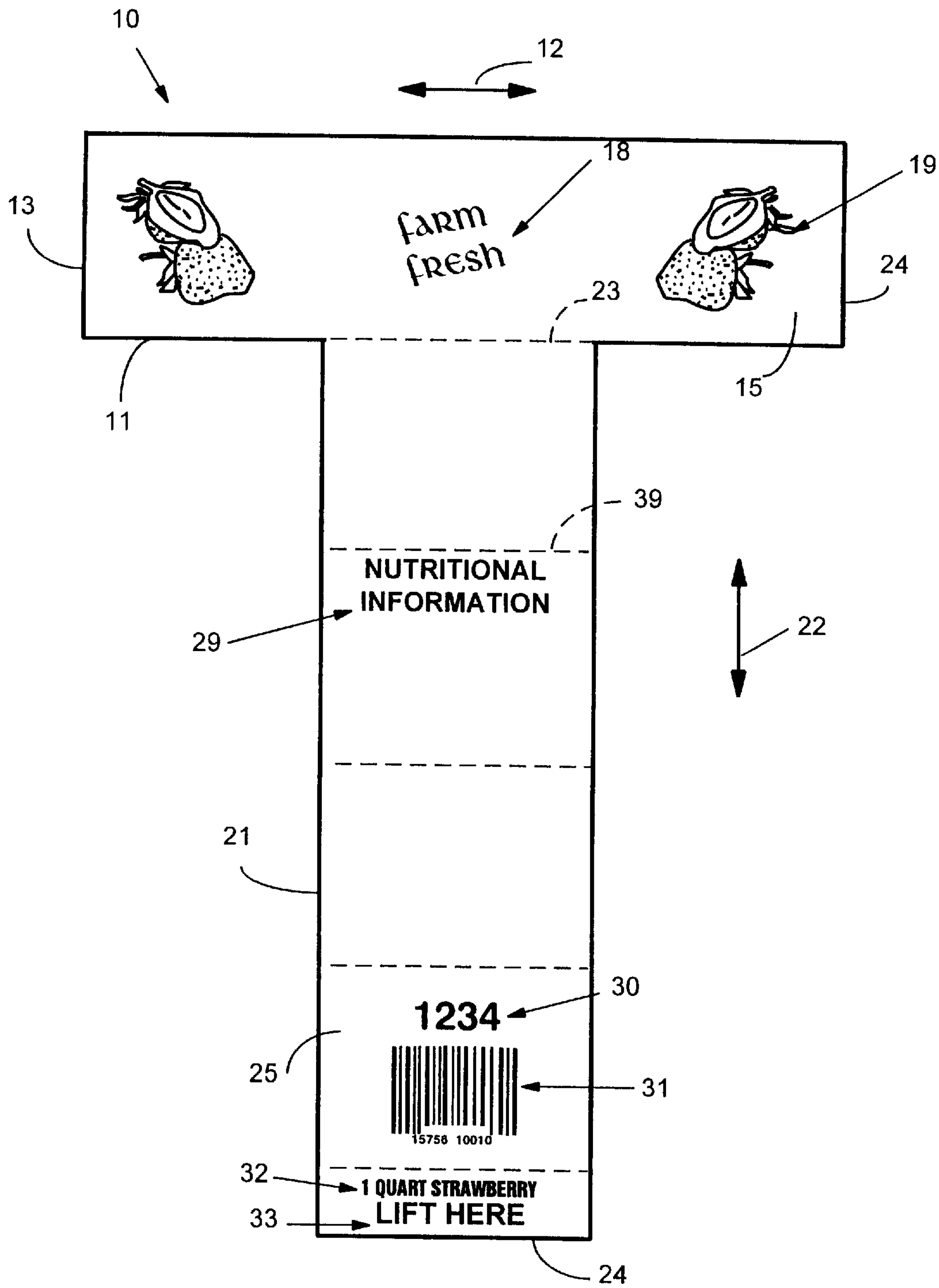
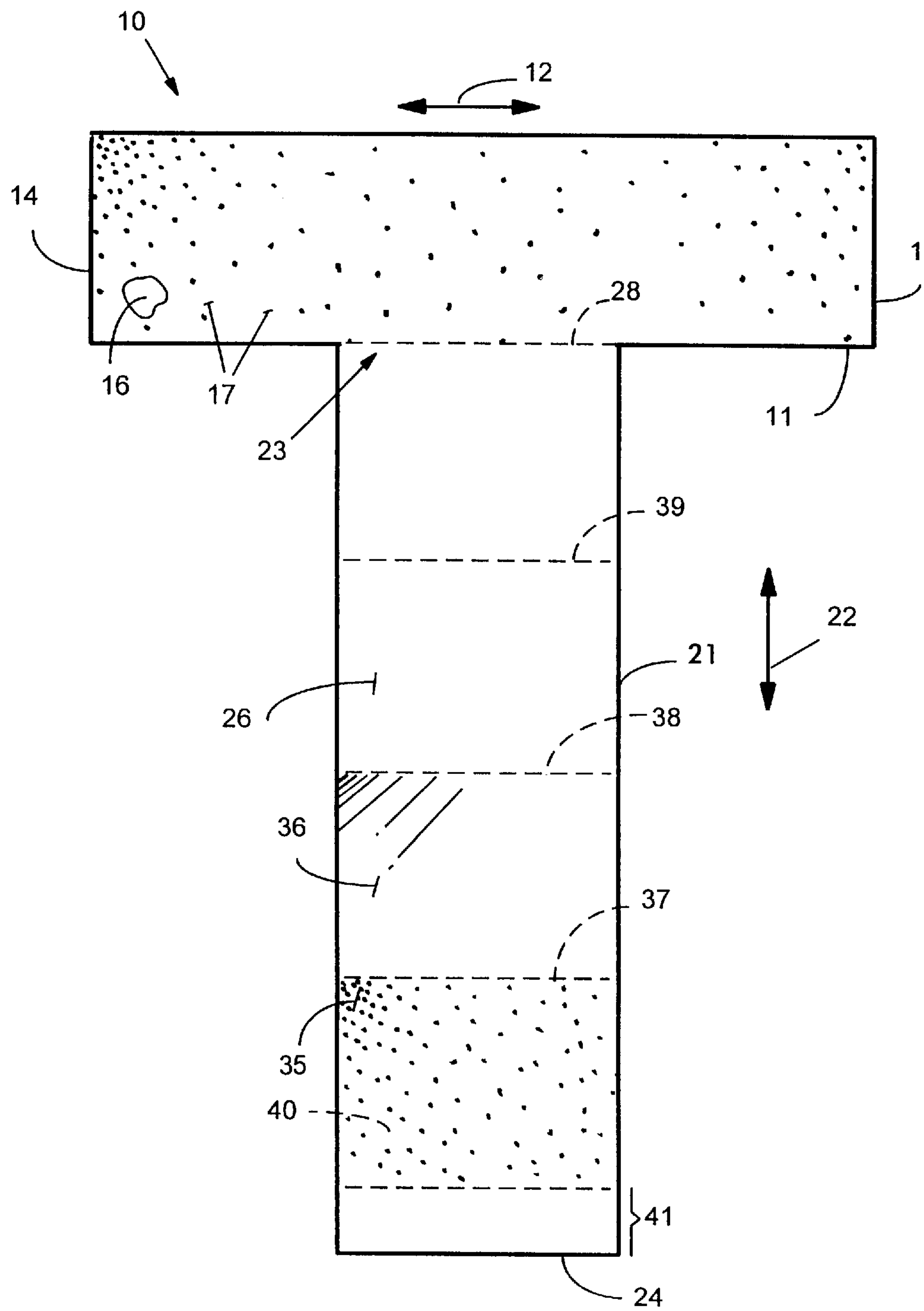

10
12
18
19
13
farm fresh
24
23
11
15
39
NUTRITIONAL INFORMATION
29
22
21
30
1234
25
31
15756 10010
32
1 QUART STRAWBERRY
33
LIFT HERE
24

Fig. 1

Fig. 2



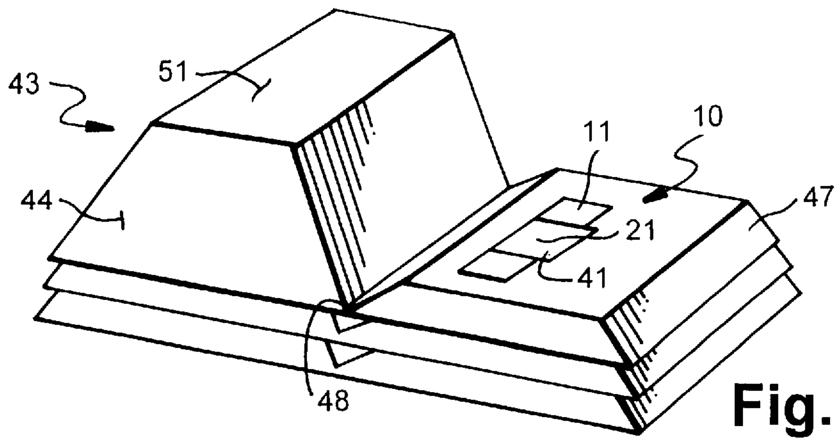


Fig. 3

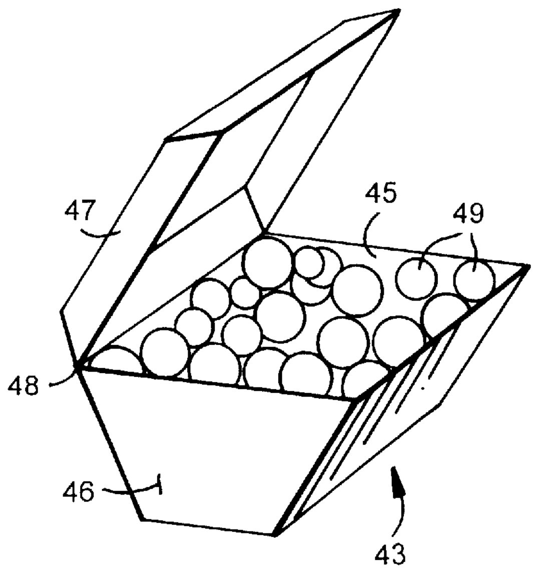


Fig. 4

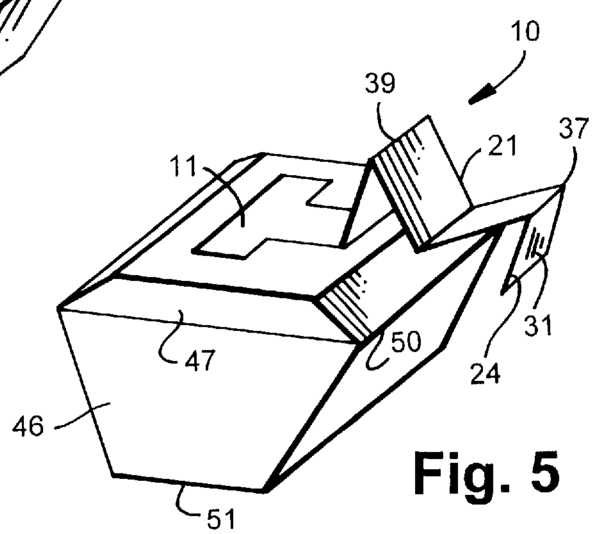


Fig. 5

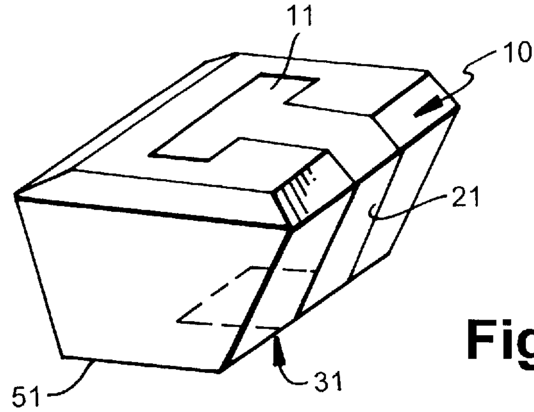


Fig. 6

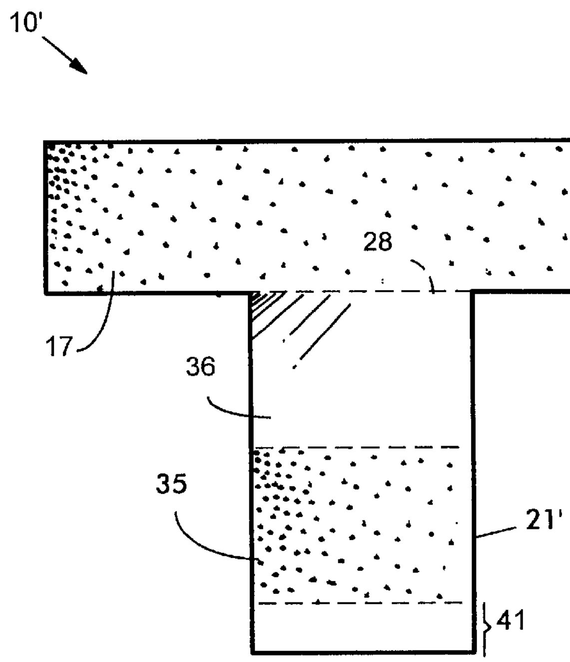


Fig. 7

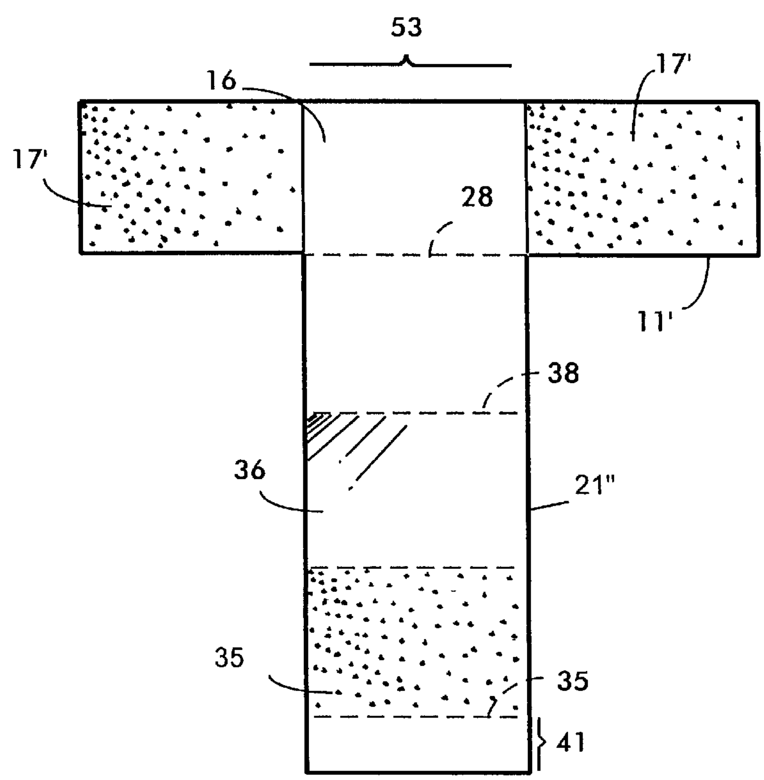


Fig. 8

PACKAGE CLOSING LABEL

This is a divisional of application Ser. No. 08/566,918, filed Dec. 4, 1995, now U.S. Pat. No. 5,704,649.

BACKGROUND AND SUMMARY OF THE INVENTION

Conventional clam shell containers for packaging produce and other food items are made of transparent polyethylene and are utilized by a number of field packers. Typically the field packers label the clam shell containers, so that the labels indicate what produce (e.g. strawberries, brussel sprouts, grapes, or the like) is packed thereby, the produce is packed, and the containers are shipped to a retail outlet. The retailer then typically culls the produce (removes bruised, spoiled, or otherwise unacceptable items or portions) and then seals the container with tape to prevent the consumer from making any "adjustments" to the contents of the container. Typically the labels do not include product look-up (PLU) numbers, bar codes, or nutrition facts. Bar code labels are typically applied separately by the retailer to the bottom of the containers or applied by the packer in a separate operation.

According to the present invention a packaging label assembly is provided which provides a number of advantages compared to the prior art described above, providing in combination with a conventional clam shell container an advantageous package assembly, and providing an advantageous method of packaging food items. The packaging label according to the present invention is large enough to provide PLU numbers, nutritional information, and bar coding; allows the retailer to use the same label assembly applied by the packer, after culling, to permanent close the container; and avoids the necessity of applying separate bar code labels.

According to one aspect of the present invention a packaging label assembly is provided comprising the following components: A first portion comprising a base elongated in a first dimension and having first and second opposite faces. A first pressure sensitive adhesive pattern on the first portion second face covering at least part of the second face. A second portion comprising a base elongated in a second dimension substantially perpendicular to the first dimension and having first and second opposite faces and first and second ends spaced from each other in the second dimension of elongation. The second portion connected to the first portion adjacent the first end thereof so that the first and second faces of the first and second portions may be disposed so that they are substantially coplanar. A first fold line adjacent the first end of the second portion for allowing folding of the second portion with respect to the first portion. Indicia on the second portion first face. A second pressure sensitive adhesive pattern on the second portion second face remote from the first fold line. A non-stick area of the second portion second face between the first fold line and the second adhesive pattern. And, a second fold line between the second adhesive pattern and the non-stick area.

The adhesive patterns preferably are both permanent adhesive, and the non-stick area of the second portion preferably comprises silicone release material substantially co-extensive in area with the second adhesive pattern. The adhesive patterns are typically substantially solid, although they may be formed by spaced dots, lines, or other configurations. Typically a lift tab is provided at the second end of the second portion, which is devoid of adhesive on the second face thereof, to facilitate unfolding of the second portion, and detachment of the second adhesive portion from the non-stick area.

The indicia on the second portion first face typically includes food nutritional information, and also typically includes PLU numbers and further includes bar coding opposite the second adhesive portion.

The label assembly may further comprise a third fold line in the second portion adjacent the non-stick area on the opposite side thereof from the second adhesive pattern, and a fourth fold line in the second portion between the first and third fold lines. The length of the first portion between the first end and the second end thereof is typically between about 4–8 inches, e.g. about 6½ inches. The second portion second face between the first and third fold lines is typically devoid of adhesive.

A wide variety of additional components or features, or modifications, may be provided. For example indicia indicating the contents of the package (e.g. "strawberries") may be provided on the first portion first face, and the first and second portions preferably comprise an integral piece of cellulose stock. The term "cellulose stock" as used in the present specification and claims means paper, or imagible paper containing laminates, or combinations of paper and plastic fibers which include a significant amount of paper fibers and are imagible.

According to another aspect of the present invention a package assembly (typically utilizing the label assembly as described above) is provided. The package assembly comprises the following features and components: A container body including an open top base for containing product therein, and a lid pivotally connected to the base and movable between an open position in which the base top is uncovered, and a closed position in which the base open top is closed by the lid. A label assembly comprising a first portion adhesively secured to the lid, and a second portion having a first end connected to the first portion, and a second end remote from the first portion, the second portion having a pressure sensitive adhesive section adjacent the second end thereof and a non-adhesive section between the adhesive section and the first end. Indicia indicating the contents of the container body imaged on at least one of the label assembly first and second portions. And, the adhesive section of the second portion spaced from the first portion a distance greater than the circumferential distance between the first portion and the base when the lid is in the closed position.

The second portion may include a plurality of fold lines formed therein so that the second portion is movable from a first position in which it substantially overlaps, or is substantially overlapped by, the first portion, to a second position in which the second end thereof is remote from the first portion and adhesively secured to the base of the container body by the adhesive section. The indicia typically comprises nutritional information about a food product packaged by the container body, and a bar code, the nutritional information and the bar code typically being provided on the second portion. The label assembly is typically of cellulose stock.

The container base typically includes a bottom portion opposite the open top and lid. The indicia includes a bar code corresponding to a food product packaged by the container body disposed on the second portion adjacent the second end thereof, and the adhesive section on the second body is adhesively secured to the bottom portion of the container base, and the bar code overlaps the bottom portion and is scannable by moving the bottom portion of the container body over a scanner. Preferably the first and second portions are adhesively secured to the lid and bottom portion, respectively, by permanent adhesive. The permanent adhesive of the second portion is typically spaced from the first portion about 3–7 inches for a common size of polyethylene clam shell packages.

The package assembly is typically provided in a stack—at one point during its utilization—with a plurality of other substantially identical package assemblies so that the container bodies of each are in a first stack and so that the lids with attached label assemblies of each are in a second stack connected to the first stack.

The invention also relates to a method of packaging food items in clam shell plastic containers as described above. The method comprises the steps of substantially sequentially: (a) Adhesively securing a label assembly first portion to a lid of each claim shell container, with the label assembly folded up so that it does not extend past the lid. (b) Stacking the clam shell containers into a stack in which the bodies and lids are disposed in two separate stacks with pivotal connections therebetween. (c) Transporting the stacked clam shell containers to a packaging location. (d) At the packaging location removing containers from the stack and filling them with a food product. (e) At the packaging location pivoting the lid of each filled container to a position closing the open top thereof with the lid. And, (f) unfolding the label assembly of each filled container and adhesively securing the second portion pressure sensitive adhesive section thereof to the container body.

The label assembly second portion typically has a bar code on an opposite face thereof from the adhesive section, and the container body includes a bottom. In that case step (f) is practiced so as to adhesively secure the adhesive section to the bottom of the container body so that the bar code is readily scannable by moving the bottom of the container over a scanner. Where the food items are not particularly perishable or bruisable step (f) may also be practiced at the packaging location. However where the food product is perishable or bruisable, such as conventional berries, grapes, and other produce, there are the further steps, between steps (e) and (f), of (g) transporting the containers to a retail establishment, and (h) culling the produce at the retail establishment.

It is the primary object of the present invention to provide for the simple yet effective packaging of items in containers, particularly produce in clam shell containers. This and other objects of the invention will become clear from an inspection of the detailed description of the invention and from the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a full scale top plan view of an exemplary label assembly according to the present invention in a deployed configuration;

FIG. **2** is a fill scale bottom plan view of the label assembly of FIG. **1**;

FIG. **3** is a top perspective view showing a stack of package assemblies according to the invention, with the label assembly of FIGS. **1** and **2** in a folded up condition provided thereon;

FIG. **4** is a top perspective view of a package of FIG. **3** filled with produce;

FIG. **5** is a top perspective view of the package of FIG. **4** after the lid has been closed and as the label assembly is being deployed;

FIG. **6** is a view like that of FIG. **5** with the label assembly completely deployed and holding the container lid closed;

FIG. **7** is a bottom plan view of another modification of label assembly according to the present invention; and

FIG. **8** is a bottom plan view of yet another label assembly according to the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** illustrate an exemplary embodiment of a packaging label assembly according to the present invention. The label assembly, shown generally by reference numeral **10**, includes a first portion **11**, comprising a base (typically of cellulose stock) elongated in a first dimension **12**, and having first and second ends **13**, **14**, and first and second opposite faces **15** (see FIG. **1**) and **16** (see FIG. **2**) respectively, the first face **15** typically being the "top" face while the second face **16** is the "bottom" face. A first adhesive pattern **17** (see FIG. **2**) is disposed on the second face **16**, covering at least part of the second face **16**. The adhesive **17** is preferably a pressure sensitive permanent adhesive and typically is applied in a continuous manner as illustrated in FIG. **3**, and substantially completely covers the face **16**. However other patterns may be utilized, such as spaced blocks of adhesive (see **17'** in FIG. **8**), spaced dots, spaced strips, or the like. Typically indicia is imaged on the first face **15** of the first portion **11**, such as the word indicia **18** indicating what the contents of the package with which the label assembly **10** is utilized, and/or graphics **19** (e.g. a pictorial representation of the contents of the package).

The packaging label assembly **10** further comprises a second portion **21** comprising a base (typically of cellulose stock) elongated in a second dimension **22** substantially perpendicular to the first dimension **12**, and having first and second ends **23**, **24** spaced from each other in a dimension of elongation **22**, and having first and second opposite faces **25** (see FIG. **1**) and **26** (see FIG. **2**). The second portion **21** is connected to the first portion **11** at the first end **23** thereof so that the first and second faces **15**, **25** and **16**, **26**, respectively, of the first and second portions **11**, **21** may be disposed so that they are substantially co-planar, as illustrated in FIG. **1**. Preferably the portions **11**, **21** are formed of an integral piece of paper stock which may die cut, or otherwise detached, from a web of cellulose stock to which various coatings and images have been applied.

A first fold line, best seen at **28** in FIG. **2**, is provided adjacent the first end **23** of the second portion **21** for allowing folding of the second portion **21** with respect to the first portion **11**. Fold line **28** in the embodiment illustrated in FIG. **3** is shown as a perforation line, but it may be formed by a score line, a partially die cut line, a crease line, or in any other manner that facilitates precise folding thereabout.

As seen in FIG. **1**, indicia is imaged on the second portion **21** first face **25**. The indicia typically includes—where the packaging label assembly **10** is used to package food items—nutritional information indicia **29**, a PLU number **30**, bar coding **31**, contents indicia **32** distinct from the bar coding **31**, and/or directional indicia **33**. The packaging label assembly **10** is large enough to include all of this indicia comfortably while still providing an area for graphics, logos, or the like.

As see in FIG. **2**, the label assembly **10** also includes a second pressure sensitive adhesive pattern **35** disposed on the face **26** remote from the first fold line **28**, and preferably adjacent the second end **24**, and a non-stick area **36** between the fold line **28** and the second adhesive pattern **35**. The pattern **35** preferably also is of permanent pressure sensitive adhesive, and as seen in FIG. **2** comprises a substantially continuous block of adhesive, although other patterns (such as dots, spaced blocks, lines, or the like), may be provided. The non-stick area **36** is substantially co-extensive with the adhesive pattern **35**, and where the adhesive pattern **35** is permanent adhesive typically comprises a silicone release coating, or like readily adhesive-releasable material. Typically the silicone adhesive-release material **36**, when used, is in block form comparable to the block form of the adhesive pattern **35**.

The label assembly **10** also preferably comprises a second fold line **37** (see FIG. **2**) between the adhesive pattern **35** and the nonstick area **36** to allow folding of the second portion **21** thereat. The second fold line **37** may be of any conventional type, as described above with respect to the first fold line **28**.

In the preferred embodiment illustrated in FIG. **2**, third and fourth fold lines **38**, **39** (see FIG. **2**) are also provided, the third fold line **38** adjacent the non-stick area **36** on the opposite side thereof from the second adhesive pattern **35**, and the fourth fold line **39** between the first and third fold lines **28**, **38**. A fifth fold line, typically in the form of a line of weakness such as a perforation, **40** may also be provided separating the second adhesive portion **35** from a lift tab portion **41** at the second end **24**.

In the embodiment illustrated in FIGS. **1** and **2**, the length of the second portion **21**—between the ends **23**, **24** thereof—is between about four-eight inches, depending upon the size of the clam shell container (to be described below) with which it is to be utilized. In the preferred embodiment—as seen by the full scale illustrations in FIGS. **1** and **2**—the spacings between each of the lines **28**, **39**; **39**, **38**; **38**, **37**; and **37**, **40**; is about one and a half inches for a total length of the second portion **21** of about six and a quarter-six and a half inches.

The label assembly **10** of FIGS. **1** and **2** is constructed so that it may be folded up to the folded configuration illustrated in FIG. **3** in which the second portion **21** overlaps the first portion **11** with essentially only the tab **41** extending outwardly therefrom (the width of the first portion **11** being about one and one-half inches in the embodiment illustrated in FIGS. **1** through **3**). When in the folded up configuration illustrated in FIG. **3**, the adhesive **35** engages the silicone release material **36**. While normally the inertia provided by folding about the fold line **28**, **38**, **39**—combined with the "weight" of the parts of the portion **21** containing the adhesive **35** and silicone release material **36**—is sufficient to maintain the folded up configuration illustrated in FIG. **3**, if necessary to further provide such a configuration, repositional adhesive may be provided on the face **26** between the fold lines **38**, **39**, and repositional adhesive provided on the face **25** between the fold lines **28**, **39**. The conventional repositional adhesive may be provided in any desired pattern.

In FIG. **3**, the label assembly **10** is shown as part of a package assembly—illustrated generally by reference numeral **43**—according to the present invention.

In addition to the label assembly **10** the package assembly **43** comprises a container body **44** having an open top **45** (see FIG. **4**) for the base **46** thereof and a lid **47** pivotally connected (e.g. by integral hinge **48**) to the base **46**. The lid **47** is movable about the pivot connection **48** between an open position (as illustrated in FIGS. **3** and **4**) in which the open top **45** is uncovered, and a closed position (FIGS. **5** and **6**) in which the open top **45** is closed by the lid **47**. While different lids, bases, and hinges, maybe provided (almost any conventional constructions being suitable), in the most desirable configuration according to the invention the container body **44** comprises a clam shell container of transparent plastic (e.g. polyethylene).

As illustrated in FIGS. **3**, **5**, and **6** the first portion **11** of the label assembly **10** is secured by the permanent adhesive **17** to the top of the lid **47** with the tab **41** facing away from the hinge **48**. As seen in FIG. **3** the package assemblies **43** may be stacked with the label assembly **10** attached to the lid **47** of each package **43** in the stack.

FIGS. **3** through **6** illustrate schematically a preferred method of packaging food items in clam shell plastic containers **43** utilizing the label assemblies **10**. As seen in FIG. **3**, the label assemblies **10** are applied to the lids **47** (either by machine or by hand) with the label assemblies **10** in the folded configuration illustrated in FIG. **3**, allowing the packages **43** to be restacked and cartoned. The stacked containers as illustrated in FIG. **3** are transported to a packaging location, such as an actual field where produce is being grown, or a packing house. At the packing location the package **43** is filled with food product, such as the produce (e.g. berries) **49** illustrated in FIG. **4** and then the lid **47** is closed. As is conventional for clam shell packaging, locking portions (not shown) between the lid **47** and the base **46** hold the lid **47** in place.

Where the food items **49** being packaged are not particularly perishable or subject to damage during shipment, the label assembly **10** may be deployed at that point; however in a typical situation the closed packages **43** are shipped to a retailer. At the retailer the package **47** is opened up by pivoting the lid **47** upwardly about the pivot **48** (to a position illustrated in FIG. **4**), and the retailer culls the produce **49**. Then the lid **47** is reclosed, as illustrated in FIG. **5**, and the label assembly **10** deployed, typically by grasping the tab **41** and pulling so that the adhesive **35** releases from the silicone release material **36**. By grasping the tab **41** the second portion **21** is tensioned and the end **24** moved past the openable seam **50** between the lid **47** and the base **46**, and down around the base **46** to overlie the bottom portion **51** of base **44**. The adhesive **35** is then pressed into contact with the bottom **51**, permanently adhering thereto, and providing the bar code **31** on the bottom **51** of the package **43** so that merely by moving the package **43** over a stationary scanner (such as in a grocery check out counter) the bar code **31** can be scanned.

While the configuration of the label assembly **10** illustrated in FIGS. **1** through **6** is preferred, other configurations may also be provided. For example, for use with smaller clam shell containers, or other types of containers, or where it is not necessary to provide bar coding on the bottom of a container, the label assembly **10'** illustrated in FIG. **7** may be utilized. In FIG. **7** components the same as those in the FIG. **2** embodiment are illustrated by the same reference numeral. Note that in this embodiment the portion **21'** is simply shorter—by the length of the portion between the fold lines **28**, **38** of the FIG. **2** embodiment—than the portion **21** in the FIG. **2** embodiment.

In the FIG. **8** embodiment the face **16** of the portion **11** has a non-adhesive central section **53** so that the portion **21"** may be folded under the portion **11'**, overlapped by the non-adhesive section **53**. In this embodiment the fold line **39** is eliminated and the distance between the fold lines **28**, **38** compressed. The tab **41** will extend outwardly from beneath the first portion **11'**, and may be grasped and pulled to deploy the rest of the portion **21"**.

Other modifications aside from those illustrated in FIGS. **7** and **8** may also be provided, the whole purpose merely being to provide a folded configuration and a deployed configuration with adhesive inactive when folded, and sealable to a container (such as a clam shell container) when deployed.

It will thus be seen that according to the present invention a label assembly suitable for sealing packages, especially packages for produce, has been provided, as well as an advantageous package assembly and method of packaging produce. While the invention has been herein shown and described in what is presently conceived to be the most practical and preferred embodiment thereof it will be apparent to those of ordinary skill in the art that many modifications may be made thereof within the scope of the invention, which scope is to be accorded the broadest interpretation of the appended claims so as to encompass all equivalent assemblies and methods.

What is claimed is:

1. A food package assembly comprising:

a container body including an open top base for containing a food product therein, and a lid pivotally connected to said base and movable between an open position in which said base top is uncovered, and a closed position in which said base open top is closed by said lid;

a label assembly comprising a first portion adhesively secured to said lid, and a second portion having a first end connected to and extending substantially transversely away from said first portion, and a second end remote from said first portion, said second portion so that said first and second portions have a substantially T-shaped configuration;

said second portion having a pressure sensitive adhesive section adjacent said second end thereof and a non-adhesive section between said adhesive section and said first end;

indicia indicating the contents of said container body imaged on at least one of said label assembly first and second portions; and

said adhesive section of said second portion spaced from said first portion a distance greater than the circumferential distance between said first portion and an upper portion of said base when said lid is in said closed position.

2. A package assembly as recited in claim **1** wherein said second portion further includes a plurality of fold lines formed therein so that said second portion is movable from a first position in which said second portion substantially overlaps, or is substantially overlapped by, said first portion, to a second position in which said second end thereof is remote from said first portion and adhesively secured to said base of said container body by said adhesive section.

3. A package assembly as recited in claim **1** wherein said container base includes a bottom portion opposite said open top and lid; and wherein said indicia includes a bar code corresponding to a food product packaged by said container body disposed on said second portion adjacent said second end thereof, and wherein said adhesive section of said second portion is adhesively secured to said bottom portion, and said bar code overlaps said bottom portion and is scannable by moving said bottom portion of said container body over a scanner.

4. A package assembly as recited in claim **1** wherein said adhesive section of said second portion is spaced from said first portion about 3–7 inches.

5. A package assembly as recited in claim **1** wherein said indicia comprises nutritional information about a food product packaged by said container body, and a bar code.

6. A package assembly as recited in claim **5** wherein said nutritional information and said bar code are on said second portion, and wherein said label assembly is of cellulose stock.

7. A package assembly as recited in claim **1** wherein a plurality of container bodies are arranged in a stack, so that the bases of each container body are in a first stack and the lids with attached label assemblies of each are in a second stack connected to said first stack.

8. A package assembly as recited in claim **7** wherein said container body and lid comprises a transparent clam shell plastic container.

9. A method of packaging food items in clam shell plastic containers, each container comprising an open top body with a lid pivotally connected thereto, and a label assembly including a first adhesive portion, and a second portion with a pressure sensitive adhesive section, said method comprising the steps of: substantially sequentially:

(a) adhesively securing a label assembly first portion to a lid of each claim shell container, with the label assembly folded up so that the label does not extend past the lid;

(b) stacking the clam shell containers into a stack in which the bodies and lids are disposed in two separate stacks with pivotal connections therebetween;

(c) transporting the stacked clam shell containers to a packaging location;

(d) at the packaging location removing the containers from the stack and filling the containers with a food product;

(e) at the packaging location pivoting the lid of each filled container to a position closing the open top thereof with the lid; and

(f) unfolding the label assembly of each filled container and adhesively securing the second portion pressure sensitive adhesive section thereof to the container body.

10. A method as recited in claim **9** wherein the label assembly second portion has a bar code on an opposite face thereof from the adhesive section; and wherein the container body includes a bottom; and wherein step (f) is practiced so as to adhesively secure the adhesive section to the bottom of the container body so that the bar code is readily scannable by moving the bottom of the container over a scanner.

11. A method as recited in claim **10** wherein the food product comprises produce; and comprising the further steps, between steps (e) and (f), of (g) transporting the containers to a retail establishment, and (h) culling the produce at the retail establishment.

12. A method as recited in claim **9** wherein the food product comprises produce; and comprising the further steps, between steps (e) and (f), of (g) transporting the containers to a retail establishment, and (h) culling the produce at the retail establishment.

13. A food package assembly comprising:

a container body including an open top base for containing a food product therein, and a lid pivotally connected to said base and movable between an open position in which said base top is uncovered, and a closed position in which said base open top is closed by said lid;

a label assembly comprising a first portion adhesively secured to said lid, and a second portion having a first end connected to and extending away from said first portion, and a second end remote from said first portion, said second portion having a pressure sensitive adhesive section adjacent said second end thereof and a non-adhesive section between said adhesive section and said first end;

indicia indicating the contents of said container body imaged on at least one of said label assembly first and second portions;

said adhesive section of said second portion spaced from said first portion a distance greater than the circumferential distance between said first portion and an upper portion of said base when said lid is in said closed position; and

wherein said second portion further includes a plurality of fold lines formed therein so that said second portion is movable from a first position in which said second portion substantially overlaps, or is substantially overlapped by, said first portion, to a second position in which said second end thereof is remote from said first portion and adhesively secured to said base of said container body by said adhesive section.

14. A package assembly as recited in claim **13** wherein said indicia comprises nutritional information about a food product packaged by said container body, and a bar code.

15. A package assembly as recited in claim **14** wherein said nutritional information and said bar code are on said second portion, and wherein said label assembly is of cellulose stock.

16. A package assembly as recited in claim **13** wherein a plurality of container bodies are arranged in a stack, so that the bases of each container body are in a first stack and the lids with attached label assemblies of each are in a second stack connected to said first stack.

17. A package assembly as recited in claim **16** wherein said container body and lid comprises a transparent clam shell plastic container.

18. A food package assembly comprising:

a container body including an open top base containing a food product therein, and a lid pivotally connected to said base and movable between an open position in which said base top is uncovered, and a closed position in which said base open top is closed by said lid, said container base including a bottom portion opposite said open top and lid;

a label assembly comprising a first portion adhesively secured to said lid, and a second portion having a first end connected to and extending away from said first portion, and a second end remote from said first portion, said second portion having a pressure sensitive adhesive section adjacent said second end thereof and a non-adhesive section between said adhesive section and said first end;

indicia indicating the contents of said container body imaged on at least one of said label assembly first and second portions, said indicia including bar code corresponding to a food product packaged by said container body disposed on said second portion adjacent said second end thereof;

said adhesive section of said second portion spaced from said first portion a distance greater than the circumferential distance between said first portion and said base bottom portion when said lid is in said closed position; and

wherein said adhesive section of said second portion is adhesively secured to said bottom portion, and said bar code overlaps said bottom portion and is scannable by moving said bottom portion of said container body over a scanner.

19. A package assembly as recited in claim **18** wherein said first and second portions are secured to said lid and bottom portion, respectively, by permanent adhesive.

20. A package assembly as recited in claim **18** wherein said adhesive section of said second portion is spaced from said first portion about 3–7 inches.

* * * * *

US005276703A

United States Patent [19]

Budin et al.

[11] **Patent Number: 5,276,703**

[45] **Date of Patent: Jan. 4, 1994**

[54] **WIRELESS LOCAL AREA NETWORK COMMUNICATIONS SYSTEM**

[75] Inventors: **Dan Budin**, Newton; **Alexander Herman**, Sharon, both of Mass.; **Colin Lanzl**, Nashua, N.H.

[73] Assignee: **Windata, Inc.**, Northboro, Mass.

[21] Appl. No.: **819,825**

[22] Filed: **Jan. 13, 1992**

[51] **Int. Cl.**[5] **H04L 27/30**

[52] **U.S. Cl.** **375/1**; 370/85.2; 370/93

[58] **Field of Search** 375/1, 106, 107; 380/34; 370/85.2, 85.3, 93, 94.1, 94.2, 100.1, 110.1

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,921,137	11/1975	McClearn, Jr. et al.	370/85.7
3,980,945	9/1976	Bickford	375/1
4,030,033	6/1977	Bibl et al.	375/1
4,112,372	9/1978	Holmes et al.	375/1
4,161,786	7/1979	Hopkins et al.	364/900
4,210,780	7/1980	Hopkins et al.	370/80
4,361,890	11/1982	Green, Jr. et al.	375/1
4,587,662	5/1986	Langewellpott	375/1
4,601,043	7/1986	Hardt et al.	375/1
4,644,560	2/1987	Torre et al.	375/1
4,672,658	6/1987	Kavehrad et al.	375/1
4,691,326	9/1987	Tsuchiya	375/1
4,694,467	9/1987	Mui	375/1
4,703,474	10/1987	Foschini et al.	370/18
4,710,944	12/1987	Nossen	375/40
4,724,435	2/1988	Moses et al.	340/870.13
4,759,034	7/1988	Nagazumi	375/1
4,760,586	7/1988	Takeda	375/1
4,811,357	3/1989	Betts et al.	375/1
4,866,735	9/1989	Mori et al.	375/1
4,866,771	9/1989	Bain	380/23
4,873,699	10/1989	Saussier et al.	375/1
4,894,841	1/1990	Martinino et al.	375/1
4,901,307	2/1990	Gilhousen et al.	370/18
4,928,274	5/1990	Gilhousen et al.	370/92
4,930,139	5/1990	Chandler et al.	375/1
5,029,183	7/1991	Tymes	375/1
5,056,109	10/1991	Gilhousen et al.	375/1
5,084,900	1/1992	Taylor	375/1

OTHER PUBLICATIONS

Burns ("Traders Future in their Hands," *Chicago Sun—Times*, Feb. 3 1991).

Crawford, Jr. ("Electronic Trading Card Heads for Pits," *Chicago Tribune*, Feb. 3, 1991).

Wexler ("Wireless networks pass early tests," *Computerworld*, Feb. 25, 1991, p. 49).

("LAN's—Unwired for Success," *Global Networking Strategies*, Apr. 30, 1991).

Davis ("Wireless LAN's Broadcast Their Benefits over Cable," *Electronic Business*, May 6, 1991, pp. 58, 60, 62).

Hancock ("Wireless is Up and Coming," *Digital Review*, May 20, 1991, p. 17).

Greenstein ("Pulling the Plug on LANs," *Networking Management*, Jun. 1991, pp. 21–28).

Rosenbaum ("The Technology Behind Wireless LANs," *LAN Times*, vol. 8, Issue 13, Jul. 8, 1991).

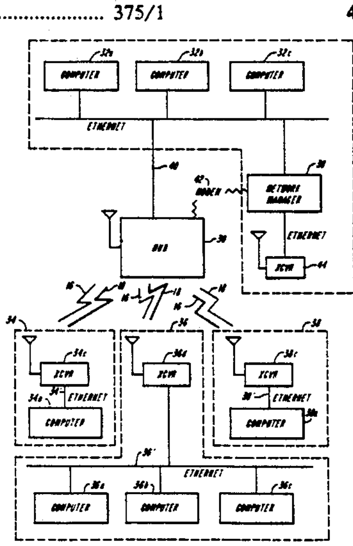
Cerf ("Networks," *Scientific American*, Sep. 1991, pp. 72–81).

Primary Examiner—Salvatore Cangialosi
Attorney, Agent, or Firm—Lahive & Cockfield

[57] **ABSTRACT**

A local area network including at least one hub unit, at least one associated station unit and a wireless communication link between each hub unit and its associated station units. The communication link includes a wireless down-link channel for transferring information from each hub unit to its associated station units and a wireless up-link channel for transferring information from each station unit to its associated hub unit. Communication is conducted in accordance with a combination time division multiplexing and contention based protocol. A synchronized common slotted time frame between each hub unit and its associated station units is imposed by the hub unit.

49 Claims, 6 Drawing Sheets



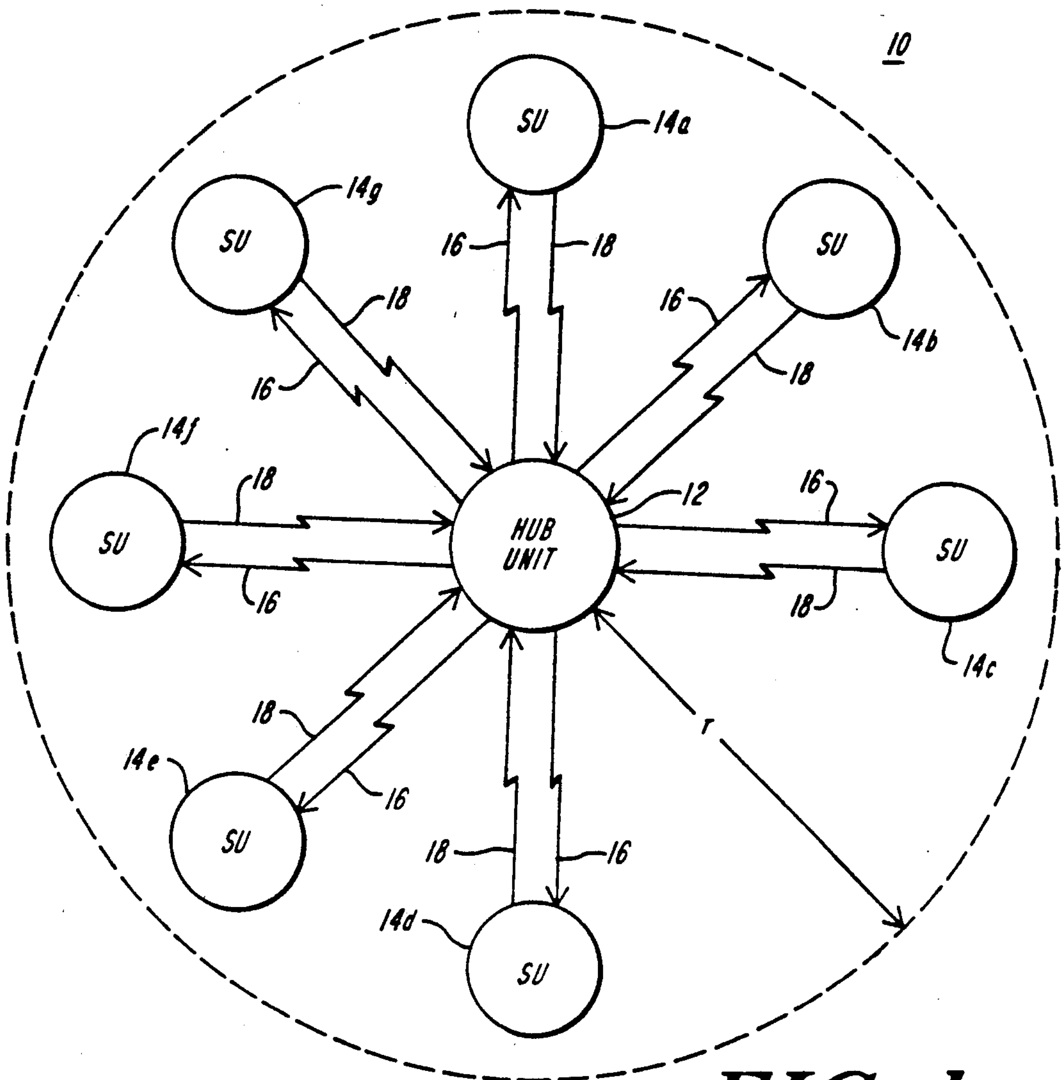
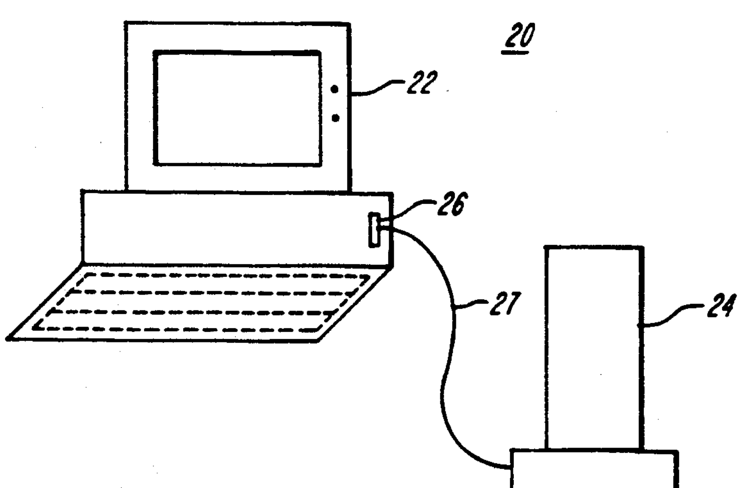

10
SU
14a
14g
SU
16
18
SU
18
16
14b
16
18
16
14f
18
HUB
UNIT
12
16
SU
SU
16
18
14c
18
r
14e
16
SU
18
16
14d
SU

FIG. 1


20
22
26
27
24

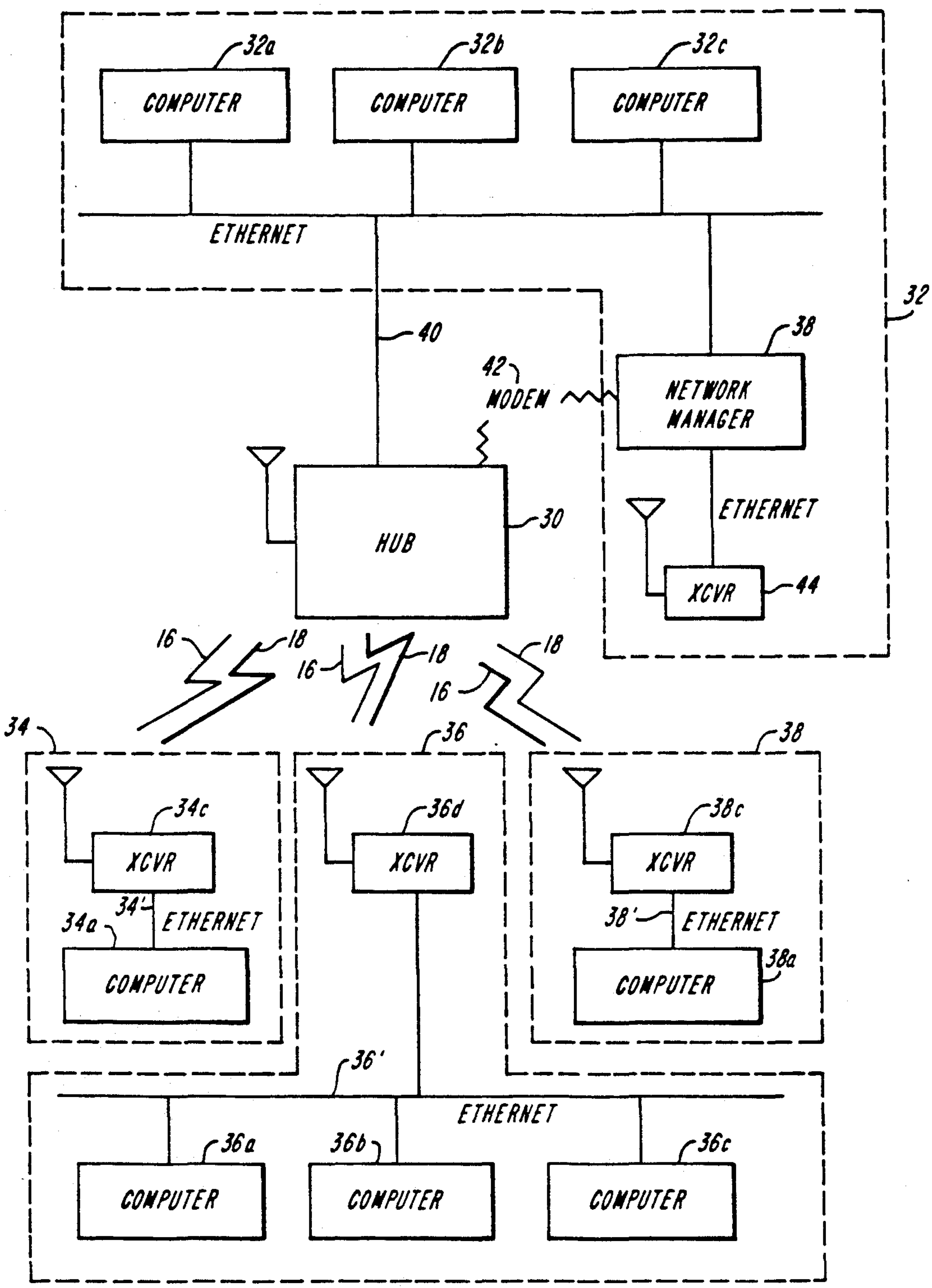

32a
COMPUTER
32b
COMPUTER
32c
COMPUTER
ETHERNET
32
40
38
42
MODEM
NETWORK MANAGER
HUB
30
ETHERNET
XCVR
44
16
18
16
18
16
18
34
36
38
34c
XCVR
36d
XCVR
38c
XCVR
34'
34a
ETHERNET
38'
ETHERNET
COMPUTER
COMPUTER
38a
36'
ETHERNET
36a
36b
36c
COMPUTER
COMPUTER
COMPUTER

FIG. 3

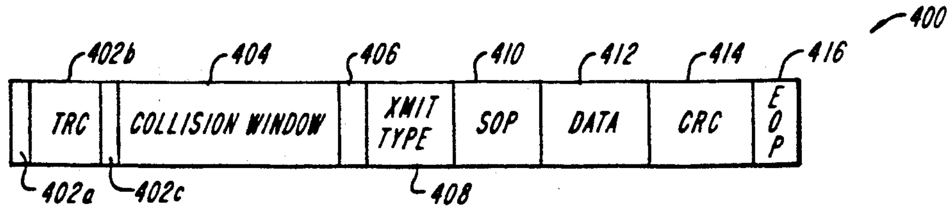

400
402b
404
406
410
412
414
416
TRC
COLLISION WINDOW
XMIT TYPE
SOP
DATA
CRC
EOP
402a
402c
408

FIG. 4

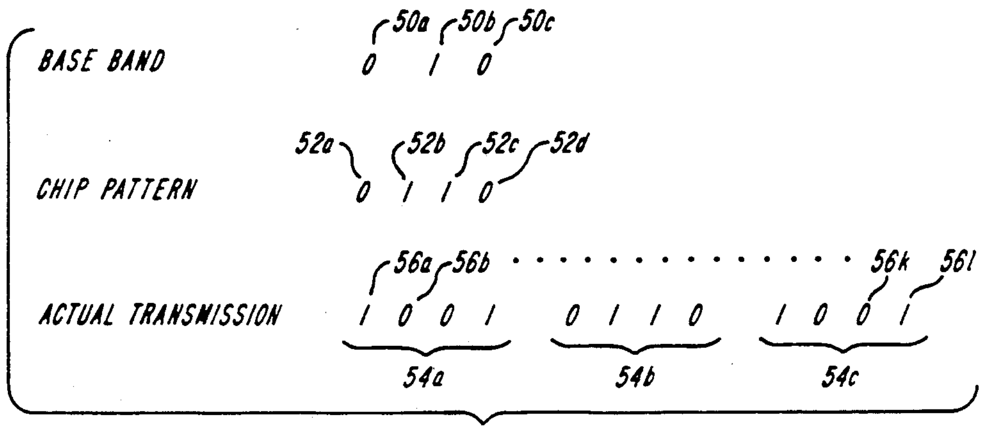
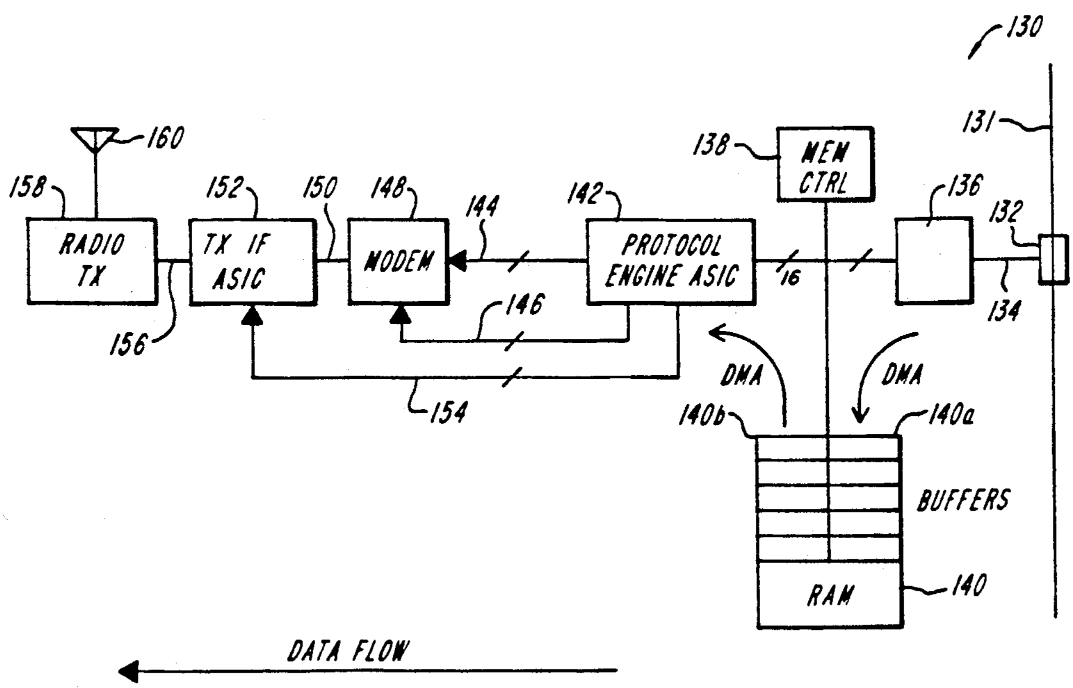

BASE BAND
50a
50b
50c
0 1 0
CHIP PATTERN
52a
52b
52c
52d
0 1 1 0
ACTUAL TRANSMISSION
56a
56b
56k
56l
1 0 0 1
0 1 1 0
1 0 0 1
54a
54b
54c

FIG. 5


130
131
160
158
RADIO TX
152
TX IF ASIC
150
148
MODEM
144
142
PROTOCOL ENGINE ASIC
138
MEM CTRL
136
132
16
134
156
146
154
DMA
DMA
140b
140a
BUFFERS
RAM
140
DATA FLOW

I .6

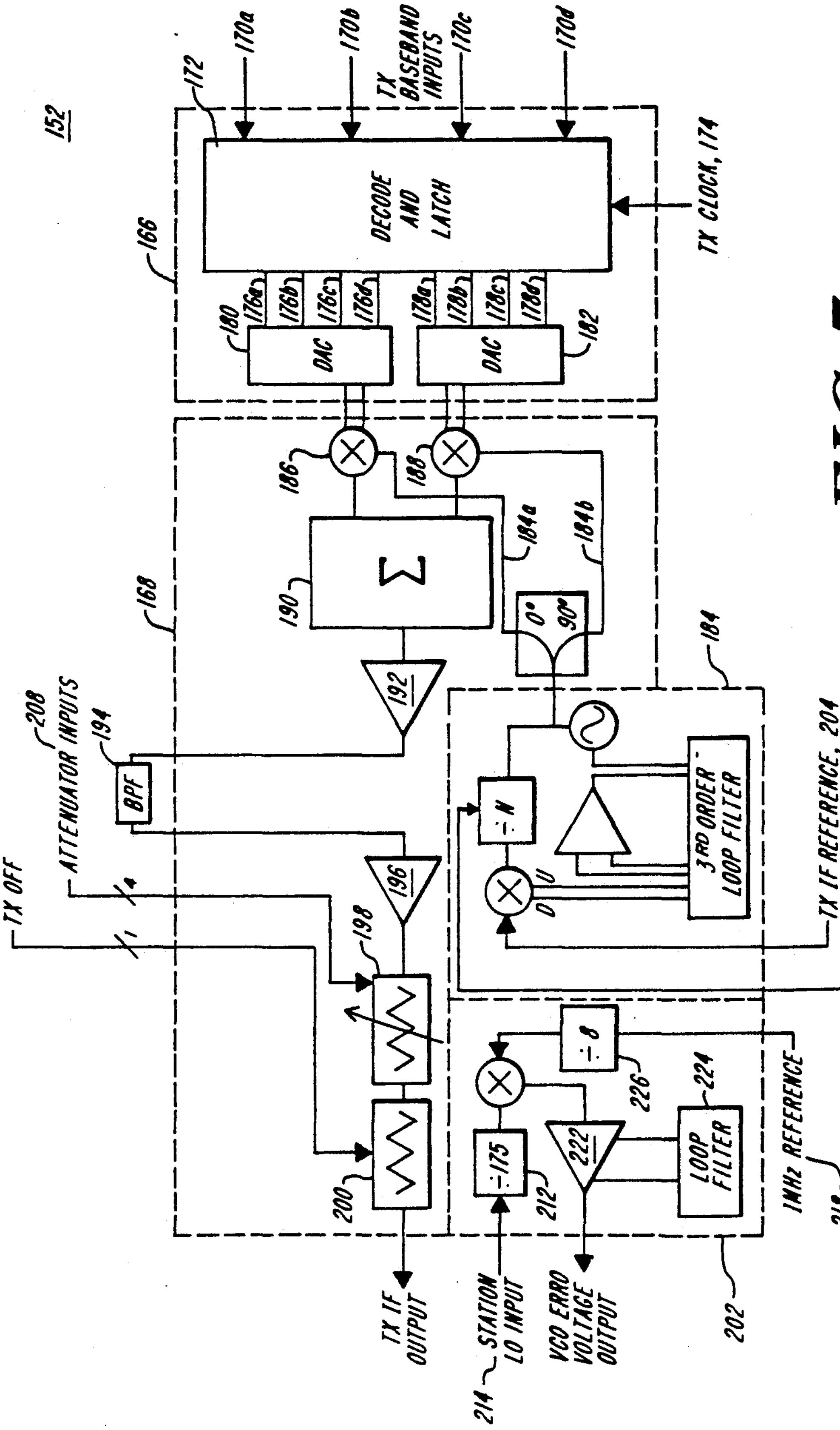

152
170a
170b
TX BASEBAND INPUTS
170c
170d
172
DECODE AND LATCH
TX CLOCK, 174
166
176a
176b
176c
176d
178a
178b
178c
178d
180
DAC
DAC
182
186
188
184a
184b
190
Σ
168
0°
90°
184
192
208
ATTENUATOR INPUTS
194
BPF
210
TX OFF
196
198
÷N
D
U
3RD ORDER LOOP FILTER
TX IF REFERENCE, 204
DIVIDER SELECT, 206
÷8
226
224
LOOP FILTER
222
÷175
212
200
1MHz REFERENCE
218
TX IF OUTPUT
214
STATION LO INPUT
VCO ERRO VOLTAGE OUTPUT
202

FIG. 7

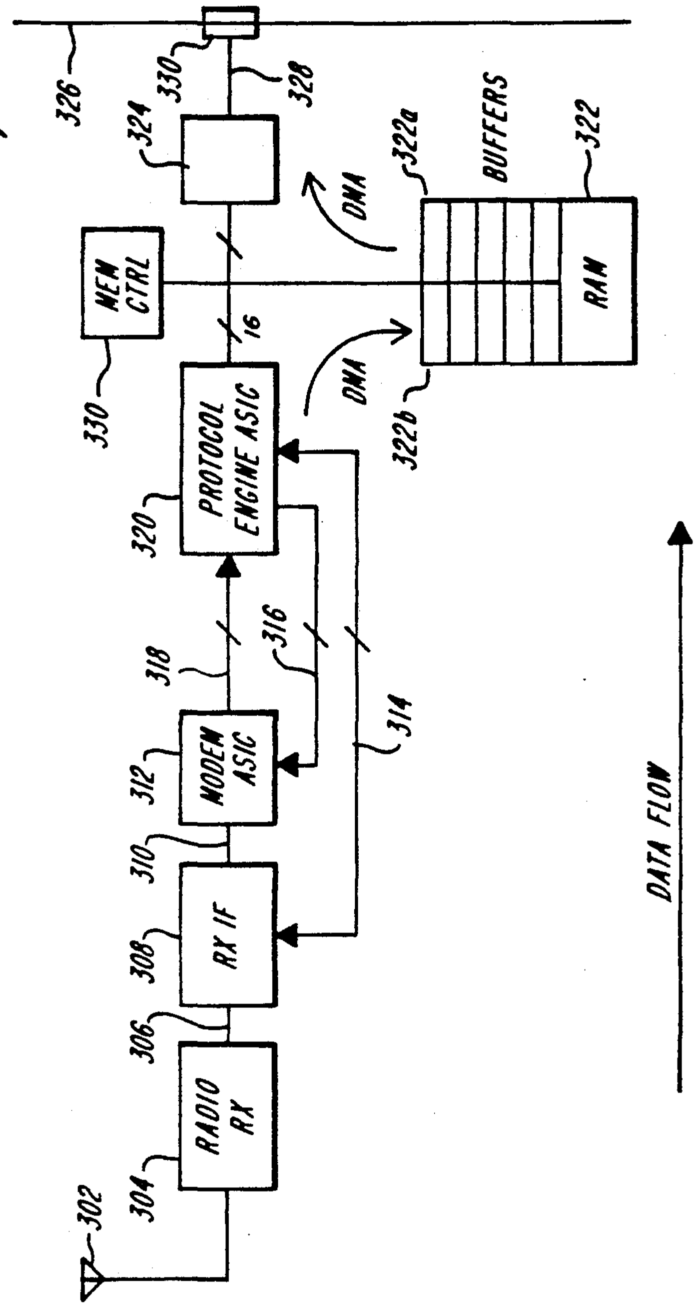

300
302
304
RADIO RX
306
308
RX IF
310
312
MODEM ASIC
314
316
318
320
PROTOCOL ENGINE ASIC
16
330
MEM CTRL
DMA
DMA
322a
322b
BUFFERS
322
RAM
324
328
330
326
DATA FLOW

FIG. 8

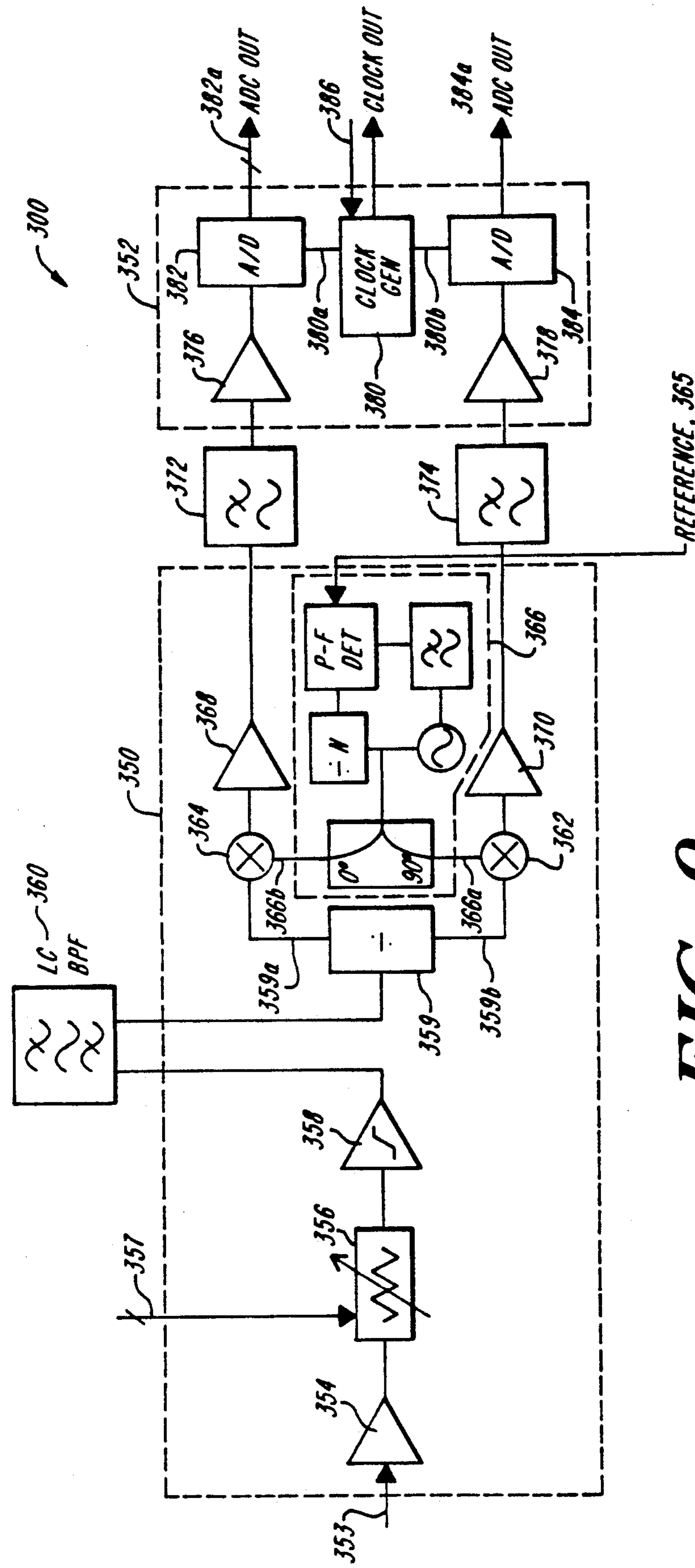

300
382a
ADC OUT
386
CLOCK OUT
384a
ADC OUT
352
382
A/D
CLOCK GEN
A/D
384
380a
380b
380
376
378
372
374
REFERENCE, 365
P-F DET
÷ N
366
368
370
350
364
362
0°
90°
366b
366a
359a
359
359b
LC BPF
360
358
356
357
354
353

FIG. 9

WIRELESS LOCAL AREA NETWORK COMMUNICATIONS SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to multiple access communication systems. More particularly, it relates to multiple access wireless local area network (LAN) communication systems.

The need for wireless interconnection of computers operating over LANs has become increasingly apparent as the popularity of LAN usage in office environments has grown. Traditionally, computers and computer related devices operating as part of a LAN have been interconnected using such conventional technologies as twisted pair, coaxial cable and optical fiber cable. A primary goal of conventional systems has been to utilize these technologies to realize fast, reliable, multiple access communications over the LAN. Historically, several communication protocols and topological architectures have been combined with traditional interconnection technologies to realize this goal.

In attempting to achieve the goal of fast communication, the issue of how to make efficient usage of the chosen transmission medium was repetitively addressed by prior art systems. A common trade off encountered with respect to bus allocation is how to allocate bus usage between high duty cycle subscribers and low duty cycle subscribers whose transmissions are characterized by a high peak-to-average transmission rate. Such low duty cycle subscribers are commonly referred to as "bursty" subscribers. Three general approaches were developed; time division multiplexing, frequency division multiplexing and space division multiplexing.

Time Division Multiplexing (TDM) attempts to take advantage of transmission mediums which can support a faster communication data rates then are required by any one user on the network. Essentially, multiple digital communication signals are interleaved in time over a single transmission path. Many different types of TDM based systems have become well known in the art. Examples include polling, priority request, communication path contention, and cyclic time division systems.

In a polling system, a central controller polls remote stations, offering each an opportunity to utilize the communication path. In a priority request system, remote stations request usage of the communication path and a central controller awards control of the path according to priority levels assigned to each station. Contention systems generally involve remote stations transmitting at random times and then retransmitting in the event of a detected collision. In a cyclic time division implementation, devices on the network are only permitted to transmit during a preassigned periodically occurring time slot. Some cyclic time division systems have fixed slot lengths and a fixed period while others allow for these parameters to be dynamically updated. Still others control the length of the time slots by passing a digital code, called a token, between devices operating on the network. Only when a device possesses the token, may it transmit.

Frequency Division Multiplexing (FDM), attempts to exploit transmission mediums which can support a wider bandwidth than is necessary to accommodate the highest frequency baseband device coupled to the network. In an FDM system, each transmission signal is modulated onto a different carrier signal operating about a particular center frequency. Each unique carrier signal is referred to as a channel. One example of frequency division multiplexing is frequency shift keying (FSK). FSK systems may be designed to operate in either a full or half duplex environment. A full duplex implementation assigns separate channels for transmission and reception, thereby enabling transmission and reception to occur simultaneously. Alternatively, half duplex systems require a single channel to be time multiplexed for both transmission and reception. FSK systems generally represent a logical one by a frequency shift in a particular direction relative to the center frequency. Similarly, a logical zero may be represented by an equivalent frequency shift in the opposite direction.

Space Division Multiplexing (SDM) simply adds more signal paths which are spacially isolated from each other, thereby increasing the number of signals that can be simultaneously transmitted. As implemented in a local area network, this involves providing a separated interconnection between any two devices wishing to communicate.

Another common issue raised in attempting to efficiently utilize a transmission medium is whether to implement a baseband or a broadband system. In the context of LANs, broadband refers to any system which transmits the digital information as an analog signal. One example is the FSK approach discussed above. Another example is phase shift keying (PSK). As the name suggests, PSK entails representing a logical one by a signal having a particular frequency and a particular phase while representing a logical zero by a signal having identical frequency but being phase shifted by a predefined amount.

The transmission path multiplexing approaches discussed above have traditionally been applied to various permutations of four topological architectures. These topologies are commonly referred to as; bus networks, loop networks, ring networks and star networks.

A bus network is one of the simplest configurations. In this type of a system the network is typically comprised of a passive transmission bus. The bus may consist of a single cable or many branches. Devices operating on such a network, commonly referred to as subscriber devices, interface directly to the bus and every device has access to transmissions from every other device. Since the bus is passive, it is the responsibility of the devices operating over the network to manage bus access. Traditionally, both frequency and time division multiplexing have been employed on such systems.

A loop network typically consists of an inbound unidirectional signal path, an outbound unidirectional signal path and a unidirectional path coupler for transferring signals from the inbound path to the outbound path at the system head-end. A loop network may also be a passive system. However, in some prior art implementations, a digital bus repeater (DBR) is employed as a path coupler. A DBR provides certain minimal formating functions and regenerates signals tending to deteriorate over long signal paths. Devices operating on a loop network typically interface to the network via an appropriate bus interface unit (BIU). As in the case of bus networks, both frequency and time division multiplexing have been utilized for efficient transmission path allocation.

A ring architecture, in its most rudimentary form, is a unidirectional closed loop signal path. Typically, devices may interface to the ring either directly or through an appropriate BIU. In some prior art implementations DBRs are inserted into the signal path periodically around the ring, and each subscriber device interfaces to the ring via a DBR. In other prior art implementation, two concentric unidirectional rings are employed. In an analogous fashion to the loop network, one ring services incoming communications signals while the other services the outgoing. Since the ring is a predominantly passive network, the devices operating over the network are responsible for efficient network allocation.

A star network typically involves having each subscriber device connected, via a dedicated communications path, to a central communication controller. Traditionally, if one device on the network wishes to send a message to another device on the network, it transmits the message to the central controller and the central controller, in turn, redirects the transmission to the appropriate destination device. In other prior art implementations of star networks the central controller acts as a switching unit. As such, instead of relaying communications, upon request from a transmitting device, it Performs switching operations to physically connect a transmitting device to a specified receiving device. As can be seen, the central controller relieves the subscriber devices of responsibility for efficient network allocation.

Many common prior art implementations have been developed which employ contention type time multiplexing protocols in an attempt to realize the most advantageous usage of the above discussed topologies. One early implementation, capable of utilizing either a bus, loop or ring topology can be characterized as a free-for-all system. According to this early implementation, subscriber devices transmitted at random and then waited a period of time for an acknowledgment from the destination device. If no acknowledgment was received then the sending device retransmitted. A substantial deficiency of this system was the number of communication collisions caused by contending subscriber devices.

Subsequent prior art implementations improved on this approach by adding a carrier sensing feature. Generally referred to as carrier sense multiple access (CSMA) or listen before talk (LBT), this protocol required transmitting devices to determine whether the shared communication path was available prior to beginning a transmission. However, this protocol, nevertheless, suffered inefficiencies because collisions of simultaneously transmitted signals went undetected until the transmitting device failed to receive the expected acknowledgment from the receiving device.

The CSMA approach was later improved upon by the addition of collision detection (CSMA/CD), also known as a listen while talk protocol (LWT). According to a LWT protocol, the transmitting device monitors the bus during transmission so that a collision is detected at the earliest possible time. Considerable time savings occur by early detection if transmission distances are such that there is a long round trip delay between the transmitter and the receiver. Additional time savings occur when lengthy communications are involved and a collision occurs early on in the transmission.

Several non-contention based prior art systems have been developed which relieve subscriber devices operating on the network from having to detect collisions, One such implementation which tends to eliminate communication collisions is a cyclic TDM approach, commonly referred to as a token passing ring. As the name suggests, this network exploits a ring type architecture. In a token passing ring system, the devices on the network continuously pass, between themselves, a digital code, called a token. Only when a device possesses the token, may it transmit data over the ring. In this way network communications are interleaved in time. FDM may also be utilized to modulate the baseband signals being time multiplexed over the communication path.

Two other implementations of cyclic TDM systems are well known in the art. They are fixed slot allocation and dynamic slot allocation. In a fixed slot allocation system, regularly occurring time slots in a repetitive framed sequence are dedicated to specific devices operating on the network, for their transmissions. In dynamically allocated systems, Parameters such as the size of each time slot and the number of time slots allocated to a particular device may be varied. Since a device only transmits during its allocated time slots, communication collisions generally do not occur.

Although the above discussed prior art implementations have succeeded in realizing fast, reliable, secure communications in a multiple access LAN environment, they nevertheless suffer from substantial deficiencies. High on the list of drawbacks to a hardwired system is the considerable cost of installation resulting from having to run cables throughout an office. Another deficiency is the difficulty associated with relocating subscriber devices within an office. A further drawback of hardwired systems is the cost and difficulty associated with moving an entire system from one location to another. Therefore, the most recent activity in the field of LANs has centered around the development of wireless LANs.

There are two primary technologies being developed to provide wireless LAN connections. One is infrared light and the other is radio. Most systems that propose the use of light to transmit data over a local area networks focus on wavelengths in the infrared part of the visible spectrum. This choice is natural because the physical devices for transmitting are plentiful and inexpensive. Additionally, infrared technology is also suited to very high data rates.

However, infrared communication systems are mostly limited to line-of-sight links because light cannot penetrate doors and walls. Systems which use diffused sources and which rely on reflections off walls and ceilings have been built, but none have succeeded in multiple-room environments without the use of extensive repeater networks. Additionally, infrared tranceivers are easily interrupted by people walking around an office.

Radio waves have long been used for voice communication. Hand-held walkie-talkies are essential for plant-maintenance personnel in large office buildings. FAX and telephone communications over cellular radio links are becoming integral to many modern businesses. The use of radio technology for high speed data communication over such links is now emerging.

The primary advantage that radio has over infrared is its ability to penetrate most solid objects found within a building. Consequently, objects such as wall boards, wood doors, modular office walls, and people will not disrupt a radio signal to the same degree as an infrared signal. However, prior art systems have yet to completely overcome several difficulties inherent to designing a radio based LANs for operation in an office environment.

One significant difficulty is effectively dealing with multiple signal paths created by transmission signal reflection. Other issues involve guarding against unauthorized reception of communication signals and interference with those signals.

The FCC has recognized the need to use radio transmissions for commercial in-building communication systems and has allocated three separate bands for low powered systems that do not require user licensing. Specifically, these frequency bands are 902–928 MHz, 2.4–2.5 GHz, and 5.8–5.9 GHz. The 902–928 MHz band is both fairly narrow and crowded with such devices as store security systems and paging systems. However, the other two bands offer sufficient bandwidth to transmit data at LAN megabit data rates and they are virtually free of interference from other devices.

Another frequency band that is being used for wireless networks is 18–19 GHz. This frequency range does offer a great deal of bandwidth, ten 10 MHz channels. However, the use of this band requires an FCC license on a per location basis. This restricts the freedom a user has in installing a wireless LAN as well as the ability to move the system. Connection costs are significantly higher because the cost of radio components increases along with the frequency.

Another drawback to utilizing this band is that it is very close to infrared and as a result, shares many of the propagation characteristics of light. Since signal penetration of solid objects, such as walls is low, the effective range is small, typically a 40 foot radius. This increases the need to provide many repeaters to cover a typical office environment and further increases the overall system cost.

Accordingly, it is an object of the present invention to provide a wireless, radio frequency, multiple access communication system for use within an office environment.

It is a further object to provide a wireless, radio frequency, multiple access communication system which is effectively immune to information transmission problems caused by signal reflections.

It is another object of the invention to provide a wireless radio frequency, multiple access communication system which accommodates both high and low duty cycle subscribers.

An additional object of the invention is to provide a wireless radio frequency, multiple access communication system which implements a carrier sense multiple access with collision detection protocol.

Another object of the invention is to provide a wireless system which avoids any need for FCC licensing, thereby providing the user with additional flexibility with respect to system installations and subsequent system relocation.

SUMMARY OF THE INVENTION

The invention is directed to multiple access communication systems. In particular, it relates to a local area network including at least one hub unit, one or more associated station units, and a wireless communication link between each hub unit and its associated station units. The wireless communication link includes a wireless radio frequency signal path for transferring information from each hub unit to all of its associated station units at a first frequency, f_1. The communication link also includes a wireless radio frequency signal path for transmitting information from each station unit to its associated hub unit at a second frequency, f_2.

According to the invention, f_1 and f_2 are frequencies at which reflections from local objects may occur, causing a plurality of the first and second frequency paths to exist between a particular hub unit and an associated station unit. The invention includes recovery elements for recovering the transmitted information signal, by combining signals passing over the plurality of paths.

The invention also includes synchronization elements for establishing a common slotted time frame for each hub unit and its associated station units and for allocating subsets of the slots of the time frame to each of the associated station units. A combination slotted and contention-based communication protocol is utilized.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects of this invention, the various features thereof, as well as the invention itself, may be more fully understood from the following descriptions, when read together with the accompanying drawings in which:

FIG. 1 shows a block diagram of a wireless communication system in accordance with the invention;

FIG. 2 shows a detailed block diagram of a station unit in accordance with the system of FIG. 1;

FIG. 3 shows a block diagram of the hub unit of FIG. 1 acting as a central controller for a plurality of networks, both wired and wireless;

FIG. 4 illustrates a communication format utilized by the up-link channel of the invention;

FIG. 5 illustrates spread spectrum encoding;

FIG. 6 depicts a block diagram of a Transmitter section of a Wireless Transceiver according to the invention;

FIG. 7 is a detailed block diagram of baseband and IF modules of FIG. 6;

FIG. 8 depicts a block diagram of the Receiver section of a Wireless Transceiver according to the invention; and FIG. 9 is a more detailed block diagram of the baseband and IF modules of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Basic System Architecture

FIG. 1 shows a wireless multiple access communication network 10 according to the invention. The system of FIG. 1 includes a Hub Unit (HU) 12 in radio communication with a plurality of Subscriber Units (SUs) 14*a*–14*g*. All transmissions from the HU 12 to the SUs 14*a*–14*g* are over a channel 16. That channel operates at a frequency of 5.78 GHz in the depicted embodiment. All transmissions from the SUs 14*a*–14*g* to the HU 12, are over an up-link channel 18. The SU to HU transmission frequency is 2.44 GHz. Both channels, 16 and 18 thus operate at frequencies at which significant reflections occur from local objects.

As is shown in FIG. 2, according to one embodiment of the invention a typical SU 20 is comprised of a data terminal 22, a wireless transceiver 24 and a network interface 26. The data terminal 22 may be a programmed digital computer or computer-related device. The wireless transceiver 24 is coupled to the data terminal 22 by way of the cable 27 and the network interface 26. The network interface 26 is typically mounted internal to the data terminal 22 and converts information from the format being utilized over the wireless network to the particular format used by the data terminal 22. In the wireless system of FIG. 1, the wireless tranceivers included in SUs 14a–14g transfer information, over the wireless network 10, between the SUs 14a–14g and the HU 22. Similarly, the HU 22 also includes a wireless transceiver operating in a comparable fashion.

Referring to FIG. 1, HU 12 controls all communication occurring over the wireless network 10. It receives transmissions on the channel 18 from the wireless tranceivers associated with particular SUs and rebroadcasts those communications over the channel 16 to all SUs 14a–14g on the network 10. The HU 12 has associated with it an Effective Service Area which defines an area of coverage 19 which may be generally characterized by a maximum HU to SU radial distance, r. In a preferred embodiment, the Effective Service Area has an r of at least eighty meters and each HU supports at least sixty-two wireless units. In systems with more than on HU, with each HU having an associated set of SUs, the Effective Service Areas of multiple HUs may overlap. However, some denegration in performance may occur along the overlapping areas.

The HU 12 also acts as the agent for all network management functions. One example of such a function is collecting appropriate performance and error statistics. Another management function involves executing all control commands, such as enabling and disabling specific wireless transceivers. Although FIG. 2 depicts a SU as being comprised of a single data terminal having a dedicated wireless transceiver, this may not be the case in other embodiments.

FIG. 3 depicts an alternative embodiment of the invention wherein an HU 30 acts as the central controller for a plurality of networks 32, 34, 36 and 38, both hardwired and wireless. As shown in FIG. 3, each of those networks is an Ethernet local area network having two or more computers functioning as terminals at there respective Ethernet nodes. Each network 32, 34, 36 and 38 may also be considered to be an SU in the present invention. Network 32 includes a plurality of data terminals 32a–32c connected to an Ethernet bus 32' and an additional network controller 38. Network 32 is in communication with the HU 30 by way of a wired interconnection 40. The HU 30 is also in communication with the network manager 38 via modem 42 and a wireless transceiver 44. Network 34 includes data terminal 34a coupled to Ethernet bus 34' and communicates with the HU 30 via wireless transceiver 34c. Likewise, network 36 comprises data terminals 36a–36c coupled to bus 36' and communicates with the HU 30 through wireless transceiver 36d. Finally, network 38 includes data terminals 38a coupled to bus 38' in communication with the HU 30 via wireless transceiver 38c.

As in the case of the system of FIG. 1, the HU 30 receives transmissions over channel 18 from the various wireless tranceivers and retransmits them over channel 16 to all devices in its Effective Service Area. It also sends this same information over a wired connection 40 to bus 32'. Information transmitted to the HU 30 from the bus 32' is also broadcast to all wireless tranceivers. As can be seen from network 36, a single wireless transceiver may support a plurality of data terminals operating over a hardwired network.

In the illustrated embodiment, the hardwired network is an IEEE 802.3 (Ethernet) type system and the wireless transceiver appears to the wired network as an IEEE 802.3 Media Access Unit (MAU). Alternatively, when the wired network is an IEEE 802.5 (token ring) network, the wireless transceiver appears to the network as part of the ring wiring.

Communications Protocol Overview

The network communications protocol is described below in terms of the basic architecture depicted in FIG. 1. However, the same protocol is readily applied to the more complex system of FIG. 3.

Referring to FIG. 1, the HU 12 transfers information to its associated SUs 14a–14g via a down-link radio communication channel 16 having a frequency of 5.78 GHz. Likewise, the SUs 14a–14g transfer information to the HU 12 over an up-link radio communication channel 18 having a frequency of 2.44 GHz. Substantially all communications to the HU 12 are rebroadcast over the down-link 16 to all communicate with another SU, then the transmission is first directed, via the up-link 18, to the HU 12. The SU for whom the communication is intended will receive it during the HU's 12 rebroadcasting.

Communication between the HU 12 and its SUs 14a–14g is conducted utilizing a combination contention and time division multiple access (TDMA) based protocol. The specific type of time division multiplexing employed is a form of dynamic slot allocation. Therefore, the HU 12 identifies which SU 14a–14g is transmitting from either an explicit identifier in the transmission or from the particular time slot in which the transmission occurs. Likewise, a particular SU identifies HU transmissions intended for it by when the transmission occurs or by an identifier in the transmission.

A traditional slotted protocol typically involves the HU 12 establishing a common time frame between itself and all SUs 14a–14g operating over the network 10; dividing the common time frame into a plurality of cyclicly repeating time slots; and assigning one or more time slots to each SU 14a–14g. In a typical slotted system, each SU 14a–14g is restricted to only transmitting over the wireless network 10 during its assigned time slots. Additionally, if dynamic allocation is employed, the HU 12 is able to modify such parameters as the number of time slots assigned to a particular SU 14a–14g and the length of such time slots. Since no two SUs 14a–14g are ever transmitting at the same time, a plurality of SUs 14a–14g can share a common transmission frequency without concern for signal collisions.

Traditional slotted systems, even when dynamic allocation is employed, suffer from inefficiencies encountered from trying to accommodate both bursty and high duty cycle SUs. As previously discussed, some prior art systems have attempted to overcome these inefficiencies by utilizing slotted allocation over a portion of the defined time frame to accommodate the high duty cycle users and utilizing a contention based protocol over another portion of the time frame to accommodate the bursty type users. Although that approach is an improvement over traditional slotted systems, communication over the contention portion of the time frame can be slowed greatly due to multiple communication collisions between contending devices.

The system of FIG. 1 implements an alternative variation of a dynamically allocated time slotted system. Initially, the HU 12 imposes a common slotted time frame. During this period the SUs 14a–14g requiring use of the up-link channel 18, utilize assigned time slots to broadcast Transmit Request Codes to the HU 12. The HU 12 identifies which SU is requesting access to the up-link 18 by the particular time slot in which the request arrives. The HU 12 grants access to the up-link channel 18 by responding affirmatively to the requesting SU. Once granted access to the channel 18, the transmitting SU has sole control until it completes its transmission. Information is transmitted over the network as discrete packets. Therefore, access time can be regulated by limiting the number and size of data packets that an SU is allowed transmit pursuant to any single transmission request.

A considerable advantage of this system is that it more efficiently accomodates both high duty cycle and bursty type users. Since assigned time slots are primarily used for exchange of short control type messages such as Transmit Request Codes, they can be made very small as compared with time slots utilized in many prior art systems. Therefore, a time slot assigned to a particular SU occurs more frequently, therein increasing the likelihood of fast access to the transmission channel. Additionally, the packet size and quantity limitations ensure that high duty cycle users will not load down the network to such a degree that bursty type users are not adequately serviced. Furthermore, since the HU 12 may dynamically change the number of packets that a particular SU may transmit pursuant to a single transmission request, the network can accommodate occasional long transmissions. The HU 12 may also assign more than one time slot to a particular SU, causing certain high priority users to be serviced more often. Time slot assignment is also dynamically updatable, generally by the HU 12.

Imposing a slotted time frame during the period when SUs 14a–14g are requesting up-link channel 18 access substantially reduces communication collisions between competing SUs. However, collisions nevertheless, have the potential to occur during the time when one SU is transmitting and another SU wishes to request up-link channel access. Therefore, the requesting SU must not only synchronize itself to a preassigned time slot, but must also ensure that the HU 12 has not previously allocated sole control of the channel 18 to another SU. To ensure the channel 18 has not been previously allocated, the HU 12 imposes a listen before talk (LBT) protocol. Accordingly, prior to broadcasting a request, an SU 14a–14g monitors the HU down-link channel 16, to determine that no other SU is in the midst of transmitting. This further reduces the chance of communication collisions.

Regardless of the LBT collision avoidance approach, communication collisions sometimes occur as a result of the round trip communication delay between the HU 12 and the SUs 14a–14g. Therefore, the HU 12 also imposes a Listen While Talk (LWT) collision detection approach. This ensures the earliest possible detection of those collisions that do occur. Accordingly, each SU 14a–14g monitors the HU down-link channel 16 during transmission to ensure that its broadcasted message is correctly received by the HU 12. If the transmitting SU determines that its signal is not being correctly received by the HU 12 then it terminates its transmission, relinquishes control of the channel 18, and waits for its assigned time slot to occur so it can once again request control of the up-link channel 18.

Communication Protocol Detail Description

According to one embodiment of the invention, the time frame is divided into 64 time slots. Each time slot is further divided into symbols. Each time slot typically contains six symbols. The smallest sub-division of the time frame is a chip. A chip is essentially equivalent to a binary bit. Each symbol is typically comprised of 48 chips.

Typically, the network 10 of FIG. 1 transits through three states of operation. They are IDLE, BUSY and PACKET. As will be discussed in greater detail below, the network may transit from IDLE to BUSY, from BUSY to either IDLE or PACKET, and from PACKET to IDLE. Operation of the HU 12 and the SUs 14a–14g during each of these states is described below.

During the IDLE state the network is operating in a slotted environment, and the HU 12 is waiting for new packets to be received from its associated SUs 14a–14g. The SUs 14a–14g are permitted to broadcast requests to join the network and Transmit Request Codes, as long as the requests are synchronized to their assigned time slots. Requests to join the network are discussed in greater detail below with respect to system initialization. While in the IDLE state, the HU 12 transmits an Idle Code over the down-link channel 16 to all of the SUs 14a–14g at a particular data rate.

SUs that experience multiple communication errors or that are attempting to join the network 10 may be in a subcategory of the IDLE state called IDLE NO TX. In this state the SU is trying to synchronize itself with the network and acquire the network spread spectrum codes. This state is discussed in detail in the system initialization section below.

FIG. 4 illustrates a communication format utilized by the up-link channel of the invention.

The HU notifies a requesting SU that it has been granted control of the up-link channel by transmitting a BUSY code over the down-link channel, timed in such a way that the SU being granted channel control receives the BUSY code exactly at its slot boundary. Consequently, to request control of the up-link channel, a SU must broadcast its Transmit Request Code (TRC) over the up-link channel 18, at precisely the correct time so that, taking into account all delays, the HU is able to cause the BUSY code response to arrive at the requesting SU's slot boundary. This requires each SU to have a first preassigned time slot when transmissions are appropriate and a second preassigned slot when receptions directed to particular SU's should be expected. As can be seen, the reception time slots are delayed in time from the transmission time slots by an amount substantially equal to the round trip delay between the HU and the requesting SU.

The TRC is typically five symbols long. The first symbol 402a provides the differential phase shift keying (DPSK) reference for the HU receiver. The following four symbols 402b comprise the actual TRC. After the code symbols 402b, there is a one symbol guard band 402c which ensures that the TRC 402b does not overlap into the next preassigned slot. The four symbol length of the TRC allows the HU to make an initial determination that this request is not a false alarm. Following the TRC 402, the requesting SU broadcasts a stream of fifteen ZERO symbols to the HU 12. The first fourteen of these symbols are known as a Collison Window 404 because collisions may occur with TRCs from other SUs. Collisions result from other SUs not knowing that a particular SU is requesting access to the network until the HU rebroadcasts the request. Thus, the length of the collision window 404 is determined by the round trip communication delay. If at any time during the collision window the requesting SU receives any transmission except a BUSY Code, it assumes another SU has control of the channel and terminates its transmission. The fifteenth symbol **406** is not subject to collision. The HU **12** causes the network **10** to transit into the BUSY state following detection of a TRC from any of its associated SUs **14a–14g**.

If the TRC is approved by the HU **12**, the HU **12** transmits a sequence of BUSY Codes for twenty-eight consecutive symbols over the down-link channel **16**, causing all SUs **14a–14g** to transit into the BUSY state and indicating that no further transmission requests will be entertained. The HU **12** causes the first BUSY code to occur at the slot boundary for the requesting SU. The requesting SU **14a** interprets a BUSY code, so received, as confirmation that it has been granted control of the up-link channel **18**. This occurs at approximately the end of the collision window **404**.

Following transition into the BUSY state, the requesting SU **14a** transmits a two symbol UPTYPE code **408** which specifies whether it is about to transmit a regular packet, a supervisory packet, a transmitter test packet (TTP), or a regular packet with buffer overflow warning. The SU **14a** then transmits a ten symbol Start-Of-Packet (SOP) Code **410**. The ten symbol SOP length results from the delay time required by Trellis encoding utilized by the system. However, this delay time is not wasted.

According to the invention, the HU uses the known SOP symbols to once again confirm that a false alarm has not occurred. Without this confirmation, the HU would have to wait for and End-Of-Packet (EOP) symbol to detect a false alarm. The HU **12** detects a false alarm by performing signal quality measurements. If the signal quality does not meet a predetermined threshold or if the HU **12** does not receive the SOP code within a predetermined time, the HU **12** declares a False Alarm, broadcasts a DOWNTYPE code informing the SUs of the False Alarm and transits back to the IDLE state. Any time the HU **12** causes the network **10** to transit back into the IDLE state, it broadcasts a Information Supervisory Packet (ISP) which includes information directing which of its associated SUs **14a–14g** is up first in the slotting sequence. The HU **12** may assign any of the SUs **14a–14g** to be up next in the sequence, regardless of which SU was previously being serviced. Early false alarm detection increases network throughput by terminating spurious communications quickly. Moreover, having the second false alarm detection allows the TRC to be fewer symbols than would be necessary if false alarms were required to be completely eliminated during the first test. Since the required length of the TRC directly impacts the length of the time slots, a short TRC allows for implementation of short time slots. Short time slots further increase network throughput because each SU can be served more quickly. The HU further utilizes the SOP symbols to perform signal quality measurements used to select which of the three HU modems (e.g., early, late, or on time) will be utilized to receive the data portion of the transmission.

If the signal quality level is sufficient, then the HU **12**: (1) selects a modem having the best quality signal to receive the subsequently transmitted symbols; (2) transmits over the down-link channel **16** a DOWNTYPE Code announcing to the SUs **14a–14g** which HU modem is to be used; (3) rebroadcasts the Start-Of-Packet Symbols over the down-link channel **16**; (4) enables a trellis encoder to operate during rebroadcast of the symbols subsequently received from the transmitting SU **14a**; and (5) causes the network to transit into state.

During the PACKET state, the data packet **412** is broadcast from the transmitting SU **14a** over the up-link channel **18** to the HU **12**. The data packet **412** is transmitted in a trellis encoded format. There is a three symbol processing delay between reception at the HU **12** over the up-link channel **18** and rebroadcast by the HU **12** over the down-link channel **16**. The transmitting SU **14a** includes a thirty-two symbol check sum (CRC) **414** and a nine symbol End-Of-Packet Code at the end of a transmission. The CRC **414** and the End-Of-Packet Code **416** are echoed over the down-link **16**, followed by a **10** symbol Tail which enables Trellis Decoders at the SUs **14a–14g** to complete the decoding of the data transmitted by the HU **12** over the down-link **16**.

Following rebroadcast of the packet, as originated by the transmitting SU **14a**, including the Tail, the HU **12** disables its Trellis Encoder and broadcasts an additional HU Message to all of its associated SUs **14a–14g**. The additional information appended by the HU **12** is twelve symbols long and includes five fields. Those fields are: (a) an indication whether the transmitting station should increase its power prior to its next transmission; (b) an indication whether the transmitting SU's transmission delay should remain as it is or be increased or decreased; (c) an indication whether a reception error was detected by he HU; (d) an indication whether a strong interference is present in the up-link to the HU; and (e) the index of the first slot to be serviced following the end of the transmission.

In the PACKET state all of the SUs **14a–14g**, including the transmitting SU **14a**, receive the rebroadcast packets from the HU **12**, detect the End-Of-Packet Code, check the CRC, decode the HU Message and apply whatever is implied by that message. If it is not a transmitting SU and the CRC is good, the data filed within the packet is transferred to the SU's processors. Upon completion of the HU Message, the HU **12** causes the network to transit back into the IDLE state.

Transmission Format

Discussed above is the communication protocol by which the HU **12** and its associated station units communicate **14a–14b**. As was pointed out in the background section, there are a variety of electrical implementations, both baseband and broadband, for such a protocol. A system according to a preferred embodiment utilizes a combination of direct sequence spread spectrum (DSSS) along with differential multiphase shift keying (MPSK) and Trellis Code Modulation (TCM).

DSSS is a form of Code division multiplexing (CDM), developed by the US military in the 1950's to provide reliable and secure voice communications in the field. DSSS involves spreading the power contained in a baseband signal over a broadband in a psuedo-random manner during transmission and retrieving the narrow brand signal during reception. It accomplishes this by individually coding each bit of a digital communication signal. Spread spectrum techniques are well known for their immunity to multipath fading environments, for their resistance to interference and for their natural security features.

In a multipath environment echoes of the transmitted signal are created due to reflections from various objects. These echoes are essentially replicas of the transmitted signal only delayed in time and subjected to an attenuation and a phase rotation. Each path is specified by a particular delay, attenuation and phase shift. All three parameters are independent from each other and vary in a substantially random manner. The signal delay may be expressed in terms of the delay between adjacent paths or the delay span encompassed by significant paths ("delay spread"). In an office environment, adjacent paths are typically separated in time by a few nanoseconds, while a typical delay spread is on the order of a few hundred nanoseconds.

A DSSS receiver, of the type employed in the invention, is synchronized to multiply an incoming spread spectrum signal, having a selected delay, by a despreading code. In this way, the narrow band signal is recovered. Synchronization of the receiver is such that multiplication of incoming signals, having delays other than the selected one, yields substantially insignificant results as compared to multiplication involving the signal having the selected delay. Therefore, DSSS acts to reject almost completely, all the channel delays which do not match the selected delay. By repeating the despreading process for several channel delays, the receiver combines signals arriving at a plurality of different time delays. A receiver which combines a number of differently delayed signals is known as a RAKE receiver.

FIG. 5 depicts a simplified example of DSSS. As can be seen, the baseband message bits **50***a*–**50***c* are multiplied by digital chip pattern **52***a*–**52***d*. This results in each message bit being spread into a four bit code **54***a*–**54***c* of sub-bits **56***a*–**56***r* called chips. Spread spectrum code **54***a* corresponds to baseband data bit **50***a*. Likewise, code **54***b* and **54***c* correspond to data bits **50***b* and **50***c* respectively. In that example the signal **54** has a bandwidth which is four times the bandwith of the original message signal **50**. Additionally, the power contained in the original signal **50** is spread over the extended bandwidth of the spread spectrum signal **54**. Typically, the chip pattern **52** is a relatively long psuedo-random code. Therefore, a receiver which does not possess the psuedo-random code will not be able to coherently combine the signal power contained in each chip **56***a*–**56***r* to reconstruct the original message bits **50***a*–**50***c*.

As is well known in the art, MPSK involves representing binary codes by incremental shifts in the phase of a carrier signal. In one preferred embodiment, sixteen phases (0–337.5 degrees in 22.5 degree steps) are utilized to represent all possible combinations of a four bit binary code. The utilization of multiphase shifting improves the throughput of the system over a standard dual PSK system. Since it is easier for a receiver to detect the presence or absence of a change of phase than it is to determine the phase itself, a differential implementation is utilized.

DPSK fits well into the indoor multipath environment. The reason for this is that the dynamics of an indoor multipath channel is such that changes in response are relatively slow and may be regarded as practically zero, from one transmitted symbol to the next. Consequently, DPSK, which is based on the difference in phase between adjacent symbols is not affected by channel variations.

DPSK is also a natural match with the RAKE processing. If K delays are processed, each of them has an independent phase and amplitude. However, the differential phase of each signal, nevertheless, is representative of the transmitted phase. The differential phase is generated by complex multiplication of the current symbol phase by the conjugate of the previous symbol phase. According to the invention, a weighted average of the differential phase vectors of each of the K delayed signals is taken to determine a resultant vector having a particular phase. Each signal is weighted by the product of the amplitudes of its two adjacent delayed signals. Through this averaging process, the signal to noise ratio is improved.

The invention also employs Trellis Modulation Encoding. Trellis encoding is well known in the art. It has the advantage of having minimal affects on the original data bandwidth while achieving a reasonable coding gain. The coding gain is the improvement in the signal to noise ratio. The coding gain achieved in an embodiment of the present invention is approximately 3dB by utilizing a four state Trellis code.

Hardware Description

The primary components of the invention are the Hub Unit (HU) and the Subscriber Units (SUs). As previously discussed with respect to FIG. **2**, the SU may be further comprised of data terminal, a wireless transceiver and a network interface. As depicted in FIG. **3**, the data terminal may be any computer or computer related device. Moreover, an SU may include a single data terminal or an entire network, interfaced to the HU through one or more wireless tranceivers. The network interfaces typically mount internal to the data terminal and are the wired communication interface over which information is transferred between the wireless transceiver and the data terminal.

Wireless tranceivers are included in both SUs and HUs and are essentially the interpreter between either an SU or an HU and the network. In the case of transmissions, the wireless transceiver receives information from the SU over the network interface, according to the particular protocol the SU is operating under, such as IEEE 802.3 or IEEE 802.5. The wireless transceiver then reformats the information according to the wireless network protocol, and transmits it over network. In the case of SU receptions, the wireless transceiver receives the transmission over the network, reformats it according to the SUs particular protocol and transmits the information, via the network interface, to the particular SU. In the case of HU reception, reformatting may only be necessary if the HU is also in wired communications with another network as depicted in FIG. **3**.

Employing a down-link **16** according to the embodiments of FIGS. **1** and **3** requires the following synchronization processes: (1) spreading sequence acquisition; (2) spreading sequence delay tracking; (3) carrier frequency synchronization or compensation.

The goal of sequence delay acquisition is to locate the RAKE "window" (the range of continuous sequence delays to be processed) in such a way that the power of the channel paths falling within this window is maximized. According to the invention, different delays are scanned by a moving digital correlator. At a given time interval an acquisition module compares the power measured in the current RAKE window with the power measured within an alternative window. The power of the alternative window is measured by the moving correlator, while the current window's power is measured by the K correlators used for the RAKE demodulation. The search for the better window is of the type "double dwell" where, in the first dwell a short comparison is performed the result of which, if indicating a suspected better window, causes the longer second dwell to occur. A measurement of a better window at both dwells causes the RAKE window location to change to that of the alternative one. This type of change may result in a very short burst of symbol errors due to the discontinuity of the respective delays' phases prior to the differential demodulation. Therefore, according to the invention, sequence delay acquisition does not occur during packet reception mode. Instead, it takes place during IDLE mode.

The goal of the delay tracking is to track the transmitter's chip clock as well as changes in the channel response. Local optimization of the RAKE window location occurs as a result. To achieve location optimization, the edges of the current window are examined. The K delays processed by the RAKE demodulator are designated by the indices 0 to $K-1$. The two delays adjacent to the window have the indices -1 and K. If the window spanning from -1 to $K-2$ has more power than the 0 to $K-1$ window then the window is shifted to the "left". If the 1 to K window contains more power then the window is shifted to the "right". Whether to institute a shift and in which direction is determined by a power comparison of the "right" window with the "left window." If the power comparison applied at a relatively high rate (relative to the channel time constant which is on the order of 10ms), it results in an average window location which is close to the locally optimal one. Any chip clock frequency offset between transmitter and receiver will generate a phase drift which is tracked by applying the power comparison algorithm, assuming the frequency offset is small, as it is when considering practical values. If for some reason, the multipath Profile (its response described in time domain as reflected to the receiver) changes locally this mechanism is also able to track it. Drastic changes are detected and adjusted for by the sequence delay acquisition mechanism.

Two modes can be defined for the tracking process, "digital" and "analog." In the digital mode, the receiver's chip clock is just a local, crystal derived clock which does not track the received signal. The tracking is performed by applying the "right" and "left" energy comparisons previously discussed and simply jumping the window location by one chip according to that comparison. The "right" and "left" energies are measured over many symbols. However, an inherent location jitter of $+1$ chip occurs as a result of this technique.

According to the analog technique, the "right" and "left" energies are accumulated over a much shorter period, and their comparison is not applied directly to the window location. Instead, it is used to drive a type of a Phase Lock Loop (PLL) called a Delay Lock Loop (DLL). Basically, the right/left comparison plays the role of the phase detector, while the loop filter and VCO are as in a standard PLL. The PLL bandwith is sufficiently narrow to effectively filter out the jitter and results in the average location window being very close to the locally optimal one.

A drawback of the analog mode is its inability to acquire and lock on the incoming chip rate if significantly different from the VCO initial frequency. The problem stems from the SUs using the same chip clock for both its up-link transmitter and its down-link receiver. This is done because the HU uses the same clock for both up-link and down-link, hence when the SU receiver synchronizes itself to the HU clock, its transmitter is automatically synchronized to the appropriate clock. A voltage controlled crystal oscillator (VCXO), being inherently more stable, solves this problem. However, the use of a VCXO is much more expensive than a simple VCO.

Regardless of the mode of window adjustment, the impact of a window shift in the receiver is minimized by executing the shift on a symbol boundary (transition between adjacent symbols). By swapping the correlator's indices between the symbols the differential vector generation is still correct at that transition. The effect of that shift executed during packet transmission will be an error in the Hub's receiver which is not aware of that change and cannot adjust itself. Disabling that shift during transmission is possible, however it is conditioned on the requirement that the offset between the HU and the SU chip clocks is small enough such that during the longest allowed packet, the drift between them should be maintained below some level (one chip is a reasonable threshold).

According to this invention, a mix of the digital and analog modes is utilized. During the initialization stage, defined as the period before receiving packets or other expected transmission, the digital mode is used. Later, after the acquisition and tracking have been proved to be valid by the detection of correct transmissions, a switch to the analog mode occurs.

During this initialization stage a transmission, under this invention, is not allowed (the up-link based on the validation of the down-link), therefore the problem of window location shifts does not exist. The SU receive clock is generated by a PLL consisting of a VCO (not VCXO). a divider by N, a phase-frequency detector, loop-filter and a crystal oscillator at the frequency chip rate/N. This is a standard PLL locked on a relatively cheap low-frequency oscillator and capable, due to the phase-frequency detector, to acquire the approximate chip rate frequency even though the VCO initial frequency may offset. Once acquisition has been achieved, the digital tracking mechanism starts adjusting the window location to achieve, within one chip, the locally optimal location and to digitally track phase drift due to frequency offset.

In switching to the analog mode the right/left comparison stops being averaged and applied to the digital window location. Instead the comparison outcome starts being applied as the replacement of the phase-frequency detector in the PLL configuration. This instantaneous switch enable the DLL to start operating with a VCO at almost the correct frequency and therefore, no frequency acquisition is required and the DLL can function properly as long as there is a signal to track. Thus, the need for an expensive VCXO is eliminated.

The object of carrier frequency synchronization is to compensate for any carrier frequency offset between the transmitter and the receiver. This is a typical problem in a system according to the present invention wherein a large number of phases M are employed, the carrier frequency is very high and not very expensive crystals are used, and the symbol period is not very short. The requirement is basically that the differential phase error due to frequency offset which is $2o(\Delta f \cdot T_{sym})$ where Δf is the frequency offset and T_{sym} is the symbol period, must be much smaller than the transmitted phase resolution $2o/M$. This requirement may not meet under worst case conditions, there the invention provides for compensation.

According to the invention, the average post-demodulation differential phase error is estimated. This differential phase error, if averaged long enough, becomes very close (theoretically equal) to $2\pi(\Delta f \cdot T_{sym})$ and can be subtracted from the demodulated differential phases to obtain the actual output differential phase of the demodulator. The frequency offset changes mainly with temperature and aging and is a very slow process. Therefore, very long averaging of the phase error can be accomplished to achieve a high accuracy.

A feature of the invention is that the Hub conveys its control symbols, which determine the state of the protocol, by using the differential phases of 180° and 0° as logical '1' and '0', while no other phase is used unless it is during a packet. In addition, a minimum number of such symbols is guaranteed between packets. A station synchronized on the protocol knows to anticipate when these characters should be received. The phase averager utilizes these known characters to perform its error correcting averaging.

FIG. 6 depicts a block diagram of the transmitter section **130** of a wireless transceiver according to the invention. Wired communication bus **131** may be an internal communication bus, as in the case where the SU comprises a single data terminal or where the wireless transceiver is operating in an HU. Alternatively, it may be a hardwired network bus, as in the case where the SU is a complete network. Transmitter **130** is in communication with bus **131** via wired interconnection **134** and network interface **132**. Digital communications, intended for wireless transmission are passed via interconnection **134** to interface controller **136**. The Interface Controller **136** stores those digital signals in ram buffer **140**. The transmitter protocol engine **142** receives the digital signals from ram buffer **140** and controls reformatting those signals according to the protocol requirements of the wireless network. According to the invention, interface **136** may access ram **140**, via I/O port **140***b*, at a different data rate than the protocol engine **142** accesses ram **140** via I/O port **140***a*. Dual port memory controller **138** controls this process.

The protocol engine **142** performs several formatting functions. One formatting function it performs is to encode the differential multiphase modulation information. It accomplishes this by encoding sixteen possible phases as four binary bits. Additionally, the protocol engine utilizes a forty-eight bit spread spectrum chip sequence to further encode the digital signals. The protocol engine **142** then passes the encoded digital signals to the modem **148**, via transmission path **144**. Protocol engine **142** also provides modem **148** with various control and timing signals **146**. The modem **148** does ____ and then passes the digital data to the Intermediate Frequency (IF) module **152** via transmission path **150**. The IF module **152** latches the digital signals passed from the modem **148** and then performs an analog to digital conversion on those signals. The IF module **152** then modulates the analog baseband signal onto a transmitter IF carrier at **360** MHz, according to control signals **154** provided from the protocol engine **142**. The modulated signal is then passed to radio transmitter upconverter module **158**, via transmission path **156**. At transmitter module **158** the information signal is further modulated up to a 2.440 GHz carrier frequency in the case of an SU transmisson and a 5.780 GHz carrier frequency in the case of an HU transmission and transmitted over the wireless network via antenna **160**.

FIG. 7 provides a more detailed block diagram of the IF module **152**. As can be seen from FIG. 7, the IF module **152** may be divided into a baseband section **166** and an IF section **168**. The baseband portion **166** is comprised of the input data latch and decoder **172**, and the dual digital to analog converters **180** and **182**. The elements of the IF part **168** are the quadrature output, phase-locked local oscillator **184**, the in-phase and quadrature mixers **186** and **188** respectively, the summer **190**, the amplifier **192**, external filter chain **194**, the filter buffer amplifier **196**, the programmable gain control **198**, the output switch **200**, and divider circuitry **202**.

This module processes the digital signals **170***a*–**170***d* containing the spread spectrum and phase modulation encoding which is passed on by the protocol engine. The input data is first latched by the input data latch and decoder **172** to synchronize it with the transmitter clock **174** and to eliminate potential data jitter. The four bits **170***a*–**170***d*, representing each of the possible sixteen phases needed, are then decoded into two digital words **176***a*–**176***d* and **178***a*–**178***d*. Digital words **176** and **178** are then converted into analog signals at analog to digital converters **180** and **182** respectively. The two analog signals are then passed to the dual quadrature fed mixer modules **186** and **188**. Mixers **186** and **188** modulate the baseband data signals onto the transmitter IF carrier at 360 MHz. Mixers **186** and **188** are matched to preserve the output phase accuracy. The matched outputs of the mixers **186** and **188** are then summed in phase in summer **190**. The output of summer **190** is then buffered through driver amplifier **192** and filtered through band pass filter **194**. The output from bandpass filter **194** is also buffered through amplifier **196** to buffer the impedance of filter **194**.

The quadrature mixers **186** and **188** are fed from a local oscillator **184** at 360 MHz whose output is split into two signals **184***a* and **184***b* that are separated in phase by 90 degrees. The oscillator **184** is phase-locked to an external reference signal **204** at either 5.625 MHz or 1.0 MHz depending on whether the wireless transceiver is being used for a SU or a HU. Likewise, the divider ratio is also selectable at either 64 or 360 by control signal **206**.

The next stage in the transmitter IF module **152** is a programmable gain stage **198**, controlled by a four bit binary control signal **208**. This stage provides a monotonic attenuation range of 0–75 dB in 5 dB increments. The minimum value of the maximum attenuation should be 40 dB.

The final stage in the primary signal path in module **152** is the on/off switch **200**. When the SU is not transmitting, switch **200** provides a mechanism by which transmitter **130** may be turned off. Switch **200** has a minimum off state isolation of 30 dB and an off to on delay of less than 100 ns and is controlled by digital input **210**.

The IF module **152** also contains a divider **202**. Divider **202** is used in phase-locked loops for external microwave circuits. It consists of a divider **212** which divides a 21.875 MHz input signal **214** by **175**, a phase-frequency detector **216** which is fed with an external reference signal **218** at 1 MHz which is internally divided by eight in divider **220**, and a loop amplifier **222** that has external elements **224** which determine the loop parameters.

FIG. **8** is a block diagram of the receiver portion **300** of a wireless transceiver according to the invention. The incomming communication signal is received at antenna **302**. Where the transmission is being received by a SU, the received signal is at a frequency of 2.440 GHz. However, if the signal is being received at a HU, the received signal is at a frequency of 5.780 GHz. The signal is immediately passed to Radio Receiver Down Converter **304** which demodulates the signal down to an intermediate frequency of 180 MHz. Down Converter **304** passes the converted signal to Receiver IF Module **308** via transmission path **306**. The IF Module **308** then, further demodulates the received signal and converts it to a baseband digital representation. The IF Module **308** performs its functions according to control signals **314** provided by the Protocol Engine **320**. The converted baseband digital signals are transmitted from the IF Module **308** to the Modem **312**. The Modem **312** passes the digital signals on to the Protocol Engine **320** via transmission path **318**. The Protocol Engine **320** strips out the multiphase modulation information and the spread spectrum encoding, formats the information according to the requirements of the particular SU or HU and stores the baseband digital information in the ram buffer **322** via port **322***b*. The Interface Controller **324** reads the formatted information from the RAM buffer **322** via port **322***a* and passes it to the wired bus **326** via the wired interconnection **328** and the network interface **330**. The wired bus **326** may be an internal data bus as in the case where the SU is comprised of a single data terminal or where the information is being received at an HU. Alternatively, it may be a hardwired network, as in the case where the SU is comprised of an entire network. The Protocol Engine **320** and the Interface Controller **324** may access the ram buffer **322** at two different data rates. Memory Controller **330** coordinates this memory access.

FIG. **9** is a more detailed block diagram of the Receiver IF Module **300** of FIG. **8**. The purpose of the Receiver IF Module **300** is to condition the input phase modulated signal and to convert this signal from a polar, IF representation to a Cartesian, baseband digital representation. The resulting digital signals are then passed to the Modem **312** for further processing.

There are two functional subdivisions to this module, an IF part **350** and a baseband part **352**. The elements of the IF part are an input amplifier **354**, a programmable gain control **356**, a limiting amplifier **358**, a bandpass filter **360**, an I-Q down converter mixer set **362** and **364** and a quadrature output phase-locked local oscillator **366**. The elements of the baseband part **352** are video buffer amplifiers **368** and **370**, low-pass filters **372** and **374**, video driver amplifiers **376** and **378**, a clock generation module **380** and analog to digital converters **382** and **384**.

The IF Module **300** receives, as its input **353**, a spread spectrum, differentially encoded phase modulated signal centered at 180 MHz with an effective noise bandwidth of approximately 70 MHz. The input signal to the module **352** ranges from −63 dBm to approximately −7 dBm. The signal is amplified in a low-noise input amplifier **354** and then the signal level is set by a programmable gain stage **356**. The programmable gain stage **356** is controlled by inputs **357** from the Protocol Engine **320** depicted in FIG. **8**. The programmable gain stage **356** acts to compensate for unit-to-unit and temperature variations in gain in both this module and the preceding stages. The approximate range of the gain control is about 16 dB. Approximately 8 dB is allocated for prior stages and 8 dB is allocated for module **352**.

The signal is then passed to a limiting amplifier **358** to remove any amplitude modulation present to improve the systems dynamic range. It also limits the magnitude of the baseband signals applied to the inputs of the analog to digital converters **380** and **382**. After the limiter the signal is further filtered through bandpass filter **360** and then passed to the mixer module divider **359**.

At the divider **359**, the signal is split into an in-phase channel **359***a* and a quadrature channel **359***b* for mixing down to baseband. The mixers **362** and **364** are driven by a local oscillator **366** whose outputs **366***a* and **366***b* are 90 degrees offset from one another. The local oscillator is a VCO at the IF frequency and is phase-locked to an external, 1 MHz reference signal **365** derived from a crystal oscillator at 16 MHz.

Following conversion to baseband, the in-phase and quadrature signals are passed to video amplifiers **372** and **374** respectively. Amplifiers **372** and **374** server to buffer the mixers **364** and **362** from the impedances of the filters **372** and **374** and to provide sufficient signal drive into those filters. Once passed through lowpass filters **372** and **374**, the signals are buffered through amplifiers **376** and **378** and then fed into analog to digital converters **382** and **384**. Analog to digital converters **382** and **384** sample the baseband signals according to clock signals **380***a* and **380***b* generated by clocking circuit **380** and convert them to digital data. The sampling frequency of the analog to digital converters **382** and **384** is controlled by input **386** to clock circuit **380**. The digital signals **382***a* and **382***b* are then passed to the modem **312** of FIG. **8** for further processing.

As was previously discussed, one embodiment of the invention typically operates in an office environment. In such an environment, there are many objects such as walls, file cabinets and desks which may act to deflect transmitted signals. This deflection may result in creating multiple signal paths by which a given transmission reaches its destination. Such a multiple path channel is characterized by each path having a different time delay, amplitude and phase. Since the different paths may have random independent phases, the received combined amplitude could vary by considerable amount and may sometimes be below the required minimum signal level. As also noted above, a direct sequence spread spectrum (DSSS) approach improves on the multipath problem combining the signals received from the different signal paths.

System Initialization

During system initialization the HU performs various functions. These functions are divided into two categories: HU initialization and SU initialization. The SU initialization functions include allowing SUs to establish membership in the network, and setting SU to HU transmission signal power level and time delay parameters. The HU initialization includes selecting the spread spectrum code to be used, setting the HU receiver gain, and setting the HU to SU transmission signal power level. These initialization functions are described below.

A particular SU is considered a member of the wireless network when its associated wireless terminal possesses the correct network spread spectrum-code and has been assigned a free time slot number. Only when the wireless terminal has both of those parameters may its associated SU communicate with the HU. If it has both of these parameters and it wishes to become active on the network then it sends a message, during its allocated time slot, to the HU that it is active. The HU then acknowledges activation on the network through transmission of an identification supervisory packet (ISP). An ISP typically consists of five fields: configuration serial number, spread spectrum code set number, number of configured SUs, number of active SUs and a list of identification addresses of all configured stations.

In a preferred embodiment, any one of a plurality of network spread spectrum codes may be utilized with respect to a particular HU. Additionally, different HUs will employ different network codes to minimize inter-network interference. Each wireless terminal has the potential network codes stored in an internal ROM, along with the network configuration serial number so it can identify the correct HU. If the wireless terminal does not know which of the possible codes to use, then it shifts into IDLE NO TX state and monitors HU transmissions over the down-link channel until it determines that code. Once the transceiver, wishing to join the network, ascertains what it believes to be the proper spread spectrum code, it transmits a request to join the network during slot 0. The request to join includes an identifying address. When the HU receives a request to join the network, it first looks for the identifying address in its members list. If the SU appears on its list, the HU returns a message that assigns the SU a slot number. If not, it rejects the request. The member list prevents SUs from one network accidentally joining another network.

If the SU attempting to join the network is denied access by the HU, or if it is responded to by the wrong HU, it may repeat its request to join, utilizing the other spread spectrum codes in its wireless terminals. If after a predefined number of attempts, it is still unable to join the network, it then executes an SOS sequence. The SU is not synchronized with the HU during an SOS transmission. Therefore, a relatively long transmission is utilized which enhances the chances of HU reception, despite collisions and lack of synchronization. If the SU receives an ISP from the correct HU, then it joins the network. Otherwise, after a defined number of SOS attempts, it becomes inactive.

Because SUs may be at varying distances from their HU, SU to HU transmission signal delays may differ for each SU. Additionally, the required transmission power at each SU, which ensures reliable HU reception may also differ. Therefore, once communication is established, the transmission power level and time delay is fine tuned. The particular SU being initialized transmits Transmitter Test Packets (TTPs) to its HU, at a plurality of power-delay combinations. The HU selects the best power as the lowest level which has a signal quality exceeding a defined threshold, or if none exceeds the threshold, then the highest quality power level. The best delay is selected as the one which provides the best timing results, with respect to the predefined time frame, at the selected power level. Both power level and transmission signal delay may be dynamically modified subsequent to a SU joining the network.

The criteria for selecting the particular spread spectrum code to be used and for setting the gain control for the HU receiver is that combination which results in minimum noise in the received signal. The HU determines the proper combination by monitoring the up-link channel from its associated SUs and tracking the rate of falsely detected transmission requests with respect to each potential gain and code combination. If the HU changes the particular spread spectrum code being used over the network it must inform all SUs by transmitting an ISP.

The HU to SU transmission power is adjusted based on SU reception statistics. For example if the stations are receiving a number of erroneous transmissions from the HU then the power level at the HU is increased. The HU transmitter power is also adjusted based on signal quality index measurements taken at each SU. These, like those taken at the HU during the SU power adjustment, involve comparing the received signal to an acceptable threshold level.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

We claim:

1. A multiple access communications system, comprising

A. one or more hub units,

B. a plurality of station units associated with each of said hub units,

C. link means for establishing a bidirectional communications link between each of said hub units and its associated station units, said link means including:

i) downlink means for establishing a unidirectional downlink radio frequency signal path from each of said hub units to all of its associated station units at a first predetermined frequency,

ii) uplink means for establishing a unidirectional uplink radio frequency signal path from each of said station units to its associated hub unit at a second predetermined frequency,

iii) synchronization means, selectively operative in a first mode, for establishing a common slotted time frame for each of said hub units and its associated station units, said time frame defining a plurality of time slots, and for allocating subsets of said time slots to each of said associated station units, and selectively operative in a second mode, for allocating sole access to said uplink radio frequency signal path to one of said associated station units, in response to receipt of an access request signal from said one station unit in a time slot included in said subset of time slots allocated to said one station unit,

verification means for verifying, within a predetermined number of said time slots the integrity of said bidirectional communications link between each of said hub units and its associated station units, wherein said predetermined number is less than the total number of slots in said time frame.

2. A system according to claim 1 wherein said link means further includes:

uplink transmit means at each of said station units, said uplink transmit means being operative in said station unit's subset of time slots of said time frame for selectively transmitting station unit signals over said uplink radio frequency signal path to said hub unit associated with said station unit,

HU receive means at each of said hub units for receiving said station unit signals from its associated station units via said uplink radio frequency signal path,

downlink transmit means at each of said hub units, said downlink transmit means being operative in response to said received station unit signals from each of its associated station units for transmitting hub unit signals corresponding to said received station unit signals over said downlink radio frequency signal path to each of its associated station units,

SU receive means at each of said station units for receiving said hub unit signals from its associated hub unit via said downlink radio frequency signal path,

verification means at each of said station units for comparing said transmitted station unit signals and corresponding received station unit signals, and

error means responsive to said comparison for generating an error signal when said transmitted station unit signals and said corresponding received station unit signals fail to be characterized by a predetermined correlation.

3. A system according to claim 1 wherein said link means further comprises

SU uplink conversion means at each of said station units for converting, from a baseband digital format to a direct sequence spread spectrum format, said station unit signals to be transmitted,

HU uplink conversion means at each of said hub units for converting, from a direct sequence spread spectrum format to a baseband digital format, said received station unit signals,

HU downlink conversion means at each of said HU's for converting, from a baseband digital format to a direct sequence spread spectrum format, said hub unit signals to be transmitted from said hub units to said associated station units,

SU downlink conversion means at each of said station units for converting, from direct sequence spread spectrum format to a baseband digtal format, said received hub unit signals.

4. A system according to claim 3 wherein

said SU uplink conversion means further includes means for converting, from a baseband format to a phase modulated format, said transmitted station unit signals,

said HU uplink conversion means further includes means for converting, from a phase modulated format to a baseband format, said received station unit signals,

said HU downlink conversion means further includes means for converting, from a baseband format to a phase modulated format, said transmitted HU signals, and

said SU downlink conversation means further includes means for converting, form a phase modulated format to a baseband format, said received HU signals.

5. A system according to claim 1 wherein said link means further includes uplink availability detector at each of said station units, said uplink availability detector including:

means for monitoring said downlink radio frequency signal path from its associated hub unit and

LBT means responsive to said monitoring means for determining availability of said uplink radio frequency signal path prior to transmitting a signal from said station unit to its associated hub unit via said uplink radio frequency signal path.

6. A system according to claim 5 wherein said LBT means includes means for identifying periods when such periods being indicative of permitted transmission by said station unit.

7. A system according to claim 1 wherein said link means further includes uplink unavailability detector at each of said station units, said uplink unavailability detector including:

means for monitoring said downlink radio frequency signal path from said hub unit during transmission of said station unit signals by said station unit to its associated hub unit over said uplink radio frequency signal path and

LWT means for detecting if the hub unit becomes unavailable to said station unit during said transmission.

8. A system according to claim 7 wherein said LWT means includes means for identifying,

9. A system according to claim 1 further including station unit transmission signal power adjustment means for adaptively controlling transmission signal power for at least one of said station units whereby said transmission signal power level from said station unit is substantially at a predetermined level at its associated hub unit.

10. A system according to claim 9 wherein the transmission signal power levels of said station units at their associated hub unit are controlled to be substantially equal.

11. A system according to claim 1 further including hub unit transmission signal power adjustment means for adaptively controlling transmission signal power at least one of said hub units whereby transmission signal power level from said hub unit is substantially at a predetermined level at a selected one of said station units associated therewith.

12. A system according to claim 11 wherein said selected one of said station units is the station unit farthest away from said hub unit.

13. A system according to claim 1 further including station unit transmission signal delay adjustment means for adaptively controlling transmission signal delay for at least one of said station units whereby transmissions from said station units occur substantially at a predetermined time within said time frame at said hub unit.

14. A system according to claim 1 wherein said link means further includes hub unit retransmission means at said hub units for retransmitting from said hub units to each of said associated station units over said downlink radio signal path, substantially all communications received by said hub unit from each of said associated station units via said uplink radio signal path.

15. A system according to claim 1 further including

a backbone communications bus and

a plurality of network interface units coupled along said bus wherein at least one of said hub units is coupled to and in communications with said bus, said coupling being through an associated network interface unit.

16. A system according to claim 15 wherein said backbone is wireless.

17. A system according to claim 15 wherein said backbone is fiber optically connected.

18. A system according to claim 15 wherein said backbone employs a token passing ring protocol.

19. A system according to claim 15 wherein said backbone employs an ethernet protocol.

20. A system according to claim 15 wherein said backbone is hard wired.

21. A multiple access communications system, comprising

A. one or more hub units

B. a plurality of station units associated with each of said hub units

C. link means for establishing a bidirectional communications link between each of said hub units and its associated station units, said link means including

i) downlink means for establishing a unidirectional downlink radio frequency signal path from each of said hub units to all of its associated station units at a first predetermined frequency,

ii) uplink means for establishing a unidirectional uplink radio frequency signal path from each of said station units to its associated hub unit at a second predetermined frequency, and

iii) synchronization means, selectively operative in a first mode, for establishing a common slotted time frame for each of said hub units and its associated station units, said time frame defining a plurality of time slots, and for allocating subsets of said time slots to each of said associated station units, and selectively operative in a second mode, for allocating sole access to said uplink radio frequency signal path to one of said associated station units, in response to receipt of an access request signal from said one station unit in a time slot included in said subset of time slots allocated to said one station unit,

22. A multiple access communications system operating over a predetermined region, comprising:

A. one or more hub units,

B. a plurality of station units associated with each of said hub units,

C. link means for establishing a bidirectional wireless communications link between each of said hub units and its associated station units, said communications link supporting a data rate, R, said link means including:

i) downlink means for establishing at least one wireless downlink radio frequency signal path for transferring information from each of said hub units to all of its associated station units at a first predetermined frequency, f_1,

ii) uplink means for establishing at least one wireless uplink radio frequency signal path for transferring information from each of said station units to its associated hub unit at a second predetermined frequency, f_2,

wherein f_1 and f_2 are frequencies at which signal reflections from local objects may exist within said region such that a plurality of said uplink and said downlink radio frequency signal paths may occur between a particular hub unit and an associated station unit,

each of said signal paths having an associated signal delay for a signal passing over said path, said associated delay varying in proportion to said signal path's deviation in length from that of a theoretical straight line path between said particular hub unit and said associated station unit,

said signal path having the greatest of said deviations in length being associated with a maximum delay, D_{max}, wherein D_{max} is a predetermined portion of 1/R,

iii) recovery means, responsive to said signals passing between said particular hub unit and said associated station unit, over said plurality of paths, for regenerating said information transferred between said hub unit and said associated station unit, and

iv) synchronization means, selectively operative in a first mode, for establishing a common slotted time frame for each of said hub units and its associated station units, said time frame defining a plurality of time slots, and for allocating subsets of said time slots to each of said associated station units, and selectively operative in a second mode, for allocating sole access to said uplink radio frequency signal path to one of said associated station units, in response to receipt of an access request signal from said one station unit in a time slot included in said subset of time slots allocated to said one station unit.

23. A system according to claim 1 wherein said link means further includes controller means for selecting between said first mode and said second mode, and wherein said controller means includes means for transitioning from said first mode to said second mode in response to said hub unit receiving an request signal from one of said associated station units.

24. A system according to claim 1 wherein said subset includes at least one pair of associated time slots in said time frame, and said pair includes a first occurring time slot and a second occurring time slot, wherein each of said station units can request access to said uplink radio frequency signal path during said first occurring time slot and can receive acknowledgement of being granted said access during said second occurring time slot, said first occurring time slot being spaced in time from said second occurring time slot by a period of time equal to or greater than a minimum two-way radio frequency transit time between said hub unit and said associated station unit.

25. A system according to claim 1 wherein each of said subsets include at least one pair of associated time slots in said time frame, each pair including a first occurring time slot and a second occurring time slot, said first occurring time slot being spaced in time from said second occurring time slot by a period of time equal to or greater than a minimum two-way radio frequency transit time between said hub unit and said associated station unit, and wherein

A. each of said associated station units include

i) means for transmitting an access request signal to said hub unit over said uplink radio frequency signal path during said first occurring time slot of one of its pairs of associated time slots to request sole access to said uplink radio frequency channel,

ii) means for receiving, over said downlink radio frequency signal path during said second occurring time slot of said one pair, an allocation signal representative of a grant of sole access to said uplink radio frequency signal path, and

B. said hub unit includes

i) means for receiving said access request signal over said uplink radio frequency signal path,

ii) means for identifying which one of said associated station units originated said access request signal by identifying the one of said pairs of said time slots during which said access request code was received at said hub unit, and

iii) means for selectively transmitting said allocation signal to said identified station unit over said downlink radio frequency signal path during said second occurring time slot of said identified pair.

26. A system according to claim 25 wherein said link means further includes controller means for selecting between said first mode and said second mode, and wherein said controller means includes means for transi-

tioning from said first mode to said second mode in response to said hub unit receiving said access request signal from said identified station unit.

27. A system according to claim 1 wherein said associated station units include means for transmitting (m) characters to said hub unit over said uplink radio frequency signal path during said second mode of operation, where (m) is an integer less than a predetermined number.

28. A system according to claim 1 wherein said associated station units include means for transmitting (n) packets of information to said hub unit over said uplink radio frequency signal path during said second mode of operation, where (n) is an integer less than a predetermined number.

29. A system according to claim 28 wherein each said packets of information include a selectable number of characters, and said associated station units include means for selecting said number of characters included in each of said packets in response to a control command from said hub unit.

30. A system according to claim 28 wherein said associated station units include means for selecting (n) in response to a control command from said hub unit.

31. A system according to claim 1 wherein said synchronization means further includes means for signaling said associated station units as to which of said allocated subsets of times slots will be a first to occur upon transitioning from said second mode of operation to said first mode operation.

32. A system according to claim 21 wherein said link means further includes controller means for selecting between said first mode and said second mode, and wherein said controller means includes means for transitioning from said first mode to said second mode in response to said hub unit receiving an request signal from one of said associated station units.

33. A system according to claim 21 wherein said subset includes at least one pair of associated time slots in said time frame, and said pair includes a first occurring time slot and a second occurring time slot, wherein each of said station units can request access to said uplink radio frequency signal path during said first occurring time slot and can receive acknowledgement of being granted said access during said second occurring time slot, said first occurring time slot being spaced in time from said second occurring time slot by a period of time equal to or greater than a minimum two-way radio frequency transit time between said hub unit and said associated station unit.

34. A system according to claim 21 wherein each of said subsets include at least one pair of associated time slots in said time frame, each pair including a first occurring time slot and a second occurring time slot, said first occurring time slot being spaced in time from said second occurring time slot by a period of time equal to or greater than a minimum two-way radio frequency transit time between said hub unit and said associated station unit, and wherein

A. each of said associated station units include

i) means for transmitting an access request signal to said hub unit over said uplink radio frequency signal path during said first occurring time slot of one of its pairs of associated time slots to request sole access to said uplink radio frequency channel,

ii) means for receiving, over said downlink radio frequency signal path during said second occurring time slot of said one pair, an allocation signal representative of a grant of sole access to said uplink radio frequency signal path, and

B. said hub unit includes

i) means for receiving said access request signal over said uplink radio frequency signal path,

ii) means for identifying which one of said associated station units originated said access request signal by identifying the one of said pairs of said time slots during which said access request code was received at said hub unit, and

iii) means for selectively transmitting said allocation signal to said identified station unit over said downlink radio frequency signal path during said second occurring time slot of said identified pair.

35. A system according to claim 34 wherein said link means further includes controller means for selecting between said first mode and said second mode, and wherein said controller means includes means for transitioning from said first mode to said second mode in response to said hub unit receiving said access request signal from said identified station unit.

36. A system according to claim 21 wherein said associated station units include means for transmitting (m) characters to said hub unit over said uplink radio frequency signal path during said second mode of operation, where (m) is an integer less than a predetermined number.

37. A system according to claim 21 wherein said associated station units include means for transmitting (n) packets of information to said hub unit over said uplink radio frequency signal path during said second mode of operation, where (n) is an integer less than a predetermined number.

38. A system according to claim 37 wherein each said packets of information include a selectable number of characters, and said associated station units include means for selecting said number of characters included in each of said packets in response to a control command from said hub unit.

39. A system according to claim 37 wherein said associated station units include means for selecting (n) in response to a control command from said hub unit.

40. A system according to claim 21 wherein said synchronization means further includes means for signaling said associated station units as to which of said allocated subsets of times slots will be a first to occur upon transitioning from said second mode of operation to said first mode operation.

41. A system according to claim 22 wherein said link means further includes controller means for selecting between said first mode and said second mode, and wherein said controller means includes means for transitioning from said first mode to said second mode in response to said hub unit receiving an request signal from one of said associated station units.

42. A system according to claim 22 wherein said subset includes at least one pair of associated time slots in said time frame, and said pair includes a first occuring time slot and a second occurring time slot, wherein each of said station units can request access to said uplink radio frequency signal path during said first occurring time slot and can receive acknowledgement of being granted said access during said second occurring time slot, said first occurring time slot being spaced in time from said second occurring time slot by a period of time equal to or greater than a minimum two-way radio

frequency transit time between said hub unit and said associated station unit.

43. A system according to claim 22 wherein each of said subsets include at least one pair of associated time slots in said time frame, each pair including a first occurring time slot and a second occurring time slot, said first occurring time slot being spaced in time from said second occurring time slot by a period of time equal to or greater than a minimum two-way radio frequency transit time between said hub unit and said associated station unit, and wherein

A. each of said associated station units include
   i) means for transmitting an access request signal to said hub unit over said uplink radio frequency signal path during said first occurring time slot of one of its pairs of associated time slots to request sole access to said uplink radio frequency channel,
   ii) means for receiving, over said downlink radio frequency signal path during said second occurring time slot of said one pair, an allocation signal representative of a grant of sole access to said uplink radio frequency signal path, and

B. said hub unit includes
   i) means for receiving said access request signal over said uplink radio frequency signal path,
   ii) means for identifying which one of said associated station units originated said access request signal by identifying the one of said pairs of said time slots during which said access request code was received at said hub unit, and
   iii) means for selectively transmitting said allocation signal to said identified station unit over said downlink radio frequency signal path during said second occurring time slot of said identified pair

44. A system according to claim 43 wherein said link means further includes controller means for selecting between said first mode and said second mode, and wherein said controller means includes means for transitioning from said first mode to said second mode in response to said hub unit receiving said access request signal from said identified station unit.

45. A system according to claim 22 wherein said associated station units include means for transmitting (m) characters to said hub unit over said uplink radio frequency signal path during said second mode of operation, where (m) is an integer less than a predetermined number.

46. A system according to claim 22 wherein said associated station units include means for transmitting (n) packets of information to said hub unit over said uplink radio frequency signal path during said second mode of operation, where (n) is an integer less than a predetermined number.

47. A system according to claim 46 wherein each said packets of information include a selectable number of characters, and said associated station units include means for selecting said number of characters included in each of said packets in response to a control command from said hub unit.

48. A system according to claim 46 wherein said associated station units include means for selecting (n) in response to a control command from said hub unit.

49. A system according to claim 22 wherein said synchronization means further includes means for signaling said associated station units as to which of said allocated subsets of times slots will be a first to occur upon transitioning from said second mode of operation to said first mode operation.

* * * * *

US005159592A

United States Patent [19]

Perkins

[11] **Patent Number:** **5,159,592**

[45] **Date of Patent:** **Oct. 27, 1992**

[54] **NETWORK ADDRESS MANAGEMENT FOR A WIRED NETWORK SUPPORTING WIRELESS COMMUNICATION TO A PLURALITY OF MOBILE USERS**

[75] Inventor: **Charles E. Perkins**, Peekskill, N.Y.

[73] Assignee: **International Business Machines Corporation**, Armonk, N.Y.

[21] Appl. No.: **605,592**

[22] Filed: **Oct. 29, 1990**

[51] **Int. Cl.**^{5} **H04J 3/24**; H04B 7/00

[52] **U.S. Cl.** **370/85.7**; 370/85.13; 370/94.1; 370/95.1

[58] **Field of Search** 370/60, 85.1, 85.2, 370/85.3, 85.7, 85.13, 94.1, 94.3, 95.1; 340/825.5, 825.51; 455/39, 68, 53.1, 54.1, 54.2, 55.1, 56.1

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,644,461	2/1987	Jennings	364/200
4,665,519	5/1987	Kirchner et al.	370/94.1
4,706,081	11/1987	Hart et al.	340/825.03
4,750,109	6/1988	Kita	364/200
4,807,222	2/1989	Amitay	370/85.12
4,809,257	2/1989	Gantenbein et al.	370/4
4,893,307	1/1990	McKay et al.	370/94.1
4,914,652	4/1990	Nguyen	370/85.5
5,014,345	5/1991	Comroe et al.	455/54
5,029,183	7/1991	Tymes	375/1
5,040,175	8/1991	Tuch et al.	370/94.1
5,068,916	11/1991	Harrison et al.	455/39

FOREIGN PATENT DOCUMENTS

0182417	5/1986	European Pat. Off. .
0328100	8/1989	European Pat. Off. .
WO88/07794	10/1988	PCT Int'l Appl. .

OTHER PUBLICATIONS

IEEE Transactions On Communications, vol. 38, No. 8, Aug. 1990, New York, pp. 1272–1280; D. J. Goodwin: "Cellular Packet Communications".

10th Conference On Local Computer Networks, Oct. 1985, New York, US pp. 149–157 W. M. Loucks et al.: "Implementation Of A Dynamic Address Assignment Protocol In A Local Area Network".

Data Communications, vol. 16, No. 12, Nov. 1987, New York US, pp. 209–225; D. Retz: "TCP/IP: DOD suite marches into the business world".

"Internet Protocol DARPA Internet Program Protocol Specification", Sep. 1981, Information Sciences Institute, University of Southern CA, Marina del Rey, Calif. 90291.

"Infrared Microbroadcasting Network For In-House Data Communication", F. Gfeller, *IBM Technical Disclosure Bulletin*, vol. 24, No. 8, Jan. 1982.

Primary Examiner—Douglas W. Olms
Assistant Examiner—Alpus H. Hsu
Attorney, Agent, or Firm—Perman & Green

[57] **ABSTRACT**

Apparatus and method for managing bidirectional transmission of information between a wired network and at least one mobile communication unit (**10**) in wireless communication with the wired network. The wired network is of the type wherein users of the network are each assigned a unique network address such as in, for example, a TCP/IP network. In accordance with the invention there is provided a local gateway (**16**) coupled between a wireless LAN and the wired network for communication with a mobile communication unit. There is also provided a global gateway (**18**) coupled to the local gateway and to remote users of the network. The global gateway functions to maintain a plurality of network addresses and, in response to a request for an assignment of a network address from the mobile communication unit, assigns one of the plurality of network addresses to the requesting mobile communication unit. The global gateway also buffers and routes data received from a remote user, the data being directed to an addresss corresponding to the assigned network address, to the mobile communication unit having the assigned address.

20 Claims, 5 Drawing Sheets

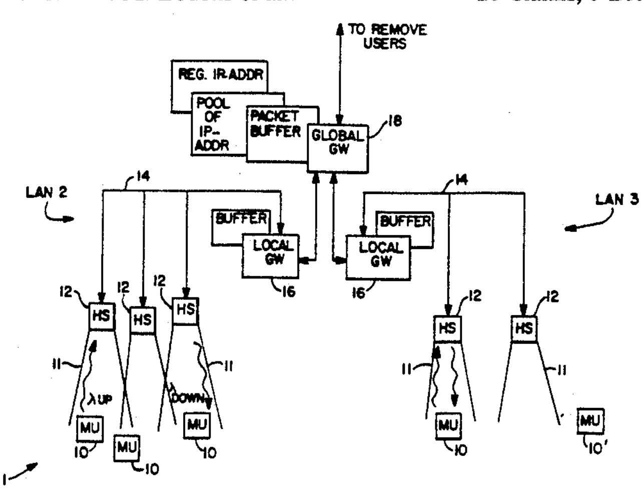
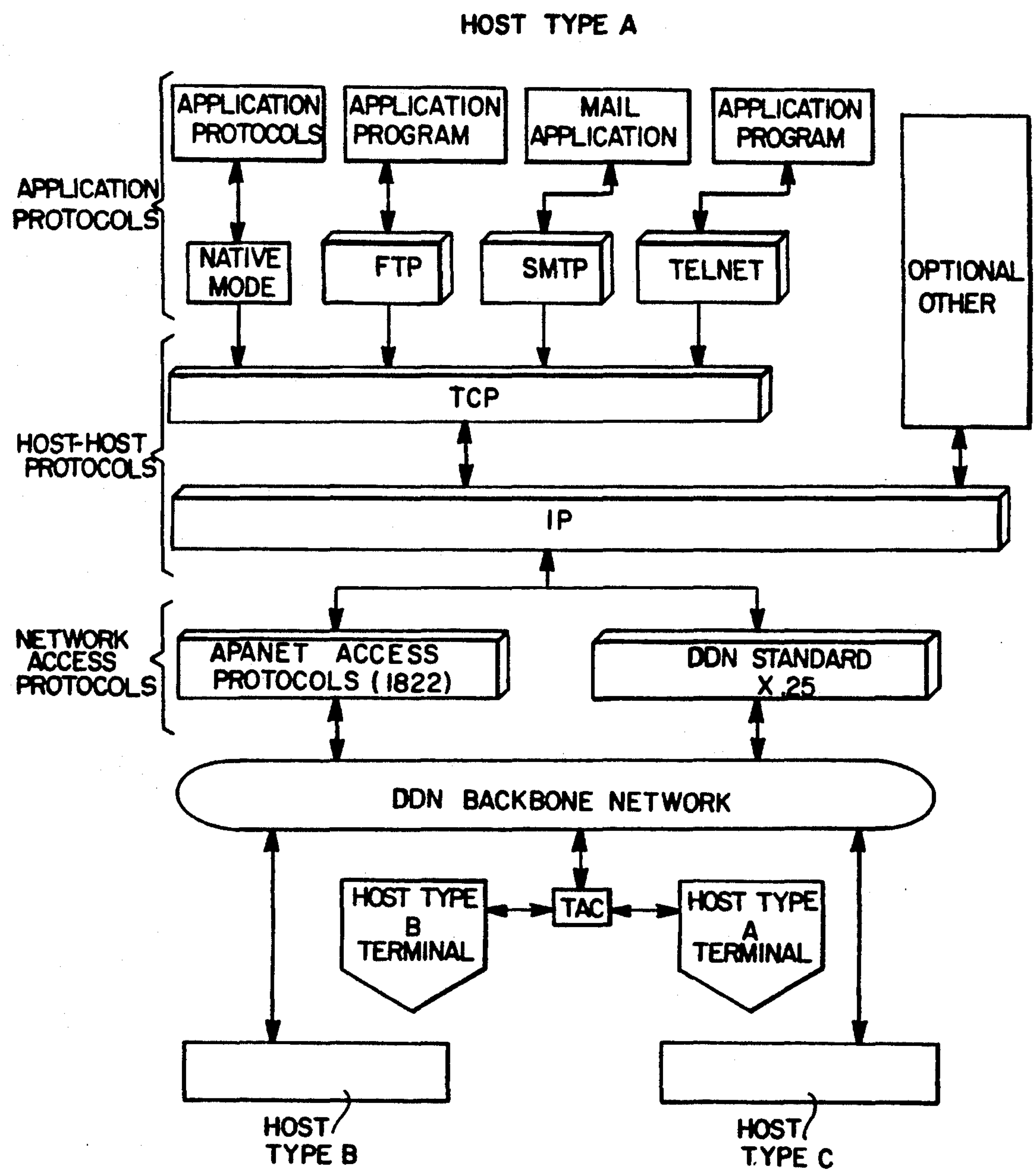


FIG. 1
(PRIOR ART)



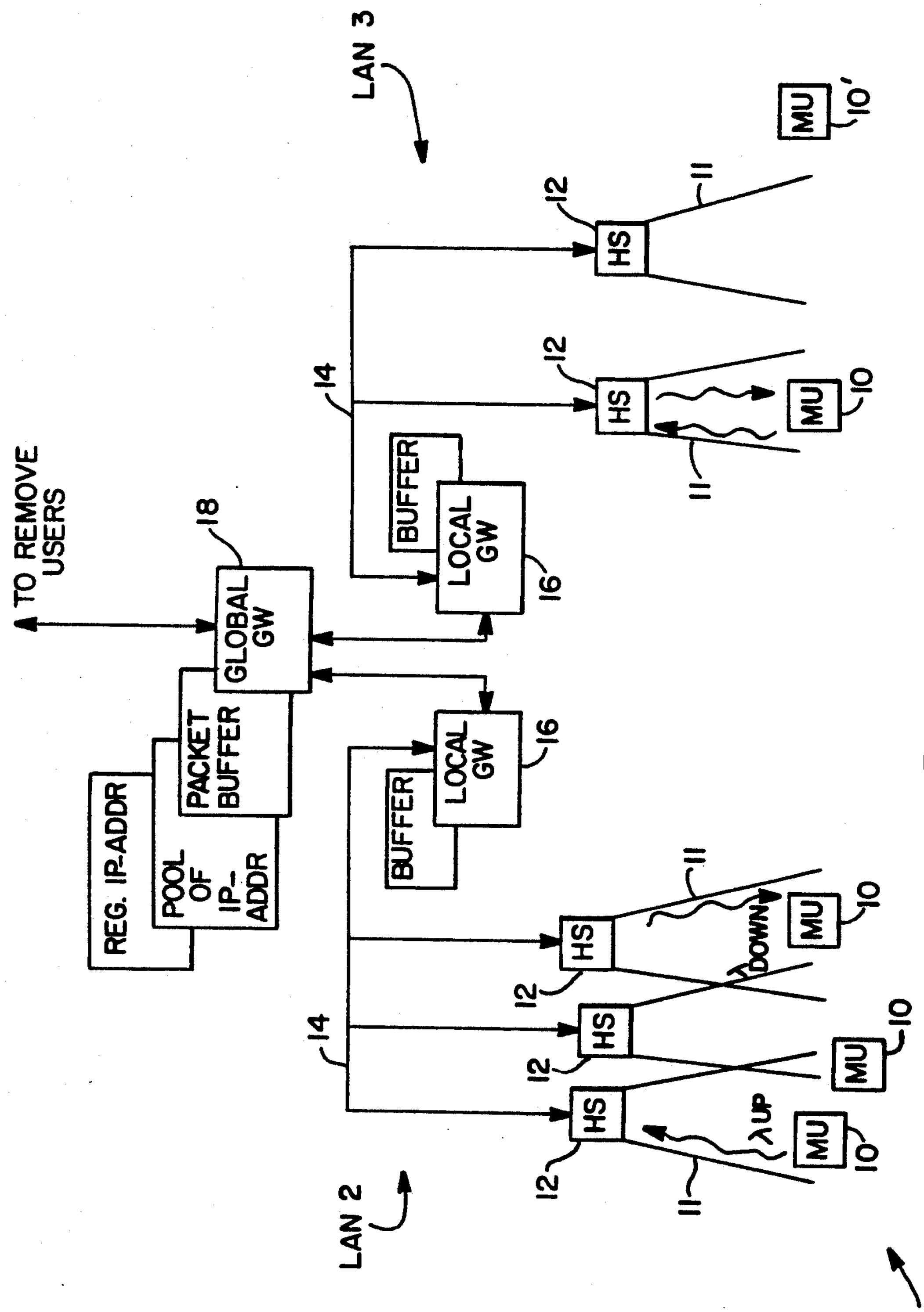

LAN 3
LAN 2
TO REMOVE USERS
GLOBAL GW
18
PACKET BUFFER
POOL OF IP-ADDR
REG. IP-ADDR
LOCAL GW
16
BUFFER
14
HS
12
11
MU
10
10'
λDOWN
λUP
1

FIG. 2

FIG. 3

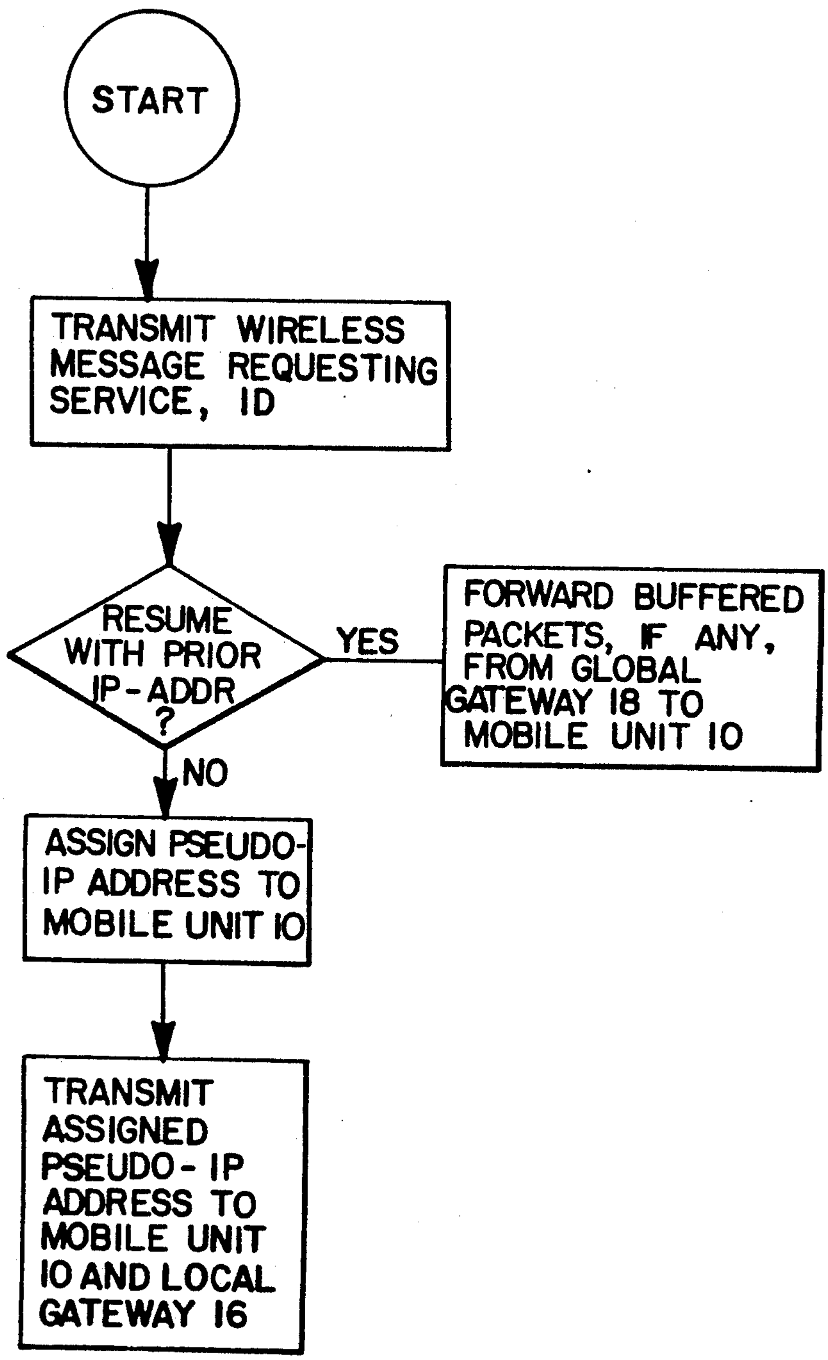

START
TRANSMIT WIRELESS MESSAGE REQUESTING SERVICE, ID
RESUME WITH PRIOR IP-ADDR ?
YES
FORWARD BUFFERED PACKETS, IF ANY, FROM GLOBAL GATEWAY 18 TO MOBILE UNIT 10
NO
ASSIGN PSEUDO-IP ADDRESS TO MOBILE UNIT 10
TRANSMIT ASSIGNED PSEUDO-IP ADDRESS TO MOBILE UNIT 10 AND LOCAL GATEWAY 16

FIG. 4

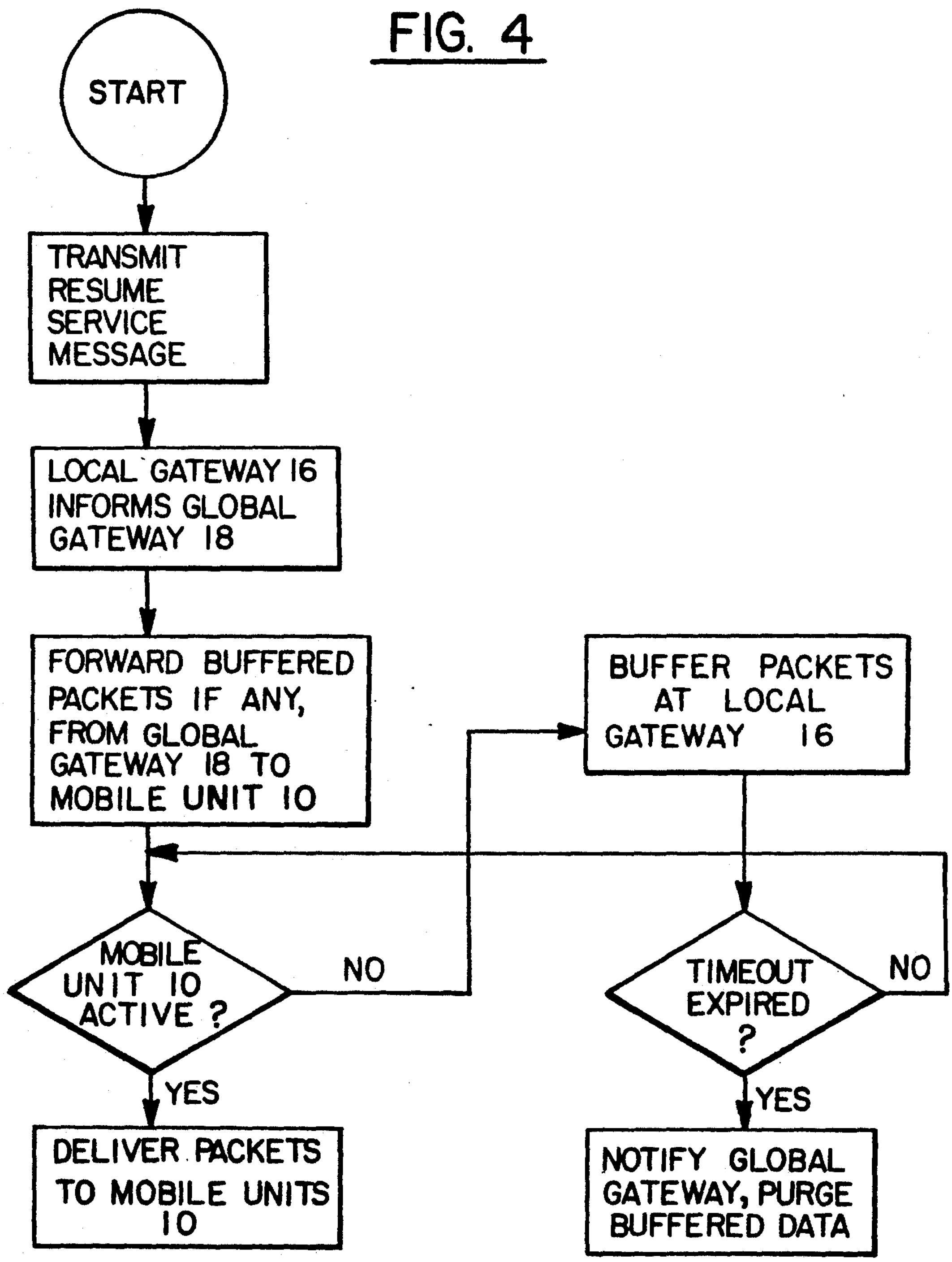

START
TRANSMIT RESUME SERVICE MESSAGE
LOCAL GATEWAY 16 INFORMS GLOBAL GATEWAY 18
FORWARD BUFFERED PACKETS IF ANY, FROM GLOBAL GATEWAY 18 TO MOBILE UNIT 10
MOBILE UNIT 10 ACTIVE ?
NO
YES
DELIVER PACKETS TO MOBILE UNITS 10
BUFFER PACKETS AT LOCAL GATEWAY 16
TIMEOUT EXPIRED ?
NO
YES
NOTIFY GLOBAL GATEWAY, PURGE BUFFERED DATA

FIG. 5

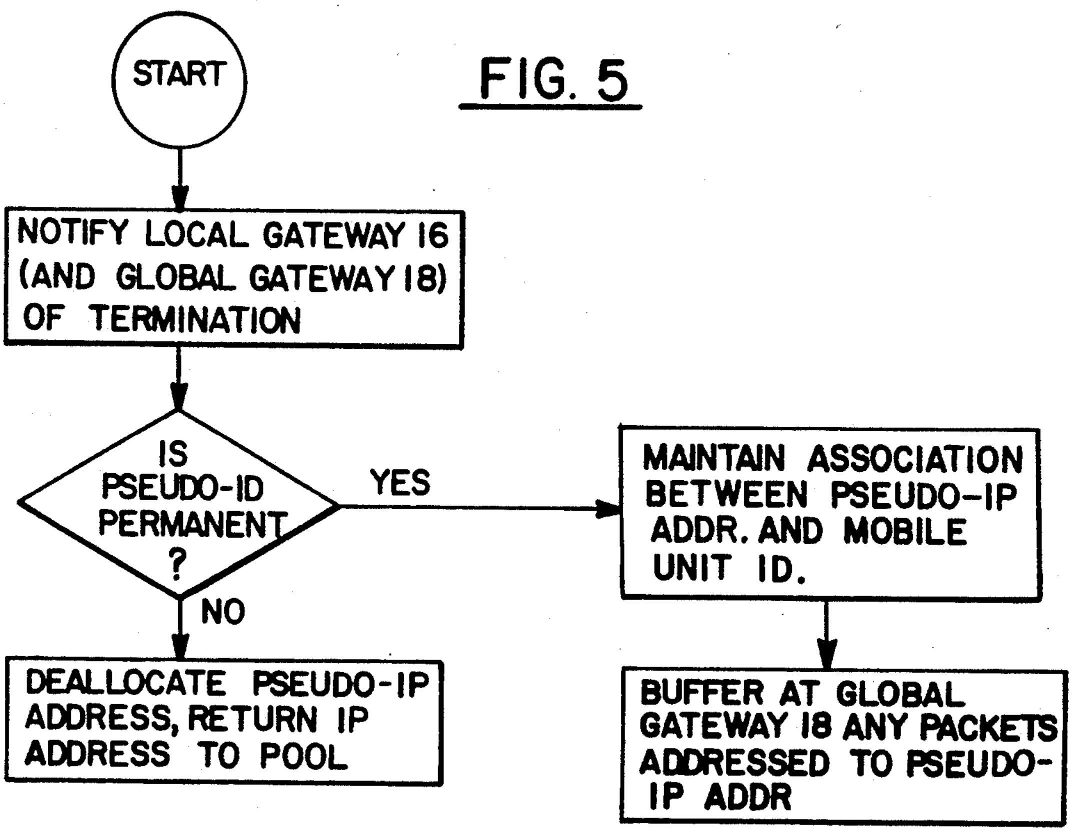
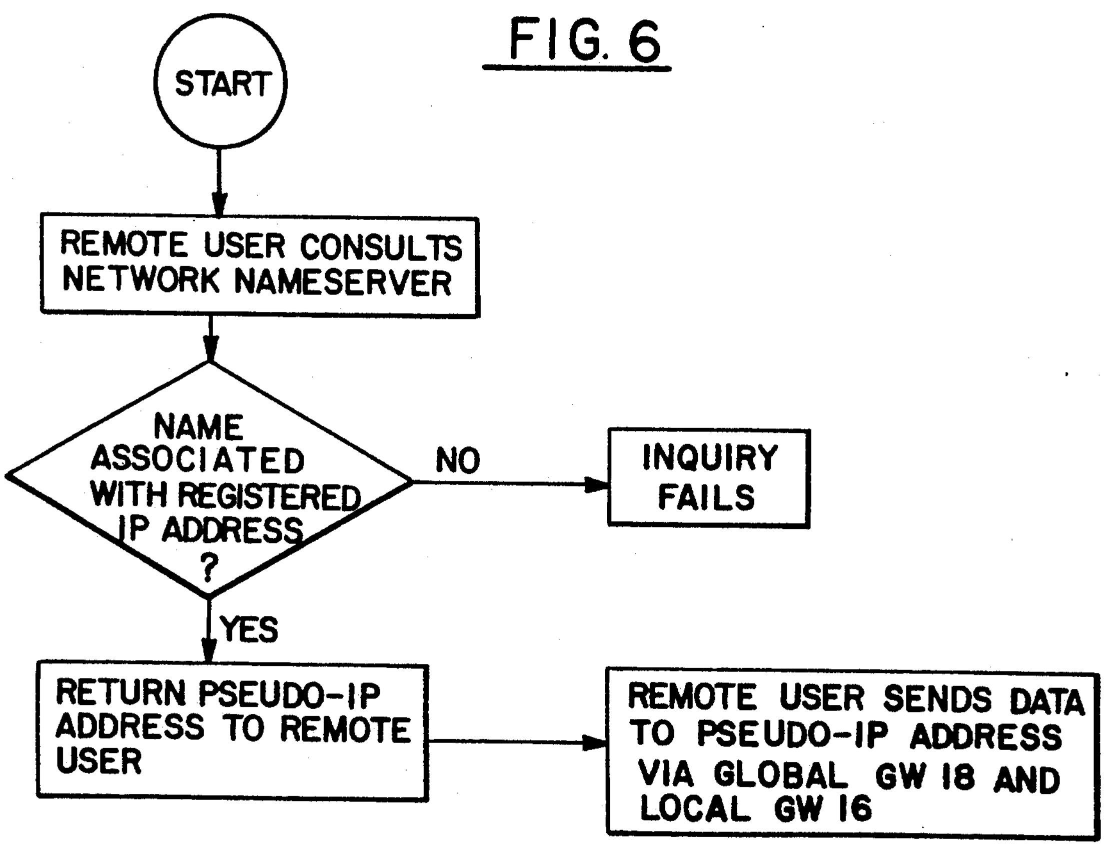

START
NOTIFY LOCAL GATEWAY 16 (AND GLOBAL GATEWAY 18) OF TERMINATION
IS PSEUDO-ID PERMANENT ?
YES
NO
MAINTAIN ASSOCIATION BETWEEN PSEUDO-IP ADDR. AND MOBILE UNIT ID.
BUFFER AT GLOBAL GATEWAY 18 ANY PACKETS ADDRESSED TO PSEUDO-IP ADDR
DEALLOCATE PSEUDO-IP ADDRESS, RETURN IP ADDRESS TO POOL

FIG. 6


START
REMOTE USER CONSULTS NETWORK NAMESERVER
NAME ASSOCIATED WITH REGISTERED IP ADDRESS ?
NO
INQUIRY FAILS
YES
RETURN PSEUDO-IP ADDRESS TO REMOTE USER
REMOTE USER SENDS DATA TO PSEUDO-IP ADDRESS VIA GLOBAL GW 18 AND LOCAL GW 16

NETWORK ADDRESS MANAGEMENT FOR A WIRED NETWORK SUPPORTING WIRELESS COMMUNICATION TO A PLURALITY OF MOBILE USERS

FIELD OF THE INVENTION

This invention relates generally to communication method and apparatus and, in particular, to method and apparatus for managing network address assignments in a network that includes mobile users.

BACKGROUND OF THE INVENTION

Commonly assigned U.S. Pat. No. 4,893,307, issued Jan. 9, 1990, "Method and Apparatus for Linking SNA Terminals to an SNA Host Over a Packet Switched Communications Network", D. B. McKay, R. M. Morten and M. P. Marsili, describes an architectural model of the Department of Defense (DoD) protocol suite. Referring to FIG. 1 the architecture is said to be similar to, but not identical with, the International Standards Organization (ISO) Open Systems Interconnection (OSI) architecture.

A Defense Data Network (DDN) standard establishes criteria for an Internet Protocol (IP) which supports the interconnection of communication LANs. It introduces the Internet Protocol's role and purpose, defines the services provided to users, and specifies the mechanisms needed to support those services. The standard also defines the services required of the lower protocol layer, describes the upper and lower interfaces, and outlines the execution environment services need for implementation.

A Transmission Control Protocol (TCP) is a transport protocol providing connection-oriented, end-to-end reliable data transmission in packet-switched computer LANs and internetworks.

The Internet Protocol (IP) and the Transmission Control Protocol (TCP) are mandatory for use in all DoD packet switching networks which connect or have the potential for utilizing connectivity across network or subnetwork boundaries. Network elements, such as hosts, front-ends, gateways, etc., within such networks which are to be used for internetting must implement TCP/IP.

The Internet Protocol is designed to interconnect packet-switched communication LANs to form an internetwork. The IP transmits blocks of data, called internet datagrams, from sources to destinations throughout the internet. Sources and destinations are hosts located on either the same subnetwork or connected LANs. The IP is purposely limited in scope to provide the basic functions necessary to deliver a block of data. Each internet datagram is an independent entity unrelated to any other internet datagrams. The IP does not create connections or logical circuits and has no mechanisms to promote data reliability, flow control, sequencing, or other services commonly found in virtual circuit protocols.

The DDN standard specifies a host IP. As defined in the DoD architectural mode, the Internet Protocol resides in the internetwork layer. Thus, the IP provides services to transport layer protocols and relies on the services of the lower network protocol. In each gateway, a system interconnecting two or more LANs, an IP resides above two or more LANs protocol entities. Gateways implement the internet protocol to forward datagrams between networks. Gateways also implement the Gateway to Gateway Protocol (GGP) to coordinate signalling and other internet control information.

The Internet protocols were originally developed with an assumption that users, each of which is assigned a unique Internet address, would be connected to the network at fixed locations. However, for portable and handheld computers the movement, or migration, of users about the network is typically the rule rather than the exception. As a result, a problem is created in that the implicit design assumptions of the Internet protocol are violated by this type of usage.

Other patents of interest include the following. In U.S Pat. No. 4,914,652, issued Apr. 3, 1990, Nguyen discloses a method for managing data transmissions in a single network, but not the routing and delivery of data between networks. In U.S. Pat. No. 4,750,109, issued Jun. 7, 1988, Kits teaches methods for allocating communication channels. In U.S. Pat. No. 4,706,081, issued Nov. 10, 1987, Hart et al. teach the merging of physically separate networks into a single logical network at a level below the addressing considerations required to affect the Internet protocols. In U.S. Pat. No. 4,644,461, issued Feb. 17, 1987, Jennings discloses a computer architecture including cross-bar and queue structures for routing tokens within the computer.

In commonly assigned U.S. Pat. No. 4,809,257, issued Feb. 28, 1989, entitled "Hierarchical Distributed Infrared Communication System" Gantenbein et al. disclose the integration of workstations into an IR network. FIG. 1D shows a system that includes a gateway 23 to another network such as a ring or a bus local area network, or to a cable-bound subnetwork.

Other patents of interest include the following. In U.S. Pat. No. 4,807,222, issued Feb. 21, 1989, N. Amitay discloses a wireless network using intelligent interfaces for each wired network connection. The interface is to a token bus network.

In U.S. Pat. No. 4,665,519, issued May 12, 1987, T. L. Kirchner et al. disclose the use of VHF FM radio as a means of connecting computers and computer peripherals. This patent describes the implementation of an asynchronous access, token based protocol. In International Patent W088/07794, published Oct. 6, 1988, G. Vacon discloses the use of a wireless microwave bridge between two networks utilizing a CSMA/CD protocol.

In IBM Technical Disclosure Bulletin Vol. 24 No. 8, 1982 F. Gfeller describes general control principles of an infrared wireless communication network incorporating multiple base stations and multiple mobile computers. Transmission occurs over the wireless IR medium using different frequencies for the uplink and the downlink.

What is not taught by this prior art, and what is thus an object of the invention to provide, is method and apparatus for coupling wireless migrating users to a network operating in accordance with the TCP/IP type-protocol.

SUMMARY OF THE INVENTION

The foregoing problems are overcome and other advantages are realized by method and apparatus that manages mobile communication unit address assignments and which assumes responsibility for the routing of all packets destined for the mobile units. Additionally, a local mobile unit gateway service is provided on every network or LAN in order to route packets to the mobile units coupled to the network. In accordance with the invention a network address, such as an Internet address, that is associated with a particular mobile unit encodes a network not physically embodied anywhere, referred to herein as a 'pseudo-network'. Routers of data packets are instructed to forward packets, destined for the designated network, to the global gateway. The global gateway subsequently executes methods, described in detail, to accomplish the packet transmission to the target mobile unit. The Internet addresses for each mobile unit are allocated and deallocated from a pool of addresses available for the pseudo-network. A 'permanent' assignment of a pseudo-address to a mobile unit is also within the scope of operation of the global gateway.

That is, the invention relates to apparatus and method for managing bidirectional transmission of information between a wired network and at least one mobile communication unit in wireless communication with the wired network. The wired network is of the type wherein users of the network are each assigned a unique network address such as in, for example, a TCP/IP network. In accordance with the invention there is provided a local gateway coupled between a wireless network and the wired network for communicating with a mobile communication unit. There is also provided a global gateway coupled to the local gateway and to remote users of the network. The global gateway functions to maintain a plurality of network addresses and, in response to a request for an assignment of a network address from the mobile communication unit, assigns one of the plurality of network addresses to the requesting mobile communication unit. The global gateway also buffers and routes data received from a remote user to the mobile communication unit having the assigned address, the data being directed to an address corresponding to the assigned network address.

BRIEF DESCRIPTION OF THE DRAWING

The above set forth and other features of the invention are made more apparent in the ensuing Detailed Description of the Invention when read in conjunction with the attached Drawing, wherein:

FIG. 1 is a prior art architectural diagram of the Defense Data Network;

FIG. 2 is a block diagram showing a global gateway coupled to a plurality of local gateways each of which may reside on a separate wired/wireless LAN; and

FIGS. 3–6 are each a flowchart depicting various interactions between mobile units, a global gateway, a local gateway and remote users.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 2 there is illustrated a communications area network 1. The network 1 includes one or more local area networks (LANs) 2 and 3. Each LAN includes a wireless network comprised of a plurality of mobile communication units (MU) 10 in wireless communication with a plurality of header stations (HS) 12. Each of the header stations 12 is bidirectionally coupled to a wired LAN 14. In the presently preferred embodiment of the invention the wireless medium is comprised of infrared (IR) radiation, although other embodiments may employ an RF wireless medium. Each of the header stations 12 has associated therewith a communications coverage area, or cell 11.

Communication between mobile units 10 is through the header stations 12 via the LAN 14. Communication between the header stations 12 is primarily via the LAN 14.

One suitable embodiment for the header stations 12 and the mobile units 10 is disclosed in commonly assigned U.S. patent application Ser. No. 07/605,052, filed Oct. 29, 1990, entitled "Transceiver for Extending a CSMA/CD Network for Wireless Communication" by P. Hortensius and H. Winbom.

The network 10 conforms, in the presently preferred embodiment of the invention, to a network protocol known as the Transport Control Protocol/Internet Protocol (TCP/IP), as described in detail in "Internetworking with TCP/IP Principles, Protocols, and Architectures" by Douglas E. Comer, Prentice Hall, N.J., 1988. The teaching of the invention should, however, not be construed to be limited to only such a network protocol, but may be employed with any protocol that encodes a LAN identification into a network address.

In accordance with an aspect of the invention each of the LANs 2 and 3 includes at least one local gateway (GW) 16 for coupling the mobile units 10, via the header stations 12 and the LAN 14, to a global gateway 18. The global gateway 18 is also coupled to remote network users who may be dispersed over a wide geographic area. The local gateways 16 may each be an "intelligent" header station or may be a separate dedicated network entity as shown. The global gateway 18 is preferably a data processor having suitable network adapters and an archival facility for storing packets addressed to particular ones of the mobile units 10 during a time when the mobile units are not in contact with the wireless network. The data processor that comprises the global gateway 18 includes means for assigning, maintaining and associating "pseudo-IP" addresses with particular ones of the mobile units 10, in a manner to be described.

An IP address consists of four bytes, or 32 bits, that are partitioned into a LAN identification and a Host identification. By example, an IP address may have the form 123.45.67.12. The first two bytes encode a LAN address of 123 (byte 1) and 45 (byte 2). The remaining two bytes generally encode Host information. There is a different Host associated with each LAN. Thus, in the example provided Host (12) may have up to 256 IP addresses associated therewith, as encoded in the third byte.

In accordance with IP practice each user of the network is assigned a unique network address. A problem solved by the invention relates to the assignment of IP addresses to the mobile units 10 which, inherently, do not maintain a fixed connection relationship with the network. This problem is solved, as described below, by allocating a plurality of IP addresses to the global gateway 18. These allocated IP addresses are subsequently dynamically assigned by the global gateway 18 to requesting mobile units 10, either on a temporary basis (one network session) or on a permanent, extended, basis (several network sessions). At the termination of a session or sessions the IP address is returned to the global gateway 18 for subsequent reassignment to the same or another mobile unit 10. These assigned IP addresses are referred to herein as pseudo-IP addresses and represent a dynamic pseudo-network.

In accordance with the invention a network address, such as an Internet address that is associated with a particular mobile unit 10 encodes a network not physically embodied anywhere and which is referred to herein as the pseudo-network. In accordance with an aspect of the invention the global gateway **18** "owns" all of associated pseudo-IP addresses and allocates and deallocates the pseudo-IP addresses as the mobile units **10** enter and leave the LANs **2** and **3**. A mobile unit **10** typically maintains its assigned pseudo-IP address until it is turned off, or until the network session is actively terminated. Upon specific request by a particular one of the mobile units **10** a 'permanent' association is made between a mobile unit **10** and one of the pseudo-IP addresses. This permanent assignment is preferably not permanent in the sense that the mobile unit **10** would own the address for all time, in that the available pool of pseudo-IP addresses could quickly be consumed. Preferably, the permanent assignment is only sufficiently long so as to accomplish a specific task which may require a plurality of separate network sessions. The global gateway **18** is responsible for maintaining the permanent pseudo-IP association, even though a local gateway **16** may also maintain the relationship for so long as the mobile unit **10** stays in contact with the local gateway **16**. The global gateway **18** also buffers any packets destined for a particular mobile unit **10** during any time that the mobile unit **10** is out of touch with the network, such as the mobile unit **10'** which is not located within one of the communication cells **11**.

A function of the local gateway **16** is to deliver data packets, via the wireless downlink, to known mobile units **10** within its associated cell **11**. If a mobile unit **10** is out of touch with the wireless network no other local gateway **16** participates in the transmission of packets destined for that mobile unit **10**.

Being out of touch for a predetermined period of time causes the mobile unit's local gateway **16** to notify the global gateway **18**, via LAN **14**, that the mobile unit **10** is no longer a member of the group of mobile units associated with the local gateway **16**. In response to being notified of the disappearance of the mobile unit **10** the global gateway **18** terminates the forwarding of packets, through the local gateway **16**, that are directed to the inactive mobile unit.

The following communication operations are now described in detail: (a) initialization of a mobile unit **10** and the initialization of network routing for the mobile unit **10**; (b) resumption of service to a mobile unit **10**; (c) termination of service to a mobile unit **10**; (d) delivery of packets to a mobile unit **10**; and (e) transmission of packets from a mobile unit **10**.

Initialization (FIG. 3)

When a mobile unit **10** first enters a LAN cell **11** it performs the following operations. The newly arrived mobile unit **10** first directs a message, via a header station **12**, to the local gateway **16**. This message requests the local gateway **16**, through the global gateway **18**, to activate a pseudo-IP address for the mobile unit **10**. The mobile unit **10** identifies itself by transmitting a unique identifier, such as its serial number, that is permanently stored within a memory of the mobile unit **10**. The requested pseudo-IP address may be either a pseudo-IP address that is permanently assigned to that mobile unit **10**, or a dynamically allocated pseudo-IP address that the global gateway **18** selects from a pool of such addresses.

The local gateway **16** determines from the mobile unit's request that the mobile unit **10** does not expect to resume service from any previous sessions. Otherwise, the local gateway **16** instead begins to relay packets from those sessions, the packets being stored and forwarded by the global gateway **18**. Likewise, when the global gateway **18** receives the request, it compares the incoming mobile unit **10** identifier, or serial number, with a list of serial numbers to purge any stored packets that might have been saved for the mobile unit **10**.

If the global gateway **18** returns to the newly activated mobile unit **10** a permanently registered pseudo-IP address, the global gateway **18** may also begin forwarding messages and other stored data to that mobile unit **10**, through the local gateway **16**. This data is originally received from the network during a period that the mobile unit **10** associated with the permanently registered pseudo-IP address is inactive. This received data is buffered by the global gateway **18** during this period for subsequent delivery to the mobile unit **10** when the mobile unit **10** once more becomes active.

Resumption of Service (FIG. 4)

When a mobile unit **10** enters a cell **11** and indicates that it is to continue a previous network connection, it sends a message to the local gateway **16**, via a header station **12**. The message causes the local gateway **16** to notify the global gateway **18**, and possibly a previous local gateway **16**, that the mobile unit **10** has migrated to the new cell **11**. The local gateway **16** requests from the global gateway **18** all packets currently queued for the mobile unit **10** pseudo-IP address and delivers the packets over the downlink wireless channel. The global gateway **18** thereafter forwards to the local gateway **16** all future packets addressed to the pseudo-IP address associated, either temporarily or permanently, with the mobile unit **10**. Any remote users having knowledge of the pseudo-IP address may negotiate an optimal route to the local gateway **16**, employing known IP protocols. In this regard the local gateway **16** assumes responsibility for breaking the route if and when the mobile unit **10** migrates out of the local gateway's **16** cell area.

To avoid an unstable situation that may arise if the local gateway **16** purged internal data structures of all knowledge of a mobile unit **10** as soon as the mobile unit **10** was determined to be out of touch, such as might arise if a particular mobile unit **10** wandered along the periphery of a cell **11**; the local gateway **16** temporarily queues packets destined for the mobile units **10** within the local gateway's service area (or LAN). If the mobile unit **10** returns to the local gateway's service area before the queuing time limit expires the local gateway **16** delivers the queued packets to the mobile unit **10**. As such, so long as the mobile unit **10** returns to the service area within a predetermined time interval the local gateway is not required to notify the global gateway **18** that the local gateway **16** has relinquished responsibility for the mobile unit **10**.

Termination of Service (FIG. 5)

If a mobile unit **10** intends to terminate incoming network service in an orderly manner it notifies the local gateway **16** via a header station **12**. The local gateway **16** notifies the global gateway **18** that the mobile unit's pseudo-IP address may be deallocated. The global gateway **18** also purges all stored information relating to the mobile unit **10**. The global gateway **18** does not purge the association between the pseudo-IP address and the particular mobile unit **10** if the mobile unit **10** has previously requested and received a permanently associated pseudo-IP address.

Delivery of Packets to a Mobile Unit **10** (FIG. **6**)

All communication from a remote user to a mobile unit **10** employs the pseudo-IP address of the mobile unit **10**. Fully qualified mobile unit **10** names specify a domain for use with network nameservers. By example, a mobile unit **10** having an associated name of "C_E_Perkins" may be located within a domain designated "hawII.np.watson.ibm.com" and thus have the fully qualified name "C_E_Perkins.hawII.np.watson.ibm.com". When a remote user initiates a conversation with a mobile unit **10** the remote user typically consults a network nameserver configured to send requests for specified mobile unit **10** names to a specified mobile unit **10** global gateway **18**. A request for a mobile unit **10** name fails unless there exists an association registered between the mobile unit **10** name and a particular pseudo-IP address.

Nameserver operation is now described in greater detail. If the requested name is associated to a permanently assigned address, that address is returned by the nameserver even though the associated mobile unit **10** is turned off. If the requested name is temporarily registered to a pseudo-IP address, that address is returned. However, if the name is associated with a previously known pseudo-IP address, a predetermined special IP address is returned. The special pseudo-IP address is reserved only for this use and is not otherwise ever assigned to any mobile unit **10**. This reserved address is specially handled by the global gateway **18** if it is used by remote hosts for incoming mail requests Using the example given previously the returned IP address may correspond to 123.45.199.12, where **199** corresponds to the reserved address.

If a remote user obtains the pseudo-IP address of a registered mobile unit **10**, the remote user is enabled to send messages, such as mail, to the mobile unit **10**, even if the mobile unit **10** is inactive. In this case the message packets are stored, as previously described, by the global gateway **18** until such time as the mobile unit **10** is active and the packets can be delivered via an associated local gateway **16**. TCP session requests for the mobile unit **10** from the remote user are denied by the global gateway **18** unless the mobile unit **10** is active, although the session request may be accepted by the global gateway **18** when the mobile unit is active but merely temporarily "out of touch". However, only permanently situated mobile units **10** having a registered, permanent IP address may rely on conventional IP methods for point-to-point network communications.

A mobile unit **10** delivering a packet to a remote user employs conventional methods of network transmission and uses the IP address of the remote user. A remote user, running software having no provisions for mobile unit **10** communications, transmits a packet to a mobile unit **10** by routing the packet to the global gateway **18**, which then relays the packet to the local gateway **16** that is managing mobile unit **10** network traffic for an associated subset of mobile units **10**. This operation proceeds using a non-IP protocol; however, transmission of the packets associated with the nonstandard protocol, between the gateways **18** and **16**, is accomplished by conventional IP methods.

In this regard packets bearing the IP address are routed to the global gateway **18** which encapsulates them as data within new IP packets destined for the local gateway **16**. The local gateway **16**, which may be one of the header stations **12**, accomplishes further transmission of the data to the target mobile unit by using a non-Internet protocol. That is, by whatever protocol is established for the wireless network communication. Any packet transmitted to a pseudo-IP address using IP would be routed to the global gateway **18**, thus negating the use of the pseudo-IP address. Indeed, the problem solved by the use of the invention is that of encoding the logical network number inside the IP address when the logical network number is associated with a mobile data communication entity.

If instead a remote user is executing software to enable special handling of pseudo-IP addresses, the remote user is enabled to deliver the mobile unit **10** packets directly to the mobile unit's local gateway **16**, without requiring the intervention of the global gateway **18**. This mode of operation requires the local gateway **16** to inform the remote user before the local gateway **16** terminates service for the mobile unit **10**, as in the case when the mobile unit becomes inactive or migrates out of the cells **11** served by the local gateway **16**.

In either situation described above the remote user is required to send mobile unit **10** data packets to the global gateway **18** for storage while the mobile unit **10** is inactive.

Transmission from a Mobile Unit **10** to a Remote User

Transmission of packets from a mobile unit **10** to a remote user is accomplished using conventional IP addressing techniques. However, if the remote computer is known to be able to operate with multiplexed pseudo-IP address assignments, as described below, the mobile unit **10** encapsulates outgoing data within a header within the TCP packet to ensure that the remote user becomes aware of which specific mobile unit **10** is the source of the data.

Having described the five communication operations listed above other aspects of the invention are now described, specifically multiple interactive global gateways and multiplexed, or shared, pseudo-IP addresses.

Multiple Interactive Global Gateways

A single global gateway **18** may become a bottleneck if it is simultaneously managing many separate Internetwork mobile unit **10** sessions. This is unlikely, however, unless there are many remote users having no special knowledge of the special nature of the pseudo-IP address, but which nevertheless maintain active communications with the mobile units **10**. To eliminate this potential bottleneck several global gateways **18** are employed to partition the set of all mobile units **10** into disjoint subsets. This may be accomplished in either of two ways. A first method employs different "pseudo-network" numbers, one per global gateway **18**. Alternatively, each global gateway **18** maintains and shares with its peers a consistent set of tables describing the current routing information, or location, for each mobile unit **10**. If each global gateway **18** has separate pseudo-networks, then IP routing will automatically send IP packets to the correct global gateway **18** that is primarily responsible for a mobile unit. Even so, the global gateways **18** must cooperate with one another if free movement and access to the same set of remote hosts is to be accomplished.

Multiplexed pseudo-IP Addresses

As a community of mobile units **10** develops the required pseudo-IP addresses may be in short supply. If sessions with remote users having no special knowledge of the pseudo-IP addressing are frequently required a less than optimum solution is to continue to allocate more and more IP addresses. However, the remote users can be provided with facilities specifically directed to the needs of mobile unit **10** communications. Thus, software may be employed that uses a same pseudo-IP address to designate an arbitrarily large number of mobile units **10**. Differentiation between mobile units **10** sharing a common pseudo-IP address is accomplished by including their respective unique identifiers, such as their serial numbers, within each IP packet.

This additional functionality of the remote users preferably resides in a layer above the TCP protocol handling. One suitable level is in the operating system. This added functionality demultiplexes the session stream according to an additional header, containing the mobile unit's serial number, into ports opened by the processes run by the remote user. Packets sent from the remote user to a particular mobile unit **10** are directed to the local gateway **16** that is responsible, at that particular time, for the desired mobile unit **10**.

While the invention has been particularly shown and described with respect to a preferred embodiment thereof, it will be understood by those skilled in the art that changes in form and details may be made therein without departing from the scope and spirit of the invention.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is:

1. A method for transmitting information in a network that includes a wireless network and a wired network, the network having at least one mobile communication unit in wireless communication with the wired network over the wireless network, the network being characterized in that users of the network are each assigned a unique network address, comprising the steps of:

establishing, through the wireless network, communication between the wired network and a mobile communication unit;

requesting an assignment of a network address for the mobile communication unit, the request being made to a network gateway by the mobile communication unit through the wireless network, the network gateway being bidirectionally coupled to the wired network for providing communications to remote users of the network;

in response to the request, assigning, with the network gateway, a network address to the mobile communication unit, the assigned address being transmitted from the network gateway to the wired network;

receiving the assigned network address with the mobile communication unit, the assigned address being received through the wireless network; and

in response to the received network address, the mobile communication unit thereafter communicating with the network by employing the assigned network address.

2. A method as set forth in claim **1** wherein the steps of establishing, requesting, transmitting, and receiving each include a step of routing information between the wireless network and the wired network through a local gateway, the local gateway being coupled between the wireless network and, through the wired network, to the network gateway.

3. A method as set forth in claim **2**, wherein, in response to the mobile communication unit becoming uncoupled from the wireless network, the method further includes the steps of:

notifying the network gateway that the mobile communication unit is no longer active, the step of notifying including a step of sending a message from the local gateway over the wired network to the network gateway; and

in response to the notification by the local gateway, deassigning, at the network gateway, the assigned network address.

4. A method as set forth in claim **3** wherein the step of notifying includes an initial step of buffering within the local gateway, for a predetermined interval of time, any information received from the wired network that is addressed to the mobile communication unit that is no longer active, and wherein, if the mobile communication unit again becomes coupled to the wireless network before the expiration of the predetermined interval of time, the local gateway does not execute the step of notifying.

5. A method as set forth in claim **1** and further including a step of buffering, at the network gateway, packets of data addressed to the assigned network address during a time that the mobile communication unit is not actively coupled to the wireless network.

6. A method as set forth in claim **5** wherein in response to the mobile communication unit indicating that it is once more actively coupled to the wireless network, further including the steps of:

retrieving the buffered packets of data;

forwarding the retrieved packets to a local gateway that is bidirectionally coupled between the wired network and the wireless network; and

transmitting the retrieved packets from the local gateway to the mobile communication unit over the wireless network.

7. A method as set forth in claim **1** wherein the step of assigning includes a step of allocating the assigned network address from a pool of network addresses that is maintained by the network gateway.

8. A method as set forth in claim **7** wherein the wired network conforms to a Transmission Control Protocol/Internet Protocol standard and wherein the step of allocating includes an initial step of reserving a plurality of Internet Protocol addresses for use by the network gateway.

9. A method as set forth in claim **1** wherein the step of requesting includes a step of transmitting, from the mobile communication unit to the network gateway, an identifier that is unique to the mobile communication unit.

10. A method as set forth in claim **9** wherein the step of assigning assigns a single network address to a plurality of mobile communication units, the assigned network address including, for each of the plurality of mobile communication units, the respective one of the unique identifiers so as to differentiate the plurality of mobile communication units one from another.

11. A method as set forth in claim **1** and, in response to a message from the mobile communication unit that the mobile communication unit intends to terminate communication with the wired network, the method includes a further step of deassigning the assigned network address at the network gateway.

12. A method as set forth in claim 1 and, in response to a name inquiry to determine a network address that is associated with a name, further including the steps of:

if the name is associated with a permanently assigned network address, returning the permanently assigned network address in response to the inquiry;

if the name is associated with a temporarily assigned network address, returning the temporarily assigned network address in response to the inquiry; and

if the name is associated with a previously assigned network address, returning a predetermined network address that differs from the previously assigned network address.

13. In a data communications network comprised of a wired network and a wireless network, apparatus for managing the bidirectional transmission of information between the wired network and at least one mobile communication unit in wireless communications with the wired network over the wireless network, the data communications network being characterized in that users of the data communications network are each assigned a unique network address, comprising:

local gateway means, coupled between a wireless Local Area Network (LAN) and the wired network, for communicating with a mobile communication unit; and

global gateway means coupled to the local gateway means and to remote users of the data communications network, the global gateway means including means for maintaining a plurality of network addresses, means for receiving a request for an assignment of a network address from the mobile communication unit, means for assigning one of the plurality of network addresses to the requesting mobile communication unit; and means for routing data received from a remote user, the data having an address corresponding to the assigned network address, to the mobile communication unit having the assigned address.

14. Apparatus as set forth in claim 13 wherein the global gateway means further includes means for buffering data received from a remote user, the received data being addressed to a mobile communication unit having one of the assigned network addresses.

15. Apparatus as set forth in claim 13 wherein the data communications network includes a plurality of wireless LANs each of which has at least one local gateway means coupled thereto.

16. Apparatus as set forth in claim 15 and further comprising a plurality of global gateway means individual ones of which are coupled to different ones of the plurality of wireless LANs through at least one of said local gateway means, each of said plurality of global gateway means including means for assigning network addresses to mobile communication units in wireless communication with their respective wireless LANs.

17. Apparatus as set forth in claim 13 wherein the network addresses correspond to Internet Protocol address.

18. Apparatus as set forth in claim 13 wherein the local gateway means includes means for buffering data addressed to one or more mobile communication units that are coupled to the wireless LAN.

19. In a data communications network comprised of a wired network and a wireless network, a method for managing the bidirectional transmission of information between the wired network and at least one mobile communication unit in wireless communication with the wired network over the wireless network, the data communications network being characterized in that users of the data communications network are each assigned a unique network address, comprising the steps of:

maintaining a plurality of the unique network addresses with a global gateway means, the global gateway means being bidirectionally coupled to a local gateway means, through the wired network, and also to remote users of the data communications network, the local gateway means being coupled between the wireless and the wired network;

receiving, at the global gateway means, a request for an assignment of the network address from a mobile communication unit;

in response to the received request, assigning one of the plurality of network addresses to the requesting mobile communication unit; and

in response to a message received from a remote user, the message having an address that corresponds to the assigned network address, routing the message from the global gateway to the local gateway means, and from the local gateway means to the wireless network for reception by the mobile communications unit having the assigned network address.

20. A method as set forth in claim 19 wherein the wired network operates in accordance with a protocol known as a Transmission Control Protocol, wherein the step of maintaining maintains network addresses that correspond to a protocol known as an Internet Protocol, and wherein the wireless network operates in accordance with a protocol other than the Transmission Control Protocol.

* * * * *

United States Patent [19]

Angel

[11] **Patent Number: 4,800,973**

[45] **Date of Patent: Jan. 31, 1989**

[54] **PORTABLE ELECTRONIC SCALE OF MINIMAL THICKNESS AND WEIGHT**

[76] Inventor: **Shlomo Angel,** 175, Ranong 1 Road, Bangkok 10400, Thailand

[21] Appl. No.: **163,895**

[22] Filed: **Mar. 4, 1988**

[51] **Int. Cl.**[4] **G01G 3/14;** G01L 1/22

[52] **U.S. Cl.** .... **177/211;** 177/210 C; 73/862.65

[58] **Field of Search** .... 177/211, 210 DC; 73/862.65

[56] **References Cited**

U.S. PATENT DOCUMENTS

D. 274,991	8/1984	Wirtz .	
D. 281,236	11/1985	Muller et al. .	
D. 288,071	2/1987	Muller .	
2,910,287	12/1955	Hags .	
4,043,413	8/1987	Schaenen .	
4,174,760	11/1979	Curchod .	
4,355,692	10/1982	Ostrelich	177/211
4,363,368	12/1982	Paddon et al.	177/211 X
4,685,526	8/1987	Holm	177/211
4,739,848	4/1988	Tulloch	177/211

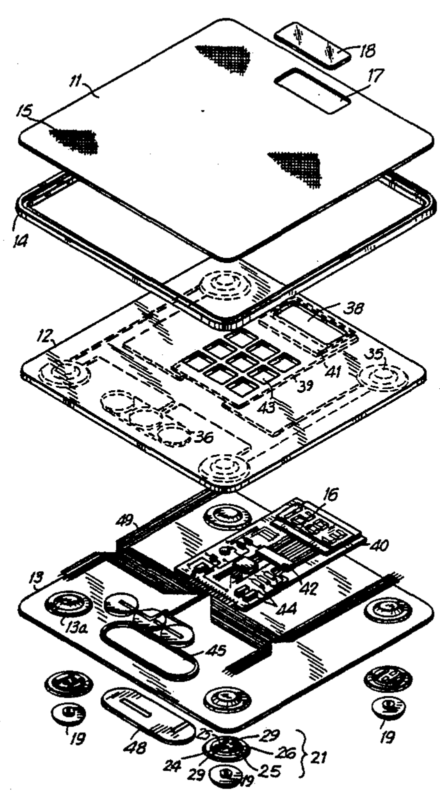
Primary Examiner—George H. Miller, Jr.

Attorney, Agent, or Firm—Bryan, Cave, McPheeters & McRoberts

[57] **ABSTRACT**

A portable electronic scale of minimal thickness and weight is provided which is suitable for measuring the weight of an individual or object and which can be easily carried in a bag, stored in a cabinet or hung on a wall. The scale comprises a single load-bearing composite plate of composite (sandwich) construction with its principle strength concentrated on its top and bottom surfaces, and including a center core plate which includes a number of small cavities for electronic components. A plurality of shallow supporting feet exert a force from below on a plurality of mechanically deformable elements embedded rigidly in the composite plate, which force is measured and translated by electronic transducers such as strain gauges into electrical signals. These signals are summed in a Wheatstone bridge configuration, amplified and converted electronically to a digital display of the weight. The electronic circuitry fits within the composite plate and consumes very small amounts of current when in use so that the need for a thick battery is eliminated. The scale (excluding the shallow feet) is less than ¼" in thickness and weighs less than one pound.

6 Claims, 5 Drawing Sheets



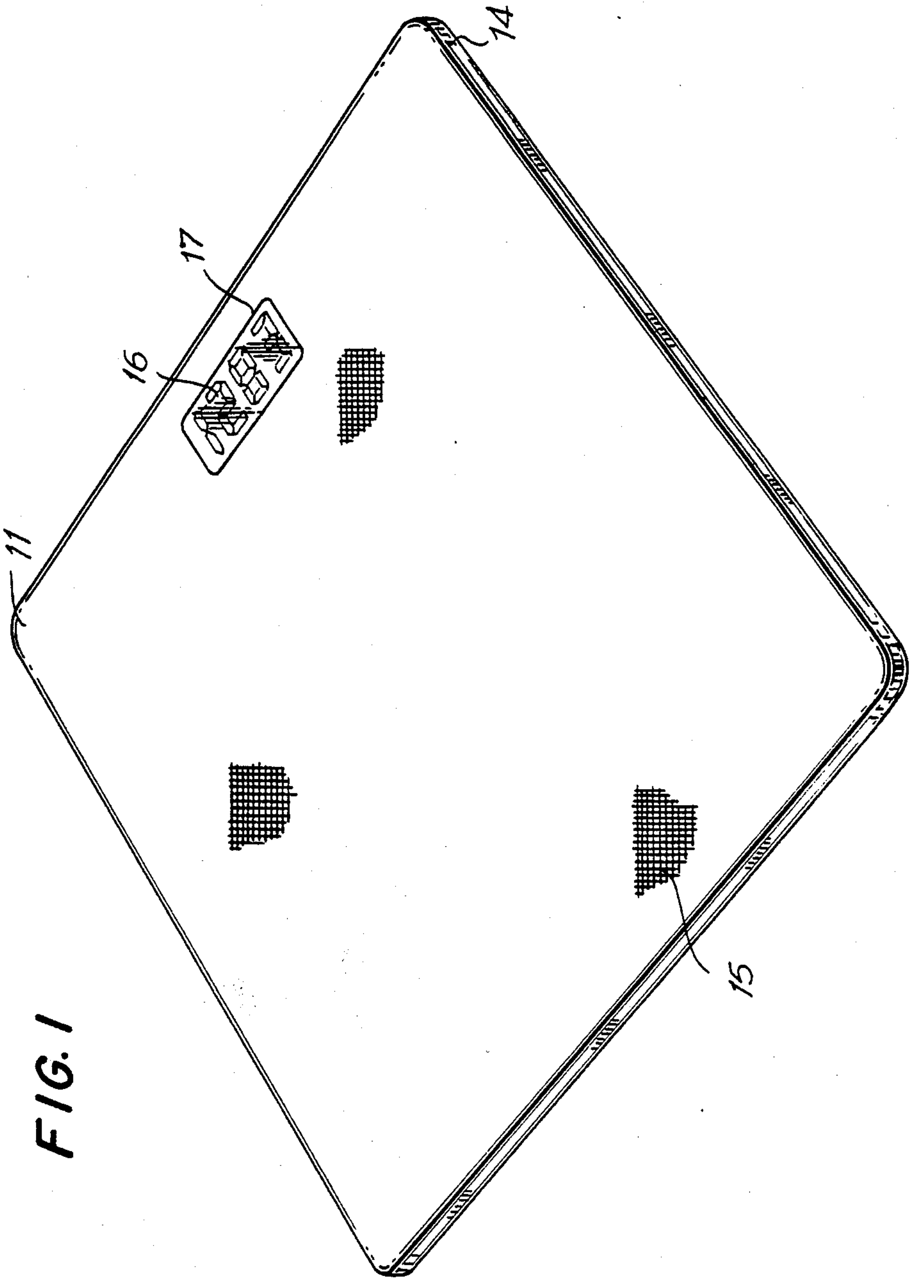


FIG. 1

FIG. 2A

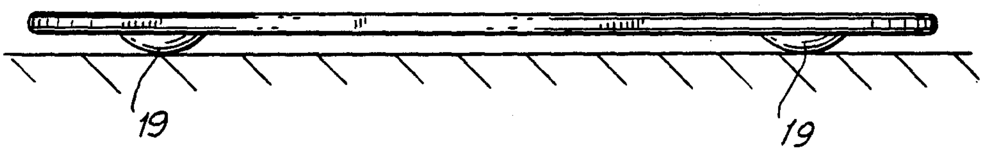


FIG. 2B

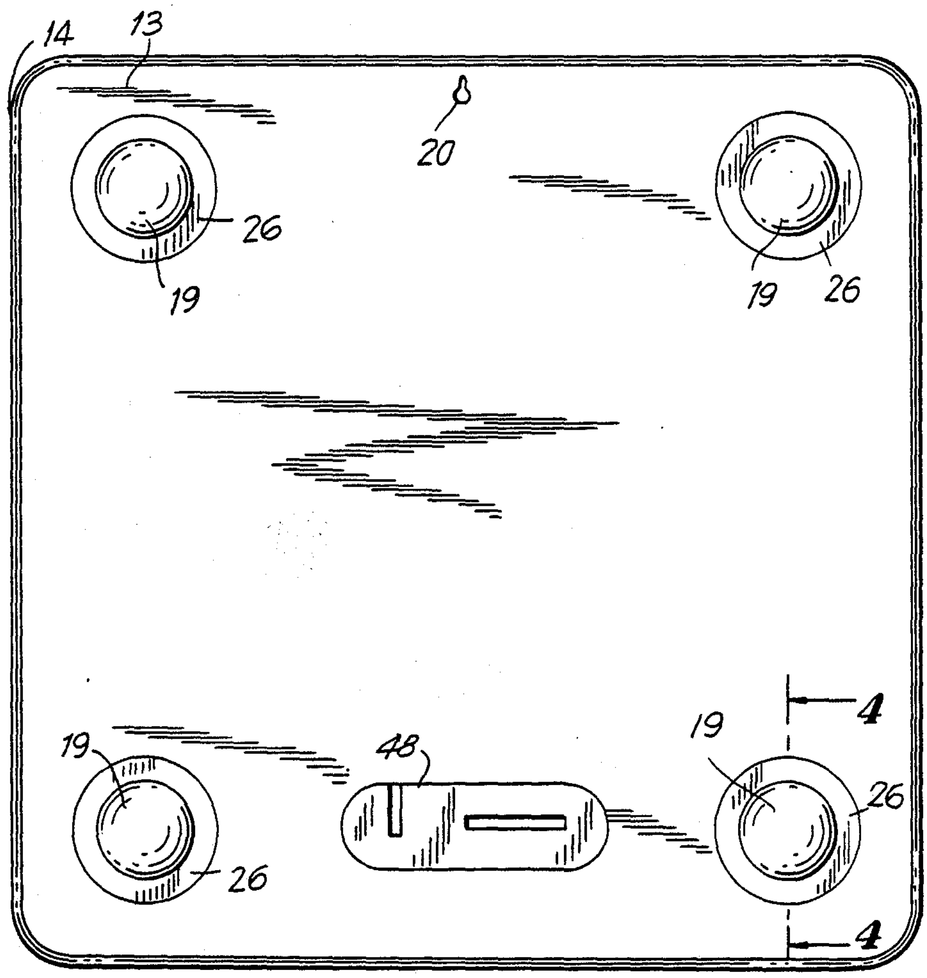


FIG. 3

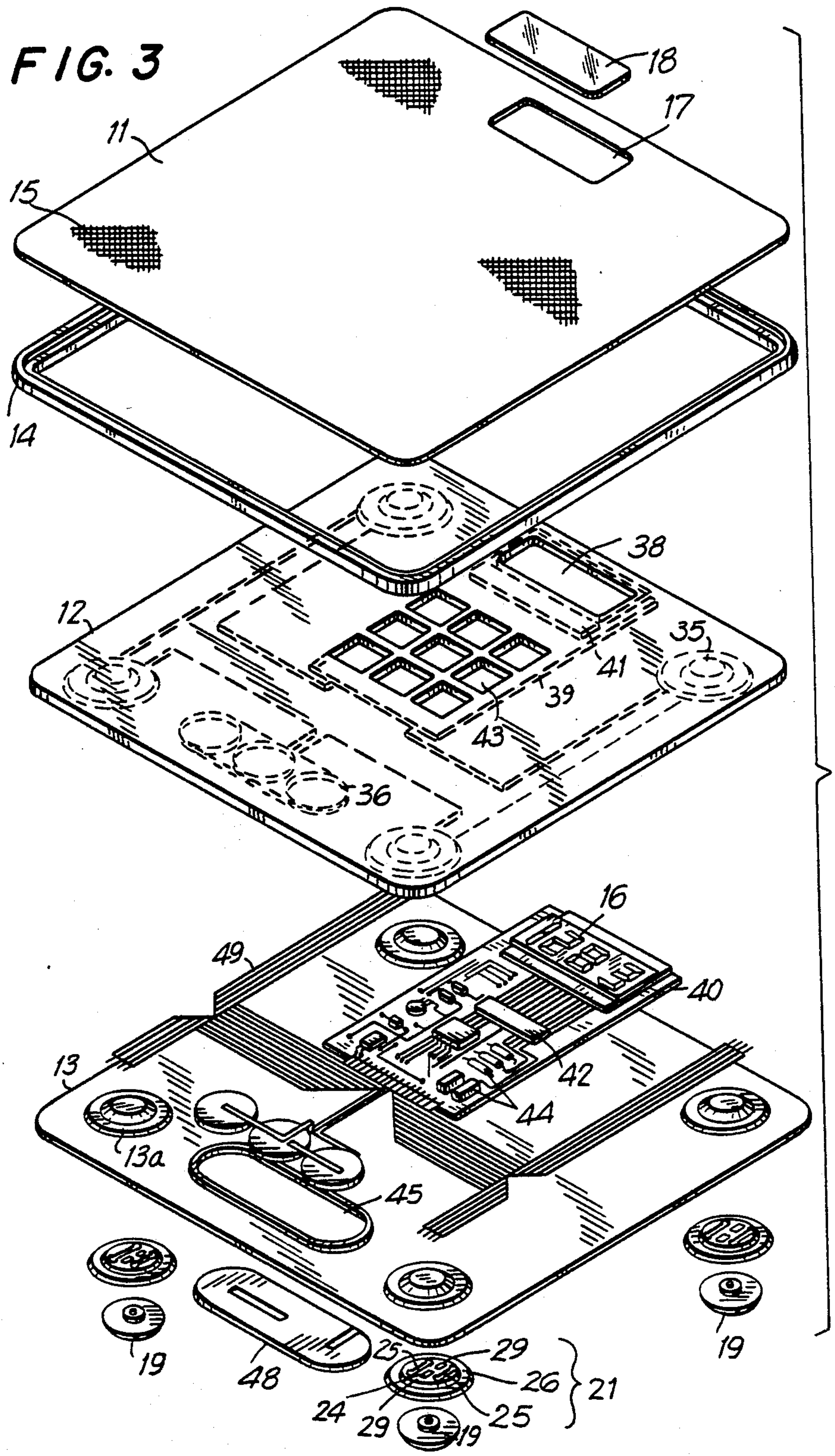

18
17
11
15
14
38
12
35
41
39
43
36
16
49
40
13
42
44
13a
45
19
48
25
29
26
21
24
29
25
19

FIG. 4A

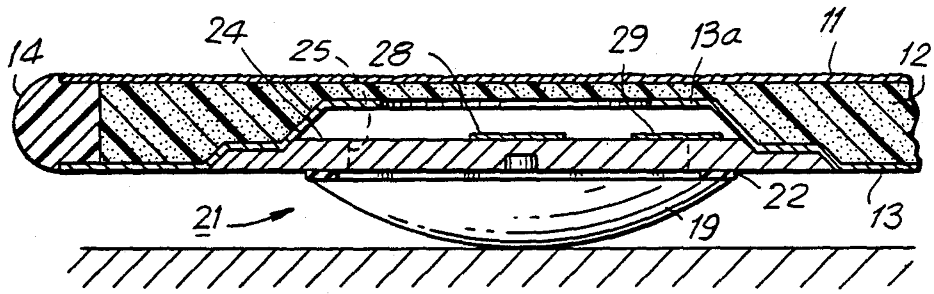
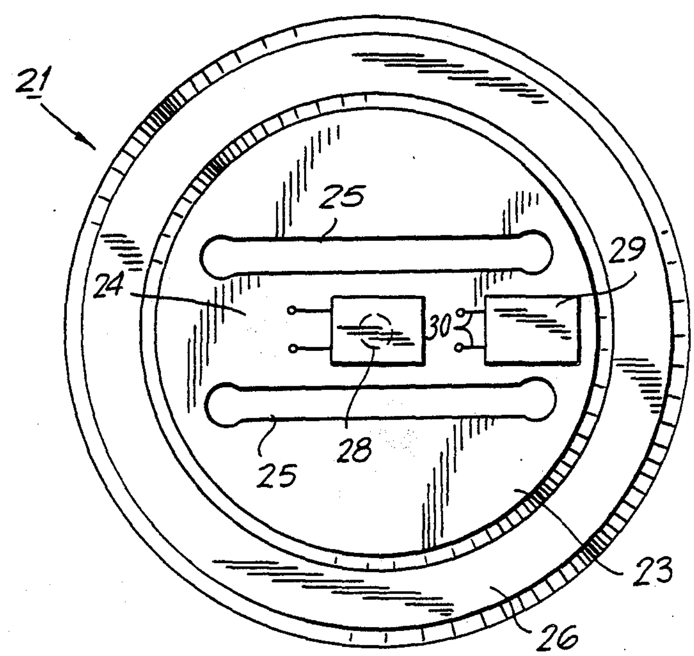


FIG. 4B



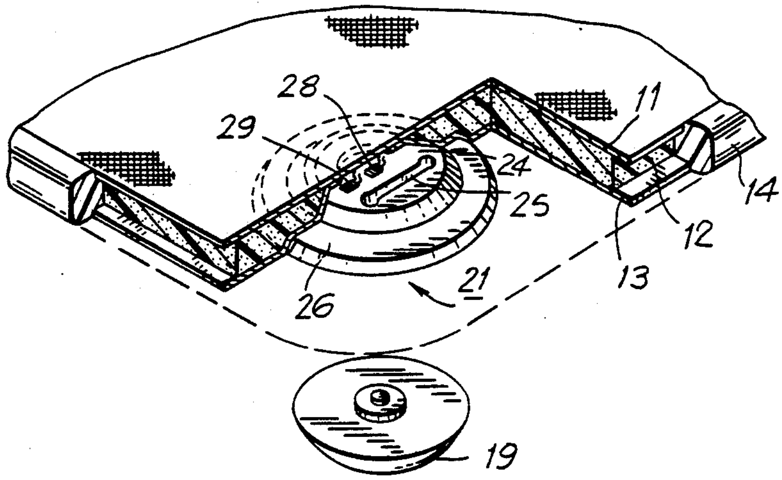


FIG. 4C

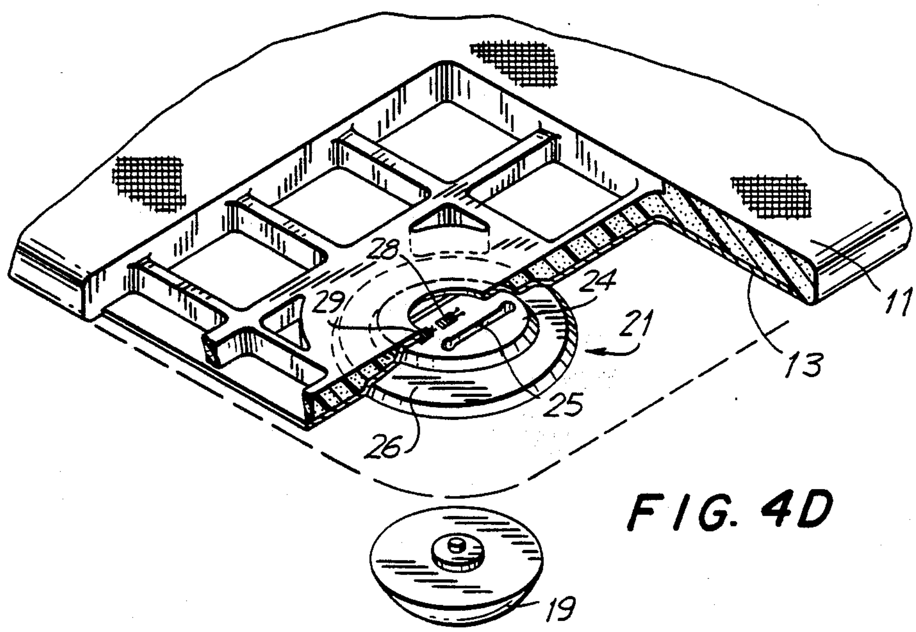


FIG. 4D

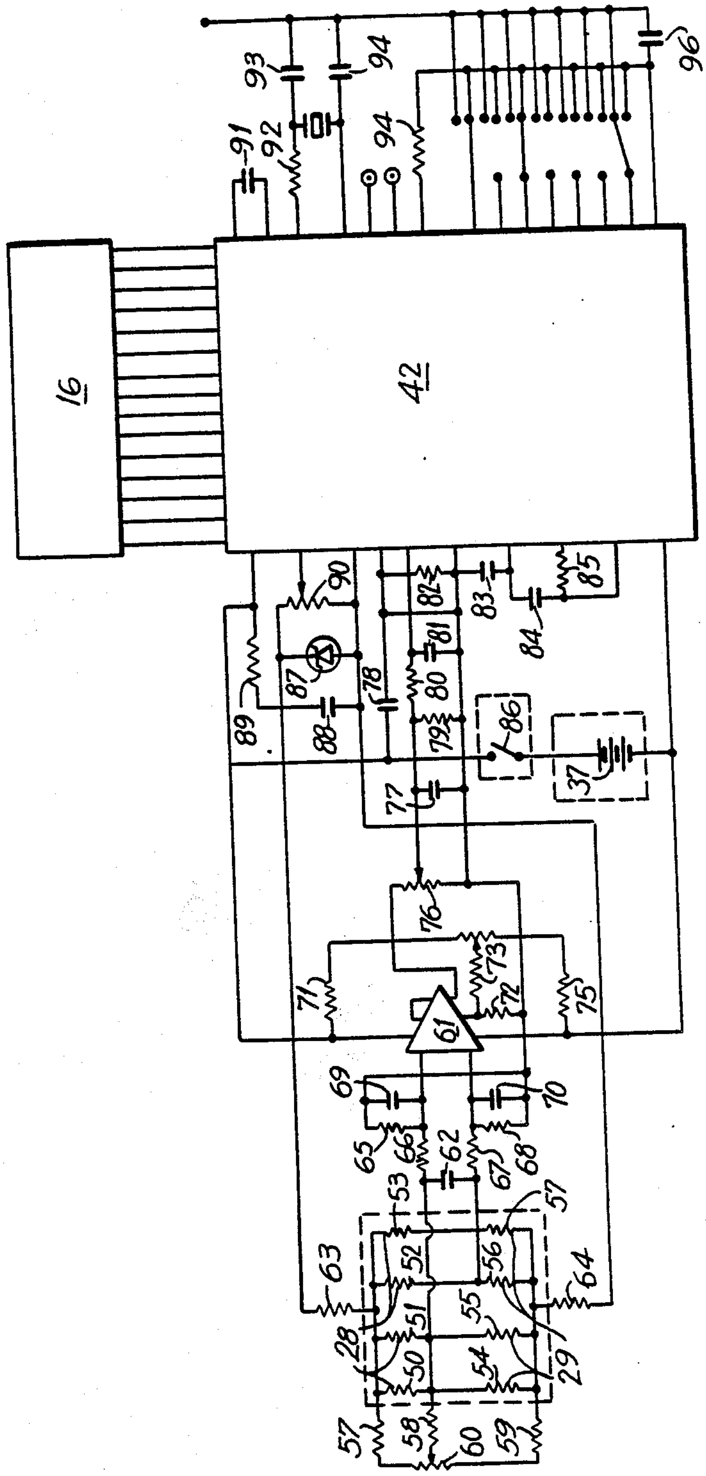

16
42
91
92
93
94
94
96
89
90
87
88
78
77
79
80
81
82
83
84
85
86
37
76
71
73
72
75
61
69
70
65
66
62
67
68
53
57
63
52
56
64
28
51
55
50
54
29
57
58
60
59

FIG. 5

PORTABLE ELECTRONIC SCALE OF MINIMAL THICKNESS AND WEIGHT

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a portable electronic scale of minimal thickness and weight which can be easily carried in a bag, stored in a cabinet or hung on a wall, for measuring the weight of persons or objects.

2. Description of the Prior Art

Most small scales, such as those used for personal weight measurement, require that the person stand or the object be placed on a flat and rigid load-bearing plate, which rests on a set of levers touching the plate from below at a number of discrete points. The levers rest on a second load-bearing plate which is, in turn, placed on a flat floor. The levers are connected in such manner that when a load is placed on the top plate, the levers exert a load at a single point which is equal to the total load on the top plate. This load is then measured, either by balancing it against a known load as in the scales commonly found in clinics, or by applying that load to a mechanically deformable element, such as a spring or a beam, and measuring the deformation. Common "portable" bathroom scales usually measure the movement of a spring by rotating a dial. Newer scales measure the deformation of a spring or an alternative mechanically-deformable element electronically, with strain gauges or capacitors, and display the measure digitally, usually with a light-emitting diode (LED).

The lever mechanisms, the two (or more) load-bearing plates and the power requirements for the LED's usually impose discrete weight and thickness requirements on most known scales, making them too heavy and too bulky to be easily transported from place to place. The smallest scales for personal weight measurement, for example, weigh several pounds and are about one to three inches in thickness. This makes it difficult for them to be carried so that an individual can watch his or her weight while away from home. It also makes it difficult to lift the scales and store them in a cabinet or hang them on a wall when floor space (such as in a bathroom) is limited.

A different principle for constructing a scale which does not require any lever mechanism for the mechanical transfer of loads for measurement at a single point has been in operation in some industrial scales for some time. It involves placing a rigid plate on a plurality of mechanically deformable elements, connecting force transducers such as strain gauges to these elements and summing up the electrical signals from these transducers in a Wheatstone bridge balancing circuit to obtain a measure proportional to the total load on the plate. Because the load on the plate is the sum of all the loads on the elements, this measure is the same regardless of the distribution of the load on the plate.

Ostrelich U.S. Pat. No. 4,355,692 cites several U.S. patents for industrial scales operating on this principle, namely U.S. Pat. Nos. 4,150,729; 3,949,822; 3,966,003; and 4,146,100. Ostrelich then describes an application of this principle to a small scale for weighing persons, proposing to reduce the cost of manufacturing by replacing the more-common strain gauge transducers with a thick film resistor. He describes a weighing scale in which a load impressed on a plurality of spaced individual transducers is electrically added to indicate a total weight of the load. While not claiming that application of this principle for small scales for weighing persons is new, he does state that the application of the thick film resistors makes it possible to produce a scale of a very limited vertical dimension. The embodiments described by Ostrelich, however, impose discrete thickness as well as weight requirements on the scale incorporating the same. While the film resistors themselves, like strain gauges, are less than 0.01" in thickness, there are a number of other mechanical and electrical components with discrete thickness and weight requirements that are required for the scale. In the embodiments described by Ostrelich, each transducer is mounted on a load-bearing base plate, and placed under pressure by means of a pair of pins separating the base plate from a loading plate and a spaced load-bearing cover plate, which bear the applied load and transmit it to the transducers. The three spaced load-bearing plates, and the intermediate force-transmitting pins, impose discrete thickness and weight requirements on the scale incorporating the same. The Ostrelich device additionally incorporates a fairly large battery cell for powering the electronic circuit and the LED, further increasing the thickness of the scale assembly.

Similar thickness and weight requirements are encountered with the small scales disclosed in Curchod U.S. Pat. No. 4,174,760; Schaenen U.S. Pat. No. 4,043,413; Hags U.S. Pat. No. 2,910,287; and Paddon et al. U.S. Pat. No. 4,363,368, for example.

These discrete thickness and weight requirements have been found in all known industrial, medical and personal scales produced to-date, thus making it difficult to transport them in bags while travelling, to lift them for a closer look, to store them in a cabinet or to hang them on the wall so as to keep them away from the floor. Even though many scales are advertised as being "portable", they are rarely small or light enough to be easily moved. For a scale to be truly portable, it should be considerably thinner and lighter than scales produced to date, e.g. $\frac{1}{4}$" or less in thickness and 1 lb. or less in weight.

SUMMARY OF THE INVENTION

The weight and thickness requirements for truly portable and at the same time accurate scale are achieved in the present invention, overcoming the disadvantages of the prior art.

The scale of the present invention is lightweight, portable and of a very low profile, comprising:

(a) a single rigid load-bearing composite plate having substantially flat upper and lower surfaces, the composite plate being of suitable size and strength to support the weight of a person standing or object placed thereon;

(b) a plurality of supporting feet upon which the load-bearing composite plate is mounted, the feet being spaced across the under-surface of the composite plate to support a load placed on the top surface thereof;

(c) a plurality of thin transducers containing mechanically deformable elements and means for translating the deformations into electrical signals, aligned with and mechanically linked to the respective supporting feet and free to deform when subject to a force exerted by the feet from below; and

(d) electronic means of low power consumption and low vertical profile for powering the transducers and for summing their signal outputs and providing a readout thereof, housed within the composite plate. The transducers and electronic means are contained within the composite plate so as not to reduce its rigidity or increase its thickness.

The scale of the present invention provides accurate weight measurements and is thin and light enough to be easily transported by an individual, even within a small briefcase or bag. The composite plate is made up of two or more layers rigidly bonded to one another in a sandwich construction, making it possible to concentrate the compressive and tensile strength of the plate on its top and bottom surfaces. In one embodiment described herein, an intermediate layer (center core plate) is provided between the top and bottom layers. This center core plate acts mainly in shear with minimal need for high tensile or compressive strength, and can then be made of a material or structure of very light weight. While the top and bottom layers require heavier material for strength, they may nevertheless be extremely thin and therefore light in weight as well. The sandwich construction of the composite plate allows the layers to act structurally as a single rigid plate of minimal weight and thickness. In addition, the rigidity of the assembly makes it possible to raise it above the floor with a plurality of shallow feet located near the periphery of the plate, without causing the plate to touch the floor due to deflection caused by loading. The feet thus add only a minimal thickness (e.g., 0.2") to the scale as a whole.

The load exerted downwards on the plate produces an equal and opposite force exerted upwards by the plurality of feet on the transducers. This permits the shallow feet themselves, which are needed to raise the plate above the floor in any case, to be used as an integral part of the load-measuring mechanism, and eliminates the need for separate force-transmitting pins or other load carrying members to act on independent transducer means, thus further reducing the required thickness of the scale. Measuring the upward loads exerted by the feet on the transducers embedded in the composite plate also eliminates the need for the multiple, separate plate structures proposed by Ostrelich, where a number of individual plates are needed—two to bear the load and one to house the transducers.

In accordance with a further feature of the invention, the electronic means for summing the signal outputs of the several transducers comprises:

(i) signal generating means for supplying a signal to each force transducer;

(ii) means suitable for connecting a power source to the signal generating means;

(iii) a Wheatstone bridge configuration of the transducers;

(iv) an analog amplifier connected to output of the Wheatstone bridge for amplifying the output thereof;

(v) an analog-to-digital converter connected to the output of the amplifier;

(vi) a display driver and display connected to the output of the analog-to-digital converter; and

(vii) switch means for enabling power to flow to the circuit;

the electronic means operating to provide a display of weight information which corresponds to the cumulative signal outputs of the transducers.

It is possible to employ a wide variety of thin force transducers or load cells in the present configuration. They may include a number of beam configurations with strain gauges bonded onto them; diaphragm-type transducers with strain gauge bonded onto them; capacitance-type transducers; piezo-electric crystals; diaphragms compressing a confined mass of carbon; or the thick film resistors proposed by Ostrelich.

The force transducers incorporated in a preferred embodiment of the present invention comprise:

(i) mechanically deformable beams which are free to deflect upwards in response to a force exerted by the feet from below when the composite plate is loaded from above, the beams being defined by slots cut into a thin disc or other member bonded onto the composite plate; and

(ii) strain gauge means comprising at least one strain gauge bonded to each beam and positioned so as to provide a signal output directly proportional to the deflection of the beam and to the load on the beam.

The circuitry which powers the transducers has a very batteries, such as lithium "coin"-type b tteries commonly found in electronic calculators and the like.

The scale of the present invention features, yet the entire composite plate is only one-quarter inch or less in thickness, the feet are less than 0.2" in height, and the entire embodiment weighs less than one pound.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a embodiment of the electronic personal scale of minimal thickness and weight of the present invention;

FIG. **2** is an end elevation view of the scale of FIG. **1**;

FIG. **2B** is a bottom plan view of the scale of FIG. **1**;

FIG. **3** is an exploded isometric of the scale of FIG. **1** showing a three-layer composite plate;

FIG. **4A** is an enlarged, partial vertical section through the scale of the present invention with a three-layer composite plate, taken along line **4**—**4** of FIG. **2B**;

FIG. **4B** is a top plan view of the transducer assembly of FIG. **4A**;

FIG. **4C** is a cut-away isometric view of the transducer assembly of FIG. **4A**;

FIG. **4D** is a cut-away isometric view of the transducer assembly of an alternative embodiment with a two-layer composite plate; and

FIG. **5** is a schematic diagram showing the electronic components of the scale of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIGS. **1**, **2A**, **2B** and **3**, there are shown overall views of a preferred embodiment of the low-profile electronic personal scale of minimal thickness and weight of the present invention. As best illustrated in FIG. **3**, the scale housing comprises a load-bearing composite plate of extremely thin layers or plates in a sandwich-type construction. The layers of this construction comprise a top plate **11**, a center core plate **12** and a bottom plate **13**. The layers are normally hidden from view by a marginal edge strip **14** placed around the periphery of the assembly. The marginal edge strip may be of plastic, rubber or other shock-absorbing material and is attached to the outside periphery of the plates **11**, **12**, **13** for protection and waterproofing. Alternatively, top plate **11** could be constructed so as to extend down over center core plate **12** and bottom plate **13**, to form a continuous smooth surface without the need for edge **14**, to protect the layers of the composite plate.

There are several variations possible in constructing the composite plate so as to keep it thin and light and yet sufficiently strong to carry a load, such as a heavy person, without deflecting appreciably. In addition to the three-layer sandwich plate discussed in detail and shown in FIG. 3, it is possible to construct the composite plate from two bonded plates in sandwich construction as shown in FIG. 4D, in particular, (i) an upper plate made of moulded light-weight material of high elastic modulus with a substantially flat top and a set of cavities below formed by an arrangement of shallow ribs; and (ii) a bottom plate similar to that shown in FIG. 3.

In FIG. 3, the plates are roughly rectangular in shape in the preferred embodiment, although oval, trapezoidal or any other configurations may alternatively be employed. These may have flat plates of a variety of sizes, depending on the size and shape of the objects to be measured. Among other forms of roughly rectangular shapes, it is possible to construct scales with the principles embodied here that are half the size of a plate needed to stand on with both legs. Such a half-size scale may be used for weighing a person standing on one leg. Furthermore, it is possible to construct scales which fold into two with different size plates (including the half-sized plate for standing on one leg) and with a different number and arrangement of feet to ensure stability and to prevent the scale from touching the floor near the hinge area. The feet in the folding versions can fit into cavities in the plate so as not to protrude from the scale when it is folded. Such folding scales may be more convenient for use in travelling.

Top plate **11**, which is preferably of steel, aluminum, or other rigid metal, plastic or like material of high elastic modulus and high tensile and compressive strength, defines a surface which is rigid enough and large enough to permit an adult to place both feet on the scale for weighing. Bottom plate **13** is preferably of a material of similar structural properties acting in tension when the composite plate is loaded from above. Bottom plate **13** also provides a housing for the transducers and protects the internal mechanical and electrical measuring components from below.

The center core plate **12** is preferably made from very light-weight, rigid material (e.g., polyurethane foam) or a grid or honeycomb arrangement of a heavier material, but overall light in weight, acting in shear when the composite plate is loaded from above, and defining various cavities for housing the transducers and the electronic components of the scale. The three layers of the composite plate preferably are bonded together with adhesive, although they may be riveted, screwed or otherwise attached to one another. The top and center plate may also be made of the same material and moulded into one single entity as shown in FIG. 4D. The several layers of the assembly thus act structurally as a single load-bearing plate.

Referring now to FIGS. **1** and **3**, top plate **11** may contain over a substantial portion of its surface a coating **15** of non-slippery material warm to the touch, such as rubber, roughened plastic or other non-metallic material to provide adhesion for safety and a non-metallic surface for warmth. A liquid crystal display (LCD) **16** provides a visible read-out of the weight on the scale. Display **16**, shown through opening **17**, is preferably covered with a transparent display cover **18** for protection and waterproofing.

As best shown in FIGS. 2A, 2B, 3, 4A, 4C, and 4D, a plurality of supporting feet **19** are provided, attached to the bottom plate **13**. The supporting feet are spaced across the under-surface of bottom plate **10**, preferably positioned near the corners thereof. The feet need not extend more than 0.2" from bottom plate **13**. Feet **19**, in addition to keeping the composite plate above the floor to prevent it from getting wet, also perform important load-transferring and weighing functions in the present invention. A silicone or other seal **22** (see FIG. 4A) provides waterproofing.

The feet **19** have a spherical bottom but many other shapes of feet which touch the floor at a point below the center of the transducer beams **24** (described below) are possible. It is also possible to use hard rubber or plastic on the bottom of the feet without adding to their overall height so as not to scratch the floor. It is further possible to add height to the feet with separate components which fit under them or replace the feet with higher feet when the scale is to be used on a thick carpet.

Directly above each supporting foot **19** is a transducer or load cell assembly **21**. The transducer assemblies **21**, which are best seen in FIGS. **3**, **4A**, **4B**, **4C**, and **4D**, perform the actual mechanical weight measurement functions of the present invention. In an improvement over the prior art, the transducer assemblies are mechanically linked directly to the respective supporting feet **19** aligned therewith.

In the preferred embodiment, each transducer assembly **21** comprises a transducer body **23** having a transducer beam **24**, defined therein by slots **25**. Transducer body **23** preferably is a shallow conical or cylindrical structure made of metal, composite material or other material of high elastic modulus (e.g. steel), and having substantially flat top and bottom surfaces and a horizontal lip **26**.

In the preferred embodiment, slots **25** are cut all the way through transducer body **23** and are substantially parallel to each other, although this is not required. There are many possible configurations of slots which may define a single beam, a pair of cross beams, or several beams in the shape of a star. It is also possible to construct a transducer body **23** without any slots at all acting as a thin diaphragm where the supporting foot **19** is bonded to the center of the diaphragm from below. As shown in FIG. 4B, slots **25** are also slightly enlarged at each end to establish areas of stress concentration at the ends of the beam. Further, the aligned supporting foot **19** is directly linked to transducer beam **24**, thus providing a simplified, extremely thin scale construction.

Each transducer assembly **21** fits within indentations **13***a* in bottom plate **13** (FIGS. **3** and **4A**). The lip **26** of each transducer body **23** extends slightly under bottom plate **13** to hold the assembly in position. Transducer assemblies **21** may be manufactured and calibrated separately and then soldered or otherwise bonded into place in final assembly. The arrangement provides a very compact assembly for the transfer of force to the transducers for measurement.

Directly above each transducer beam **24**, and attached thereto, are resistive strain gauges **28** and **29**. The center strain gauge **28** and the edge strain gauge **29** are each attached at points of maximum strain on the beam. The center strain gauge is at a point of maximum tensile strain, and the edge strain gauge, which straddles the "joint" between the bendable transducer beam **2** and the fixed portion of transducer body **23**, is at the point of maximum compressive strain. In this way, strain gauges **28**, **29** can measure the strain in transducer beam **24**, which is directly proportional to the load exerted by the foot on the beam. In the preferred embodiment illustrated, two strain gauges are provided for each transducer assembly. Each gauge has two electrical leads for attachment to electronic circuitry (described below) for measurement of the load on the beam.

As best seen in FIG. 3, immediately above the bottom plate containing the transducer assemblies is the center core plate 12. Center core plate 12 defines various varieties for housing various components of the invention. Shown, for example, are cavities 35 for indentations 13*a* formed in bottom plate 13 for the transducer assemblies 21; cavities 36 for batteries 37; cavity 38 for the LCD 16; a partial cavity 39 for a printed circuit board (PCB) 40; a cavity 41 for an integrated circuit 42; and other cavities 43 for other electronic components contained on PCB 40, which electronic components are shown generally as items 44.

The PCB 40 containing electronic components 42, 44 and LCD 16 fits within cavity 39. In the preferred embodiment, all the electronic components are soldered or otherwise electrically connected to a PCB with an extremely thin vertical dimension (e.g., less than 0.030"). It is possible, furthermore, to surface mount all the components onto the PCB so as to eliminate the solder beads below the PCB and to further reduce the overall vertical dimension of the electronic assembly. PCB 40 may be electrically connected to removable batteries 37 via wires 49, which wires may be copper bonded to plastic to form thin ribbons to permit thinness of construction of the scale. Batteries 37 may, for example, comprise lithium coin type batteries, which are extremely thin, yet provide sufficient power to power the components for a period of one to two years, depending on the frequency of use of the scale. Alternatively, it is possible to use card-shaped batteries with an even thinner vertical dimension. The ends of wires 49 are also connected to the leads (not shown) of the strain gauges PCB ~~40~~ with its accompanying wires may be bonded into thē cavities in center core plate 12 with adhesive or the like so as to form a relatively solid construction, to withstand shaking which may occur if the scale is transported and to increase the rigidity of the composite plate.

Covering the undersurface of PCB 40, wires 49 and batteries 37 is bottom plate 13 (see FIG. 3). The bottom plate contains an opening 45 for removal of the batteries 37. The battery compartment is covered from below with waterproof battery compartment cover 48 on the underside of the bottom plate. Cover 48 may be screw-in, snap-in or slidably mounted.

It is also possible to have an additional cavity and cover over all or part of the printed circuit board to make it possible to dismantle and repair it. Alternatively, it is possible to house the batteries and the printed circuit board, including the electronic components, in thin plastic compartments which may be slid into the composite plate from the top and bottom edges of the plate, rather than from below. As shown in FIG. 2B, small hanging hole 20 is provided at the top end of the bottom plate to make it possible to hang the scale on the wall.

The mechanical operation of weight measurement may now be described. Referring to FIGS. 4A, 4B, 4C, and 4D, as weight presses down on the top plate 11, the load is transmitted through the transducer assemblies 21 to the supporting feet 19. A force equal and opposite to the weight is the transmitted by feet 19 upwards to the transducer beams 24. This causes each transducer beam 24 to deflect upwards. When the weight is removed, transducer beam 24, which is of high modulus of elasticity, returns to its original flat position flush with the upper surface of transducer body 23.

The total force exerted upwards by the supporting feet, even if the weight is unevenly distributed on the top of the composite plate, must be equal to the weight pressing down from above. To know the value of this weight, one must know the value of the upward forces exerted on the four beams 24. These forces create strains at the center and at the edge of the beams which are proportional to the force exerted at its center vertically from below.

The upward deflection of the transducer beams 24 places the center strain gauges 28 in tension and the edge strain gauges 29 in compression, as the strain gauges are similarly deflected upward. This causes the electrical resistance of the strain gauges to vary, varying any voltage differential which may be applied to the gauges in direct proportion to the strain in the strain gauges and thus modulating any electrical current which may be flowing through the gauges. Since the strain gauges are of the same type, they produce similar voltage differentials but of opposite signs. These can be added to produce approximately double the voltage differential of one strain gauge, thus doubling the sensitivity of each transducer. Having two gauge emitting signals of opposite signs also cancels any temperature effects on the strain gauges, and thus provides a distinct advantage over prior art scales, such as that disclosed by Ostrelich, which require thermal insulation.

Turning now to the electronic circuitry of the present invention, FIG. 5 shows schematically the arrangement of components for converting signal outputs from the several strain gauges 28 29 into a digital read-out of the weight on the scale. In electrical operation, the strain gauges are arranged in a Wheatstone bridge configuration, so that the voltage differentials of all the strain gauges together may be summed up, the sum being proportional to the total weight on the top plate 11. This total voltage differential results in an analog signal that is fed into an integrated circuit (IC) 42, which converts it into a digital signal for driving LCD display 16. The total voltage differential may be scaled up or down as desired s that the digits of the display actually correspond to the weight expressed in pounds or kilograms, as required.

In FIG. 5, the center strain gauges 28 are shown schematically as resistors 50–53 and edge strain gauges 29 are shown schematically as resistors 54–57, connected in parallel in two bridges, which electrically act as a single bridge. Each strain gauge may, for example, have a resistance of 350 ohms. For a given load on the composite plate, the total resistance at the output of the Wheatstone bridge is constant regardless of changes in the resistance of the individual strain gauges, thus permitting constant and accurate read-out of the weight despite uneven placement of weight on the scale.

A high-resistance parallel circuit (resistors 57–60) is used for zero-balance in order to cancel bridge component mismatch at zero applied load. Opposite legs of the bridge are connected to the strain gauges 29 which are placed in compression (decreasing resistance), and to gauges 28, which are placed in tension (increasing resistance), respectively, in order to give the highest sensitivity when a load is applied.

The bridge is energized with a regulated 1.2 volt power supply (such as provided by batteries 37) in order to maintain a calibrated output throughout the life of the batteries. Batteries **37** may be of the 3 volt, 250 mah type.

The signal at the output of the Wheatstone bridge is amplified by amplifier **61**, filtered, and then converted to digital form by an analog-to-digital (A/D) converter contained within integrated circuit **42**. Integrated circuit **42** is connected to LCD display **16**, and also provides a driving function for the display. Conventional switch **86** is a momentary "on" switch for permitting power to flow to the circuitry when one is ready to use the scale. It may, for example, comprise a membrane switch to minimize the thickness of the construction.

The difference voltage signal at the output of the Wheatstone bridge is calibrated so a to display **10** microvolts/pound. Amplifier **61** may, for example, comprise an LM363D precision instrumentation amplifier, which is connected so as to have a fixed gain of 100, and an extremely low offset voltage drift. A filter network (elements **63–70**), is placed at the input of amplifier **61** in order to eliminate electrical noise. An offset voltage adjustment network (elements **71–75**) compensates for any output due to this effect. A gain control potentiometer **76** acts as a span calibration and can be used to calibrate the scale in pounds or kilograms.

The voltage is then fed, through another filter network (elements **77–85**) into IC **42**, which includes a 4½ digit, single-chip A/D converter (ICL7129), which converts the input voltage into a value for LCD **16** with better than 0.05% accuracy. Integrated circuit **42** also contains the driver circuitry necessary to operate display **16**.

The external voltage reference diode **87** (ICL8069) and associated elements **88–90** are used to energize the bridge and IC with regulated power from batteries **37**.

In the preferred embodiment, display **16** is of the LCD type which requires minimal operating current. It may be of triplex design which permits three elements to be energized per control line from IC **42**. Resistor **60** may be used for zero adjust. Resistor **76** be used for span adjust (i.e., may be adjusted to denote different units of weight measurement, such as pounds or kilograms). Components **91–96** complete the circuit. The entire circuit draws less than 5 milliamperes of current from the batteries during operation.

Nominal values for the electronic components in the preferred embodiment are as follows:

FIG. 5 Element No.	Nominal Value
37	DL2430, 3 V, 250 mah
42	ICL7129
50–57	350 ohm
57	10K ohm, ¼ W
58	10K ohm, ¼ W
59	10K ohm, ¼ W
60	10K ohm
61	LF363D or LM363D
62	10 uF
63	150 ohm, ¼ W
64	150 ohm, ¼ W
65	1 MEG, ¼ W
66	10K ohm, ¼ W
67	10K ohm, ¼ W
68	1 MEG, ¼ W
69	0.01 uF
70	0.01 uF
71	47K ohm, ¼ W
72	50 ohm, ¼ W
73	10K ohm, ¼ W
74	10K ohm
75	47K ohm, ¼ W

-continued

FIG. 5 Element No.	Nominal Value
76	10K ohm
77	0.01 uF
78	0.1 uF
79	1 MEG, ¼ W
80	1 MEG, ¼ W
81	0.1 uF
82	1.2K, ¼ W
83	560 pF
84	0.1 uF
85	150K, ¼ W
86	Momentary On Switch
87	ICL8069 or ICL8096
88	6.8 uF
89	1K, ¼ W
90	10K ohm
91	1.0 uF
92	270K, ¼ W
93	10 pF
94	5 pF
95	12K, ¼ W
96	6.8 uF

The electronic circuit thus described operates to sum the signal outputs of the strain gauges to yield a signal proportional to the total weight on the composite plate, which signal is then simplified and digitized to drive display device to give a numerical read-out of the weight.

The electronic circuitry described above is the preferred configuration for operating the scale of the present invention. There are a number of additional electronic features which may be incorporated into the scale without requiring a physical modification or a change in the scale's mode of operation. These include additional circuits for automatic zero-adjust; for locking the display on for a few seconds after a person steps down or the object is removed to enable the person to pick up the scale and look at the display at a closer distance; for switching the scale on automatically when a person touches it or steps on it; or for weighing something while a person is holding it (e.g. a suitcase) by zeroing out their individual weights first (e.g. weighing the items separately first, pushing a bottom and then weighing them again holding the object). Similarly, it is possible, for example, to light the display from below with an electro-luminescent film or other light-producing element which consumes a small amount of electrical current so that it may be read easily in a darker room. It is also possible to separate the display and the electronic controls from the composite plate in a separate compartment, connected to the plate by wire or by remote control.

It will be apparent that many other modifications and variations may be effected without departing from the scope of the novel concepts of this invention, as defined in the claims appended hereto:

What is claimed is:

1. A low-profile and light-weight portable electronic scale, comprising:

(a) a thin and rigid load-bearing composite plate comprising a plurality of layers rigidly bonded together to act as a single structural plate of minimal weight and thickness yet of sufficient size and strength to support the weight of a person standing or an object lying thereon, said plate comprising:

(i) a top layer of high elastic modulus having high compressive strength;

(ii) a bottom layer of high elastic modulus, which has a high tensile strength and which acts primarily in tension when the composite plate is loaded from above; and

(iii) an intermediate light weight, rigid layer which bonds the top and bottom layers to one another and which acts primarily in shear when the composite plate is loaded from above;

(b) at least three supporting feet upon which the composite plate is mounted, the feet being spaced across the bottom layer of the composite plate to support a load placed on the top layer thereof;

(c) at least three thin transducers secured in cavities in the composite plate above the supporting feet so that the entire load on the plate, including its own weight, is transferred to the feet through the transducers, each of the transducers incorporating:

(i) mechanically deformable means free to deform upwards when subjected to a force exerted by the supporting feet from below, and

(ii) means for measuring and transforming the deformations into electrical signals; and

(d) electronic means of low power consumption and low vertical profile for powering the transducers, for summing their signal outputs, for transforming the result into digital form, and for providing a read-out thereof, said electronic means being housed in cavities within the composite plate.

2. The scale of claim **1** in which the transducers comprise:

(a) mechanically deformable beams rigidly secured in the composite plate but free to deflect upwards in response to a force exerted by the feet from below when the composite plate is loaded from above; and

(b) strain gauge means comprising at least one strain gauge bonded to the beam and positioned so as to provide a signal output directly proportional to the load on the beam.

3. The scale of claim **11**, in which each transducer beam has attached thereto two strain gauges such that one is placed in compression and the other in tension as they deflect upward in response to a weight pressing down on the composite plate.

4. The scale of claim **1**, in which the electronic means comprises:

(i) signal generating means for supplying a signal to each strain gauge;

(ii) means suitable for connecting a power source to the signal generating means;

(iii) means connecting the strain gauges to define a Wheatstone bridge;

(iv) an analog amplifier connected to the output of the Wheatstone bridge for amplifying the output thereof;

(v) an analog-to-digital converter connected to the output of the amplifier;

(vi) a display driver and display coupled to the output of the analog-to-digital converter; and

(vii) switch means for enabling power to flow to the circuit;

the electronic circuit operating to provide a display of weight information which is directly proportional to the collective signal outputs of the strain gauges.

5. The scale of claim **1**, further comprising four supporting feet disposed near the corners of the composite plate, and including four transducers aligned with the feet.

6. A low-profile lightweight electronic floor scale comprising:

(a) a thin and rigid load-bearing composite plate, comprising a plurality of layers rigidly bonded together to act as a single structural plate of minimal weight and thickness yet of sufficient size and strength to support the weight of a person standing or an object lying thereon, said plate comprising:

(i) a top layer of high elastic modulus having high compressive strength;

(ii) a bottom layer of high elastic modulus, which has high tensile strength and which acts primarily in tension when the composite plate is loaded from above; and

(iii) an intermediate light weight, rigid layer which bonds the top and bottom layers to one another and which acts primarily in shear when the composite plate is loaded from above,

the several layers defining a plurality of cavities and indentations for receiving mechanical and electrical measuring means therein;

(b) at least three transducers received in and secured to indentations in the bottom surface of the bottom layer of the composite plate, spaced across the composite plate, each transducer having a mechanically deformable beam which is free to deflect upwards;

(c) at least three shallow load-supporting feet supporting the load-bearing composite plate and being aligned with the respective transducers, each foot pressing against the transducer beam from below and being so arranged that the total upward force exerted on the transducer beams by the supporting feet equals the total load on the composite plate;

(d) a plurality of resistive-type strain gauges, at least two for each transducer, boned to the respective transducer beams in selected locations, so that when exposed to an electric current, they each produce a voltage differential proportional to the upward force produced by reaction of the adjacent supporting foot to part of the load on the load-bearing composite plate;

(e) an electronic circuit of low-power consumption, housed in at least one of the cavities defined in the composite plate, and comprising:

(i) means for receiving direct current power;

(ii) means connecting the strain gauges in a Wheatstone bridge arrangement for measuring the total voltage differential produced by all the strain gauges (such differential being proportional to the applied load on the load-bearing composite plate);

(iii) an amplifier circuit for receiving and amplifying the signal produced by the Wheatstone bridge;

(iv) an integrate-circuit analog-to-digital converter for transforming the amplified analog signal into a digital signal and driving a display;

(v) a display coupled to the output of the analog-to-digital converter;

(vi) means for electrically adjusting the display to denote different units of weight measurement; and

(vii) switch means for enabling power to flow to the circuit.

* * * * *

United States Patent [19]

Hutchinson et al.

[11] **4,153,125**

[45] **May 8, 1979**

[54] **DIGITAL ELECTRONIC SCALE**

[75] Inventors: **William Y. Hutchinson**, Chicago; **Walter P. Kushmuk**, Niles, both of Ill.

[73] Assignee: **Continental Scale Corporation**, Bridgeview, Ill.

[21] Appl. No.: **794,058**

[22] Filed: **May 5, 1977**

[51] **Int. Cl.**^{2} **G01G 3/14**; G01G 21/02

[52] **U.S. Cl.** **177/211**; 177/241; 177/DIG. 9

[58] **Field of Search** .... 177/211, 126–128, 177/238–244, DIG. 3, DIG. 9

[56] **References Cited**

U.S. PATENT DOCUMENTS

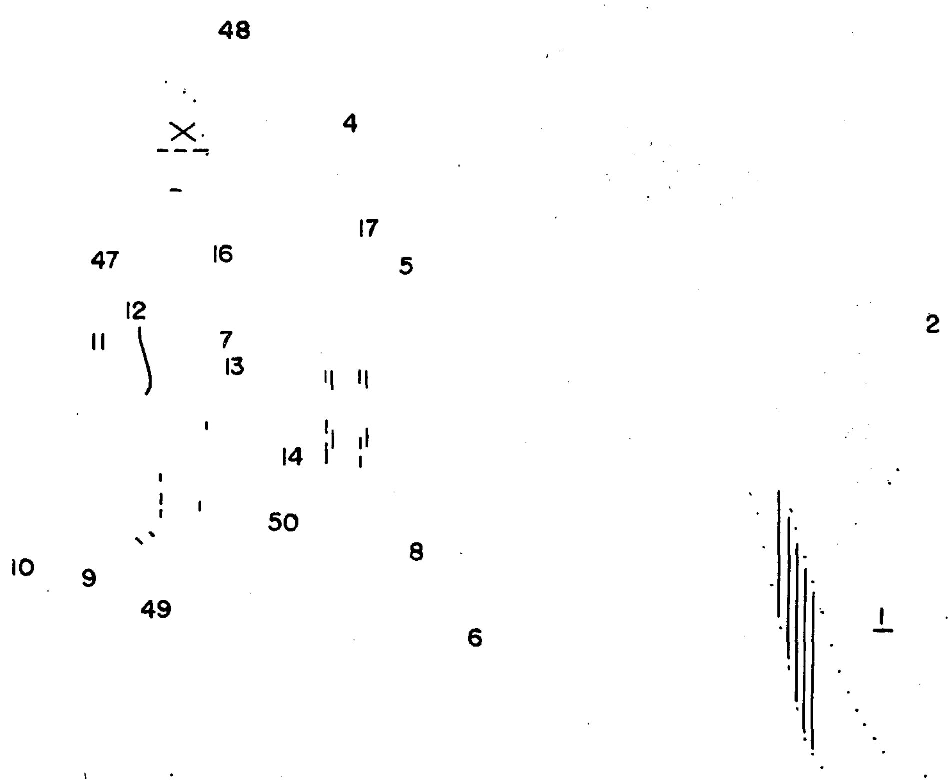
1,908,236	5/1933	Hallwood	177/241 X
2,598,812	6/1952	Marco	177/211 X
3,724,574	4/1973	Hutchinson	177/210
3,831,687	8/1974	Maffia	177/211
4,008,776	2/1977	Kushmuk	177/241 X

Primary Examiner—Joseph W. Hartary
Attorney, Agent, or Firm—Richard L. Johnston

[57] **ABSTRACT**

A platform type weighing scale is provided having a horizontally disposed base, a vertically disposed column mounted on an extension of said base with a hollow base portion in said column and a load beam mounted in said hollow base portion connected through a lever to a weighing mechanism beneath said platform, said load beam having one or more electrical strain gauges mounted thereon which are connected to a read-out meter mounted on said column to show measurements in units of weight. The housing for the read-out meter is preferably adapted to rotate horizontally or to tilt from the vertical or both and can also be removed so as to provide a number of options including a high level scale, a waist high personal scale, or a desk top or wall mounted remote unit.

8 Claims, 14 Drawing Figures



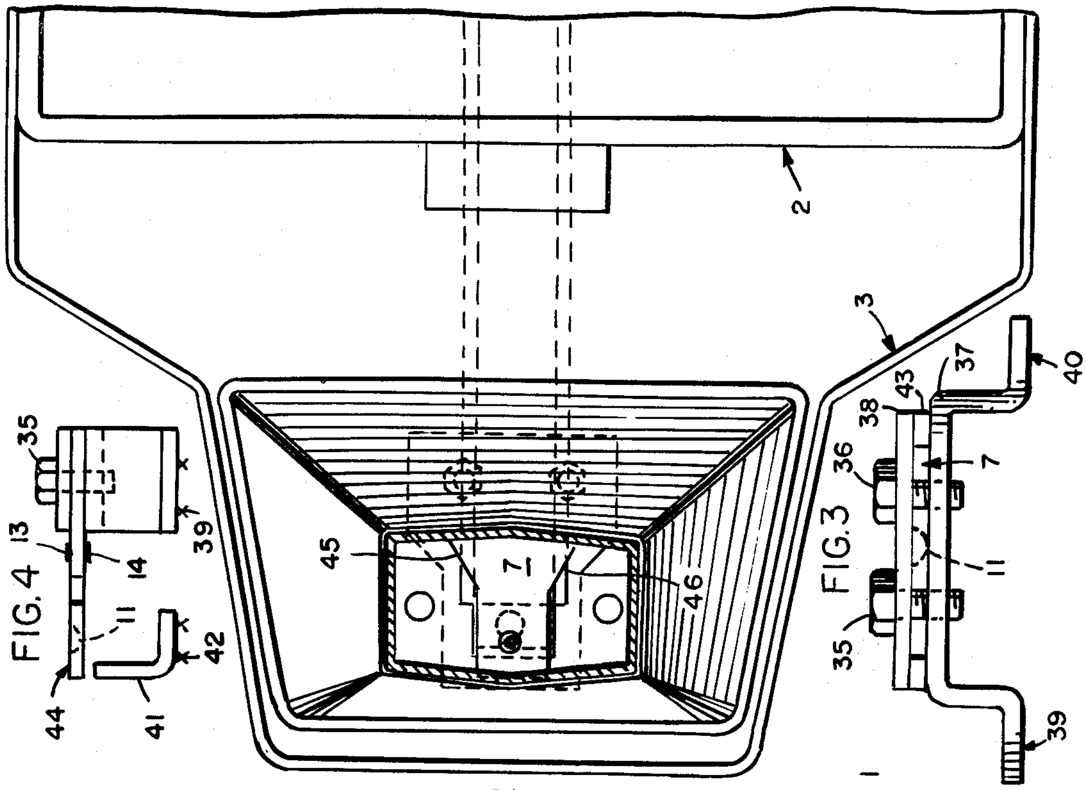


FIG. 2

FIG. 3

FIG. 4

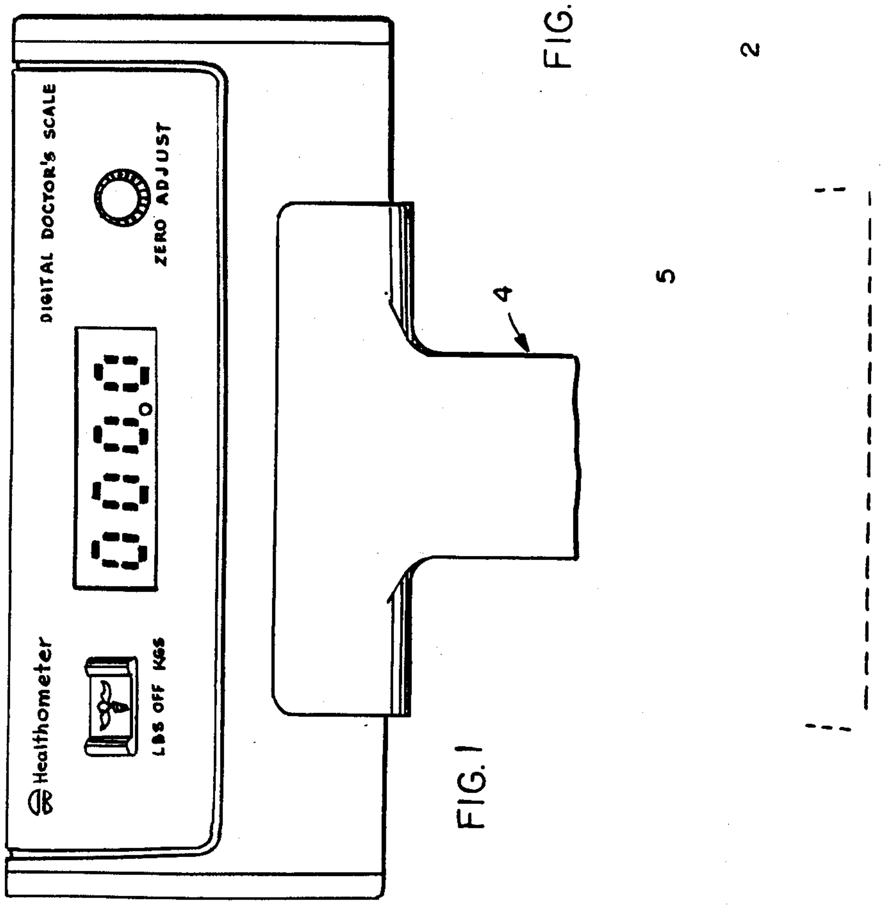


FIG. 1

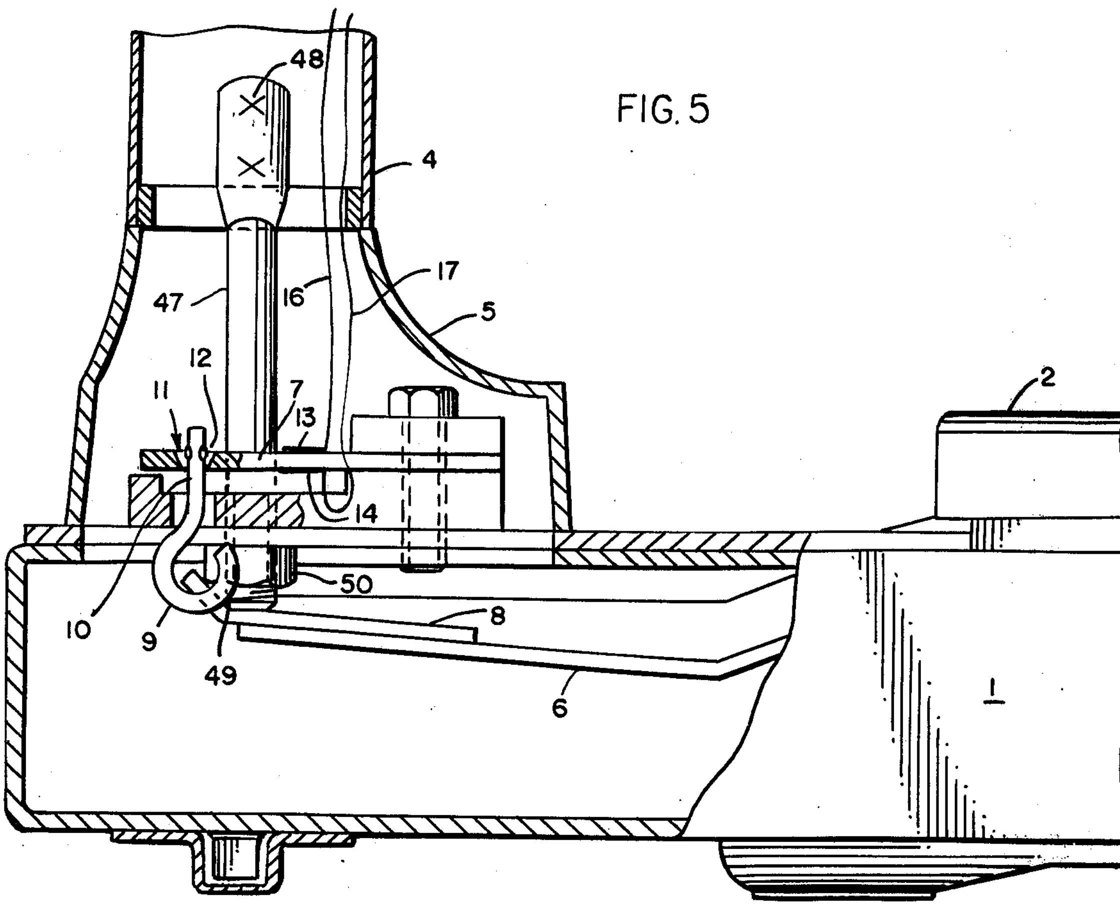


FIG. 5

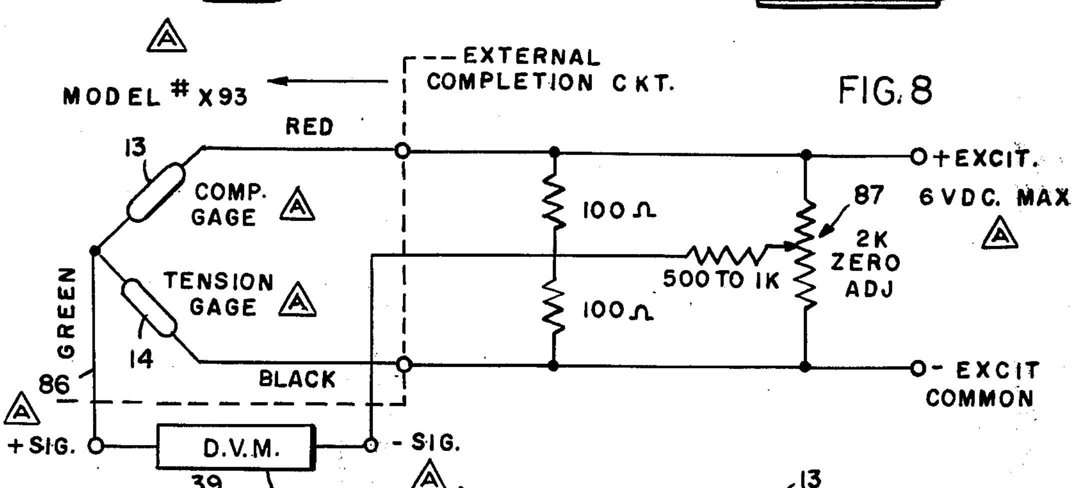


FIG. 8

FIG. 6

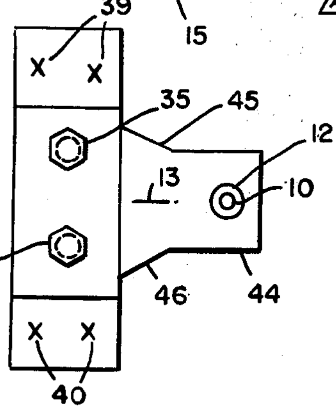


FIG. 7

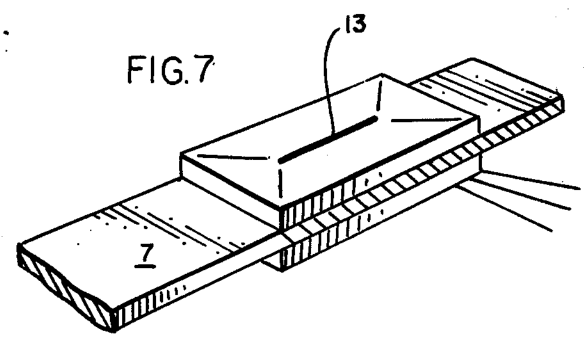


FIG. 9

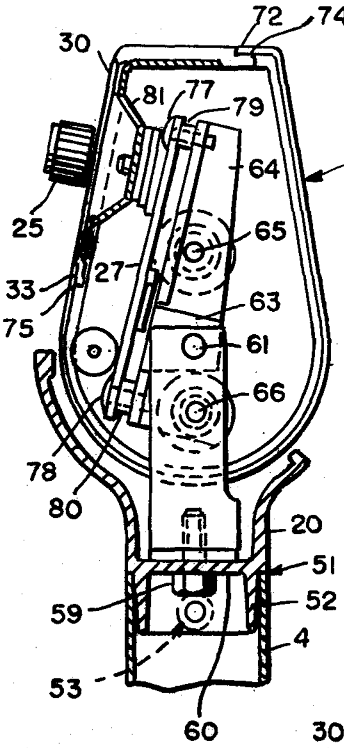
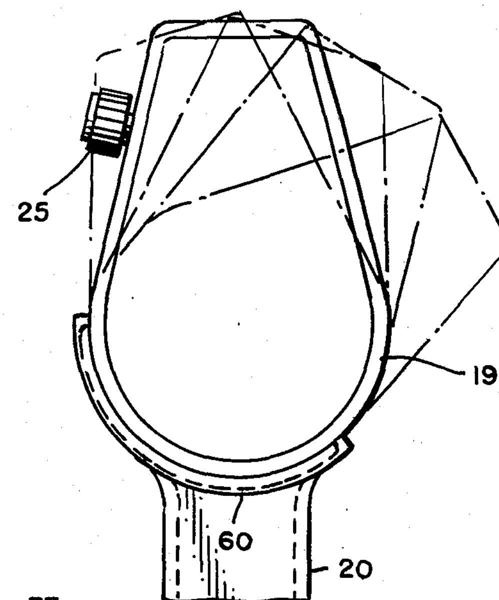


FIG. 10



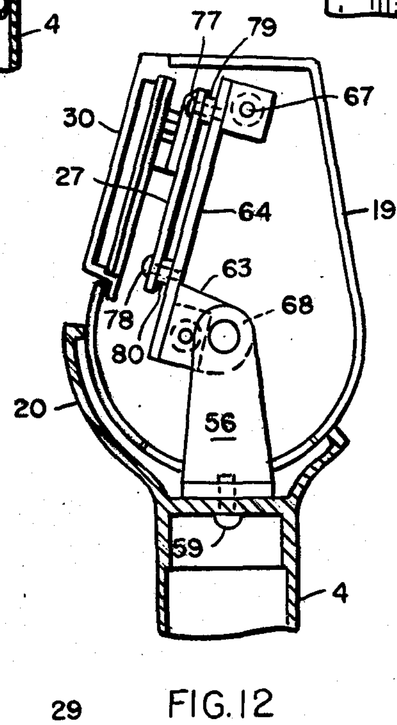


FIG. 11

FIG. 12

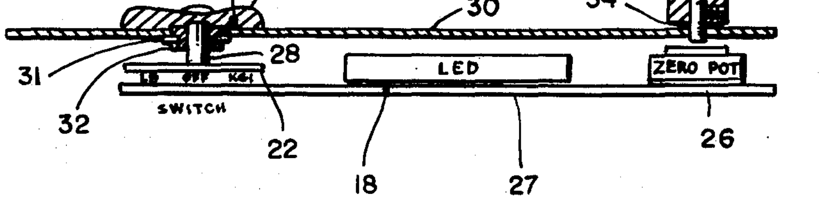


FIG. 13

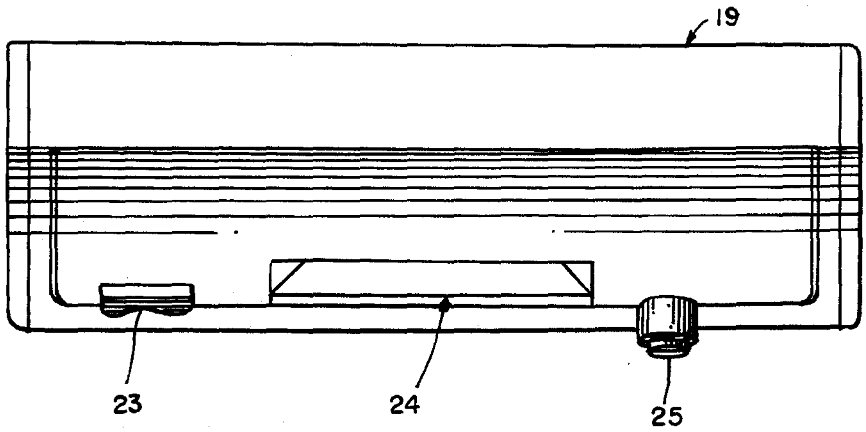
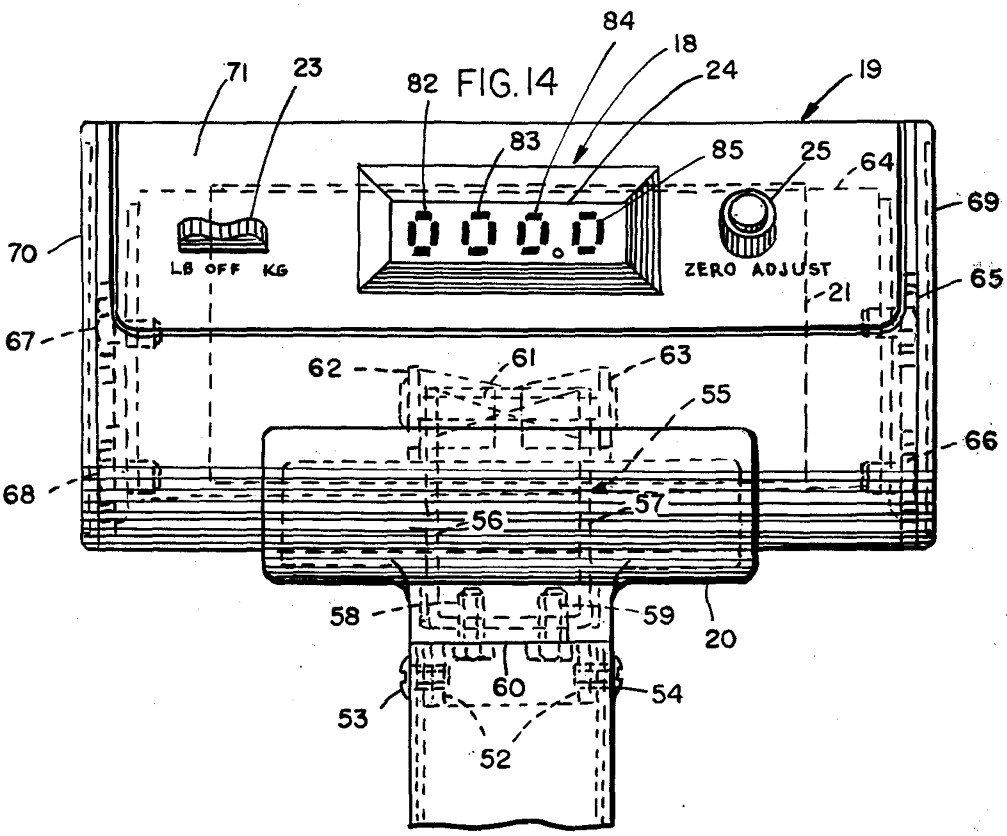

19
23
24
25

FIG. 14


84
18
71
23
82
24
19
83
85
25
64
69
70
0 0 0.0
LB OFF KG
ZERO ADJUST
65
21
67
62
61
63
55
66
68
57
56
58
59
20
60
53
54
52

DIGITAL ELECTRONIC SCALE

BACKGROUND

Many different types of electrically actuated weighing scales have been disclosed in prior art U.S. Patents such as, for example, Nos. 2,598,812, 2,899,191, 3,443,652, 3,469,645, 3,658,143, 3,666,032, 3,938,603 and 3,993,150.

These weighing scales involve the use of strain gauges in various ways and with various types of structures. Some of them are especially adapted for weighing packages, others for weighing vehicles and others are personal weighing scales.

OBJECTS

One of the objects of the present invention is to provide a new and improved digital electronic scale using a conventional doctor's scale base, lever and platform assembly with a cantilever beam fastened to the base and attached to the nose iron which deflects in proportion to the load applied.

Another object of the invention is to provide a personal weighing scale which can be manufactured at low cost and high volume as contrasted with scales presently available which have to be precision machined and are relatively costly.

A further object of the invention is to provide a scale of the type described in which an electronic read-out unit is mounted in a housing which is tiltable in a vertical plane and rotatable in a horizontal plane and, if necessary, can be removed for placement in a position on a desk or mounted on a wall.

Still a further object of the invention is to provide a digital electronic scale which can be used with a pediatric scale by simply changing the load deflection characteristics of a load beam containing one or more strain gauges.

Another object of the invention is to provide a digital electronic scale which can be used either with a conventional alternating current supply, rechargeable batteries or dry cells.

A further object of the invention is to provide a new and improved electronic weighing scale in which a modular electronic unit containing a circuit board is mounted in a housing supported by a column which in turn is supported by a base of the scale. Other objects and advantages of the invention will appear from the following description in conjunction with the accompanying drawings.

BRIEF SUMMARY OF THE INVENTION

A platform type weighing scale is provided having a horizontally disposed base, a vertically disposed column mounted on an extension of said base with a hollow base portion in said column and a load beam mounted in said hollow base portion connected through a lever to a weighing mechanism beneath said platform, said load beam having one or more electrical strain gauges mounted thereon which are connected to a read-out meter mounted on said column to show measurements in units of weight. The housing for the read-out meter is preferably adapted to rotate horizontally or to tilt from the vertical or both and can also be removed so as to provide a number of options including a high level scale, a waist high personal scale, or a desk top or wall mounted remote unit.

THE DRAWINGS

In the drawings:

FIG. **1** represents a front elevational view, with parts broken away, of a weighing scale illustrating a preferred embodiment of the invention;

FIG. **2** is a plan view of the embodiment shown in FIG. **1** with the upper portion removed;

FIG. **3** is a detailed view of one portion of the apparatus illustrated in FIGS. **1** and **2** showing the structure of the supporting means for the load beam;

FIG. **4** corresponds to the view shown in FIG. **3** rotated through an angle of 90°;

FIG. **5** is a side view, with parts broken away, of the embodiment shown in FIGS. **1** and **2**;

FIG. **6** is a top plan view of the load beam section illustrated in FIGS. **3** and **4**;

FIG. **7** is a detailed view, partially in section, enlarged to show the strain gauges carried on the upper and lower sides of the load beam illustrated in FIGS. **3**, **4** and **6**;

FIG. **8** is a wiring diagram illustrating the electrical circuitry connecting the read-out meter and the strain gauges to a source of electrical energy;

FIG. **9** is a side view, with parts removed, and partly in section, of the housing for the read-out unit;

FIG. **10** is a side view of the housing for the read-out unit showing different positions when the housing is tilted from the vertical;

FIG. **11** is another view of the housing for the read-out unit illustrating the manner in which it is mounted;

FIG. **12** is a plan cross sectional view taken transversely of a portion of the read-out unit;

FIG. **13** is a top plan view of the housing for the read-out unit shown in FIGS. **9**, **10** and **11**; and

FIG. **14** is an enlarged front view of the housing for the read-out unit shown in FIGS. **9** to **13**.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. **1** the platform-type weighing scale illustrated comprises:

(a) a horizontally disposed base **1** having a vertically movable weighing platform **2** mounted thereon, said base having an extension **3** as illustrated in FIG. **2** extending beyond said weighing platform;

(b) a vertically disposed column **4** mounted on said extension of said base **1**, said column having a hollow base portion **5**;

(c) weighing mechanism of a conventional type, not shown, mounted on said base operatively with said platform **2**, said weighing mechanism including a lever **6** which moves in response to actuation of said weighing mechanism by a load placed on said platform **2**, said lever **6** extending from said weighing mechanism to an area below said column as illustrated in FIG. **5**;

(d) a load beam **7** mounted in the hollow portion **5** of said column **4**;

(e) connecting means comprising a nose iron **8** connecting said lever **6** to a load hook **9**, the load hook **9** having a shaft portion **10** extending through a conical opening **11** adjacent the end of load beam **7** and having thereon a semi-spherical portion **12**, the sides of which engage the inner surfaces of the conical opening **11** so as to transmit a load from said lever **6** to cause said load beam to move a fraction of an inch in response to a load placed on platform **2**;

(f) an upper strain gauge **13** and a lower strain gauge **14** mounted on opposite sides of said load beam and preferably consisting of a wire of germanium or other semi-conducting material which are secured to the upper and lower surfaces, respectively, of load beam **7** by means of a resinous coating or in any other suitable manner;

(g) a digital voltmeter **15** as diagrammatically illustrated in FIG. **8**;

(h) wires **16** and **17** connecting the electrical output from strain gauges **13** and **14** from said digital voltmeter **15**, and

(i) a read-out meter **18** mounted in a housing **19** supported by a yoke **20** as illustrated in FIG. **14**, said read-out meter being operatively associated with said digital voltmeter **15** to show measurements in units of weight.

The digital voltmeter is disposed in a replaceable module **21** which contains a slide switch **22** operable from knob **23** and movable from an off-position to a lefthand position to close a circuit in order to show weight by a L.E.D. signal in pounds at the display area **24** and movable to a righthand position to close a circuit to show weight in kilograms in the display area **24**. An adjusting knob **25** is rotatable to adjust zero potential through a conventional zero potential adjuster **26**. The necessary circuitry is all mounted on a circuit board **27** as illustrated in FIG. **12**.

The slide switch **22** is connected through a shaft **28** to knob **23**, the shaft **28** being slidable in a slot **29** in lens **30** and being retained in said slot by a U-shaped washer **31** inserted in collar **32**.

The zero potential adjusting mechanism **26** is connected by a shaft **33** to knob **25**, the shaft **33** passing through a hole at **34** in lens **30**.

Referring to FIGS. **2–5**, it will be seen that the load beam **7** is clamped by means of bolts **35** and **36** between a load beam support **37** and a load beam clamp **38**. The load beam support **37** is welded to the base **1** at **39** and **40**. The stop member **41** is also welded to the base **1** at **42**. The load beam **7** as shown is flat with upper and lower sides and has a transverse portion **43** which is generally rectangular and is clamped between members **37** and **38**. The outer end **44** is free. The sides of load beam **7** are tapered at **45** and **46** in an intermediate area between the clamped end and the free end and the strain gauges **13** and **14** are disposed centrally in the tapered area whereby stress applied adjacent the free outer end from the lever **6** through the nose iron **8**, the nose hook **9**, shaft **10** and semi-spherical member **12** is substantially uniform throughout the load beam.

In the embodiment shown, the column **4** rests on the top of the hollow base portion **5** and is secured to the base **1** by means of a spade screw **47** which is welded to the side of column **4** at **48** and fastened to base **1** by means of the threaded end **49** and nut **50** (see FIG. **5**). The yoke **20** has an offset portion **51** which rests on top of column **4** as shown in FIG. **9** and also has a downwardly extending portion **52** which nests inside the top of column **4**. Column **4** in the embodiment shown is polygonal in cross section but can be circular. Yoke **20** is preferably fastened to column **4** by means of screws **53** and **54** (see FIG. **14**) which can be removed so as to permit the removal of yoke **20** and rotation through an angle of 180°. A U-shaped bracket **55** having upwardly extending legs **56** and **57** is attached by means of screws **58** and **59** to the base **60** of yoke **20**. At its upper end bracket **55** has opposing holes to receive a carriage bolt **61**. Arm members **62** and **63** which are a part of mounting plate **64** are mounted for rotation on bolt **61**. Mounted plate **64** extends transversely of the housing **19** and is secured by means of screws or bolts **65, 66, 67** and **68** to end plates **69** and **70**.

The upper part of housing **19** has an open area to receive a lens **30** which is made of a transparent polycarbonate material (Lexan) or any other suitable transparent material which is relatively rigid but sufficiently flexible to be snapped into place in said housing. The ends **72** and **73** of lens **30** are disposed between the inner surface **74** of housing **19** and the inner surface **75** of housing **19**. Printed circuit board **27** is fastened by bolts **77** and **78** through spacers **79** and **80** to mounting plate **64**. A bezel **81** provides an opening to the display area **24** wherein digits are displayed at **82, 83, 84** and **85** in L.E.D. form.

A pair of semi-conductor strain gauges **13** and **14** which are bonded to the surfaces of the load beam **7** one on top to sense the tensile strain (elongation) and one on the bottom to sense the compressive strain (compression) of the beam's outer surfaces as it bends under the load are employed in half bridge circuits as shown in FIG. **8** to electronically sense the change in resistance in the strain gauge caused by the change in length and cross sectional area as the load beam is bent. Semi-conductor strain gauges are preferably used because of their high sensitivity compared to conventional metallic gauges.

An electronic unit comprising the circuit board **27** supplies the excitation current for the strain gauges and contains the necessary circuitry to convert the proportional analogue signal to digital values and display the digital values on a digital read-out. It also provides means of converting readings to kilograms or pounds, means for calibrating a scale electronically and adjusting for zero or tare electronically by means of potentiometers. The electronic unit is mounted in the housing **19** as previously explained which is vertically tiltable around the carriage bolt **61** through a range of 30°, 60°, and 90° to enable the user to adjust it according to his height for substantially eye level readability. The yoke **20** supporting the tiltable housing can also be removed from the pillar **4** and indexed 180° if it is desirable to read the unit from the opposite side of the scale as in the case of mass weighing where it is more convenient for the observer.

The load beam **7** is preferably made of stainless steel and the total deflection for weighing up to 400 pounds on the platform **2** is preferably a maximum of 0.01" (10 mils). As previously indicated, the taper in the load beam assists in providing load beam stress throughout. The germanium strain gauges are preferably 5 mils thick by 30 mils long and have resistance values of 120 ohms or 350 ohms. Gold leads are spot welded to the strain gauges and the strain gauges are bonded by suitable resins to the load beam.

The lever reduction from the weighing mechanism in the base **1** is 10:1 for a 400 pound maximum weight and the unit operates on 6 volts direct current. Thus, for counts or gradients of 0.1 pound the current variation is 20 microvolts per count and the load beam moves 1/10 of a millionth of an inch per count.

The wiring diagram in FIG. **8** is believed to be self-explanatory. Current from a source of electricity such as a 6 volt D.C. battery or a rectifier connected to an alternating current 120 volt outlet passes through two half wheatstone bridge circuits to strain gauges **13** and **14** and thence through output line **86** to digital voltmeter **15** in the digital read-out unit where a signal is recorded and displayed. The zero potential is adjusted at **87** by means of knob **25** in a conventional manner through the circuitry in the read-out unit. The units of weight can be displayed either in pounds or kilograms by moving the slide switch knob **23** to the left or right.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit or scope of the invention, or sacrificing any of its attendant advantages, the forms herein disclosed being preferred embodiments for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. A platform type weighing scale comprising:

(a) a horizontally disposed base having a vertically movable weighing platform mounted thereon, said base having an extension beyond said weighing platform,

(b) a vertically disposed column mounted on said extension of said base of (a), said column having a hollow base portion,

(c) weighing mechanism mounted on said base operatively associated with said platform of (a), said weighing mechanism including a lever which moves in response to actuation of said weighing mechanism by a load placed on said platform of (a), said lever extending from said weighing mechanism to an area below said column,

(d) a load beam mounted on said extension of said base of (a) in said hollow base portion of said column of (b),

(e) connecting means connecting said lever of (c) with said load beam of (d) so as to transmit a load from said lever of (c) to said load beam of (d) to produce a movement of said load beam of a fraction of an inch,

(f) one or more electrical strain gauges mounted on said load beam,

(g) a digital voltmeter,

(h) means connecting the electrical output from said strain gauge of (f) to said digital voltmeter of (g), and

(i) a read-out meter operatively associated with said digital voltmeter of (g) to show measurements in units of weight(.), said connecting means of (e) extending upwardly through a hole in said load beam of (d), said hole having conical sides and said connecting means of (e) containing a semi-spherical member to seat in said conical sides of said hole and engaging the sides of said hole whereby said load beam of (d) is pulled downwardly when a load is applied to said platform of (a) causing downward movement of said lever of (c).

2. A weighing scale as claimed in claim **1** wherein said lever of (c) is connected to said load beam of (d) through a nose iron and a load hook.

3. A weighing scale as claimed in claim **1** wherein said load beam of (d) is elongated and mounted at one end of said extension of said base by clamping it between a load beam support and a load beam clamp all secured to said extension of said base, the opposite end of said load beam being free and being connected to said means of (e).

4. A weighing scale as claimed in claim **1** wherein said load beam of (d) is flat with upper and lower sides and has a transverse portion at one end which is mounted on said extension of said base of (a) and an elongate portion extending from said transverse portion to a free outer end, said transverse portion and said elongate portion being connected by outwardly tapered portions whereby stress applied adjacent said free outer end is substantially uniform throughout the load beam, said connecting means of (e) being operatively associated with said load beam adjacent its free end, a first strain gauge of (f) mounted on the upper side of said load beam centrally of said load beam between said tapered portions, a second strain gauge of (f) mounted on the lower side of said load beam beneath said first strain gauge, and means of (h) connecting the combined output of said strain gauges to said digital voltmeter of (g).

5. A weighing scale as claimed in claim **4** wherein said load beam of (d) has a total deflection which is a maximum of 0.01 inch.

6. A weighing scale as claimed in claim **1** wherein said strain gauges of (f) are semi-conductors.

7. A weighing scale as claimed in claim **1** wherein said read-out meter of (i) is mounted in a housing attached to the top of said column of (b).

8. A weighing scale as claimed in claim **1** wherein said load beam of (d) has a total deflection which is a maximum of 0.01 inch.

* * * * *

United States Patent [19]

Meckstroth et al.

[11] **4,091,449**

[45] **May 23, 1978**

[54] **COMPUTING SCALE SYSTEM**

[75] Inventors: **Robert C. Meckstroth**, Dayton; **Edwin E. Boshinski**, Englewood, both of Ohio

[73] Assignee: **Hobart Corporation**, Troy, Ohio

[21] Appl. No.: **652,851**

[22] Filed: **Jan. 27, 1976**

[51] **Int. Cl.**² **G06F 15/20**; G01G 19/40

[52] **U.S. Cl.** **364/466**; 177/25; 177/DIG. 3; 364/567; 364/738

[58] **Field of Search** .... 235/151.33; 177/3, 16, 177/25, DIG. 3, 6, 1; 340/146.1 AG

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,193,032	7/1965	Martin	177/DIG. 6
3,262,639	7/1966	Karp	177/3
3,474,230	10/1969	McMillen	340/146.1 AG
3,556,235	1/1971	Allen et al.	177/177
3,725,656	4/1973	Fukuma	235/151.33
3,741,324	6/1973	Boshinski et al.	177/3
3,825,085	7/1974	Martin	177/DIG. 6
3,825,894	7/1974	Johnson, Jr.	340/146.1 AG
3,826,319	7/1974	Loshbough	177/DIG. 1
3,860,802	1/1975	Knothe et al.	235/151.33
3,906,208	9/1975	Rogers	235/151.33
3,921,736	11/1975	Rogers	177/DIG. 3
3,961,747	6/1976	Small et al.	177/3
3,962,569	8/1976	Loshbough et al.	235/151.33
3,973,109	8/1976	Foster	235/151.33
3,984,667	10/1976	Loshbough	235/151.33
4,020,912	5/1977	Hino et al.	177/DIG. 6

Primary Examiner—Felix D. Gruber

Attorney, Agent, or Firm—Biebel, French & Nauman

[57] **ABSTRACT**

Disclosed is a computing scale system utilizing an integrated circuit microcomputer for computing the value of a product being weighed and for controlling the operation of a label printer associated therewith. The microcomputer operates with 4-bit words, and there is provided a multiplexing network for multiplexing weight, price, and status information into the microcomputer. Weight readings are made by a bank of photosensors, which read the position of a chart moveable in response to weight on the scale platter. Means are provided for performing a parity check on the data read by the weight photocells, and the data so read is converted from Gray code to BCD code by a table lookup routine. The scale system may print labels having weight and computed value, zero weight and fixed value, or weight and fixed value. The scale has both selectable price and weight dead zone capability with adjustable range. There is a motion detection routine employing a variable settling time.

47 Claims, 57 Drawing Figures

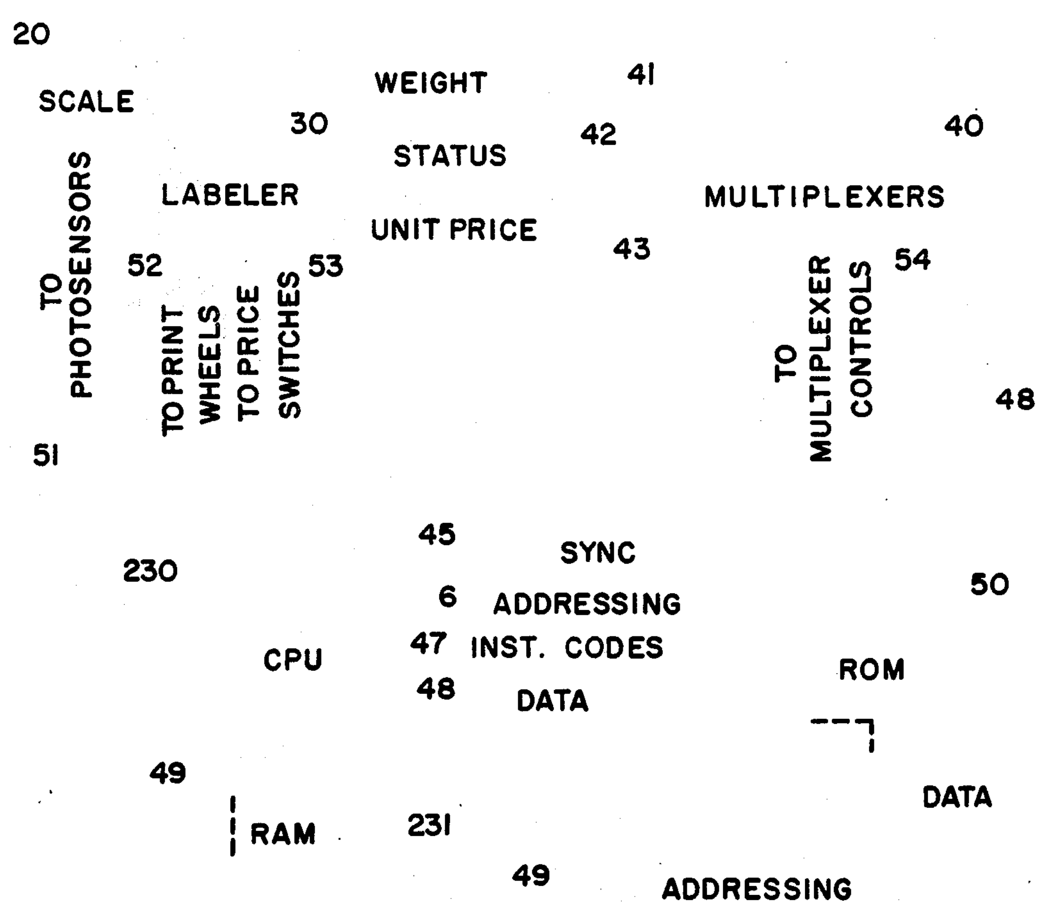


FIG-1

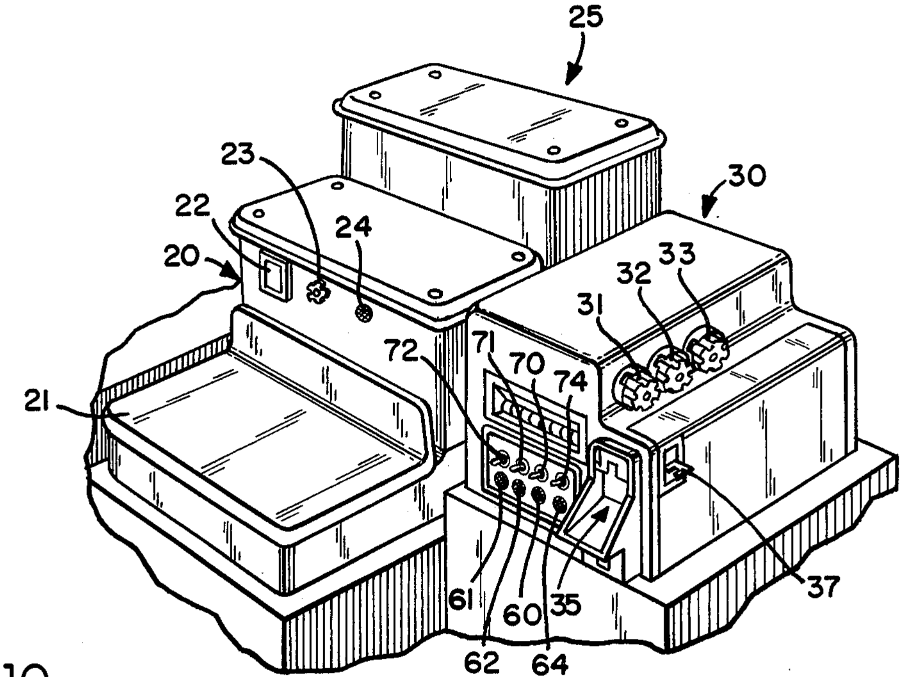


FIG-10

20
SCALE
WEIGHT
41
30
42
40
STATUS
LABELER
MULTIPLEXERS
UNIT PRICE
43
TO PHOTOSENSORS
52
53
54
TO PRINT WHEELS
TO PRICE SWITCHES
TO MULTIPLEXER CONTROLS
48
51
45
SYNC
230
46
ADDRESSING
50
47
INST. CODES
CPU
ROM
48
DATA
49
DATA
RAM
231
49
ADDRESSING

FIG-2A

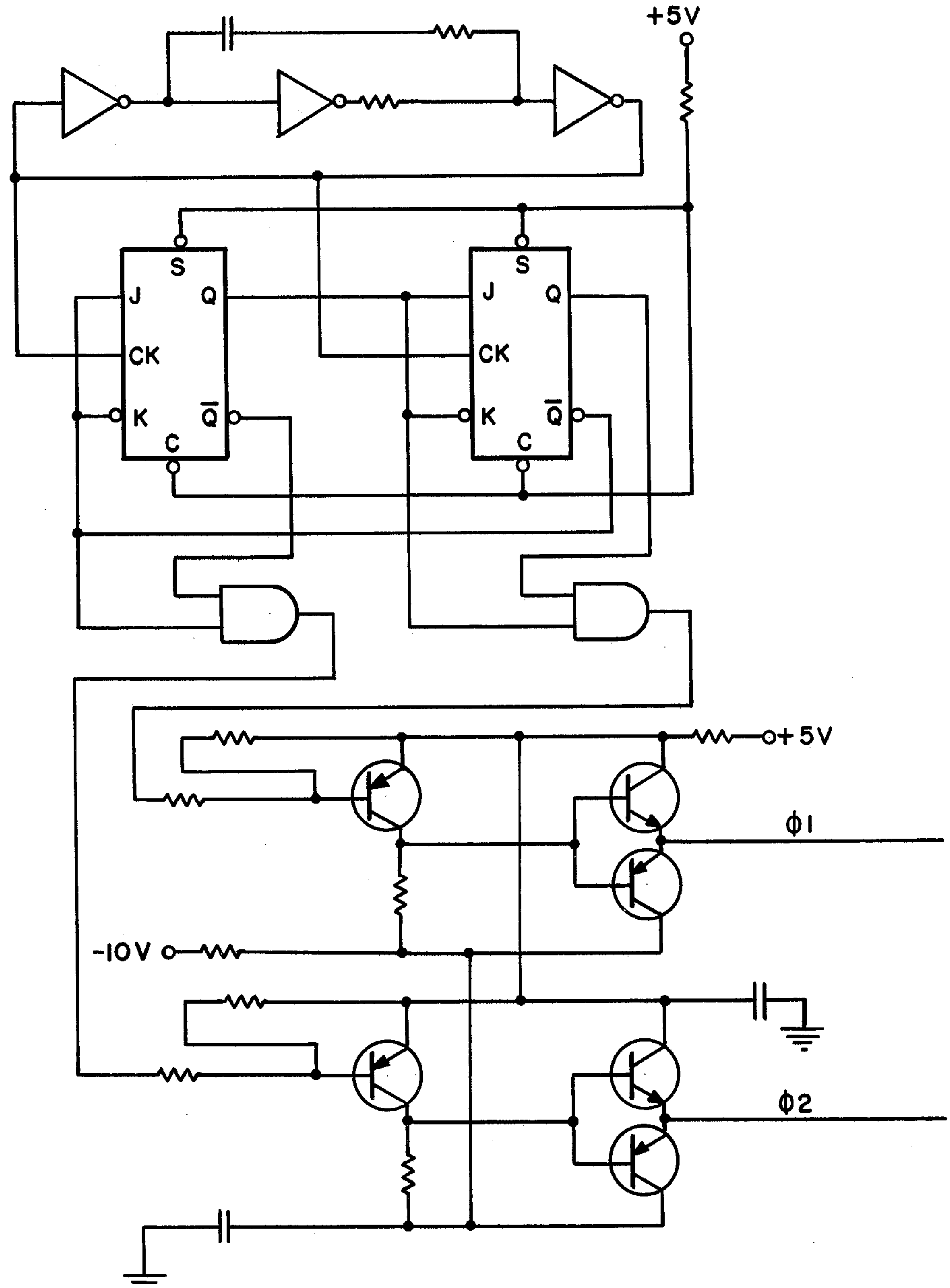


FIG-2B

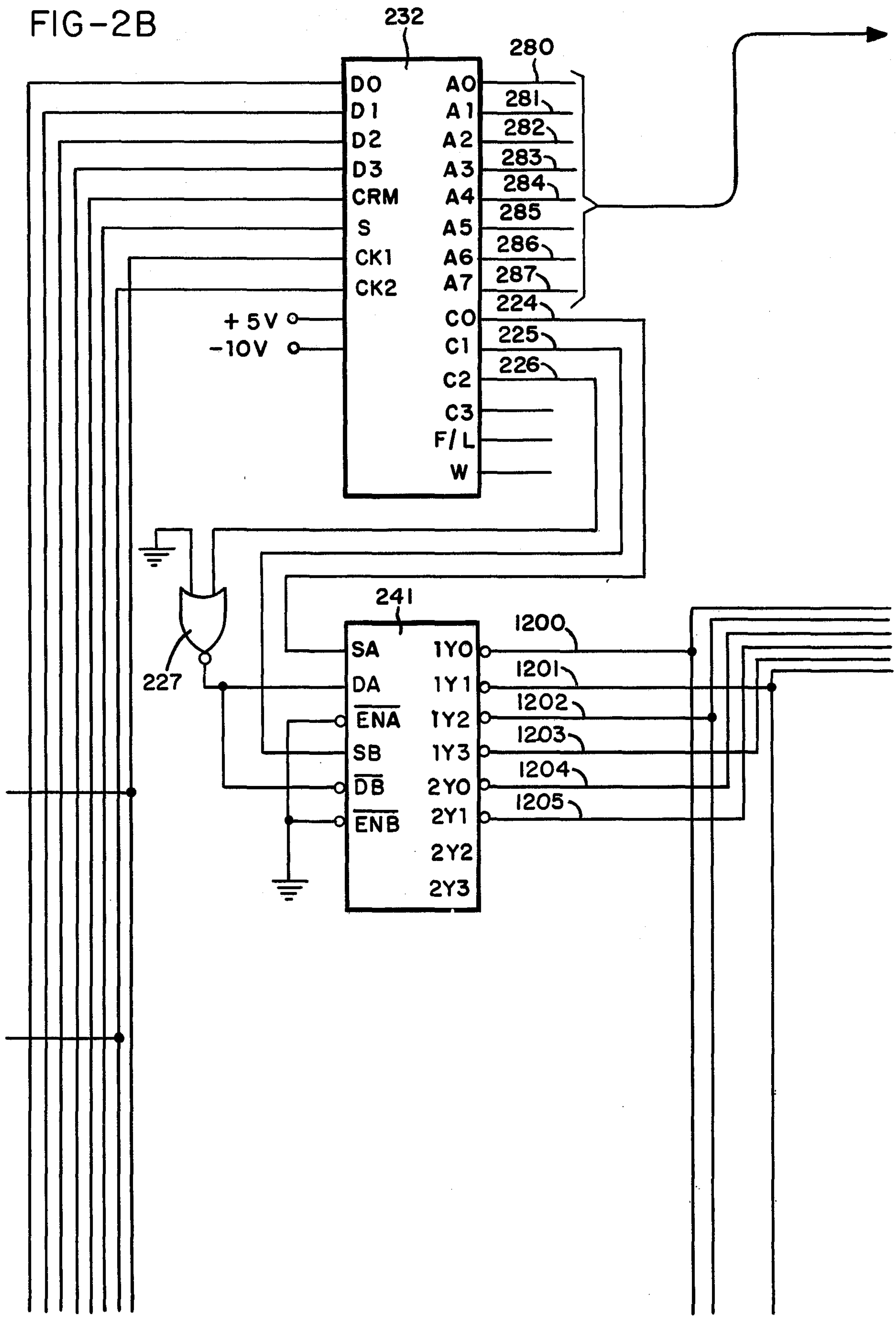

232
280
D0
D1
D2
D3
CRM
S
CK1
CK2
A0
A1
A2
A3
A4
A5
A6
A7
C0
C1
C2
C3
F/L
W
281
282
283
284
285
286
287
224
225
226
+5V
-10V
227
241
SA
DA
ENA
SB
DB
ENB
1Y0
1Y1
1Y2
1Y3
2Y0
2Y1
2Y2
2Y3
1200
1201
1202
1203
1204
1205

FIG-2C

-9V
+5V

234

236

238

A0 D0
A1 D1
A2 D2
A3 D3
A4 D4
A5 D5
A6 D6
A7 D7
CS/
PR ROM
VDD
VCC
VCC
VCC
VBB
VGG

ROM

ROM

235

237

239

A0 D0
A1 D1
A2 D2
A3 D3
A4 D4
A5 D5
A6 D6
A7 D7
CS/
PR ROM
VDD
VCC
VCC
VCC
VBB
VGG

ROM

ROM

+5V
−9V

FIG-2D

249

CK1 DO
CK2 D1
T D2
R D3
+5V VSS CMO
−10V VDD CMAO
S

1200
1202
1201
DATA BUS

270
271
272
273
274
275

CK1 DO
CK2 D1
T D2
R D3
CPU
+5V VSS CMO
−10V VDD CMAO
S
230

+5V
+5V
801
276

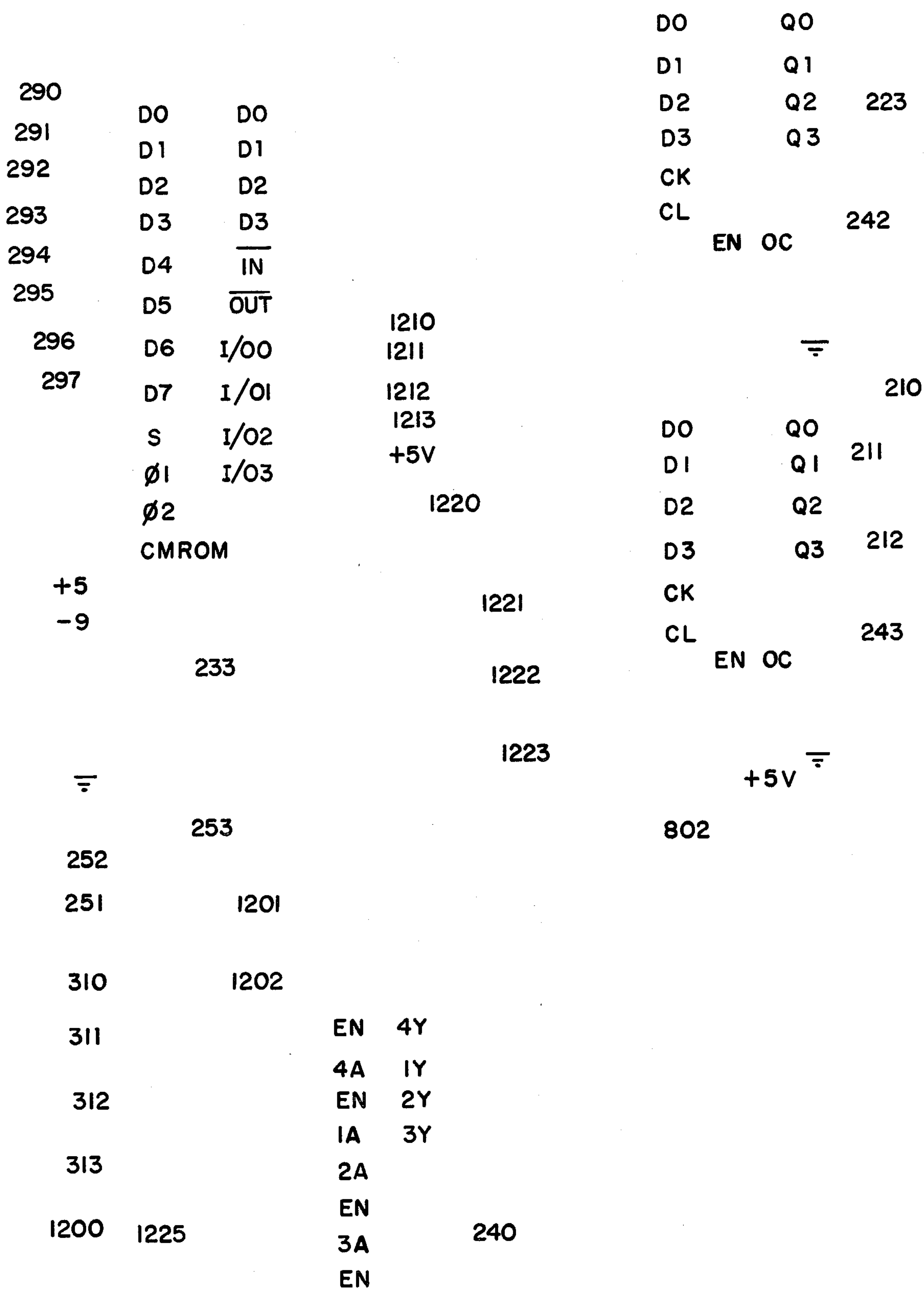
1214

DO OO
D1 O1
D2 O2
D3 O3
CK1
CK2
S
+5V PO
CM
R
RAM
+5V
−10V
231

−10V

214
261
260
204
200
205
201
215
216
206
202
262
217
263
203

FIG-2E



DO QO
D1 Q1
D2 Q2 223
D3 Q3
CK
CL 242
EN OC
290
291
292
293
294
295
296
297
DO DO
D1 D1
D2 D2
D3 D3
D4 IN
D5 OUT
D6 I/OO
D7 I/OI
S I/O2
Ø1 I/O3
Ø2
CMROM
+5
-9
233
1210
1211
1212
1213
+5V
1220
1221
1222
1223
210
DO QO
DI QI 211
D2 Q2
D3 Q3 212
CK
CL 243
EN OC
+5V
802
253
252
251
1201
310
1202
311
EN 4Y
4A IY
312
EN 2Y
IA 3Y
313
2A
EN
1200
1225
3A
240
EN

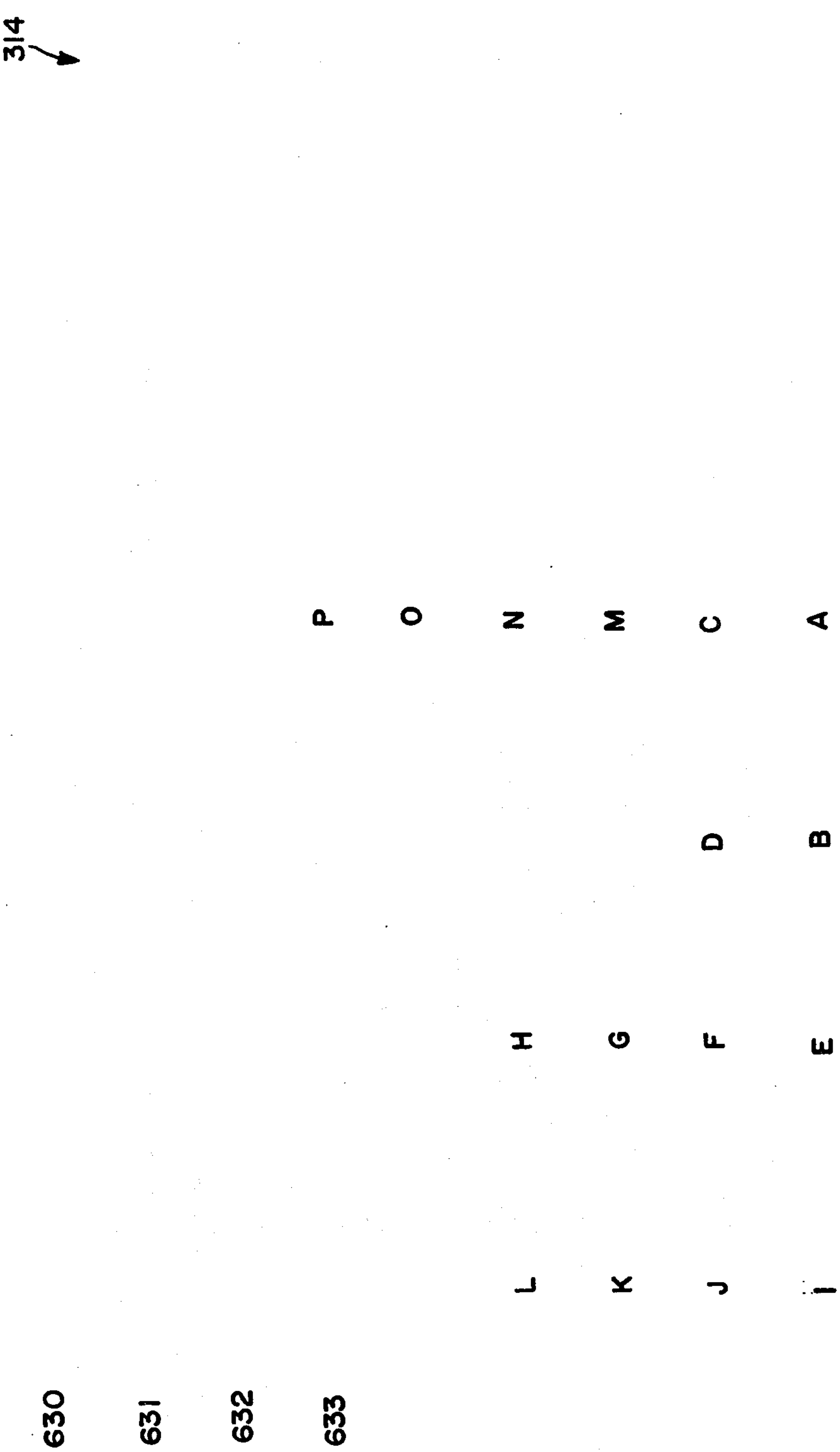


FIG-3A

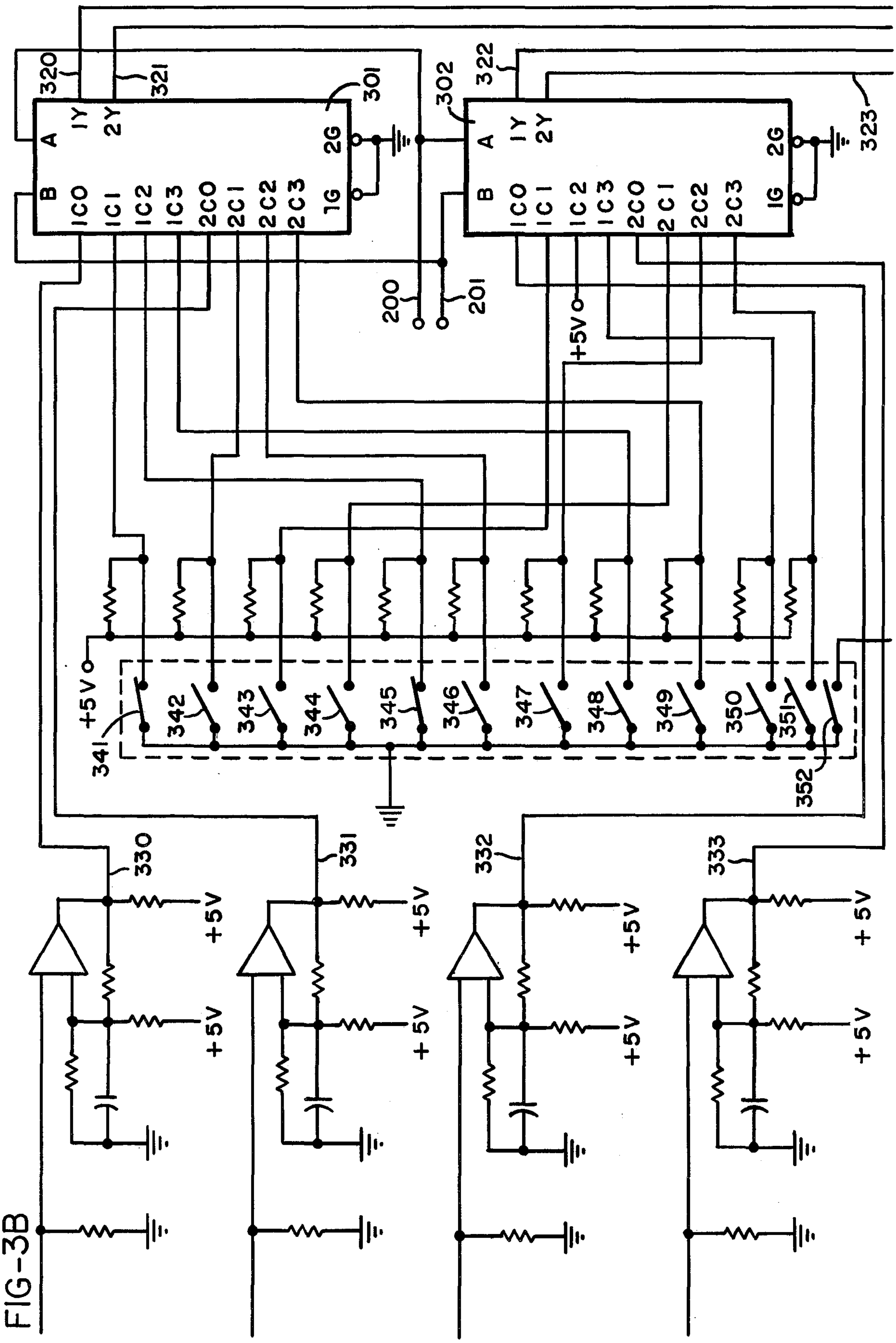

320
321
301
302
322
323
A
B
1Y
2Y
2G
1G
1C0
1C1
1C2
1C3
2C0
2C1
2C2
2C3
200
201
+5V
341
342
343
344
345
346
347
348
349
350
351
352
330
331
332
333

FIG-3B

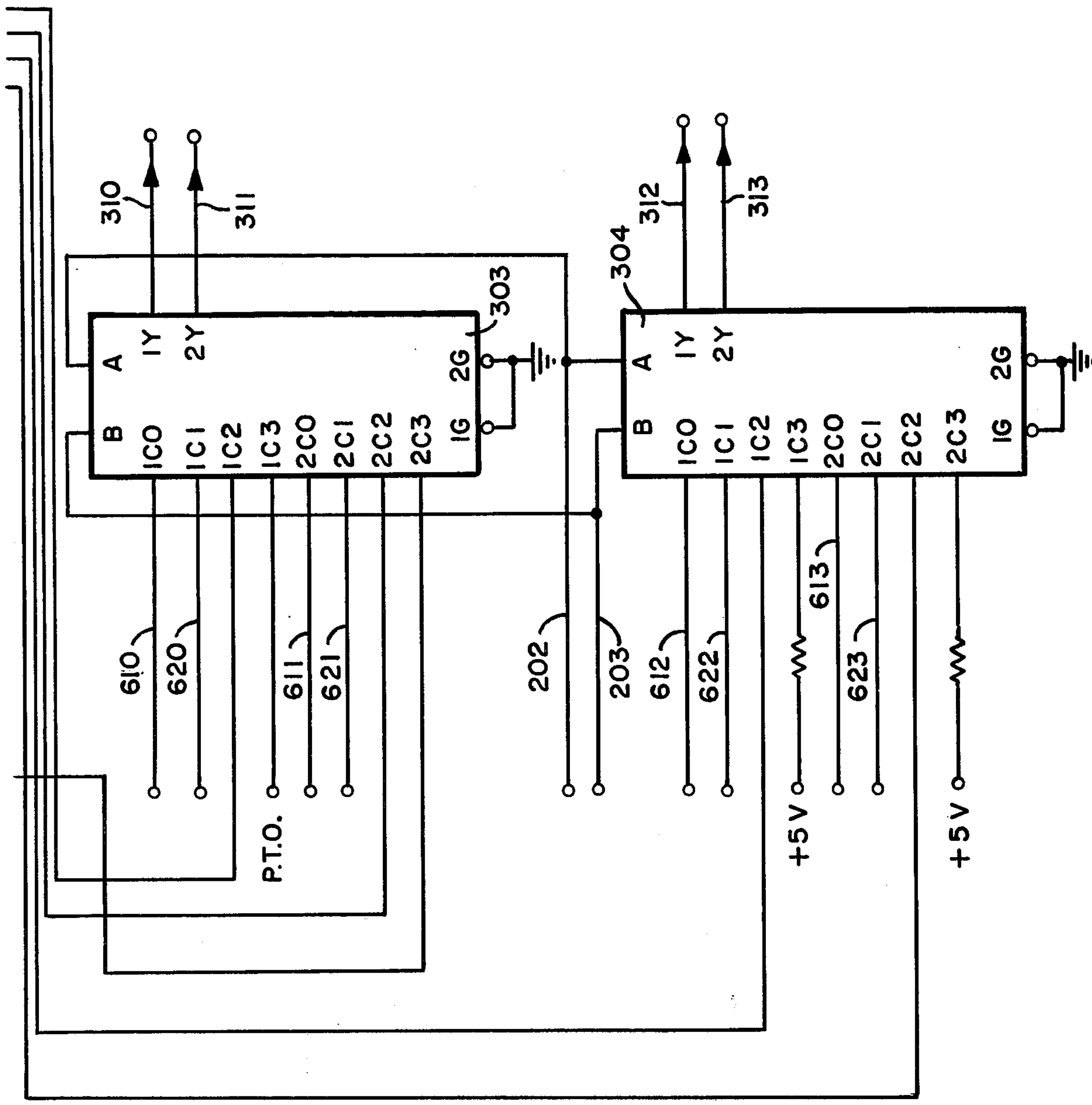
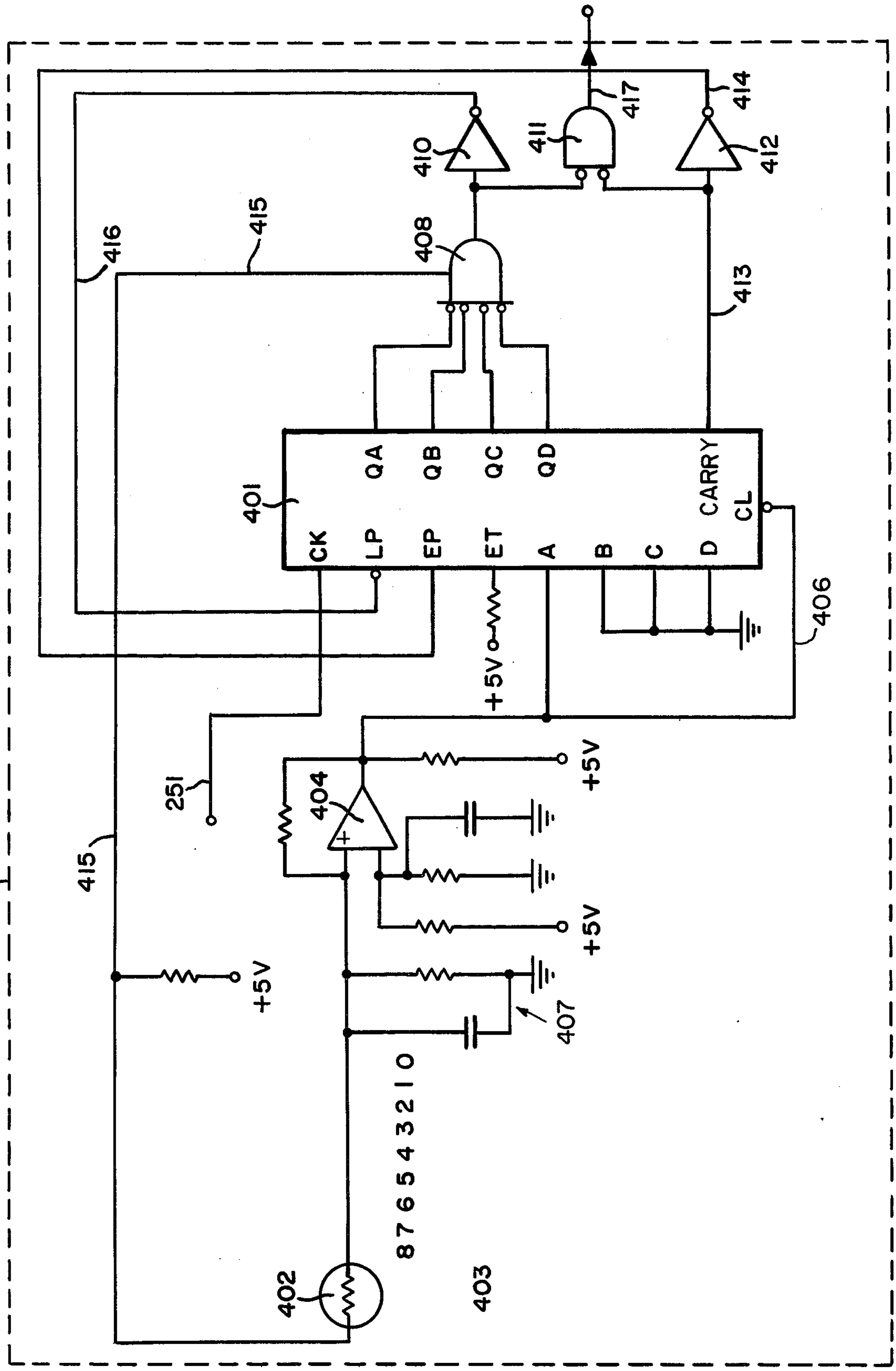

303
304
310
311
312
313
A
B
1Y
2Y
1C0
1C1
1C2
1C3
2C0
2C1
2C2
2C3
1G
2G
610
620
611
621
202
203
612
622
613
623
P.T.O.
+5V
+5V

FIG-3C


400
401
402
403
404
406
407
408
410
411
412
413
414
415
416
417
251
CK
LP
EP
ET
A
B
C
D
QA
QB
QC
QD
CARRY
CL
+5V
8 7 6 5 4 3 2 1 0

FIG—4

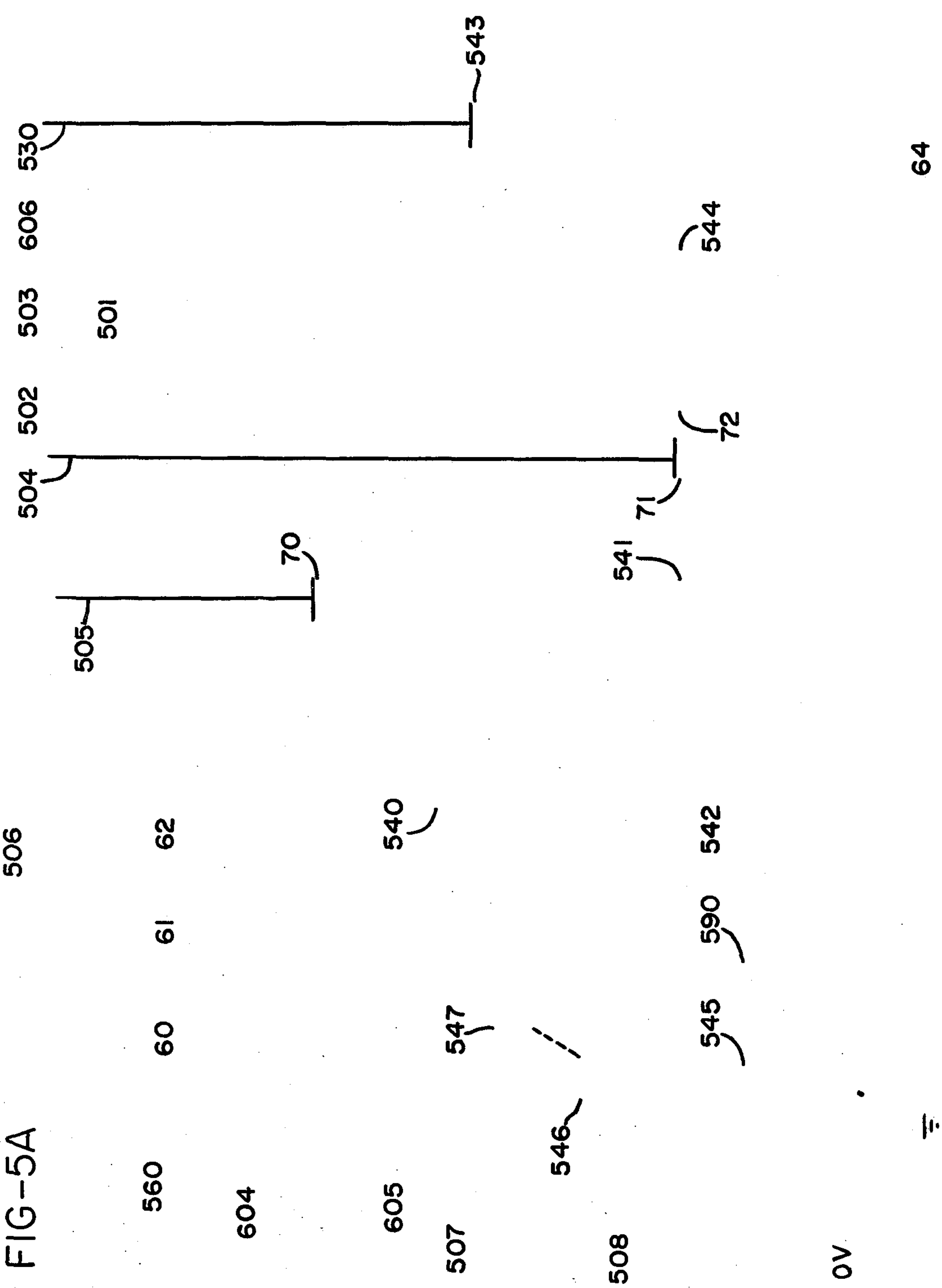

530
606
503
502
504
505
501
543
544
70
71
72
541
64
506
62
61
60
560
604
605
540
507
547
546
508
542
590
545
0V

FIG-5A

FIG-5B

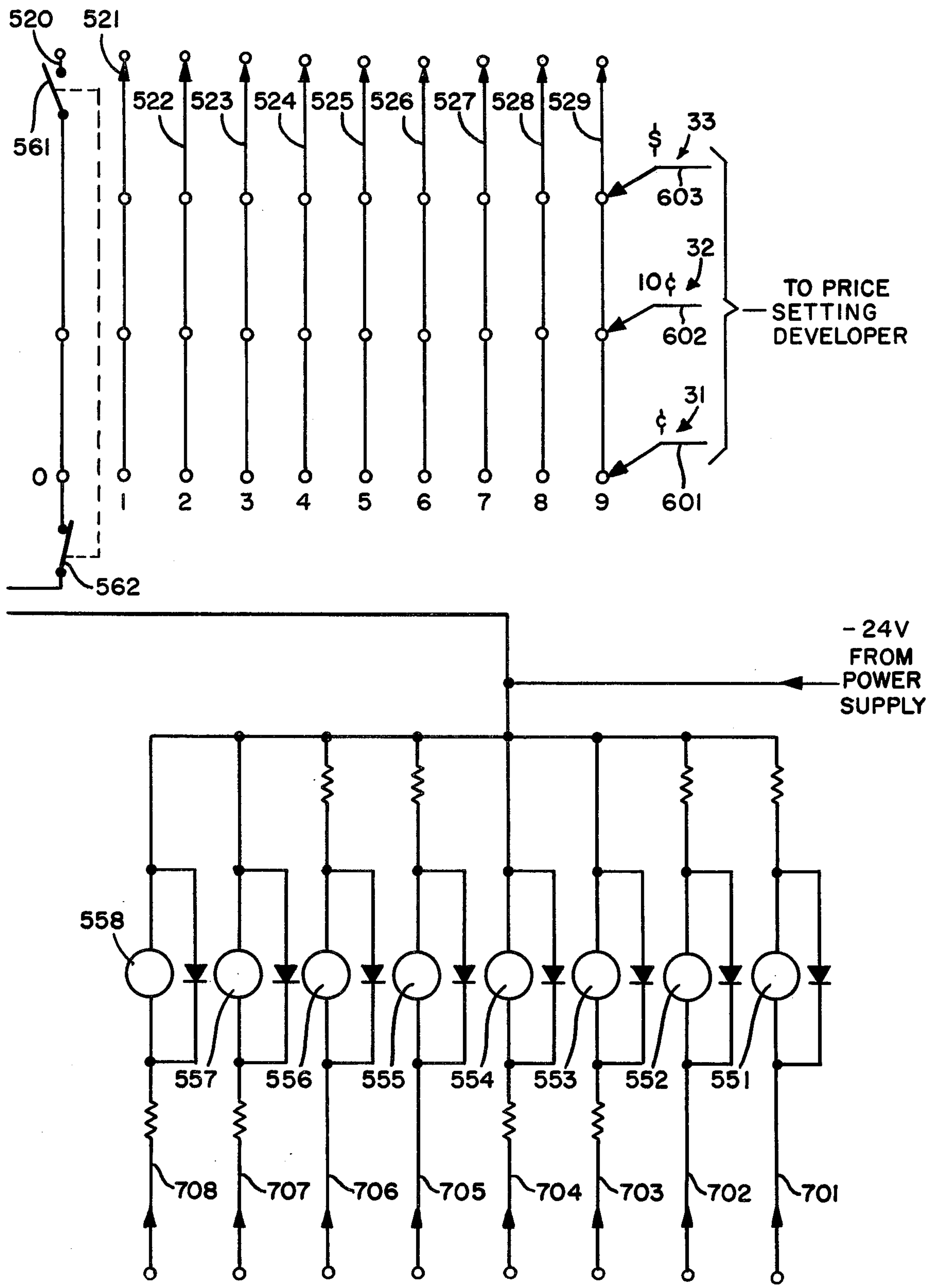

520
521
522
523
524
525
526
527
528
529
561
$
33
603
32
10¢
602
TO PRICE SETTING DEVELOPER
31
¢
601
0
1
2
3
4
5
6
7
8
9
562
-24V FROM POWER SUPPLY
558
557
556
555
554
553
552
551
708
707
706
705
704
703
702
701

FIG- 6A

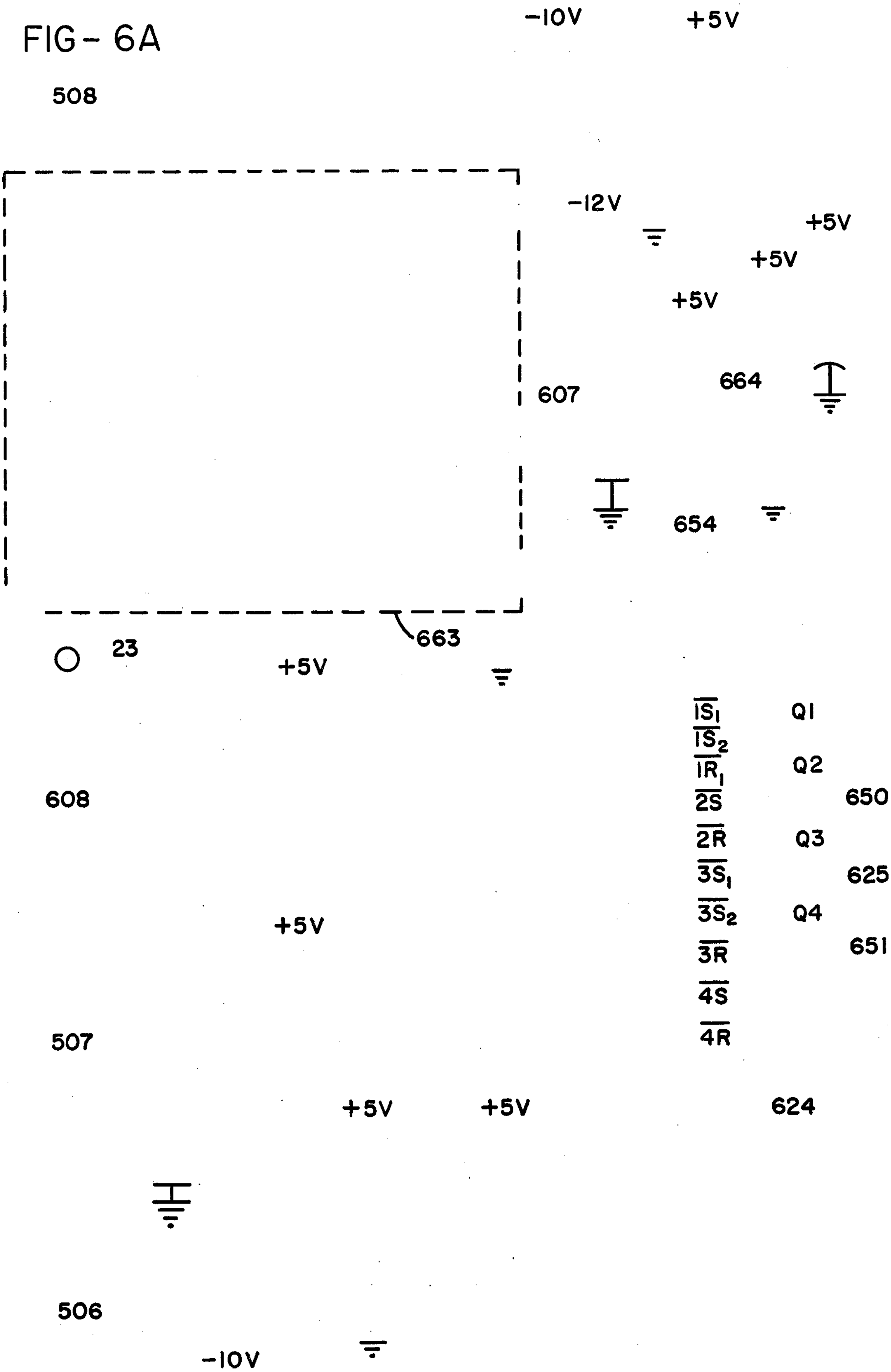
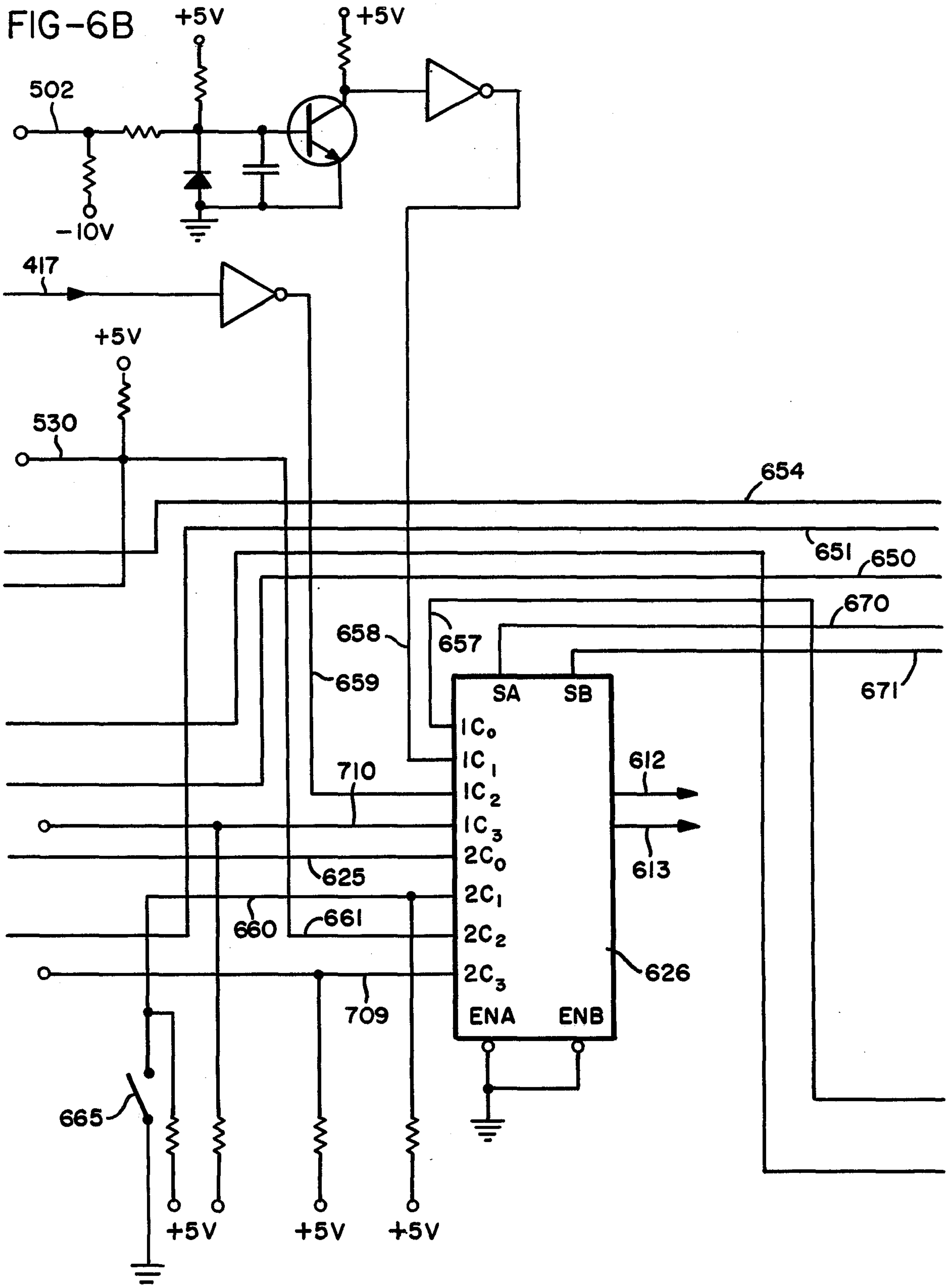

-10V
+5V
508
-12V
+5V
+5V
+5V
607
664
654
663
23
+5V
$\overline{1S_1}$
$\overline{1S_2}$
$\overline{1R_1}$
$\overline{2S}$
$\overline{2R}$
$\overline{3S_1}$
$\overline{3S_2}$
$\overline{3R}$
$\overline{4S}$
$\overline{4R}$
Q1
Q2
Q3
Q4
650
625
651
608
+5V
507
+5V
+5V
624
506
-10V

FIG-6B



+5V
+5V
502
-10V
417
+5V
530
654
651
650
670
658
657
659
671
SA
SB
$1C_0$
$1C_1$
$1C_2$
$1C_3$
$2C_0$
$2C_1$
$2C_2$
$2C_3$
ENA
ENB
710
612
613
625
660
661
626
709
665
+5V
+5V
+5V

FIG-6C

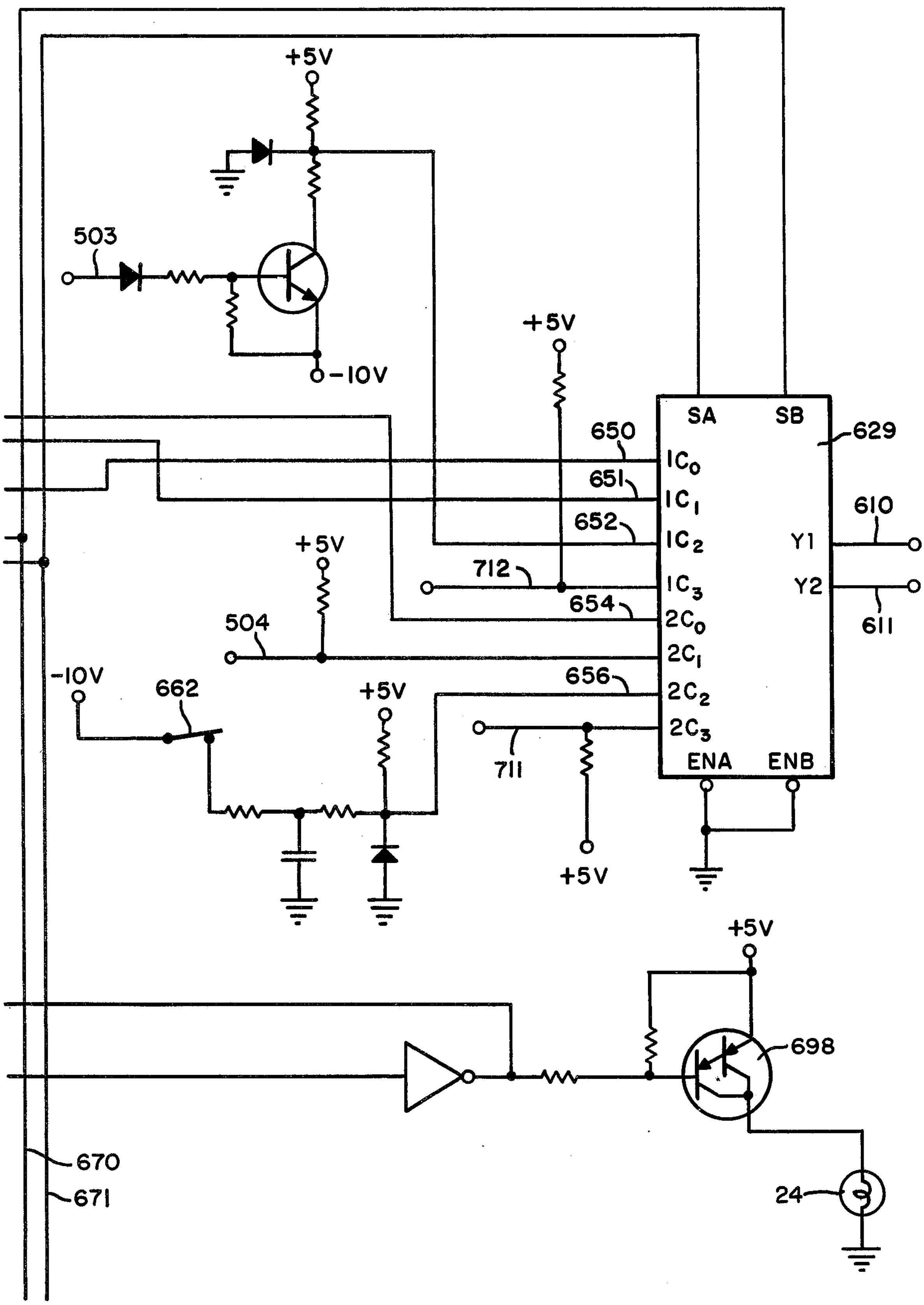

+5V
503
-10V
+5V
SA
SB
629
650
$1C_0$
651
$1C_1$
652
$1C_2$
Y1
610
712
$1C_3$
Y2
654
$2C_0$
611
504
+5V
$2C_1$
-10V
662
+5V
656
$2C_2$
$2C_3$
711
ENA
ENB
+5V
+5V
698
670
671
24

FIG-6D

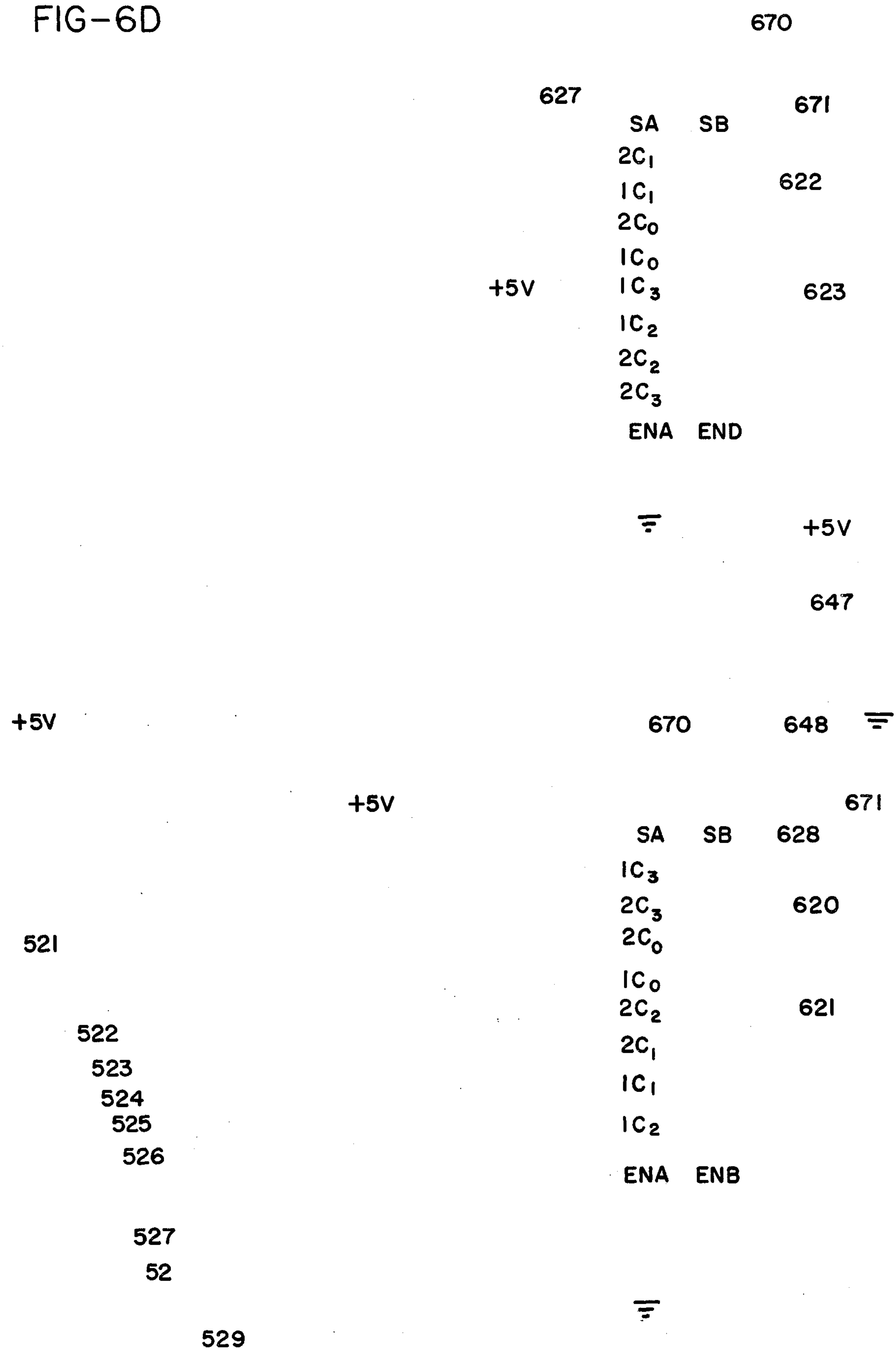

670
627
671
SA
SB
2C1
1C1
622
2C0
1C0
+5V
1C3
623
1C2
2C2
2C3
ENA
END
+5V
647
+5V
670
648
+5V
671
SA
SB
628
1C3
2C3
620
521
2C0
1C0
2C2
621
522
2C1
523
524
1C1
525
1C2
526
ENA
ENB
527
52
529

FIG-6E

+5V
606
671
−24V
+5V
670
253
644
604
D1 Q1
$\overline{Q1}$
605
D2 Q2
$\overline{Q2}$
+5V
PENNIES
D3 Q3
$\overline{Q3}$
601
DIMES
D4 Q4
$\overline{Q4}$
602
CK
DOLLARS
CL
603
672 −10V
673
671
609
645
214 670 640
646
D1 Q1 A 0
+5V
$\overline{Q1}$ 1
630
641
631
215
D2 Q2 B 2
632
$\overline{Q2}$ 3
216
642
D3 Q3 C 4
633
$\overline{Q3}$ 5
217 +5V
D4 Q4 D 6
643
$\overline{Q4}$ 7
CK 8
713
9
CL
+5V
803
608
714

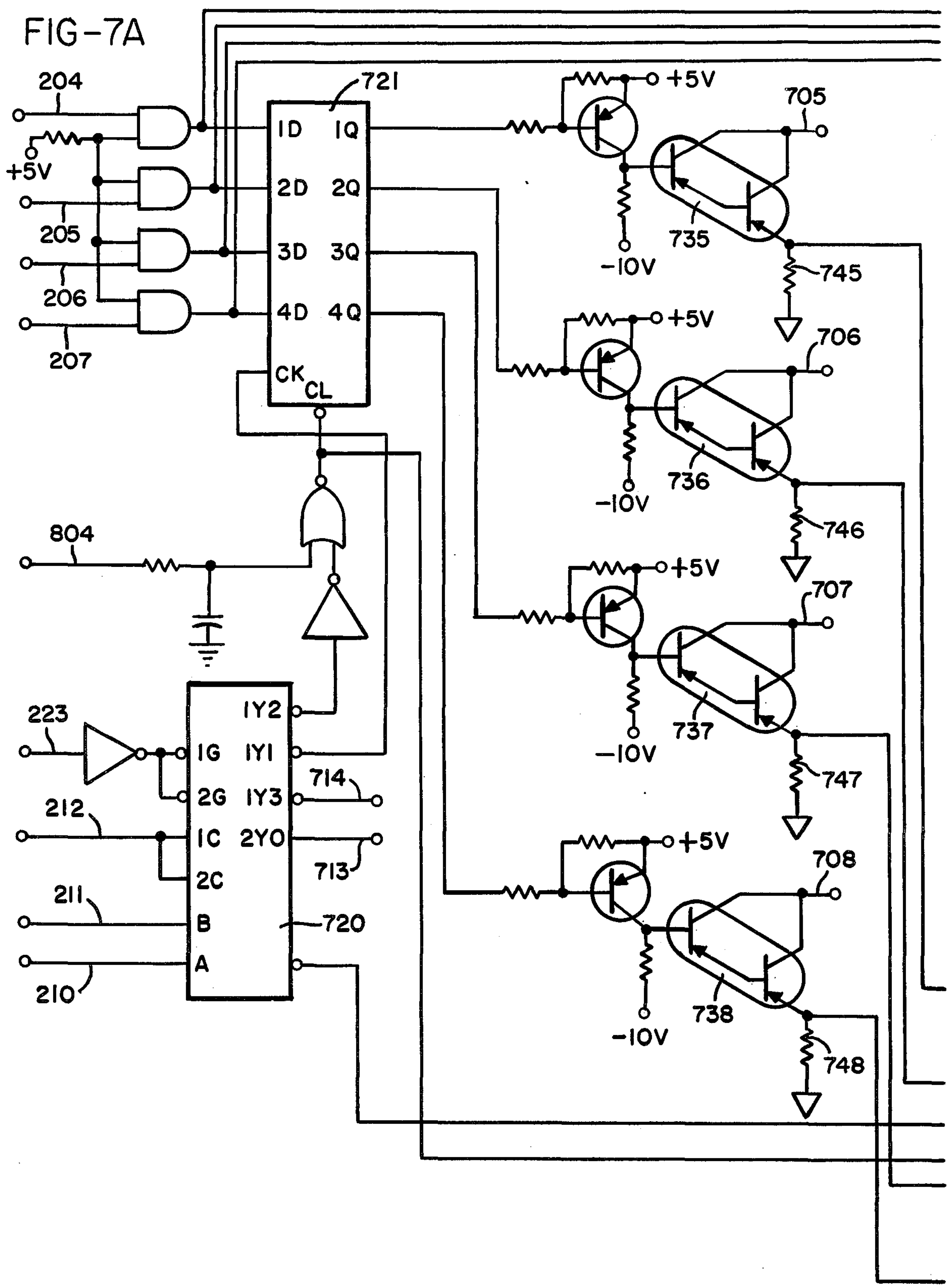


FIG-7A
204
+5V
205
206
207
721
1D
1Q
2D
2Q
3D
3Q
4D
4Q
CK
CL
+5V
705
735
-10V
745
+5V
706
736
-10V
746
804
+5V
707
737
-10V
747
223
1G
2G
1C
2C
B
A
1Y2
1Y1
1Y3
2Y0
714
713
720
212
211
210
+5V
708
738
-10V
748

FIG-7B

+5V
701
+5V
1D 1Q
2D 2Q
3D 3Q
-1 V 731
4D 4Q
+5V 741
CK
702
609
CL
+5V
722

-10V 732
+5V
742
703
+5V
712
1A S 1Y
711
-10V 733
743
1B 2Y
+5V
710
2A 3Y
704
2B 4Y
+5V
3A 709
3B
4A
-10V 734
723
4B
744
-10V
+5V
+5V
+5V
+5V

NOTE:
DENOTES POWER GND – 24V

-1 V

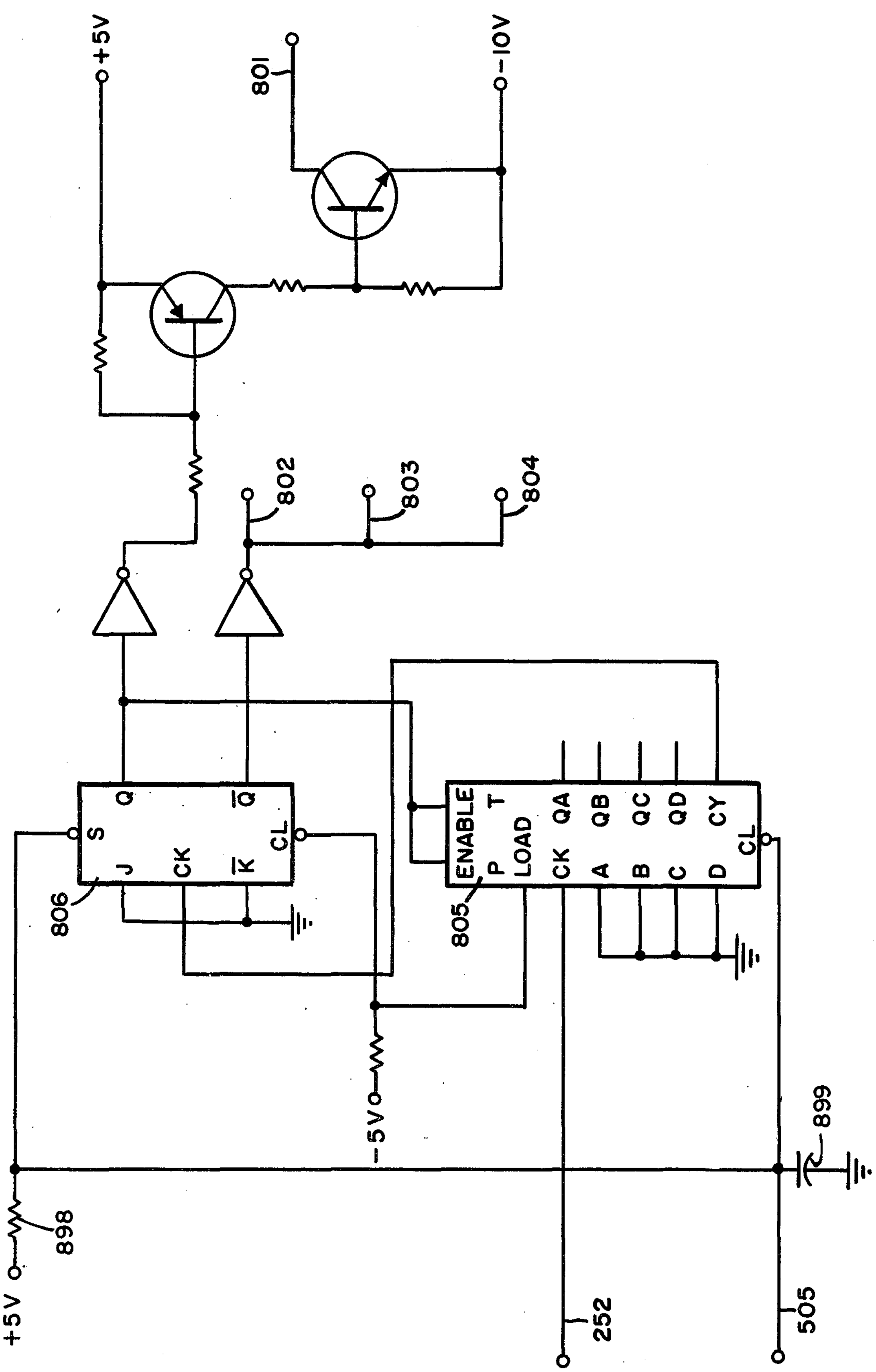

+5V
801
-10V
802
803
804
806
S
Q
J
CK
K̄
Q̄
CL
805
ENABLE
P
T
LOAD
CK
QA
QB
QC
QD
CY
A
B
C
D
CL
-5V
898
+5V
899
252
505

FIG-8

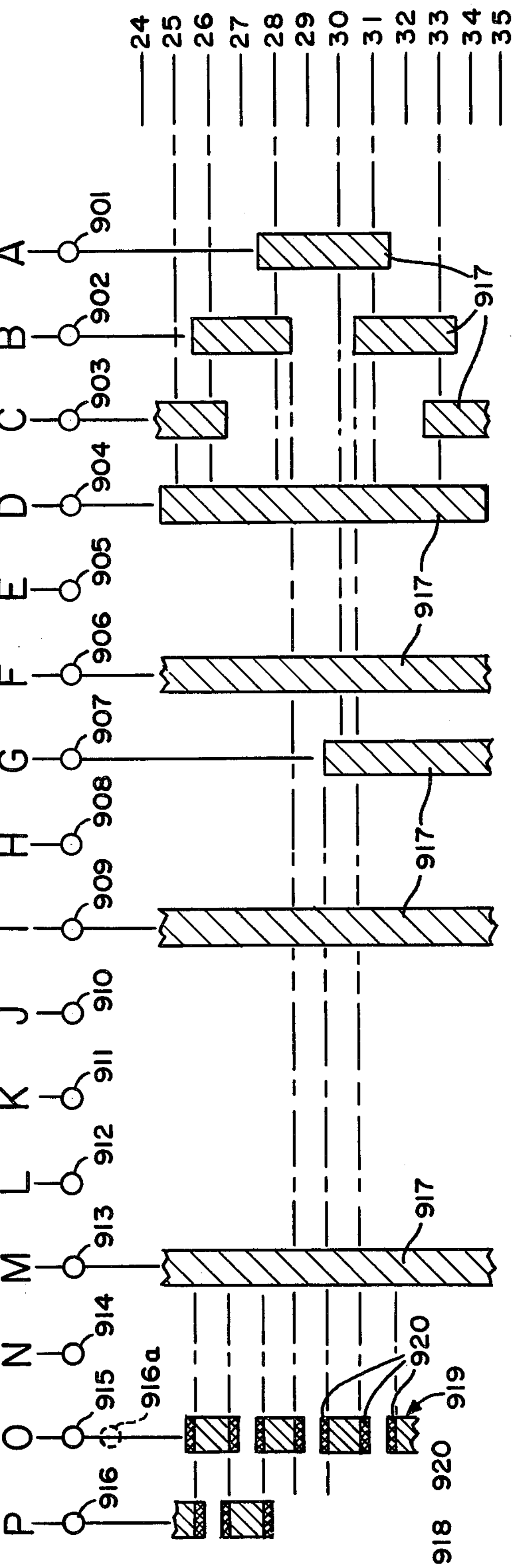


FIG-9

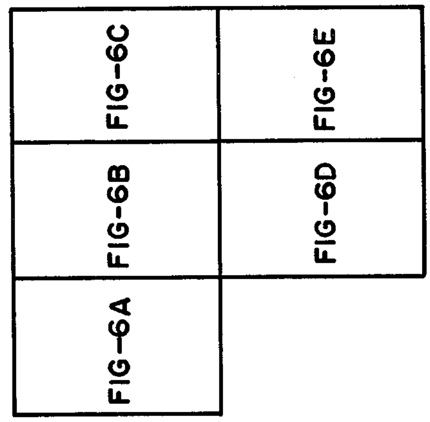


FIG-18

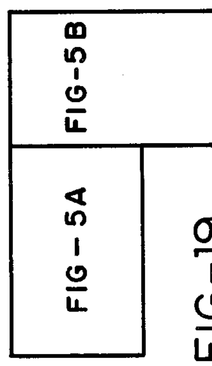


FIG-17

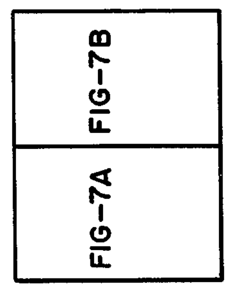


FIG-19

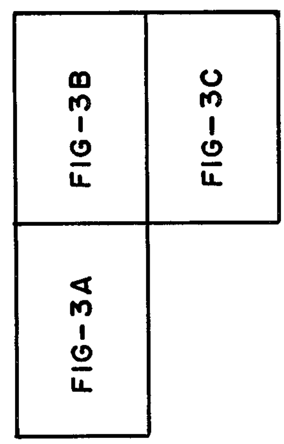


FIG-16

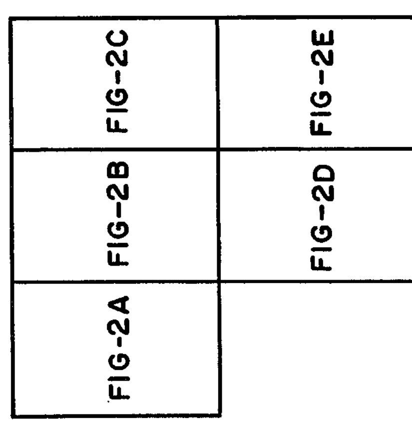


FIG-13

FIG-11 A

START

LOADS TIME
DELAY CONSTANT

1106

SEND OUT
MPX ADDR
OF PTR HOME
POS STAT SW

INPUT
PTR HOME
POS STAT

1102

ERROR

N

PTR STATUS
HOME ?

Y

WASTE
TIME

N

IS
HOME POS
TEST
DONE

Y

1104

1108

PROGRAM
HOME
A

1109

SEND OUT
MPX ADDR TO
TEST 1ST CYC,
LBL RPT, MAN ST
BY CENT, SWS

READ SW
STATUSES

STORE STATUSES
IN RAM

FIG-11B

WAS
MAN START
STATUS SET

1110

B

1111

READ TRIPS
THROUGH COUNTER

ADD .8

DOES
CARRY
RESULT

1112

N

Y

PUT SUM
INTO TRIPS
THRU COUNTER

1113

C

1114

SEND OUT
MPX ADDR
OF WASTE TIME
SELECT SWS

READ WASTE
TIME SWS

WRITE IN
WASTE TIME
CONSTANTS

SEND OUT
MPX ADDR
OF PRTR HOME
POS STAT SW

1115

INPUT
PTR HOME
POS STAT

FIG-11C

N
PTR STATUS HOME
Y

START EJECTOR MOTOR

STOP EJECTOR MOTOR

D

1118
WASTE TIME

1120
N
SCALE MOVING
Y
TO PROGRAM HOME A

TO PROGRAM HOME A

TRIPS THROUGH COUNTER SUFFICIENT
Y

1122

1124

TO B

PREVIOUS LABEL TAKEN

1126

COMPUTER START SUPRESSED (ILA)
Y
TO B

1128
WAS BY-COUNT STATUS SET

TO BY-COUNT SUBROUTINE

FIG-11D

1130
N
WAS
LABEL
REPEAT
STATUS
SET
Y
TO
LABEL
REPEAT
SUB
ROUTINE

1132
N
WAS
MANUAL
START
SET
Y

1134
N
WT
INSIDE WT
DEAD ZONE
Y

F

1136
N
WT
WITHIN SCALE
RANGE
Y

RESET
MOTION
STATUS

1138
N
MOTION
STATUS WORD
SET
Y

TO PROGRAM
HOME A

E

1140
ERROR
N
TARE
ENTRY
MADE
Y

1142
N
PRINTER
ERROR
Y
ERROR

1144
ERROR
N
WT
WITHIN
SCALE
RANGE
Y

FIG-11E

1145

ERROR

N

CHART
PARTIY
OK

Y

1146

WT
OUTSIDE
DEAD
ZONE

Y

G

1148

TO
PROGRAM
HOME

N

MANUAL
START

Y

1150

N

TEST
METRIC
SW
STATUS

Y

TO
METRIC
SUB
ROUTINE

READ UNIT
PRICE SW'S

1151

MULTIPLY UNIT
PRICE X WT; STORE
IN RAM 16-23

1152

1154

N

WAS
UNIT PRICE
ZERO IN
MPLY

Y

COPY TOTAL
VALUE PRODUCT
IN RAM 8-15

1156

1159

DIVIDE TOTAL
VALUE BY UNIT
PRICE

1158

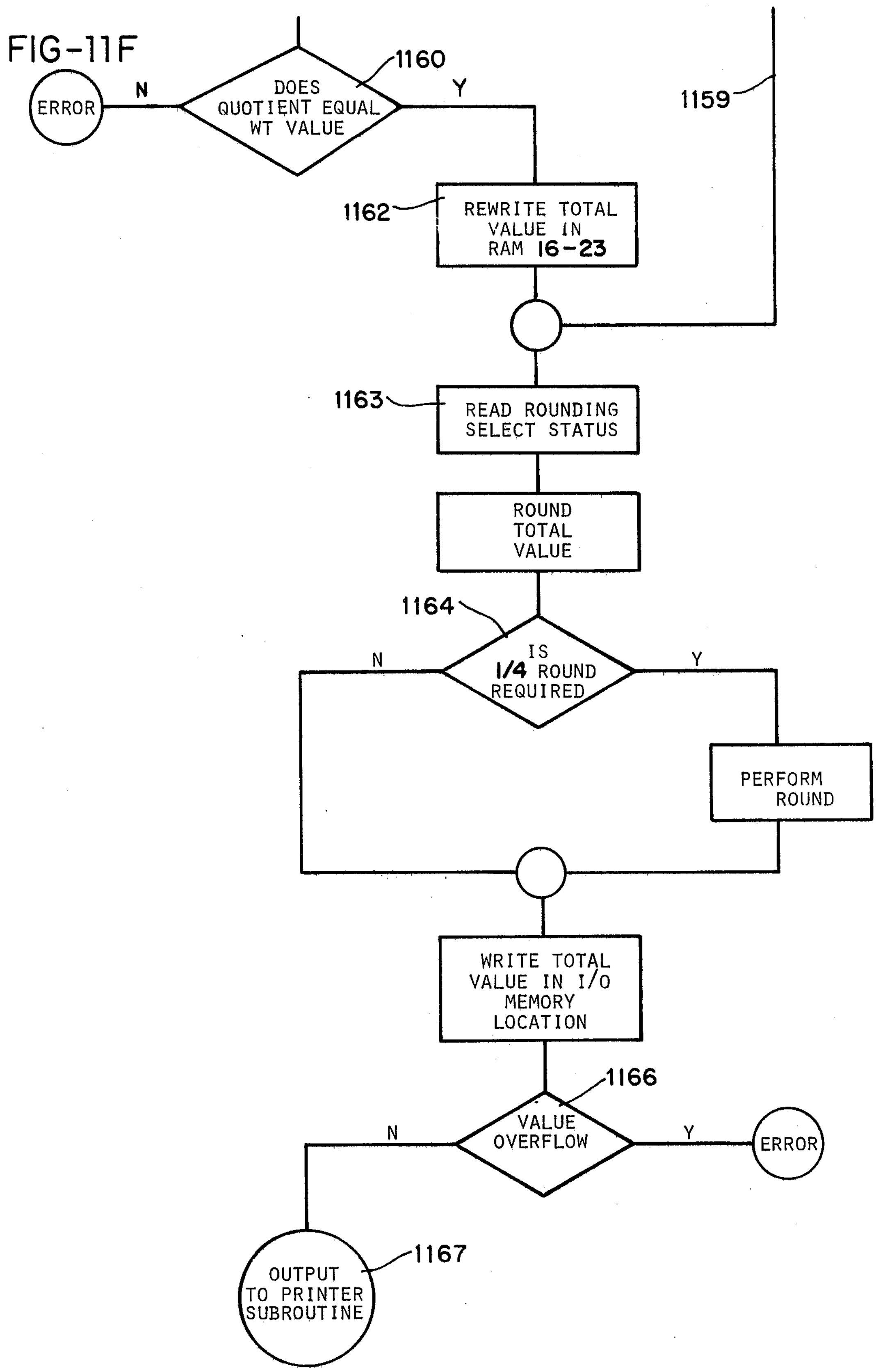


FIG-11F
ERROR
N
DOES QUOTIENT EQUAL WT VALUE
1160
Y
1159
1162
REWRITE TOTAL VALUE IN RAM 16-23
1163
READ ROUNDING SELECT STATUS
ROUND TOTAL VALUE
1164
N
IS 1/4 ROUND REQUIRED
Y
PERFORM ROUND
WRITE TOTAL VALUE IN I/O MEMORY LOCATION
1166
N
VALUE OVERFLOW
Y
ERROR
1167
OUTPUT TO PRINTER SUBROUTINE

FIG-12A

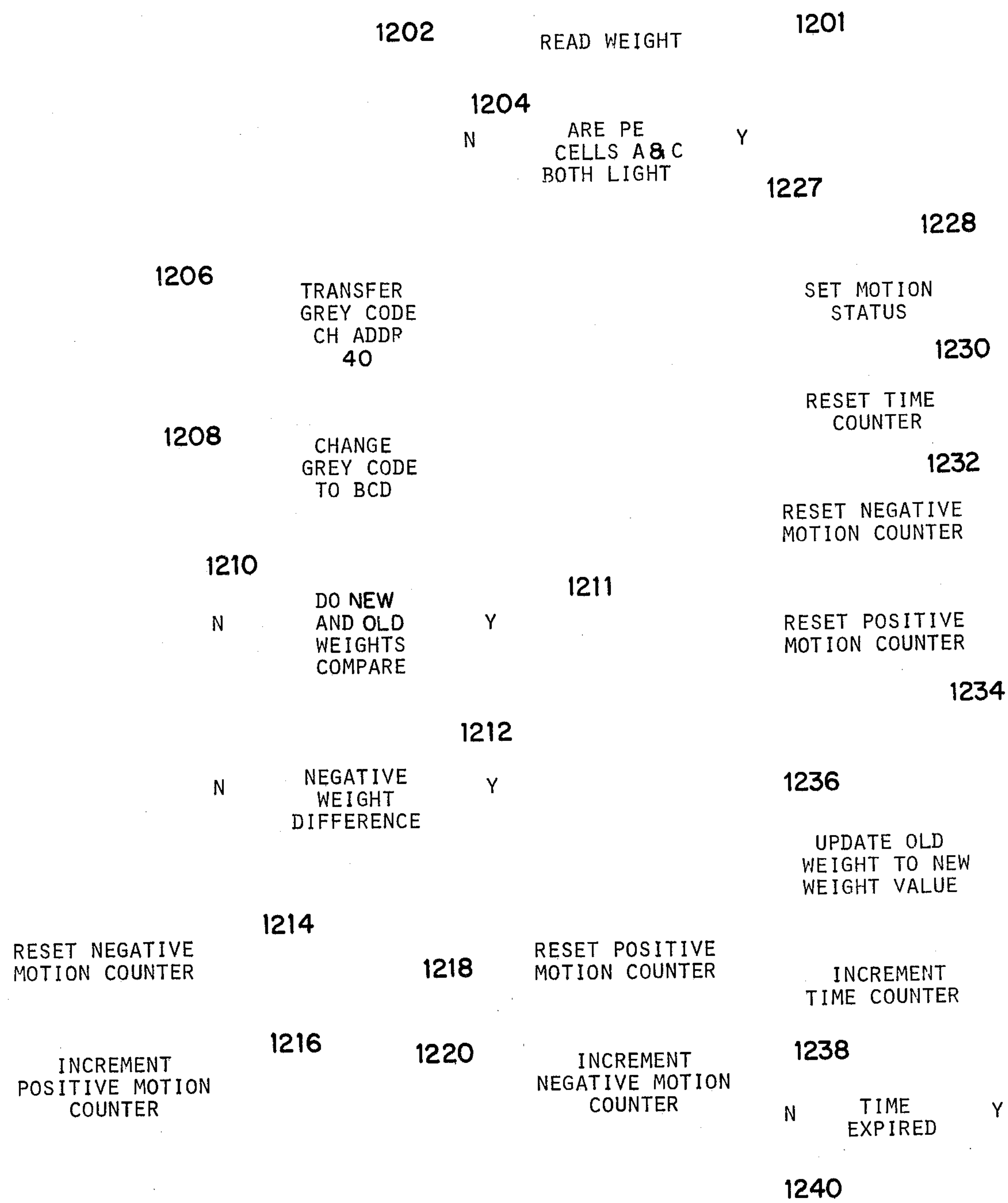

1202
READ WEIGHT
1201
1204
N
ARE PE CELLS A & C BOTH LIGHT
Y
1227
1228
1206
TRANSFER GREY CODE CH ADDR 40
SET MOTION STATUS
1230
RESET TIME COUNTER
1208
CHANGE GREY CODE TO BCD
1232
RESET NEGATIVE MOTION COUNTER
1210
N
DO NEW AND OLD WEIGHTS COMPARE
Y
1211
RESET POSITIVE MOTION COUNTER
1234
1212
N
NEGATIVE WEIGHT DIFFERENCE
Y
1236
UPDATE OLD WEIGHT TO NEW WEIGHT VALUE
1214
RESET NEGATIVE MOTION COUNTER
1218
RESET POSITIVE MOTION COUNTER
INCREMENT TIME COUNTER
1216
INCREMENT POSITIVE MOTION COUNTER
1220
INCREMENT NEGATIVE MOTION COUNTER
1238
N
TIME EXPIRED
Y
1240

FIG-12B

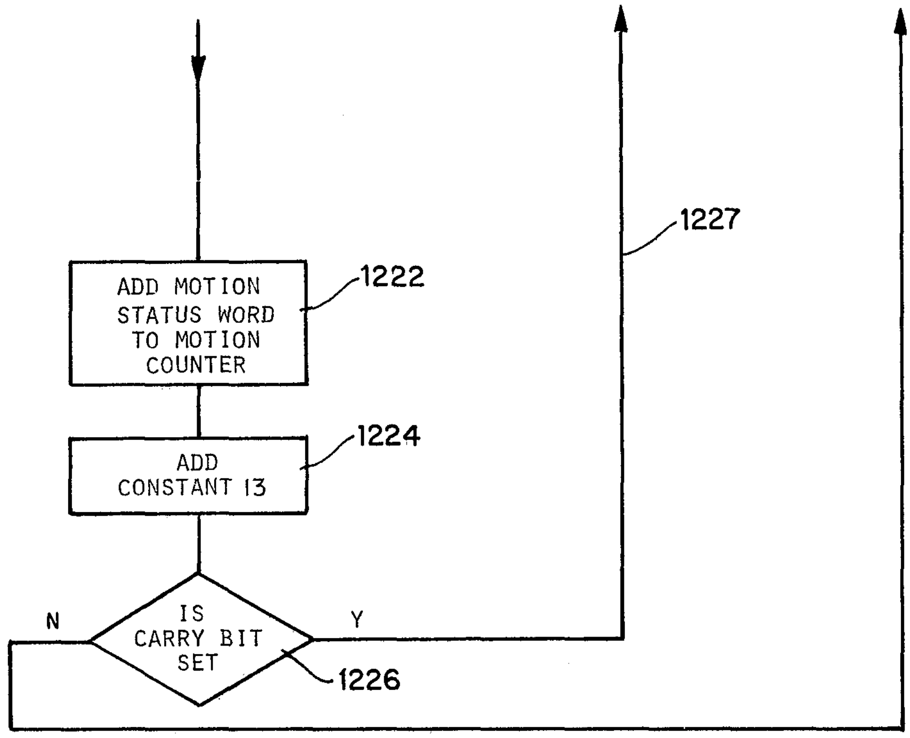

ADD MOTION STATUS WORD TO MOTION COUNTER
1222
ADD CONSTANT 13
1224
IS CARRY BIT SET
1226
N
Y
1227

FIG-14

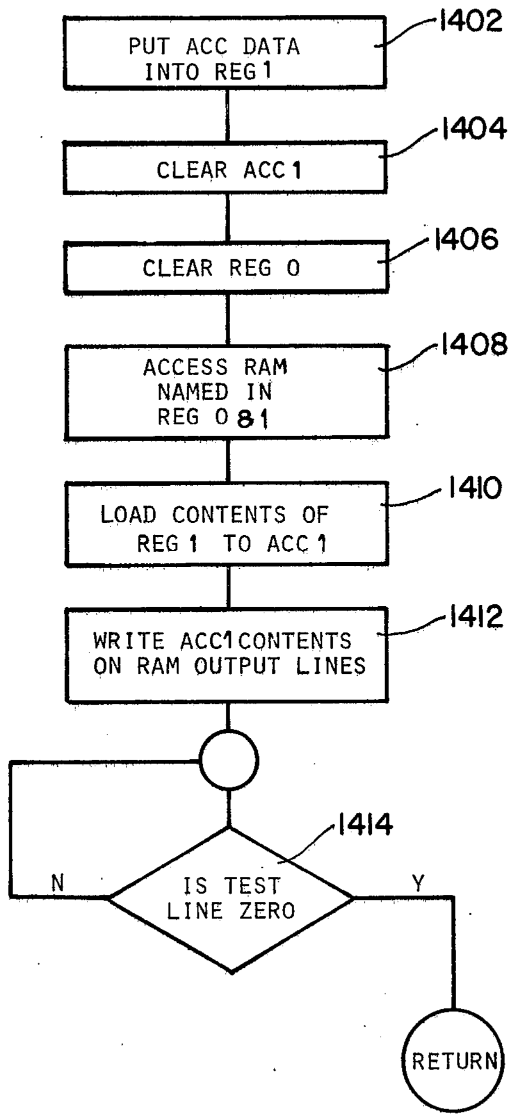

PUT ACC DATA INTO REG 1
1402
CLEAR ACC 1
1404
CLEAR REG 0
1406
ACCESS RAM NAMED IN REG 0 & 1
1408
LOAD CONTENTS OF REG 1 TO ACC 1
1410
WRITE ACC1 CONTENTS ON RAM OUTPUT LINES
1412
IS TEST LINE ZERO
1414
N
Y
RETURN

FIG-15A

1502

PUT ADDR FOR RECEIVING HIGHEST WEIGHT SOLENOID BYTE INTO INDEX REG 2&3

PTR3

1504

PUT ADDR OF WEIGHT OR T VAL LOW ORDER DIGIT IN REG 0&1

1533

PTR1

1506

PUT A 12 IN REG 4&5 P2

1539

PTR2

1508

CLEAR ACC & CARRY

1510

SEND CONTENTS OF REG 0 & 7 TO RAM FOR USE AS ADDR

1529

1512

ADD 1 TO ACC CONTENTS

1514

ADD CONTENTS OF RAM TO ACC

1516

ADD CONTENTS OF REG 3 TO ACC

SEND CONTENTS OF REG 2 & 3 INTO RAM FOR USE AS ADDR

1518

FIG-15B

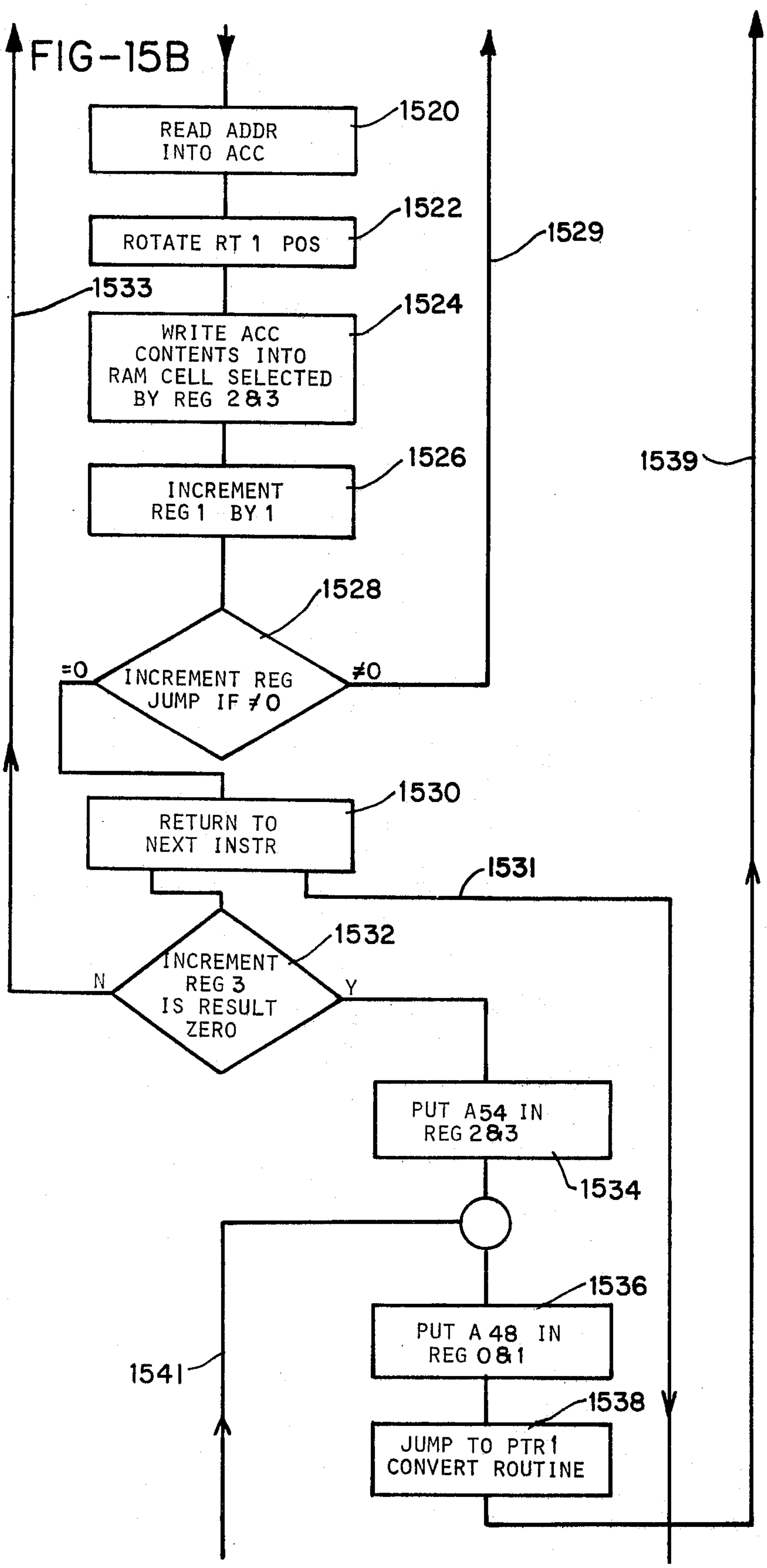

READ ADDR INTO ACC
1520
ROTATE RT 1 POS
1522
1529
1533
WRITE ACC CONTENTS INTO RAM CELL SELECTED BY REG 2&3
1524
INCREMENT REG 1 BY 1
1526
1539
1528
=0
INCREMENT REG JUMP IF ≠0
≠0
RETURN TO NEXT INSTR
1530
1531
INCREMENT REG 3 IS RESULT ZERO
1532
N
Y
PUT A54 IN REG 2&3
1534
PUT A 48 IN REG 0&1
1536
1541
JUMP TO PTR1 CONVERT ROUTINE
1538

FIG-15C

1541

1540

=0

INCREMENT
REG 3
UMP IF ≠ 0

=0

RESET MOTION
STATUS

1542

PTR5

1544

READ PRINTER
HOME POSITION
STATUS

1545

1546

N

TEST PRINTER
HOME POSITION
STATUS

Y

1548

START PRINTER
AND EJECTOR

PTR7

1550

OUTPUT WEIGHT
DATA

1559

1552

OUTPUT T VALUE
DATA

1554

LOOK FOR MOTION

1556

SEND MPX ADDR
FOR SCANNER
AND CAMS

FIG-15D

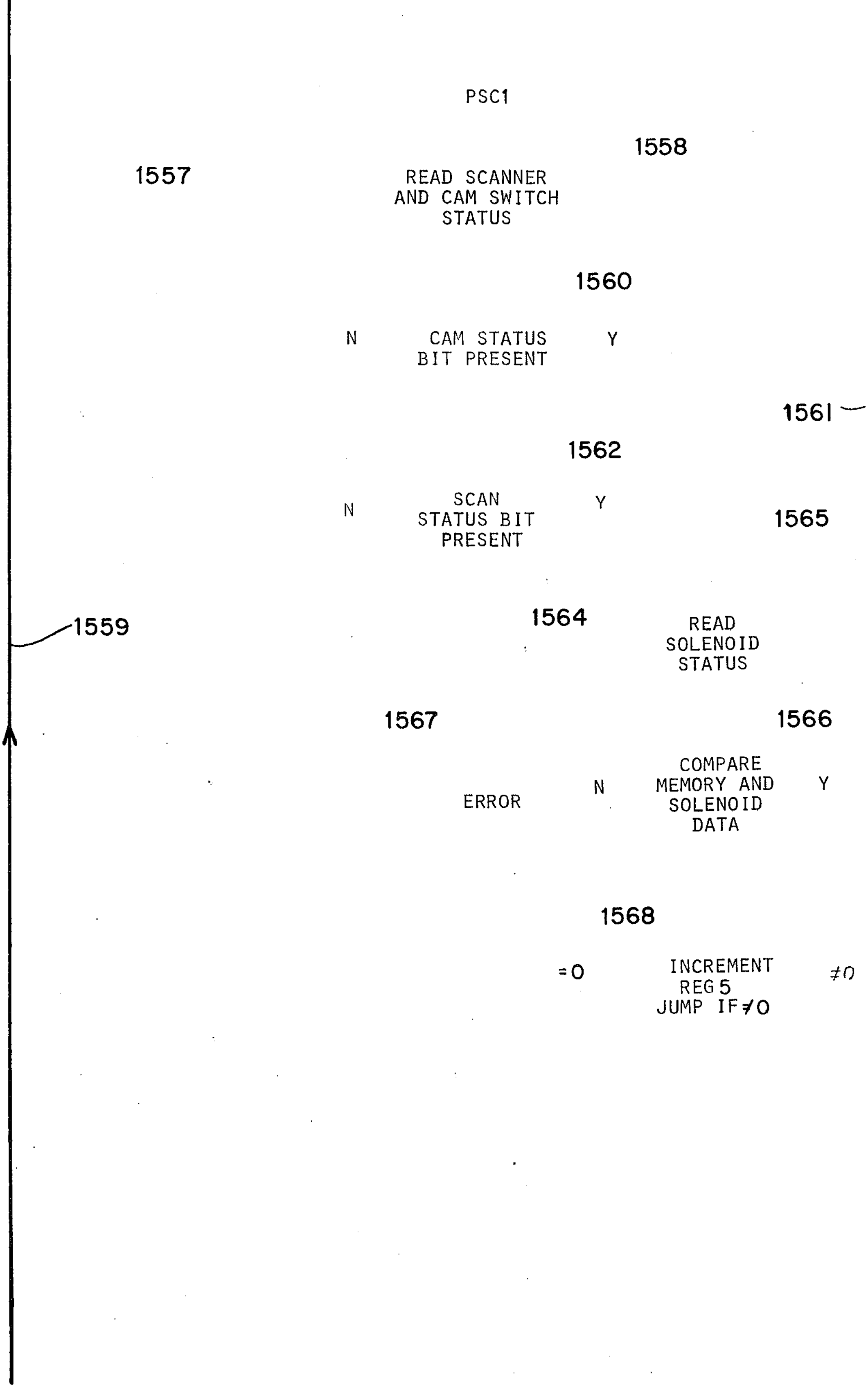

PSC1
1558
1557
READ SCANNER AND CAM SWITCH STATUS
1560
N
CAM STATUS BIT PRESENT
Y
1561
1562
N
SCAN STATUS BIT PRESENT
Y
1565
1559
1564
READ SOLENOID STATUS
1567
1566
ERROR
N
COMPARE MEMORY AND SOLENOID DATA
Y
1568
=0
INCREMENT REG 5 JUMP IF≠0
≠0

FIG-15E

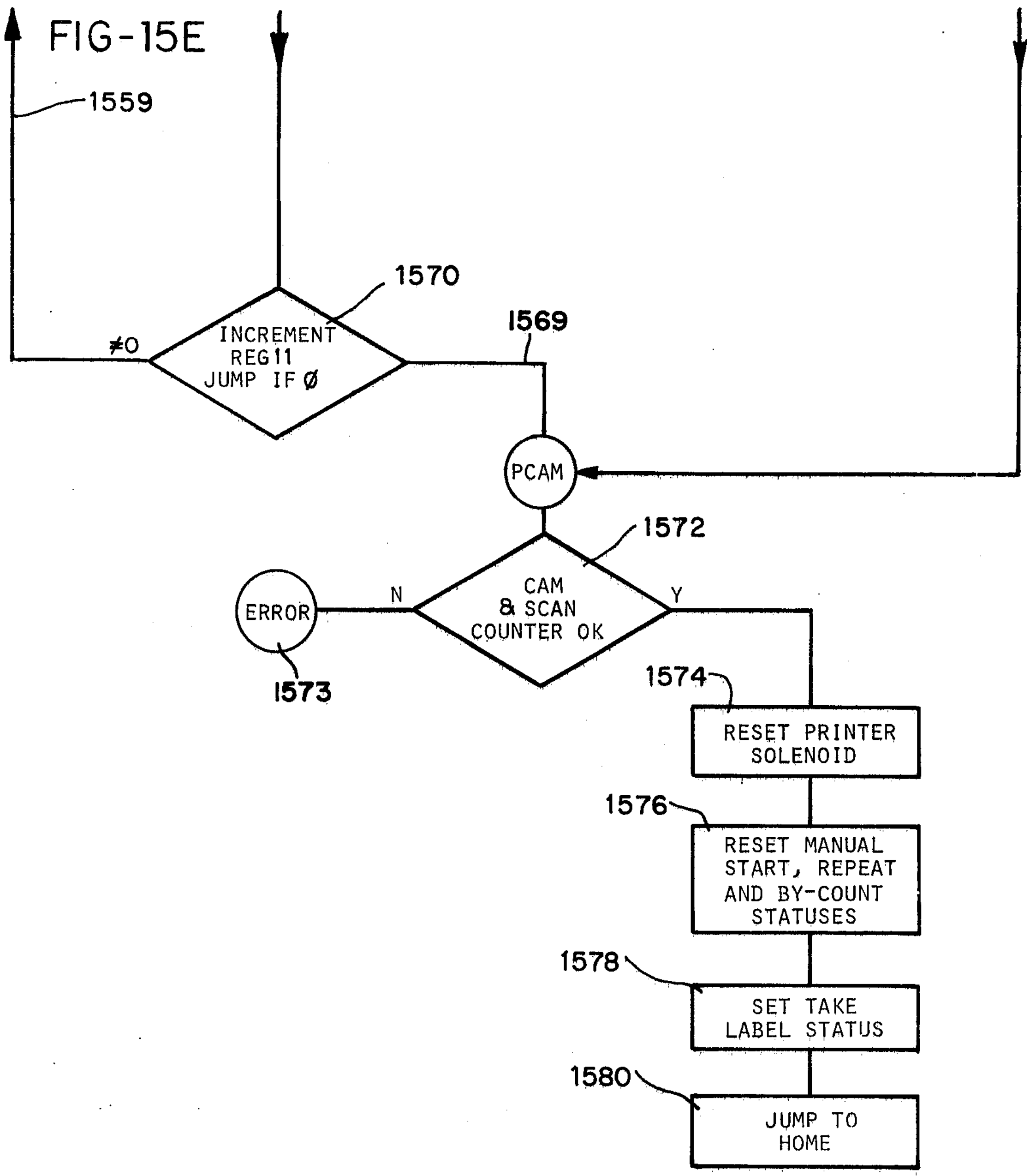
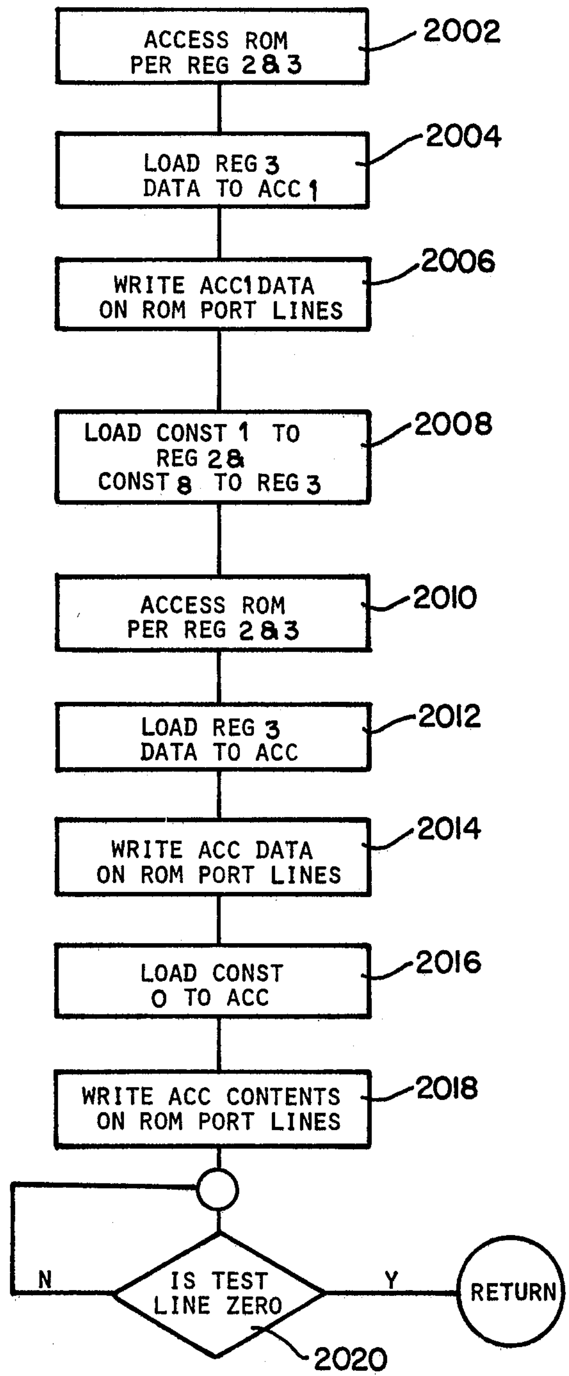

1559
1570
INCREMENT REG 11 JUMP IF Ø
≠0
1569
PCAM
1572
CAM & SCAN COUNTER OK
N
Y
ERROR
1573
1574
RESET PRINTER SOLENOID
1576
RESET MANUAL START, REPEAT AND BY-COUNT STATUSES
1578
SET TAKE LABEL STATUS
1580
JUMP TO HOME

FIG-20



ACCESS ROM PER REG 2 & 3
2002
LOAD REG 3 DATA TO ACC 1
2004
WRITE ACC1 DATA ON ROM PORT LINES
2006
LOAD CONST 1 TO REG 2 & CONST 8 TO REG 3
2008
ACCESS ROM PER REG 2 & 3
2010
LOAD REG 3 DATA TO ACC
2012
WRITE ACC DATA ON ROM PORT LINES
2014
LOAD CONST 0 TO ACC
2016
WRITE ACC CONTENTS ON ROM PORT LINES
2018
N
IS TEST LINE ZERO
Y
RETURN
2020

FIG-21

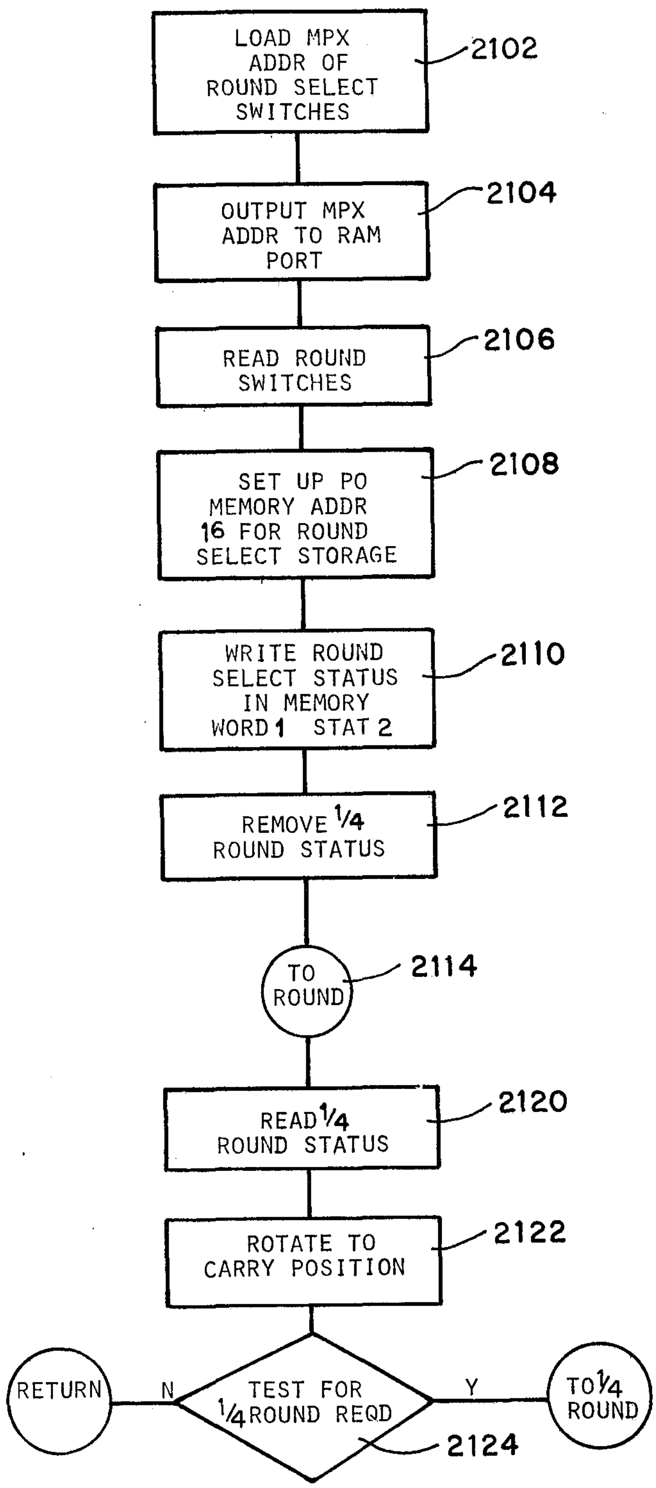

LOAD MPX ADDR OF ROUND SELECT SWITCHES
2102
OUTPUT MPX ADDR TO RAM PORT
2104
READ ROUND SWITCHES
2106
SET UP PO MEMORY ADDR 16 FOR ROUND SELECT STORAGE
2108
WRITE ROUND SELECT STATUS IN MEMORY WORD 1 STAT 2
2110
REMOVE 1/4 ROUND STATUS
2112
TO ROUND
2114
READ 1/4 ROUND STATUS
2120
ROTATE TO CARRY POSITION
2122
RETURN
N
TEST FOR 1/4 ROUND REQD
Y
TO 1/4 ROUND
2124

FIG-22A

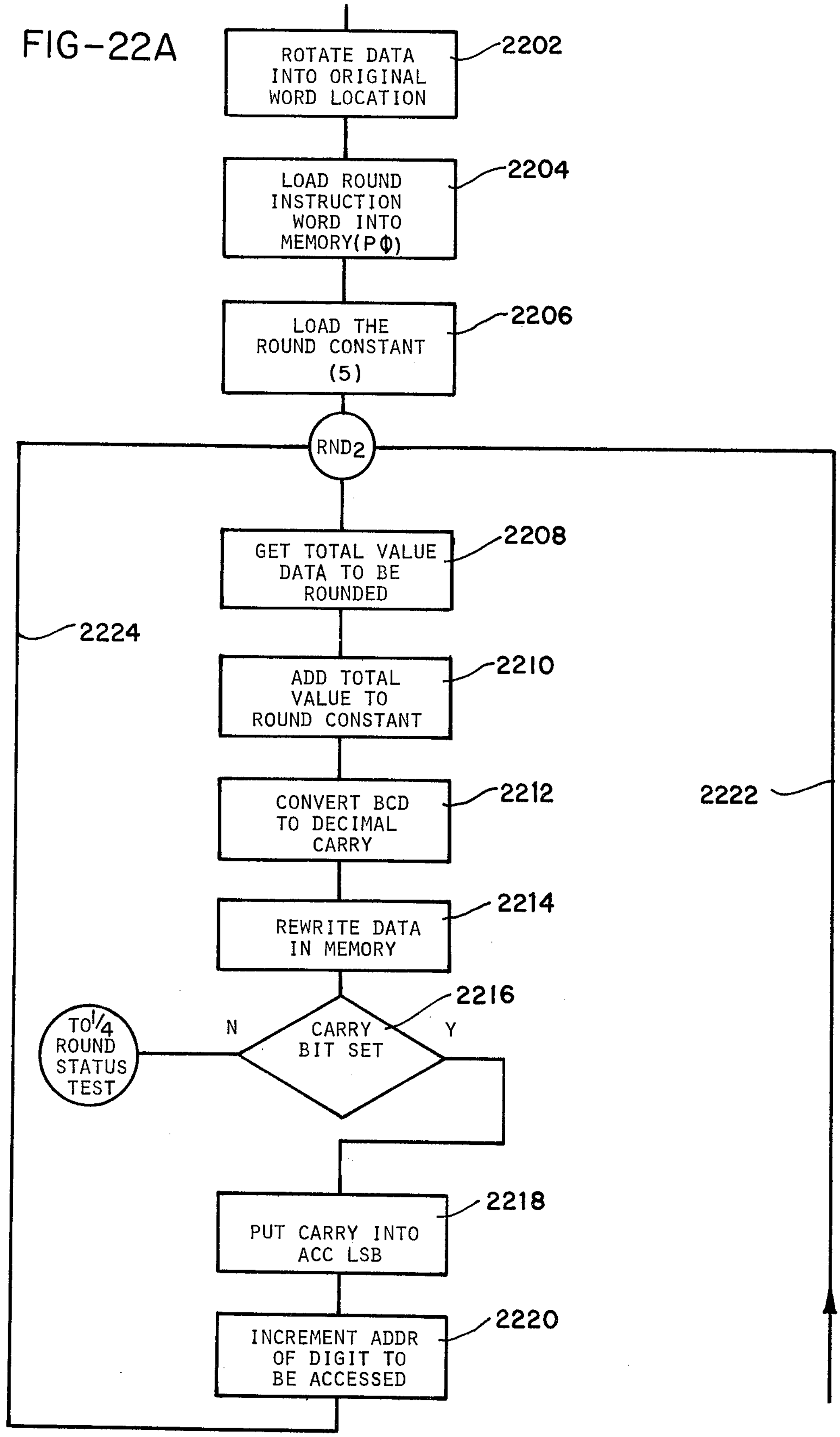

ROTATE DATA INTO ORIGINAL WORD LOCATION
2202
LOAD ROUND INSTRUCTION WORD INTO MEMORY(PΦ)
2204
LOAD THE ROUND CONSTANT (5)
2206
RND2
GET TOTAL VALUE DATA TO BE ROUNDED
2208
2224
ADD TOTAL VALUE TO ROUND CONSTANT
2210
CONVERT BCD TO DECIMAL CARRY
2212
2222
REWRITE DATA IN MEMORY
2214
CARRY BIT SET
2216
N
Y
TO 1/4 ROUND STATUS TEST
PUT CARRY INTO ACC LSB
2218
INCREMENT ADDR OF DIGIT TO BE ACCESSED
2220

FIG-22B

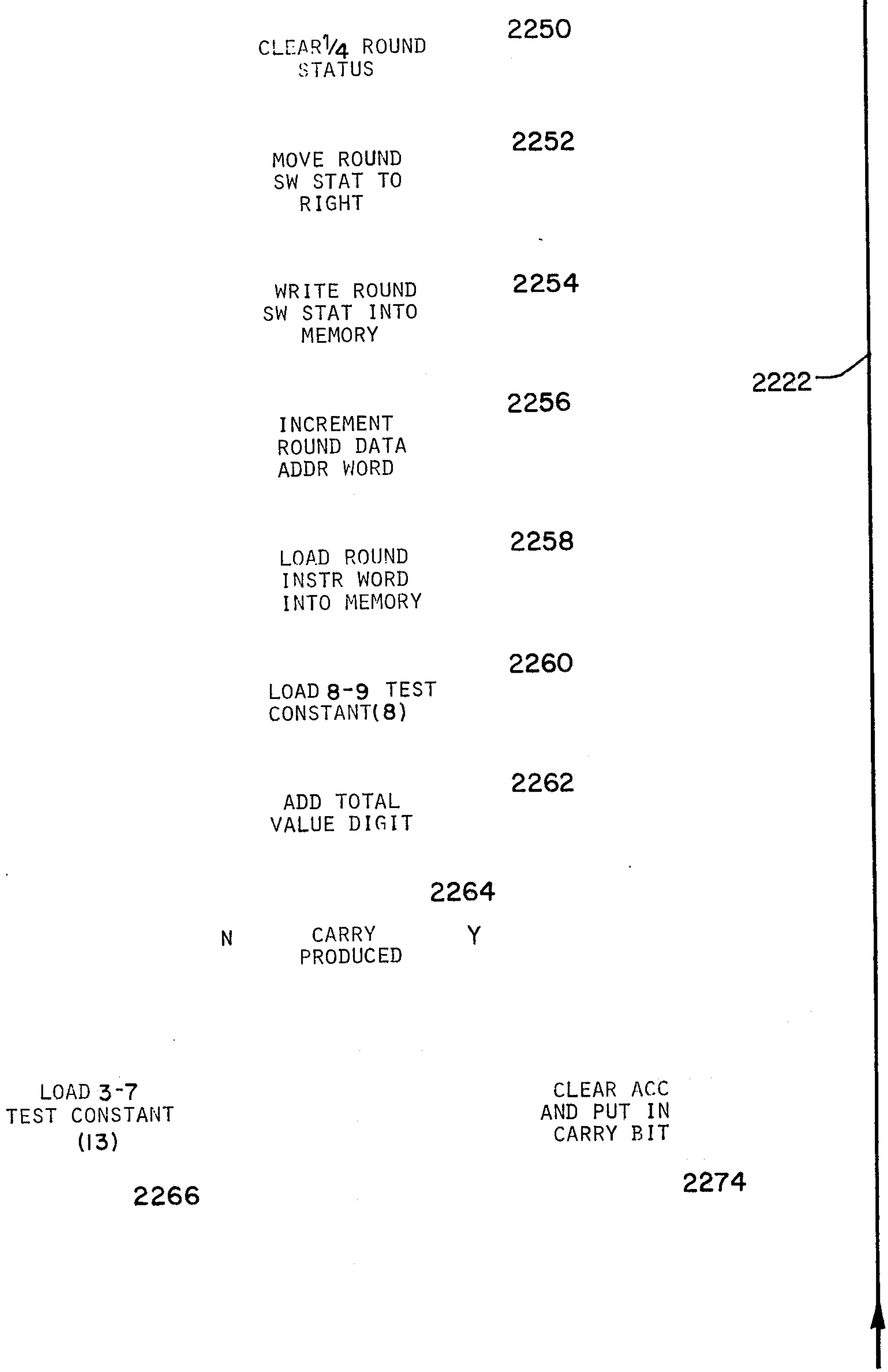

CLEAR 1/4 ROUND STATUS
2250
MOVE ROUND SW STAT TO RIGHT
2252
WRITE ROUND SW STAT INTO MEMORY
2254
2222
INCREMENT ROUND DATA ADDR WORD
2256
LOAD ROUND INSTR WORD INTO MEMORY
2258
LOAD 8-9 TEST CONSTANT(8)
2260
ADD TOTAL VALUE DIGIT
2262
2264
N
CARRY PRODUCED
Y
LOAD 3-7 TEST CONSTANT (13)
2266
CLEAR ACC AND PUT IN CARRY BIT
2274

FIG-22C

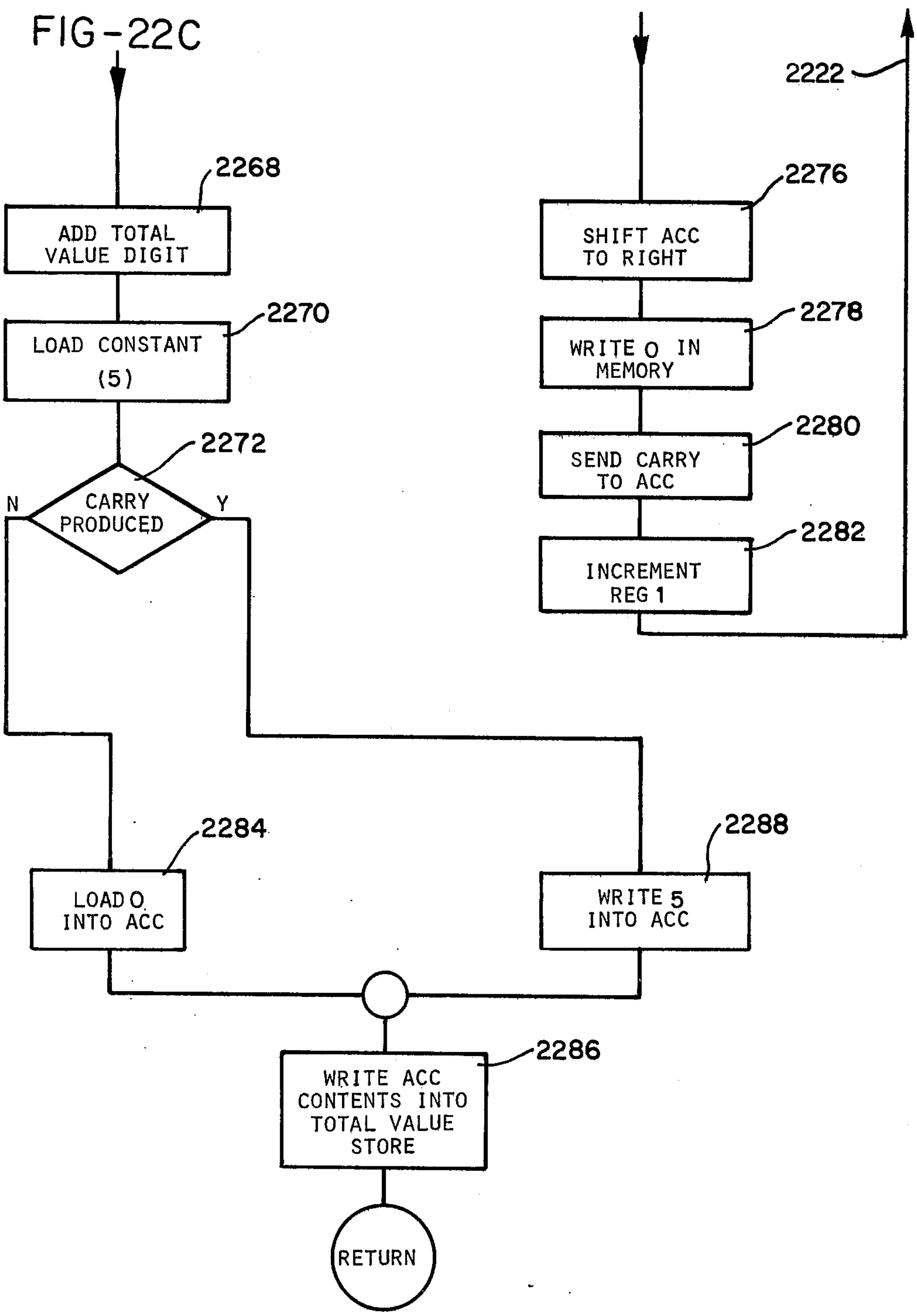
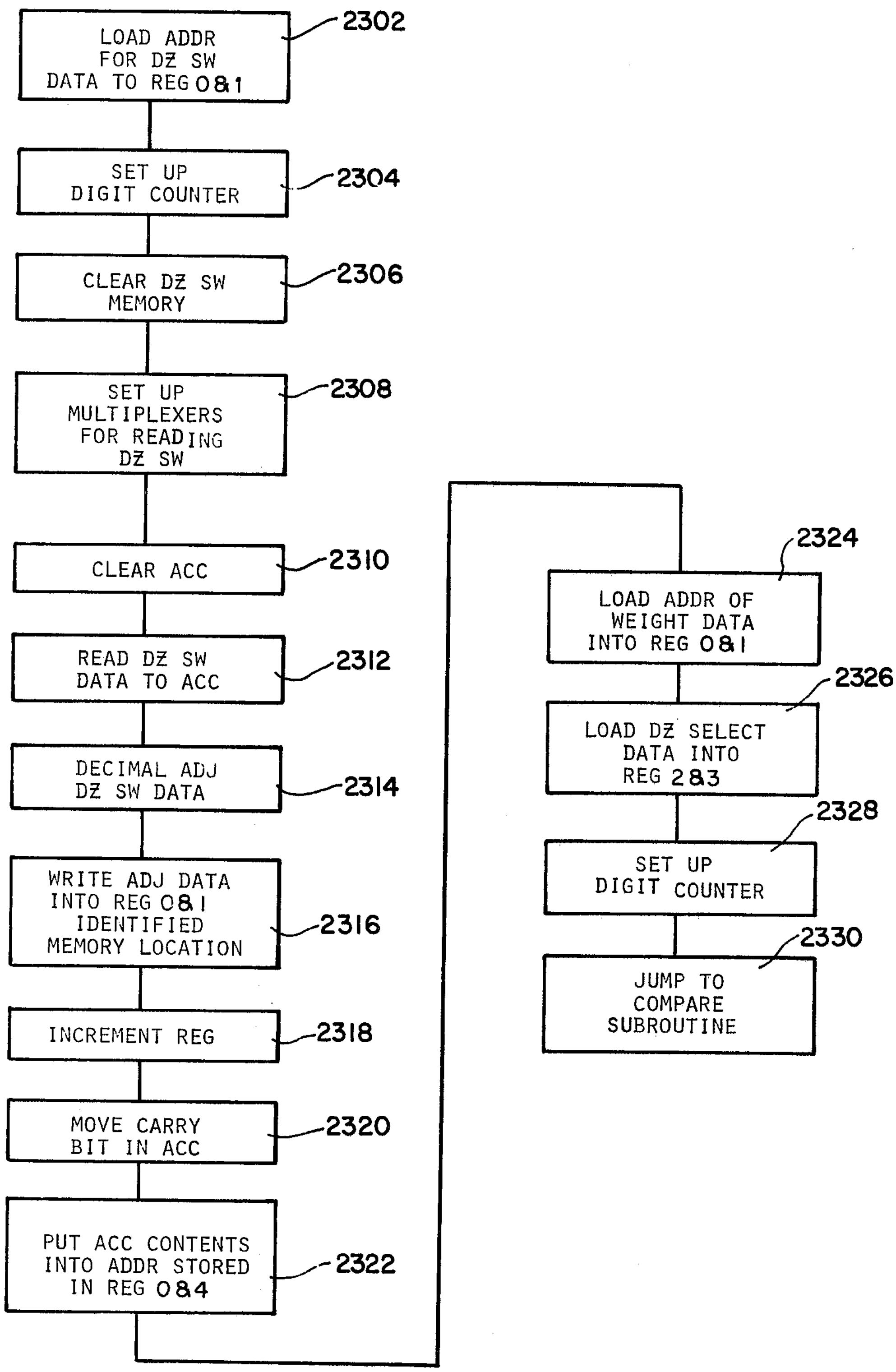

2222
2268
ADD TOTAL VALUE DIGIT
2270
LOAD CONSTANT (5)
2272
N
CARRY PRODUCED
Y
2276
SHIFT ACC TO RIGHT
2278
WRITE 0 IN MEMORY
2280
SEND CARRY TO ACC
2282
INCREMENT REG 1
2284
LOAD 0 INTO ACC
2288
WRITE 5 INTO ACC
2286
WRITE ACC CONTENTS INTO TOTAL VALUE STORE
RETURN

FIG-23



LOAD ADDR FOR DZ SW DATA TO REG 0&1
2302
SET UP DIGIT COUNTER
2304
CLEAR DZ SW MEMORY
2306
SET UP MULTIPLEXERS FOR READING DZ SW
2308
CLEAR ACC
2310
READ DZ SW DATA TO ACC
2312
DECIMAL ADJ DZ SW DATA
2314
WRITE ADJ DATA INTO REG 0&1 IDENTIFIED MEMORY LOCATION
2316
INCREMENT REG
2318
MOVE CARRY BIT IN ACC
2320
PUT ACC CONTENTS INTO ADDR STORED IN REG 0&4
2322
LOAD ADDR OF WEIGHT DATA INTO REG 0&1
2324
LOAD DZ SELECT DATA INTO REG 2&3
2326
SET UP DIGIT COUNTER
2328
JUMP TO COMPARE SUBROUTINE
2330

FIG-24A

2402
DESIGNATE MEMORY LOCATION FOR COMPARE STATUS

2404
CLEAR ACC

2406
CLEAR DESIGNATED COMPARE STATUS MEMORY

2408
READ ONE DIGIT OF COMPARE A DATA TO ACC

2410
SUBTRACT ONE DIGIT OF COMPARE B DATA

2412
N DIFFERENCE ZERO Y

2414
LOAD 1 TO ACC

2416
N CARRY SET Y

2418
LOAD 2 TO ACC

FIG-24B

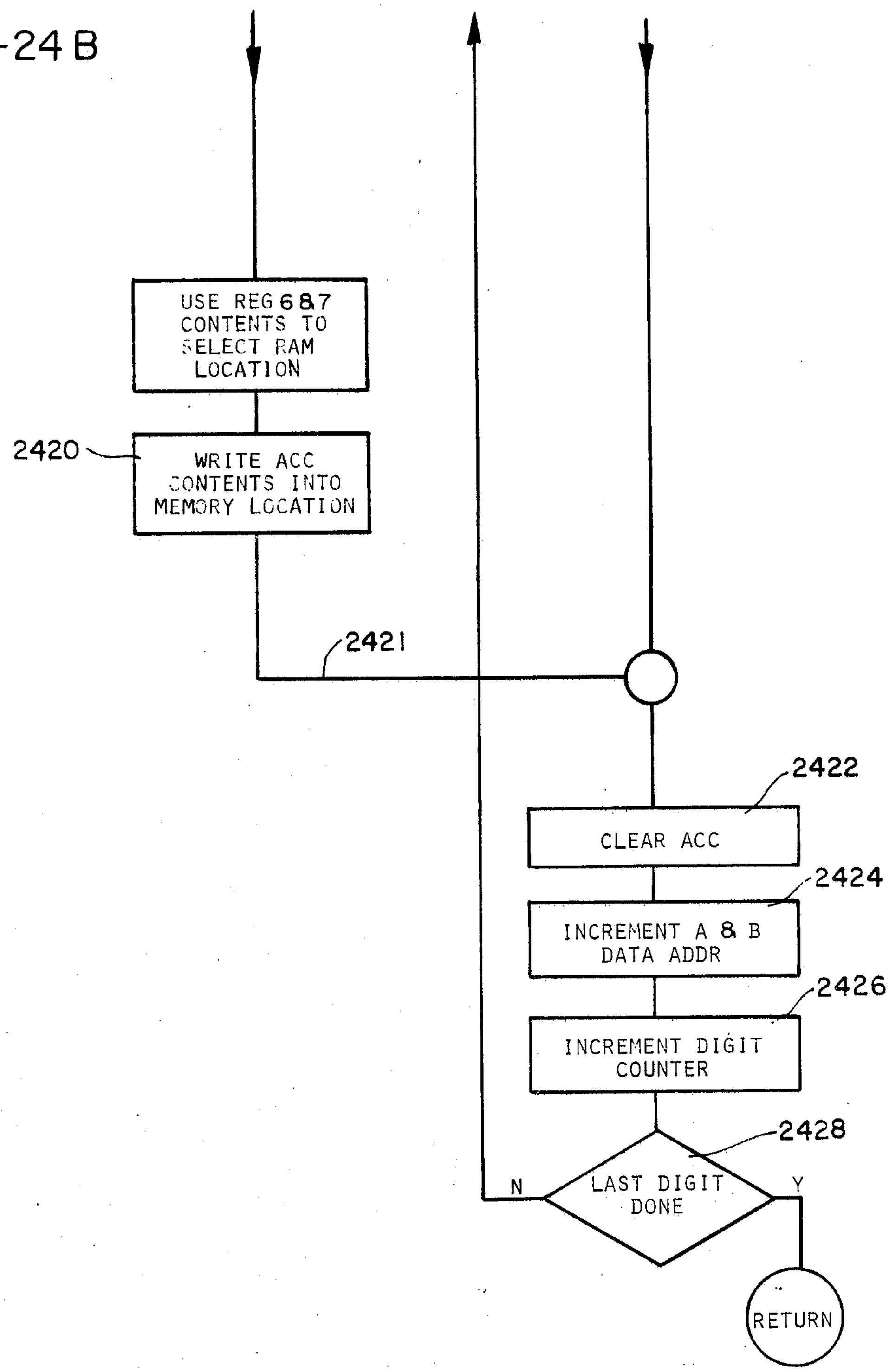

USE REG 6 & 7 CONTENTS TO SELECT RAM LOCATION
2420
WRITE ACC CONTENTS INTO MEMORY LOCATION
2421
2422
CLEAR ACC
2424
INCREMENT A & B DATA ADDR
2426
INCREMENT DIGIT COUNTER
2428
LAST DIGIT DONE
N
Y
RETURN

FIG-25A

2502
LOAD 0 IN REG 10
CHAR SENSED CTR
LOAD 12 IN REG 11
CHAR COMPLETED CTR

2504
LOAD 0 IN
REG 6 & 7 DIGIT
SELECT CTR

2506
LOAD INITIAL
MEMORY STORE
ADDR 32 INTO
REG 4 & 5

RDK2

2508
LOAD 13 IN REG 8
SEGMENT TESTED CTR
& 0 IN REG 9
SEGMENT UPGRADE CONST

2510
LOAD REG 12 WITH
SEGMENT VALUE INCREMENT
CONST (4) & 0 INTO
REG 13 ACTIVE
SEGMENT FOUND CTR

2512
LOAD REG 2 & 3 WITH
DIGIT CLOCK 32

2514
LOAD K/B MPXER
ADDR 4 IN REG 0 & 1

2516
ACCESS REG 6 & 7
DIGIT SELECT

2518
PUT REG 7 DIGIT
SELECT DATA
INTO ACC

FIG-25B

2520
SEND REG 7 DIGIT
OUT ON RAM
PORT I/O

2522
SEND OUT
SWITCH POWER
CLOCK

2551

RDK1

2524
SEND MPXER
SELECT INFO
FROM REG 0&1

2526
CLEAR ACC

2528
READ SW DATA
SEGMENT TO ACC 1

2530
CONVERT SW
DATA TO BCD

2532
N
WAS A CLOSED
SW FOUND
Y

2534
LOAD CONST 4
TO ACC

2536
SUBTRACT REG 12
CONTENTS

2538
ERROR
N
IS
RESULT
ZERO
Y

2558
REPLACE ACC DATA
WITH DATA COMPL

560
N
IS
RESULT
ZERO
Y
ERROR

2562
RESTORE
ACC DATA

2577

FIG-25C

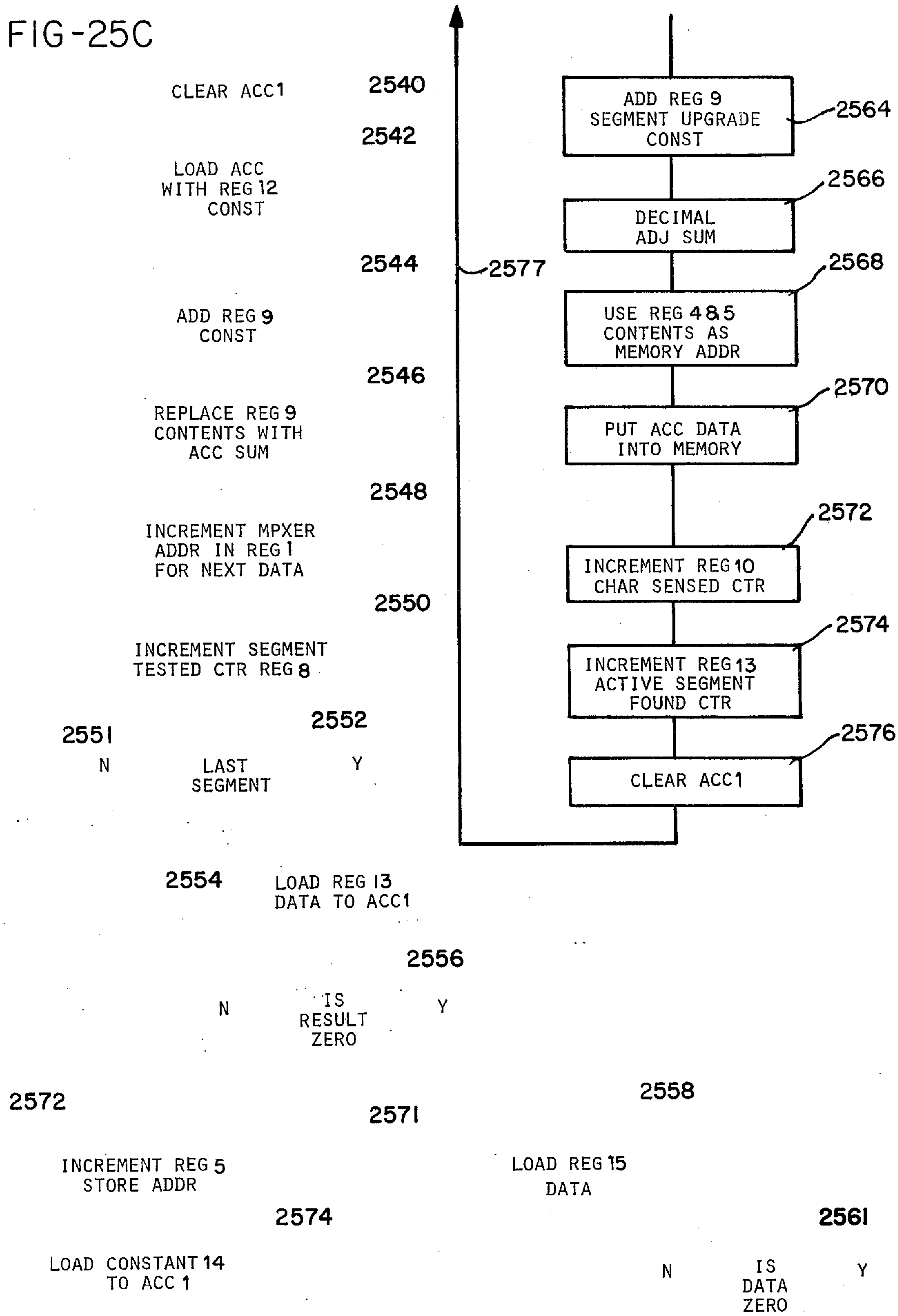

CLEAR ACC1
2540
2542
LOAD ACC WITH REG 12 CONST
2544
ADD REG 9 CONST
2546
REPLACE REG 9 CONTENTS WITH ACC SUM
2548
INCREMENT MPXER ADDR IN REG 1 FOR NEXT DATA
2550
INCREMENT SEGMENT TESTED CTR REG 8
2551
2552
N
LAST SEGMENT
Y
2554
LOAD REG 13 DATA TO ACC1
2556
N
IS RESULT ZERO
Y
2572
2571
2558
INCREMENT REG 5 STORE ADDR
LOAD REG 15 DATA
2574
2561
LOAD CONSTANT 14 TO ACC 1
N
IS DATA ZERO
Y
2577
ADD REG 9 SEGMENT UPGRADE CONST
2564
2566
DECIMAL ADJ SUM
2568
USE REG 4 & 5 CONTENTS AS MEMORY ADDR
2570
PUT ACC DATA INTO MEMORY
2572
INCREMENT REG 10 CHAR SENSED CTR
2574
INCREMENT REG 13 ACTIVE SEGMENT FOUND CTR
2576
CLEAR ACC1

FIG-25D

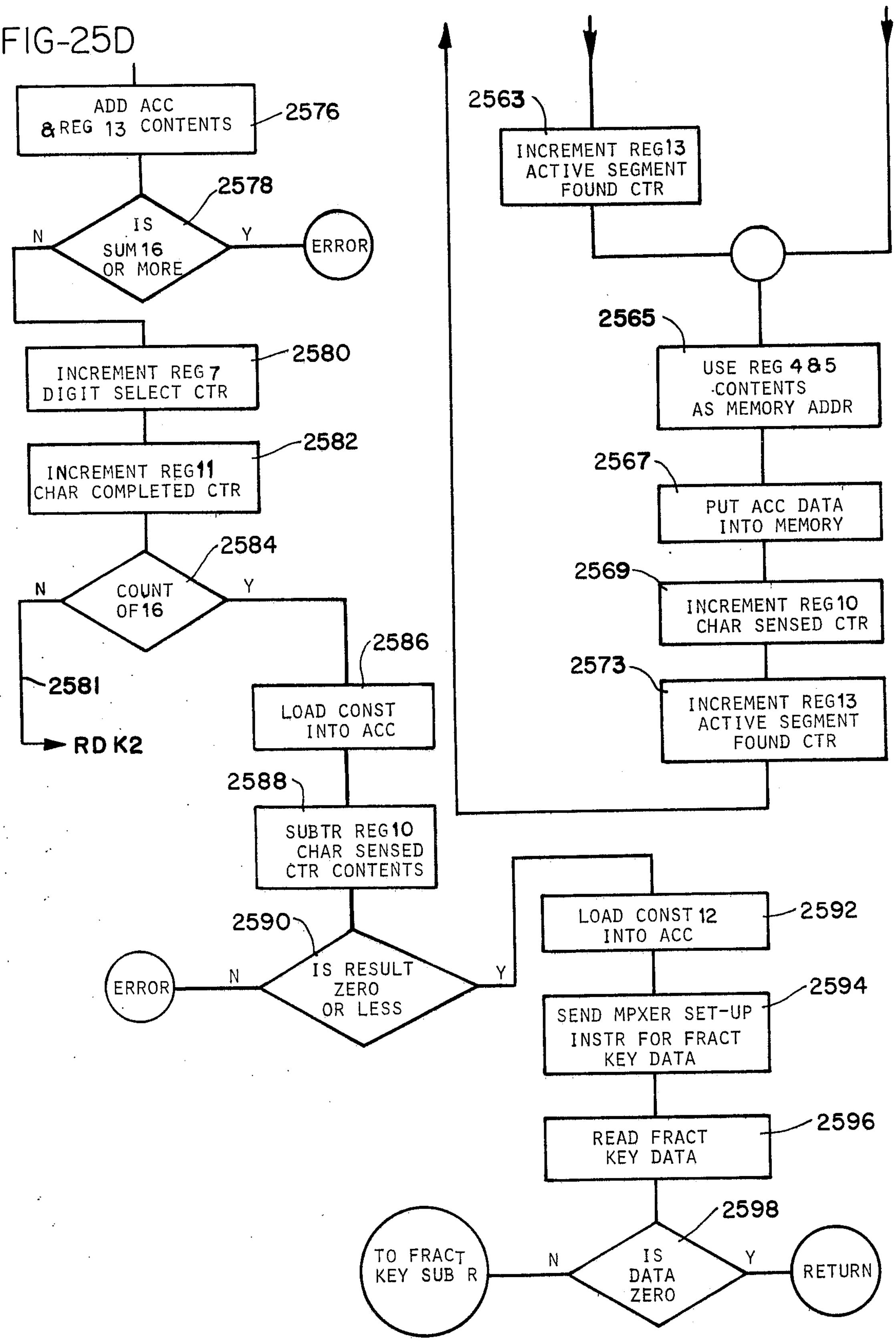

ADD ACC & REG 13 CONTENTS
2576
2578
IS SUM 16 OR MORE
N
Y
ERROR
INCREMENT REG 7 DIGIT SELECT CTR
2580
INCREMENT REG 11 CHAR COMPLETED CTR
2582
2584
COUNT OF 16
N
Y
2581
RD K2
2586
LOAD CONST INTO ACC
2588
SUBTR REG 10 CHAR SENSED CTR CONTENTS
2590
IS RESULT ZERO OR LESS
ERROR
N
Y
2563
INCREMENT REG 13 ACTIVE SEGMENT FOUND CTR
2565
USE REG 4 & 5 CONTENTS AS MEMORY ADDR
2567
PUT ACC DATA INTO MEMORY
2569
INCREMENT REG 10 CHAR SENSED CTR
2573
INCREMENT REG 13 ACTIVE SEGMENT FOUND CTR
LOAD CONST 12 INTO ACC
2592
SEND MPXER SET-UP INSTR FOR FRACT KEY DATA
2594
READ FRACT KEY DATA
2596
2598
IS DATA ZERO
N
Y
TO FRACT KEY SUB R
RETURN

FIG-26A

LOAD ADDR OF
PARITY BITS
2602

ACCESS CHART
PARITY BITS
2604

CLEAR ACC
LOAD DATA
2606

REMOVE NON
PARITY BITS
2608

STORE PARITY
BITS IN REG 10
2610

LOAD REG 10
PARITY BITS
TO ACC
2612

SUBTR CONST 3
2614

2616
PARITY
TEST
REQD
N
TO
EXEC
Y

LOAD REG 8 WITH 12
& REG 9 WITH 12
2618

LOAD REG 6 & 7
SUM OF BITS
STORE WITH 0
2620

LOAD REG 4 & 5
WITH 32
2622

CLEAR ACC
CARRY BIT
2624

READ MEMORY
ADDR 35
2626

FIG-26B

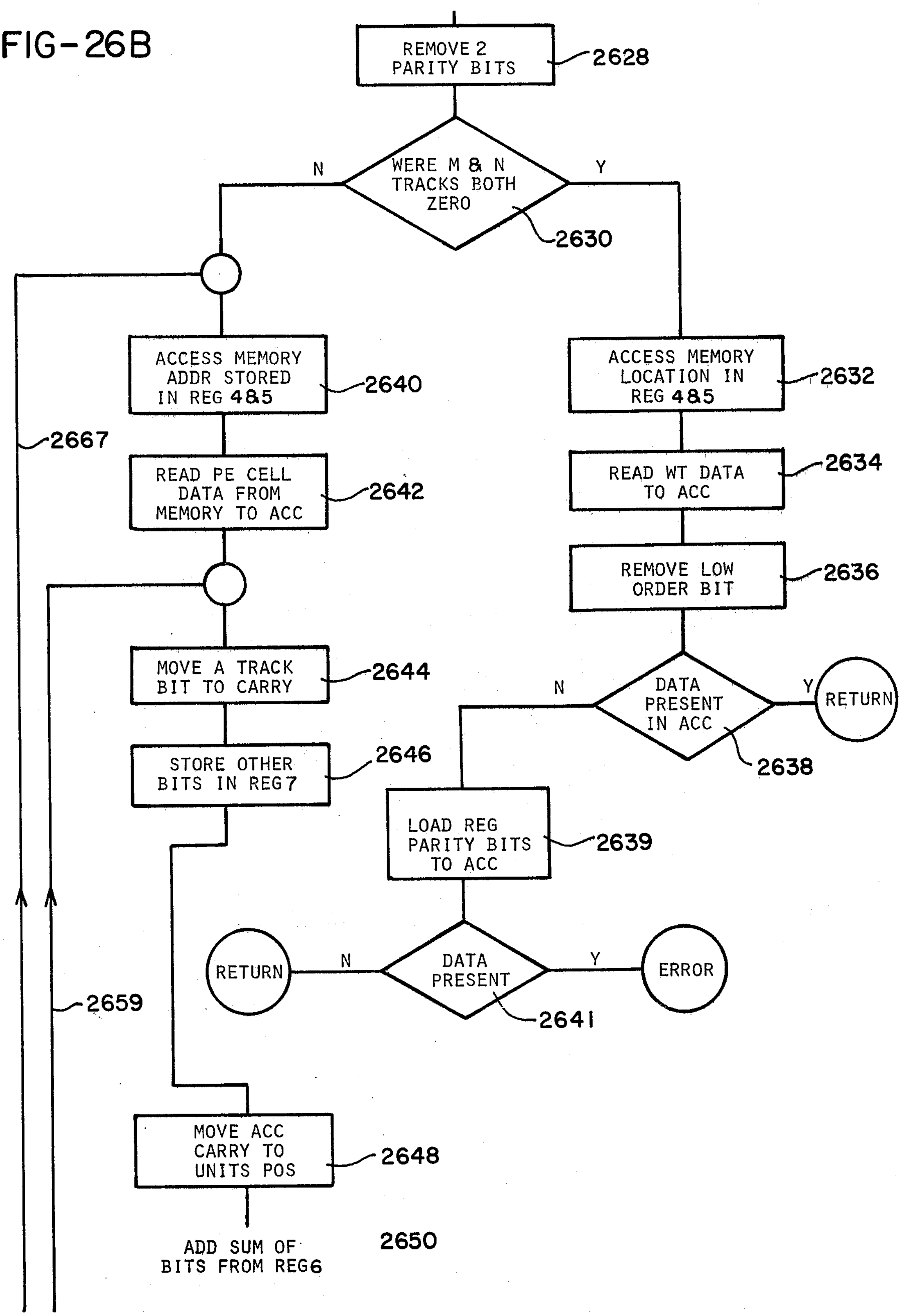

REMOVE 2 PARITY BITS
2628
WERE M & N TRACKS BOTH ZERO
N
Y
2630
ACCESS MEMORY ADDR STORED IN REG 4&5
2640
ACCESS MEMORY LOCATION IN REG 4&5
2632
2667
READ PE CELL DATA FROM MEMORY TO ACC
2642
READ WT DATA TO ACC
2634
REMOVE LOW ORDER BIT
2636
MOVE A TRACK BIT TO CARRY
2644
DATA PRESENT IN ACC
N
Y
RETURN
2638
STORE OTHER BITS IN REG 7
2646
LOAD REG PARITY BITS TO ACC
2639
RETURN
N
DATA PRESENT
Y
ERROR
2641
2659
MOVE ACC CARRY TO UNITS POS
2648
ADD SUM OF BITS FROM REG6
2650

FIG-26C

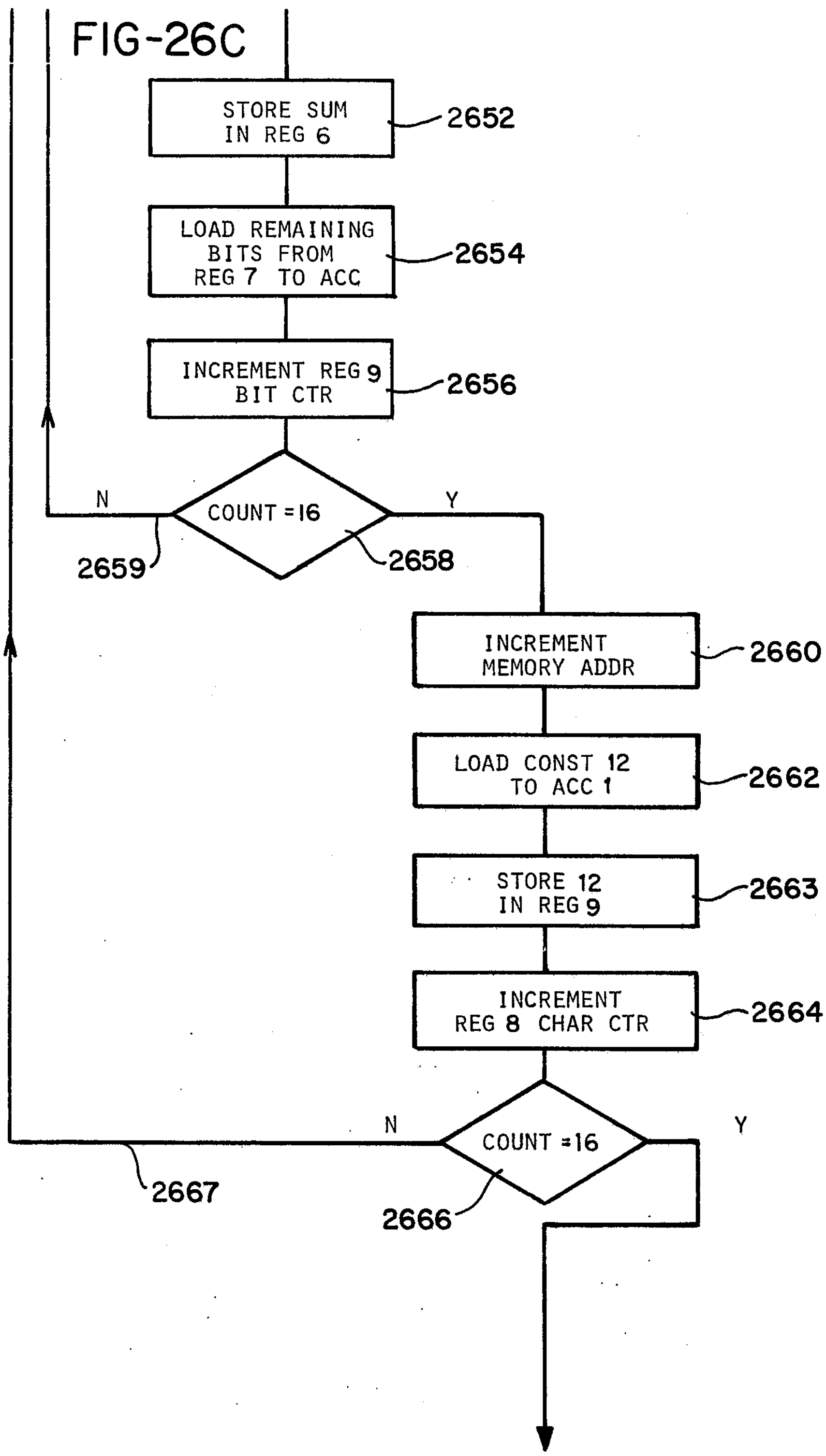
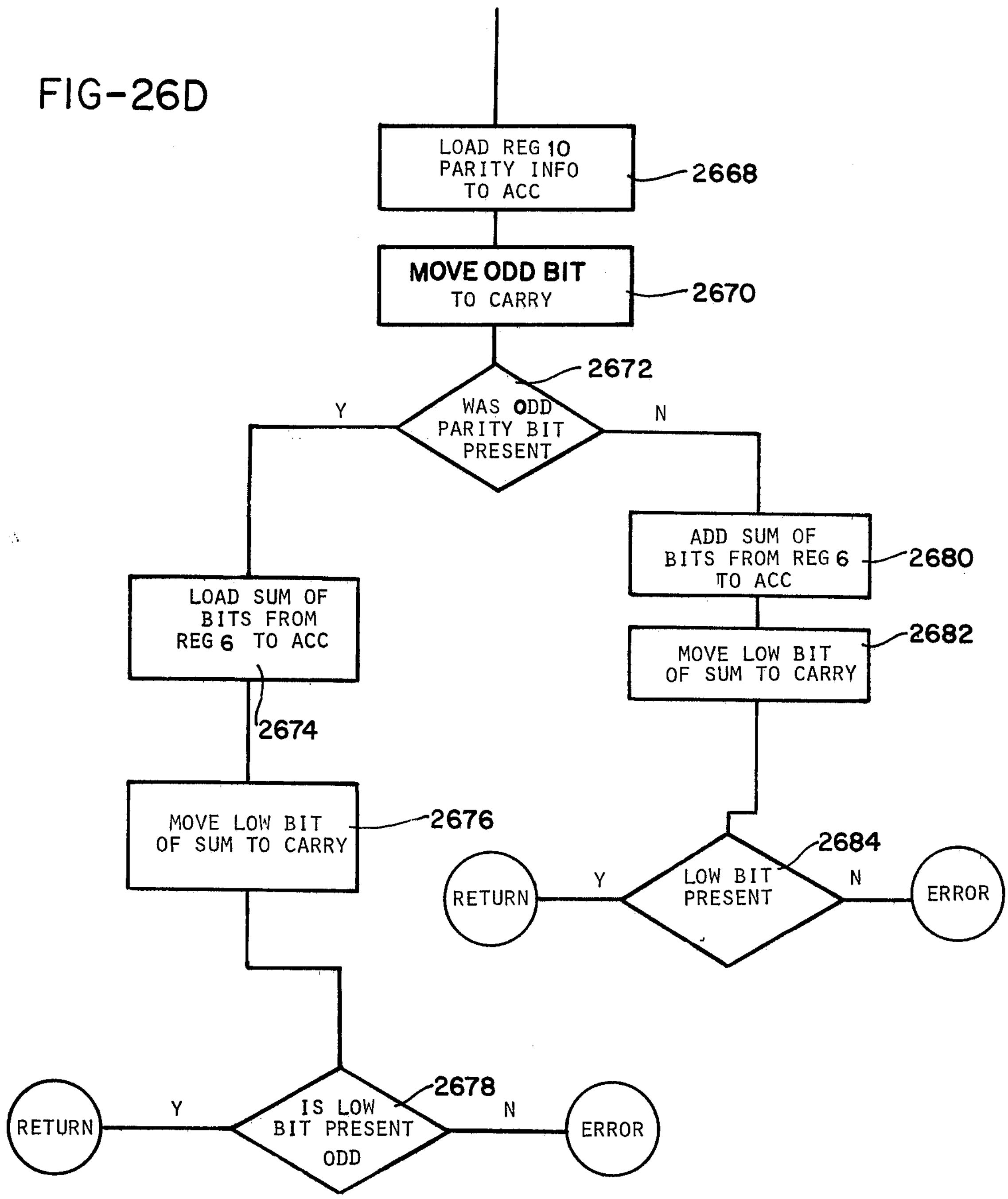

STORE SUM IN REG 6
2652
LOAD REMAINING BITS FROM REG 7 TO ACC
2654
INCREMENT REG 9 BIT CTR
2656
COUNT = 16
N
Y
2659
2658
INCREMENT MEMORY ADDR
2660
LOAD CONST 12 TO ACC 1
2662
STORE 12 IN REG 9
2663
INCREMENT REG 8 CHAR CTR
2664
COUNT = 16
N
Y
2667
2666

FIG-26D


LOAD REG 10 PARITY INFO TO ACC
2668
MOVE ODD BIT TO CARRY
2670
WAS ODD PARITY BIT PRESENT
2672
Y
N
LOAD SUM OF BITS FROM REG 6 TO ACC
2674
MOVE LOW BIT OF SUM TO CARRY
2676
IS LOW BIT PRESENT ODD
2678
RETURN
ERROR
ADD SUM OF BITS FROM REG 6 TO ACC
2680
MOVE LOW BIT OF SUM TO CARRY
2682
LOW BIT PRESENT
2684
RETURN
ERROR

COMPUTING SCALE SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to computing the scale sytems of the general type disclosed in Allen et al. in U.S. Pat. No. 3,557,353. Such computing scale systems have a scale, a label printer, and a computer fabricated from discrete components. Such scale systems are widely used in the food merchandising trade and may be used in combination with indexing and label application systems as shown in Treiber U.S. Pat. No. 3,732,966 or with automatic wrapping machines as disclosed in Treiber U.S. Pat. No. 3,429,098 or Treiber et al. U.S. Pat. No. 3,585,784.

Such prior art computing scale systems are flexible and versatile in their operation, but these scales are ordinarily constructed for a specific type of application. If it is desired to convert the scale from one application to another it is often times necessary to modify the configuration of the computer. There are now available integrated circuit microcomputers which may be easily programmed to do a large number of tasks, and it has become desirable to further increase the capabilities of the above mentioned prior art scale systems by usage of such computers. It has now been found that significantly improved operation as well as added versatility and new operating modes may be achieved by such a combination as hereinafter described.

SUMMARY OF THE INVENTION

This invention improves the operation of a scale system of the type shown in Allen et al. U.S. Pat. No. 3,557,353 by utilizing therewith a readily available integrated circuit microcomputer, which may be programmed by loading bit patterns as appropriate into a read only memory. The microcomputer operates on 4-bit data words, and there is provided a multiplexing network for multiplexing data into the computer.

In accordance with one feature of the invention weight data is read from a scale chart by a bank of photocells or photosensors, and means are provided for checking the parity of the data read by the photocells. When the scale is in a position of transition between weight readings, photocell parity checking is suppressed to avoid generation of parity errors by photocell threshold phenomena.

The weight data which is read from the scale chart is in a Gray code format, and this Gray code is converted to a BCD code by a table lookup routine. The Gray coded weight information is used as a table address for a first BCD weight indication, and the Gray code address is thereafter modified by a fixed number of address locations. Following this a second table entry is made to obtain a second BCD coded weight, which should be the nines complement of the first obtained weight. The system checks both the address of the information obtained from the lookup table and also checks the code conversion process by adding the digits of the two sets of BCD codes and checking for a predetermined sum.

Also in accordance with this invention there are provided a series of switch means for controlling the operation of the microcomputer. The microcomputer is so configured that actuation of some of the switch means adjusts the size of the weight dead zone. Other of the switch means control a value rounding routine and still others select multiplication factors for adapting the scale to metric system use.

The scale system checks for scale motion by looking for simultaneous outputs from the two preselected photocells and also by a routine which looks for a predetermined number of successive weight changes in the same direction. When the predetermined number of weight changes in the same direction are detected, then a timing routine is entered. Switch means are provided for controlling the length of time spent in the timing routine. If a scale motion indication is generated during this time, then a new entry is made into the timing routine.

A motion status word is set by the first sensing of scale motion, which may be indicated by three successive weight changes in the same direction. Thereafter two successive weight changes in the same direction are sufficient for maintaining motion status and causing reentry into the timing routine.

Provision is also made in the scale system for printing product weight and a predetermined fixed product value on labels for use on products which are sold by count. This printing of variable weight and fixed value is accomplished as part of a "by-count" operating mode, in which it is possible also to print labels with zero weight and a predetermined fixed value. The zero weight is read into the printer output control register while a product is sitting on the scale and actually indicating some finite weight.

It is therefore an object of this invention to increase the performance and versatility of prior art computing scale systems.

It is another object of this invention to provide means for checking the parity of output signals from weight reading photocells.

Another object of this invention is to provide improved means for detecting scale motion.

Still another object of this invention is to provide improved means for converting a Gray coded weight reading into a BCD format.

Other and further objects and advantages of the invention will be apparent from the following description, the accompanying drawings, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a pictorial drawing of a computing scale system;

FIGS. 2A through 2E are an electrical schematic diagram of microcomputer circuitry used with the described embodiment of the invention;

FIGS. 3A through 3C are an electrical schematic diagram of multiplexing and interface circuitry for use with the circuitry of FIGS. 2A through 2E;

FIG. 4 is an electrical schematic diagram of scanner circuitry;

FIGS. 5A and 5B are an electrical schematic diagram of printer circuitry;

FIGS. 6A through 6E are an electrical schematic diagram of circuitry for interfacing the printer circuitry of FIGS. 5A and 5B with the microcomputer circuitry of FIGS. 2A through 2E;

FIGS. 7A and 7B are an electrical schematic diagram of further circuitry for interfacing the printer circuitry of FIGS. 5A and 5B with the microcomputer circuitry of FIGS. 2A through 2E;

FIG. 8 is an electrical schematic diagram of still further interface circuitry required for operation of the described embodiment;

FIG. 9 is a schematic diagram of a portion of a scale chart;

FIG. 10 is a general system block diagram for the described embodiment;

FIGS. 11A through 11F are a program flow chart for an executive routine performed by the microcomputer;

FIGS. 12A and 12B are a flow chart for a motion detecting subroutine performed by the microcomputer;

FIG. 13 illustrates the layout of FIGS. 2A through 2E;

FIG. 14 is a flow chart for a subroutine for controlling address data outputs;

FIGS. 15A through 15E are a flow chart for a printer control subroutine;

FIG. 16 illustrates the layout of FIGS. 3A through 3C;

FIG. 17 illustrates the layout of FIGS. 5A and 5B;

FIG. 18 illustrates the layout of FIGS. 6A through 6E;

FIG. 19 illustrates the layout of FIGS. 7A and 7B;

FIG. 20 is a flow chart of a subroutine for controlling clock data outputs;

FIG. 21 is a flow chart for a subroutine for determination of rounding status:

FIGS. 22A through 22C are a flow chart for a value rounding subroutine;

FIG. 23 is a flow chart for a weight dead zone subroutine;

FIGS. 24A and 24B are a flow chart for a data comparison subroutine;

FIGS. 25A through 25D are a flow chart for a price switch reading subroutine; and

FIGS. 26A through 26D are a flow chart for a parity checking subroutine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A computing scale system operating in accordance with this invention may be incorporated within apparatus as illustrated generally by FIG. 1. The major system elements as illustrated therein are a scale 20, having a platter 21, a computer 25, and a register printer or labeler 30. Scale 20 may have a weight reading window 22, a tare adjusting knob 23 and a tare light 24. The register printer comprises three knobs 31, 32 and 33 for indication of a price per unit weight of an article being weighed, and a label or ticket ejector mechanism 35, which may be of a type described in detail in Allen, et al, U.S. Pat. No. 2,948,466.

Register printer 30 may have on its front panel a manual start switch 72, a repeat switch 71, a reset switch 70 and a power turn on switch 74. Below these switches there may be located an indicator light 61 for indicating that a change in price may be needed, an indicator light 62 for indication of a low paper supply, an error indicating light 60, and a power on indicating light 64. Provision may also be made for insertion of a commodity key 37 in the side of register printer 30.

The functions of the above mentioned controls and the operation of register printer 30 are all described in detail in Allen et al., U.S. Pat. No. 3,557,353. Also described in Allen et al., '353, and in references therein mentioned, are the operation of the scale 20 and a photoelectric scale reading system incorporated within the scale housing. The operation of the tare adjustment knob 23 and tare light 24 is described in detail in Allen, et al., U.S. Pat. No. 3,786,881.

The apparatus as shown in FIG. 1 may be supplemented with additional control switches and indicator lights, the functions of which will become apparent in the further description of the preferred embodiment. Also, as hereinafter described, the computing scale system may be used in combination with package indexing and label application apparatus as described in Treiber, U.S. Pat. No. 3,732,966, and also with an automatic labeling machine as described in Treiber, U.S. Pat. No. 3,429,098 or in Treiber, et al., U.S. Pat. No. 3,585,784. **The operating sequence of the present scale is controlled by a programmed microprocessor; steps in the program of the microprocessor cause commencing and termination of scale events such as weight reading, motion detecting and printing commencement in ordered sequence. In a discrete component or hard-wired scale embodiment, this ordered sequence control may, of course, be supplied by a series connected group of flip-flops or other sequencing circuits rather than a computer program.**

A generalized block diagram for the system is shown in FIG. 10. The blocks shown in that figure represent the scale 20, the labeler 30, a set of multiplexers 40, a read only memory (ROM) 50, a central processing unit (CPU) 230, and a random access memory (RAM) 231. Memories 50 and 231 and CPU 230 are part of a 4-bit parallel microcomputer set, as described in detail below. A series of instructions for system operation, including instructions for necessary computation and data handling, are stored at predetermined storage locations in ROM 50. CPU 230 utilizes line 46 for addressing the various storage locations within memory 50 in numerical sequence, or other sequence as called for by codes stored within ROM 50, and ROM 50 responds to such addresses by sending back along line 47 a series of instruction codes stored at the addressed locations. CPU 230 performs the operations called for by the codes received from ROM 50, and utilizes RAM 231 for temporary storage.

All data representing labeler status from line 42, price per unit weight from line 43, and commodity weight from line 41, are transmitted through multiplexers 40 and along line 48 through an input port associated with ROM 50 for transmission to CPU 230. Operation of multiplexers 40 is under the control of data received on line 54 from line 49. Line 49 carries addressing data transmitted by CPU 230 through an output port associated with RAM 231. The output port from RAM 231 also addresses the price per unit weight switches within labeler 30, as indicated by the line 53, and addresses the print wheel solenoids within labeler 30, as indicated by the line 52. This same output port further supplies address information via line 51 for addressing a set of photosensors within scale 20 to provide an indication of product weight. Reading of data from labeler 30 and scale 20 to multiplexers 40 is under the control of strobe signals generated by CPU 230 and trasnmitted, as illustrated by line 45, through a pair of output ports associated with ROM 50.

Detailed electrical schematic diagrams for the system housed within the units illustrated in FIG. 1 are presented in FIGS. 2 through 8, each of which FIGS. is broken up into several parts for preparation of the drawings. Some portions of these schematics are illustrated here primarily for completeness of the disclosure. For instance, FIGS. 5A through 5B illustrate the control switches 70, 71 and 72, and the indicator lights 60, 61, 62 and 64. The output lines from the price per unit weight switches are lines 520 through 529, which provide pricing information to other circuitry as indicated in FIGS. 6A through 6D. FIGS. 5A and 5B also illustrate an ejector switch 540, a repeat switch 541, cam switch **543**, a solenoid switch **544**, a commodity change switch **545**, a pair of price changing switches **546** and **547**, and the ejector motor winding **560**. Cam switch **543** is opened once with each cycle of the printer, and price change switches **546** and **547** are ganged together for cooperative switching whenever any of the price change knobs **31** through **33** are manually moved. The commodity change switches **545** and **590** are operated by removal of commodity key **37**. During removal of commodity key **37** or movement of one of the price change knobs **31** through **33** an error signal is generated on line **507**.

A pair of switches **561** and **562** are ganged together for cooperative switching. As described below, scale units which are designed for use in metric measuring countries utilized certain special computer routines. In order to accommodate the special metric operation switch **561** is closed and switch **562** is open. For operation in the United States the scale is delivered with switch **561** open and switch **562** closed. As a practical matter the setting of switches **561** and **562** is a factory operation, and the two switches may be omitted and replaced by a jumper wire at one location or the other.

Within register printer **30** are motors for driving a set of print wheels and for ejecting labels, the operation of which is described in Allen et al., U.S. Pat. No. 3,557,353. The print wheels are positioned by a set of primary segment gears loosely mounted on a rocker shaft (not illustrated). The primary segment gears are stopped in correct printing position by energizing or firing solenoids **551** through **558**, one solenoid halting each segment gear. The solenoids in turn are fired by input signals on lines **701** through **708**. Other control lines associated with the circuitry of FIGS. **5A** and **5B** are output lines **502** through **508** and input lines **601** through **606**. A relay **501** for activating the print wheel drive motor (not shown) is operated by line **606**. When the rocker shaft reaches its home position, a switch **544** is opened to provide a "home position" signal on line **503**. Also during rotation of the rocker shaft, a cam switch **543** is operated to cause an output on line **530** for transmission to the system computer via multiplexer **626** (FIG. 6B). The signal indicates that the printer has completed a predetermined portion of its operating cycle.

The remainder of the circuitry, which is shown in FIGS. 2 through **4** and **6** through **7**, makes extensive use of integrated circuits, which are commercially available. Table I below lists the integrated circuit types, the operating characteristics of which are readily available from the manufacturer. All of the circuit types with the prefix letters SN are manufactured by Texas Instruments Incorporated of Dallas, Texas. The remaining circuits are manufactured by Intel Corporation of Santa Clara, Calif. The Intel components, all of which appear in FIGS. 2A through 2E, are part of a 4-bit parallel microcomputer set marketed by Intel Corporation under the trademark MCS-4. For a description of such a microcomputer reference may be made to Hoff et al., U.S. Pat. No. 3,821,715. Procedures for using the microcomputer are set forth in a users manual, dated March 1974, REV. 5, published by Intel Corporation. This users manual sets forth timing diagrams, descriptions of computer modules, overall microcomputer operation, and detailed programming instructions. Table II below sets forth the Intel instruction set, as provided by the manufacturer, together with a description of the operations associated with the instructions.

MICROCOMPUTER CIRCUITRY

FIGS. 2A through 2E illustrate the connections for the microcomputer components. Integrated circuit **230** is the central processing unit. Circuit **230** communicates via data bus lines **270** through **273** with a RAM circuit **231**, and a pair of interface circuits **232** and **233**. The interface circuits **232** and **233** provide respectively a ROM address register and data multiplexing; these chips are respectively Intel **4008** and **4009** devices described in the intel users manual. RAM circuit **231** is used for temporary storage and for output of multiplexer control signals as hereinafter described. The multiplexer control signals are output from RAM **231** via four inverting amplifiers **260** through **263**. In accordance with terminology used within the above mentioned users manual for the microcomputer's set, RAM **231** is termed RAM 0, and the inverting amplifiers **260** through **263** serve as a RAM **0** output port. Accordingly the output from inverting amplifier **260** is designed RAM **0**, bit **0**. Similarly the output signals from inverting amplifiers **261**, **262** and **263** and RAM **0**, bit **1**, RAM **0**, bit **2**, and RAM **0**, bit **3**. The RAM bits are sent to appropriate control locations via lines **200** through **203**, **204** through **207**, and **214** through **217**. As further described in the above mentioned users manual, RAM **231** comprises four registers, each having a main memory of sixteen 4-bit words and four 4-bit status characters.

CPU **230** has a command output line **274** which tells IC **233** how to interpret the data bus content at any given time. This command controls the operation of ROM input and output ports as described below. Central processing unit **230** also outputs a RAM control signal on line **275** and a sync signal on line **276**. Central processing unit **230** has provision for controlling three additional RAMs, which are not used in the described embodiment of this invention.

Integrated circuit **232** interfaces the CPU to six ROM circuits **234** through **239**. CPU **230** transmits ROM addresses at appropriate times to IC **232** via lines **270** through **273**. These addresses are latched at the output lines **224** through **226** and **280** through **287**. Lines **224** through **226** carry a 3-bit ROM address code, which is decoded by NOR gate **227** and a decoder **241**. Lines **280** through **287** carry an 8-bit program address, which is sent to all of ROMs **234** through **239**. ROM circuits **234** through **239** are of the programmable variety, and they contain at each address location an 8-bit binary code which is an instruction in the computer program as hereinafter described. Decoder **241** addresses ROMs **234** through **239** via address lines **1200** through **1205**. Line **1200** addresses ROM **234**, which for programming purposes, is termed ROM **0**. Line **1200** is also connected to an AND gate **1225**, which enables a buffer circuit **240**. Buffer circuit **240** serves as a ROM **0** input port.

ROM circuits **235** through **239** are termed ROM **1** through ROM **5** respectively. The ROM select signals on lines **1201** and **1202** for ROM **1** and ROM **2** (i. e., circuits **235** and **236**) are also applied to registers **242** and **243**, which serve as output ports for ROM **1** and ROM **2** respectively. Eight-bit control codes as read out from the ROM circuits are provided via lines **290** through **297** (bit **0** through bit **7** respectively), to integrated circuit **233**. IC **233** serves as an interface between the ROM units and the central processing unit. The 8-bit codes read out from ROM are transferred from circuit **233** to central processing unit **230**, four bits at a time, via data bus lines **270** through **273**. Circuit **233** also has four input/output lines **1210** through **1213** for transferring 4-bit codes from CPU **230** to ROM output ports **242** and **243** and for transferring 4-bit data inputs from ROM input port **240** to CPU **230**.

In accordance with the convention established by the above mentioned users manual, the 4-data bits transferred from buffer **240** to lines **1210** through **1213** are termed ROM **0**, bit **0** through ROM **0**, bit **3**. In another embodiment, integrated circuits type **1702A**, which are used for the ROM units, could be replaced by integrated circuits type 4001, in which case ROM **0** would be provided with an integral data input port, while ROM **1** and ROM **2** would be provided with integral data output ports. ROM circuit types 4001 are not alterable or reprogrammable. Usuage of the 4001 circuits would eliminate the requirement for IC circuits **232**, **233**, **240**, **242** and **243**. For such an arrangement, AND gates **1220** through **1223** could also be eliminated.

As illustrated in FIGS. **2A** through **2E**, CPU **230** receives all data from the associated computing scale system, four bits at a time, from lines **310** through **313**, which lines originate on FIG. **3**. Output signals from the microcomputer are transmitted via inverting amplifiers **260** through **263** and ROM output ports **242** and **243**, as above stated. Register **242** is able to provide four outputs term ROM **1**, bit **0** through ROM **1**, bit **3**. However, as used in the described embodiment, only ROM **1**, bit **3** is employed, and this bit is transmitted out via line **223**. Similarly, register **243** is able to provide four outputs termed ROM **2**, bit **0** through ROM **2**, bit **3**, but only bits **0**, **1** and **2** are employed. These three bits are transmitted out to appropriate locations via lines **210** through **212** respectively. It will be seen that output data for registers **242** and **243** are transmitted to both of said registers via lines **1210** through **1213** from IC **233** and that a select signal on one of lines **1201** or **1202** from decoder **241** selects the appropriate one of registers **242** and **243** for output of the data. Registers **242** and **243** are cleared by a reset signal on line **802** from FIG. **8**. Likewise a reset signal on line **801** from FIG. **8** resets RAM **231** and CPU **230**. Sync signals for use by the interconnecting interface circuits are provided by lines **251** through **253**.

For test purposes a test signal may be provided to central processing unit **230** via line **1214** from an external test unit. There is also provided a socket **249**, which is interconnected with central processing unit **230** for monitoring the operation thereof. A two phase clock is provided by the circuitry of FIG. **2A**.

DATA MULTIPLEXING

The above mentioned input signals designated ROM **0**, bit **0** through ROM **0**, bit **3**, which appear on line **310** through **313**, respectively, are provided by multiplexers **303** and **304** as illustrated in FIG. **3C**. Multiplexers **303** and **304** are enabled to receive and multiplex a total of up to sixteen inputs. Four of the inputs for multiplexers **303** and **304** are received via lines **320** through **323** from multiplexers **301** and **302** of FIG. **3B**. Multiplexers **301** and **302** in turn are enabled to receive and multiplex a total of up to sixteen inputs, so that the interconnection of multiplexers **301** and **302** with multiplexers **303** and **304** enables multiplexing into the microcomputer of up to twenty-eight inputs. Selection of the data to be multiplexed into the microcomputer is controlled by 4-bit control words output from RAM **231** via lines **200** through **203**. Lines **200** and **201** control multiplexers **301** and **302**, and lines **202** and **203** control multiplexers **303** and **304**.

The operation of the multiplexers may be understood by referring to FIG. **3A**, wherein are illustrated a set of photosensors A through P, which provide outputs representative of the weight of a commodity placed on platter **21** of scale **20**. The output from these photocells is provided via a set of diodes **314** and four level converting circuits to four lines **330** through **333**. The photocells are addressed by a code appearing on lines **630** through **633** to produce a 4-bit Gray code on lines **330** through **333**. Operation of such photocells and generation of the Gray codes is discussed in detail in Allen et al., U.S. Pat. Nos. 3,439,760; 3,516,504; and 3,557,353. However, in the Allen patent there are no photocells corresponding to photocells O and P, which are used for parity checking operating as hereinafter described.

For reading a commodity weight, the microcomputer generates four successive codes, which after processing by the interface circuits, appear one at a time as photosensor selection signals on one of lines **630** through **633**. This in turn causes production of four successive portions of the weight information (in Gray code) on lines **330** through **333**. These four codes are read into the microcomputer memory, where they are converted from Gray code to BCD form, as hereinafter described, for use in computation of a product value.

In order to read the Gray code from lines **330** to **333** into the microcomputer memory, these lines must be briefly connected by multiplexers **301** and **302** to the lines **320** through **323** and then through multiplexers **303** and **304** to lines **310** through **313**. This connection in the multiplexers is accomplished by generating the number 8 in binary form (1000) on RAM output lines **200** through **203**, noting that line **203** carries RAM **0**, bit **3** which is the "1". Generation of this 8 and other steps in the photocell reading are performed in the RDWT and READ portions of the programs shown in Table V. Thus by generating the number 8 in binary form four times, once for each of four groups of four photocells, and using inverting amplifiers **260** through **263** in FIG. **2D** (which are connected to lines **200** through **203**) the microcomputer reads in four 4-bit words of coded weight data. The first three words and the lower two bits of the fourth word represent the commodity weight in Gray code form. The upper two bits of the fourth word are output bits from photosensors O and P and are used for a weight reading parity check.

Prior to each generation of the number 8, an output is generated by RAM **231**, which causes a HI output from one of inverting amplifiers **260** through **263**. This output is connected via one of lines **214** through **217** to a latching circuit **645** shown in FIG. **6**. At the appropriate strobe time latches in circuit **645** will be set. The latch outputs are decoded and will cause a HI output on one of lines **630** through **633**. A HI output on line **630** selects photosensors A, B, C and D, and the output from these photosensors is read through multiplexers **301** to **304** into the microcomputer during the succeeding generation of the number 8 on lines **200** through **203**. Similarly, a HI signal on line **631** selects photosensors E, F, G and H, while a HI on line **632** selects photosensors I, J, K and L, and a HI on line **633** selects photosensors M, N, O and P. thus to read four weight digits in Gray code into the CPU, the CPU generates the 4-bit word 0000 at the output of latches **645** to select the first group of photosensors, and then generates the word 1000 (8) to multiplex the photosensor data through multiplexer circuits **301**, **302**, **303** and **304** onto lines **310** through **313**, which in turn pass through the tri state gates **240** onto lines **1210** through **1213**, through the interface IC **233** and over data bus lines **270** through **273** to the central processing unit **230**. The tri state gates **240** provide I/O or open output circuit conditions in order that lines **1210** through **1213** can function as both input and output ports to the interface IC **233**. Thereafter the central processing unit causes generation of the RAM word 0010, followed again by 1000 to read the second word of weight information onto memory. The next two words of weight data are read similarly by generation respectively of RAM words 0100 and 1000, each followed by the RAM word 1000. Further explanation of the weight reading operation is set forth below in connection with the discussion of the computer program which is stored in ROM. In this preferred embodiment of the invention, weight information is collected into the central processor by electrically energizing successive four cell groups of the photosensors in response to a computer command. The energized condition is maintained until turned off through the use of a latch memory **645**.

The photosensor information is collected in real time during the photosensor energized period by sending the proper commutation command from the central processor to the multiplexers. The commutation command in the arrangement sets up the multiplixer (i. e., addresses the multiplexer) to allow the input from the energized four photo sensors to enter a ROM input port. It is of course possible in the alternative to employ a latch or memory to retain the selected multiplexer address and thereby maintain the multiplexers in the correct commutating condition for a prolonged period while the selected photosensors are energized briefly by the central processor in real time. Selection between these two alternate photosensor energization arrangements is best made after considering other requirements of the scale system.

To aid in more fully understanding the signal commutating operation of multiplexers **301** through **304**, there is set forth in Table III a truth table, which governs the operation of each of multiplexers **301** through **304**. In general the presence of any of RAM words 0000 through 0010 on the RAM output port lines causes the reading into memory of labeler status bits appearing on lines **610** through **613**. Other multiplexers, as illustrated in FIGS. 6A through **6E**, also respond to RAM port words to determine the labeler status information to be presented on lines **610** through **613**. RAM port words 0100 through 0111 cause reading into memory of selected digits of price per pound appearing on lines **620** through **623** as will be apparent by reference to FIGS. 6A through 6E. Table III also applied to multiplexers **626** through **629**, which appear on FIGS. **6B** through **6D**. It will be noted that RAM port word **0111** causes reading of two bits of price dead zone information, which are multiplexed into lines **620** and **621**.

RAM words 1001 through 1100 cause the reading into memory of control information which may be selected by setting of performance selection switches **341** through **352**. While shown in FIG. 3B as being switches, the switches will ordinarily be located in an inaccessible location and will be set by factory or maintenance personnel. Accordingly switches **341** through **352** could be replaced by jumpers.

Switches **341** through **344** provide four bits of weight dead zone selection information to be used by the microcomputer as hereinafter described. Switches **345** and **346** provide two bits of rounding control information for use in rounding off the computation of the commodity value. Switch **347** is also a rounding control switch, and, when closed, instructs the microcomputer to employ a quarter round routine which is part of the computer program written for implementation of this invention.

Switches **348** and **349** respectively select five kg and ten kg routines within the computer program. These routines enable usage of the system for metric weight measurement, with maximum scale readings representing respectively either five kg or ten kg readings. In each case closure of the appropriate switch causes the microcomputer to select the proper conversion factor for converting a measured reading in pounds into metric units. In either case, where the scale is to be used for metric measurements, the spring, which is used for measurement in pounds, may be replaced by a spring of somewhat different stiffness, so that the multiplication factor introduced by the five kg or ten kg routine need accomplish only a part of the total required conversion. The five kg and ten kg routine, when selected, may also cause performance of special logic functions required by weights and measure practices in countries wherein metric standards are employed.

Switches **350** and **351** provide two bits of information for control of a waiting or time delay routine as described below. Finally, closure of switch **352** calls for a logic operation required by the microcomputer in order to cause printing of labels showing actual measured weight and a fixed commodity value. This is an option provided as a special case for labeling of commodities which are sold by count (i.e., fixed value for each package) rather than by weight.

PRINTER AND SCAN PULSE GENERATOR OPERATION

As discussed above, the printer has for each digit a pair of segment gears mounted on a rocker shaft, which rotates first in one direction and then in the other. During forward motion the rotational position of the rocker shaft is monitored by a photocell circuit, so that the computer can actuate or fire the solenoids **551** through **558** at appropriate times for stopping the primary segment gears while the secondary segment gears continue to a home position. Thereafter, during return rotation of the rocker shaft, the primary and secondary segment gears move together and set up the printing wheels for printing. The scanning network, which monitors rotation of the rocker shaft to inform the microcomputer regarding the position thereof, is illustrated in FIG. **4**.

The FIG. **4** scanning network generates a pulse of uniform and predictable time duration in response to the print wheels of the printer-labeler moving through a possible printing position. As indicated in the portion of this specification which describes the printer-labeler subroutine, pulses generated by this printer scanner are used to tell the microcomputer when the print wheels have moved between printing positions. The circuit of FIG. **4** provides interface between two free-running portions of the scale system, the microcomputer clock and the printer mechanical elements.

In FIG. **4**, the scanner which moves with the print wheels is identified with the number **403**, the digits zero through eight on the scanner indicating light transmitting apertures in the scanner, while the photocell which responds to the scanner light pulses is shown at **402**.

Light falling on photocell **402** provides a positive going input to the threshold circuit **404**. The circuit of FIG. **4** also includes a 4-bit counter **401**, having clock, load parallel, enable parallel and data inputs and four output lines labeled QA-QD. The 4-bit counter **401** is connected to a four-input NOR gate **408** which has an enable line **415** that is always held in the enabled state; the gate **408** may be a type **7425** gate as listed in the component identifying table of this specification.

In response to an aperture of scanner **403** transmitting light to photocell **402**, the circuit of FIG. **4** provides an output pulse on line **417** which is positive going and remains in the positive state while counter **401** counts **14** clock pulses as received from the central processor on line **251**. This control of the signal on line **417** is achieved by commencing the counter **401** with the first clock pulse following change of the scanner input signal from threshold circuit **404** from the low or dark state to the high or light state and continuing the count in counter **401** until the appearance of a carry pulse on line **413** when the counter has reached a count of **15**. This operation is achieved by using the gate **408** to decode the initial or zero state of counter **401**; the condition of all zero inputs to the gate **408** providing a high output and thereby a low output from the inverter **410** to the load parallel control line of counter **401**.

In the presence of the load parallel input, the first positive going information on the A input of the counter, i. e., the positive going pulse from the photocell **402**, is accepted into the low order bit of the counter and results in changing the output state of gate **408**, which in turn, removes the load parallel input from counter **401**. After receiving the input signal on the input A terminal, the counter **401** steps through the states between zero and fifteen in response to central processor clock pulses received on line **251**. The change in output state of the gate **408** from high to low in response to receipt of the first clock pulse on line **251** also provides a change in output state from low to high from the gate **411** thereby initiating the printer output pulse to the central processor in response to the first scanner pulse from the photocell **402**.

The output of gate **411** on the line **417** remains in the high condition until the line **413** changes from the low to high state in response to the carry output of counter **401**, this occurring after the required number of central processor clock pulses on line **251** have been counted. Once line **413** changes from low to high state to indicate the carry pulse, the line **414** changes from the high to the low state, thereby disabling the counter from further operation until the photocell **402** sees a dark condition and provides a low output on the line **406** to reset the counter and await the next arrival of light on photocell **402**.

Thus integrated circuit **401** and its associated circuitry functions like a one-shot (mono-stable vibrator), producing pulses on line **417**, for multiplexing into the computer through multiplexer **626** (FIG. **6B**). The computer employs these pulses to time the firing control signals for the printer solenoids. In addition to the nine pulses provided by observation of scanner fan **403** by photocell **402**, there is a home position pulse generated by the computer at the time it sends data to the printer for printing the number "9". For the embodiment herein described there are eight type wheels, which rotate together, each of which may be stopped at any of 10 positions for printing of the numbers 0 through 9 on the label.

As previously stated, the scanner pulses on line **417** provide an input to multiplexer **626**, which is interpreted as a labeler status bit. Multiplexer **626** and multiplexer **629** multiplex all labeler status bits, and these bits appear as 4-bit binary words on lines **610** through **613**, which are transmitted to multiplexers **303** and **304**. Multiplexing of labeler status bits as well as price per pound switch output from lines **520–529**, is controlled by 4-bit RAM output words on lines **214** through **217**. These RAM output words are gated through AND gates **640** through **643** for application to the multiplexers.

The RAM words on lines **214** through **217** (RAM bit **0** through RAM bit **3** respectively) are also supplied through gates **640** through **643** to a quadruple D-type flip-flop **644** and to a 4-bit latch **645**. The output from latch **645** is decoded by a BCD to decimal decoder **646**, which has four output lines **630** through **633**. These lines are used, as above described, to address the weight recording photocells of FIG. 3A. Three of the outputs are also applied via amplifiers to lines **601** through **603** for price per pound switch addressing. These three lines address the pennies, dimes, and dollars switches **31** through **33** as previously discussed in connection with the description of FIG. 5. For each address a response may be received back via one of lines **521** through **529** indicating one of the decimal numbers 1 through 9. For the system configuration used in the U.S., no response on any of the lines **521** through **529** represents the decimal number zero. For use in metric countries the number zero is represented by a response on line **520**. These responses are applied to multiplexers **627** and **628** for multiplexing onto lines **620** through **624**.

For reading of price per unit weight information a binary 0 (0000) on RAM output lines **214** through **217** latches up line **601** to check the pennies switch, and thereafter binary equivalents of the numbers 4, 5 and 6 appear in sequence on RAM output lines **214** through **217**. The number 4 checks the decimal digits 1 through 3 (lines **521–524**), the number 5 checks the decimal digits 5 through 8 (lines **525–528**) and the number 6 checks the decimal digits 9 and 0 (lines **529** and **520**). After the pennies digits have been checked and multiplexed back to the CPU, the addressing of the dimes is accomplished by generating a binary or RAM output lines **214–217**. Thereafter the status of lines **520** through **529** is again checked, and finally a binary 2 is generated on the RAM output lines for addressing and checking of the dollars switch. In FIG. 6E a spare inverter is provided connected to line **633** for incorporating tens of dollars, etc., input. It will be appreciated, of course, that the pennies, dimes and dollars switches may represent three digits of price per unit weight information in any desired currency.

Multiplexer **628** has two inputs from switches **647** and **648** in addition to the above mentioned price per unit weight inputs. These two inputs are read into memory by generation of a binary 7 on the RAM output lines and indicate a price dead zone upper limit. For some applications it is desired to inhibit the system operation unless the indicated price per unit weight is greater than some preset minimum amount. Switches **647** and **648** may be set for reading into memory any of four different lower limits representing the numbers 0 to 3. A routine identified as MINP is used by the computer in connection with the minimum price check. The program listing as set forth in Table V presents a detailed description of the MINP routine.

Included within the bits of labeler status information multiplexed by multiplexers **626** and **629** are other bits relating to the status of additional equipment, which may be used in combination with the computing scale system. The input information for multiplexer **629** appears on lines **650, 651, 652, 712, 654, 504, 656** and **711**, while input information for multiplexers **626** appears on lines **661, 657, 658, 659, 710, 625, 660, 661** and **709**. Multiplexing control for multiplexers **626** and **629** is governed by signals appearing on lines **670** and **671** which are connected to terminals SA and SB respectively. These multiplexers operate in accordance with the truth table presented in Table III, and the multiplexed output at any time can be determined by noting that the input at terminal SA of both multiplexers corresponds to bit **0** of the RAM output words, while the control signal at terminal SB of both multiplexers corresponds to bit **1** of the RAM output words. In all cases for multiplexing of label status information through multiplexers **302** and **303**, bits **2** and **3** of the RAM output words must both be 0 (these bits appear on lines **202** and **203** respectively for application to multiplexers **302** and **303**).

Line **650**, which is one of the input lines for multiplexers **629**, indicates the presence of an indexing and label application system of the type described in Treiber U.S. Pat. No. 3,732,966. If such a system is being used, with the computing scale system, then line **650** will be grounded. Otherwise, a +5 volt signal will appear at line **650**.

Line **651** is an output from latch **624** and indicates that the system is in its first cycle of operation. Line **652** is controlled by the signal on line **503** and indicates that the secondary segment gears, which control print wheel positioning, have reached the home position. Line **712** indicates the status of one of four solenoid check bits. The other three of these four solenoid check bits appear on lines **711, 710** and **709**, the latter two lines being connected to provide inputs for multiplexer **626**. These solenoid check bits indicate that solenoid drivers, which control the position of the print wheels, have been fired satisfactorily. The operation of these solenoid drivers and the generation of the solenoid check bits is described in detail below in connection with the description of FIGS. 7A and 7B.

Line **654**, which provides another input to multiplexer **629**, indicates the presence of an error signal on line **507**. Such an error signal appears on line **507** if switches **546** and **547** have been operated by movement of any of the price per unit weight knobs **31** through **33**, or if switch **545** has been operated by removal of commodity key **37**.

Line **504** indicates operation of the repeat switch **71**. Repeat switch **71** is manually operated whenever it is desirable to print another label exactly like the one previously printed. This can be done as long as the weight is left on the scale or removed from the scale while in the repeat mode. If the scale is unloaded and then loaded again with the same or a different weight, while in the repeat mode, the system will go into an error status.

Line **656** carries a computer start suppression signal. The signal on this line is controlled by the position of a switch **662**. When the computing scale system is used in combination with an indexing and labeling system of the type described in Treiber '966, switch **662** will be closed by a cam during any period of time while a package is being moved. This in turn suppresses any computing cycle during package movement.

Line **657**, which provides one of the inputs to multiplexer **626**, provides a tare warning indication as generated at the Q1 output of latching circuit **624**. The output signal at the Q1 terminal of the latching circuit **624** is set by movement of commodity key **37**, which operates switch **590** (FIG. 5A), and which in turn is connected to line **508**. The signal on line **508** is sensed at terminal $\overline{IS_1}$ of latching circuit **624**. The output at terminal Q1 of latching circuit **624** is reset by an output on line **607** from tare circuit **663**.

Tare circuit **663** is operated by touching of knob **23**. Circuit **663** normally oscillates, but while knob **23** is being touched, the circuit stops oscillating, and line **607** goes from a normally non-conducting to a conducting condition, thereby grounding the base of transistor **664** to reset the Q1 output of latching circuit **624** and provide a HI tare indication for input to multiplexer **626**. At the same time, transistor **698**, which was previously conducting, ceases conducting to turn off the warning light **24**. Line **658**, which provides another input for multiplexer **626**, provides a manual start indication, and this indication is controlled by the status on line **502**. Line **502** normally carries a zero voltage and becomes negative when manual start switch **72** is operated. Operation of the manual start switch permits printing of a label, while the scale is within the weight dead zone. However, if either of switches **348** or **349** (FIG. 3B) is closed for indication of metric system operation, then operation of manual start switch **72** will not permit label printing anywhere within the weight dead zone except at zero weight, but switch **561** must be closed and switch **562** opened as previously discussed.

Input line **659** of multiplexer **626** is connected to line **417**, which carries scanning pulses generated as discussed above in connection with FIG. 4. Input line **625** for multiplexer **626** is the output line from terminal Q3 of latch circuit **624**. The status of this line indicates whether or not a printed label has been removed from ticket ejector mechanism **35**. Normally, printed labels are supplied to ejector mechanism **35** with the adhesive side up. The labels are applied to packages by pushing the package against the label, and this in turn operates ejector switch **540**. The ejector switch is normally closed and is opened during label application. This opening of the ejector switch resets the Q3 output of latching circuit **624**. The Q3 output is set by operation of cam switch **543** (FIG. 5A), which is connected to line **530**. Cam switch **543** is operated by a cam after the print wheels have been set up and before a label is printed.

Line **660** normally carries a +5 volts signal as an input to multiplexer **626**, but the input is switched to ground by closure of a manually operated switch **665**. Switch **665** may be physically located at any convenient place on register printer **30**, computer **25**, or scale **20**. This switch is termed a "by-count" switch, and closure of this switch tells the computer to enter the "by-count" subroutine which is hereinafter discussed.

Line **661**, which is connected to line **530**, carries a cam switch status signal. As discussed above, line **530** is connected to a zero volts through switch **543** and operates as a set signal for output Q3 of latching circuit **624**.

In addition to providing inputs to latching circuit **645**, and controlling multiplexers **626** through **629**, AND gates **640** through **643** also provide RAM output data to latching circuit **644**. Outputs from latching circuit **644** cause generation of a printer start signal on line **606**, pulses to trigger the ejector motor SCR on line **604** and an error light signal on line **605**. Lines **604** through **606** are all connected to circuitry shown in FIGS. 5A and 5B. A clock signal for latching circuit **644** is provided by line **714**, and a clear signal is provided by line **803**. Line **803** also provides a clear signal for latching circuit **645**, while clock signals for that latching circuit are provided by line **713**. The signals **713** and **714** are developed in FIG. 7A from ROM output information.

Referring now to FIGS. 7A and 7B, it will be seen that there are eight Darlington amplifiers **731** through **738**, which are connected to eight output lines **701** through **708** respectively. Operation of Darlington amplifiers **731** through **738** connects the respective lines **701–708** to ground thereby completing a circuit from the minus 24 volt source through respective labeler print wheel solenoids **551** through **558** (FIG. **5B**). As previously discussed, the firing of these solenoids interrupts movement of associated primary segment gears to cause correct set up of the type wheels which print the labels.

Conduction of Darlington amplifiers **731** through **734** is controlled by latching circuit **722**, and conduction of Darlington amplifiers **735** through **738** is controlled by latching circuit **721**. Latching circuits **721** and **722** in turn are controlled by RAM output control words appearing on lines **204** through **207**. As previously discussed in connection with FIG. **4**, scanner output signals on line **417** are multiplexed into the computer memory to indicate the position of the rocker shaft, which causes forward rotational movement of primary segment gears associated with each of the print wheels.

In order to set up the print wheels, it is necessary to fire the solenoids **551** through **558** at appropriate times. After the computer has multiplied the commodity weight times the price per unit weight to obtain a commodity value or total value, it is stored for determining when each of solenoids **551** through **558** should be fired. At this point the printer is started by sending a printer start signal on line **606** (FIG. **6E**). Immediately following printer start all solenoids for those print wheels which are to print the numeral 9 are fired. The first pulse on line **417** tells the computer that it is time to fire the control solenoids for all print wheels which are to print the number 8, and at this time the computer generates two RAM output words which will, through latches 721 and 722, cause conduction of the appropriate Darlington amplifiers and firing of the correct solenoids. The next pulse on line **417** similarly causes firing of the correct solenoids for setting of those printing wheels which are to print the number 7. This process continues through the number zero.

Clocking and clearing of latching circuits **721** and **722** is under the control of a demultiplexing circuit **720** and a reset signal appearing on line **804** from circuitry illustrated on FIG. 8. Demultiplexer **720** is strobed by a signal appearing on line **223**, which is ROM **1**, bit **3**, as generated by the ROM **1** output port (IC **242** of FIG. 2E). Data signals and output line selecting signals for demultiplexer **720** are provided by lines **210** through **212**, which respectively carry bits **0** through **2** of ROM **2** output words from IC **243**. In addition to controlling the clocking and clearing of latching circuits **721** and **722**, demultiplexer **720** provides output signals on lines **713** and **714**, which are clocking signals for latching circuits **645** and **644** (FIG. **6E**), respectively.

Whenever any of Darlington amplifiers **731** through **738** becomes conductive it causes a voltage drop across a corresponding one of resistors **741** through **748**. This voltage drop when compared with a reference produces a data bit at an associated one of eight input terminals to multiplexer **723**, and this data bit is used as a check bit to indicate that the associated one of solenoids **551** through **558** has been fired. The solenoid check bits multiplexed through multiplexer **723** appear as outputs on lines **709** through **712**, which are multiplexed through multiplexers **626** and **629** and read into the computer and compared with print wheel solenoid data which was previously stored in the computer memory and sent to the print wheel solenoids, if the data does not compare an error results. This comparison is performed in PSCK subroutine in the output to printer portion of Table V. Selection of either the A inputs or the B inputs to multiplexer **723** is under the control of a signal appearing on line **609**. A LO signal on line **609** selects the A inputs, while a HI selects the B inputs. Line **609** is tied to line **630**, which is one of the latched RAM signal output lines from integrated circuit **646** of FIG. **6E**.

MASTER RESET

As illustrated in FIG. **8**, there is provided a circuit which provides master resetting of the entire scale system. This circuit includes a counter **805**, which counts sync pulses generated on line **252** by the computer. This sync pulse is generated once every eight clock times by the CPU as described in the Intel manual. Counter **805** is cleared by a signal on line **505**, which is generated by operation of the scale system reset switch **70** which is shown in FIG. **1**. Whenever counter **805** is cleared and flip-flop **806** is set, reset signals are placed on lines **801–804**. When the reset switch is released by the operator, counter **805** starts counting, and upon reaching full count turns off reset flip-flop **806**. This in turn terminates counting by counter **805** and terminates the reset signals on line **801** through **804**. The reset signal on line **801** is applied directly to the CPU, and the reset signal on line **802** is used for clearing integrated circuits **242** and **243**, which serve as output ports for ROM **1** and ROM **2** respectively. The reset signal on line **803** is used as a reset for latching circuits **644** and **645**, as above discussed, and the reset signal on line **804** is used for clearing integrated circuits **721**.

During power up conditions line **505** is held in the low condition temporarily by the capacitor **899** in FIG. **8** which charges slowly through resistor **898** to clear counter **805** and set flip-flop **806**, thus initiating the above described reset functions.

WEIGHT PARITY VERIFICATION

A portion of the scale chart, which is used by scale **20** is illustrated in FIG. **9**. The illustrated portion of the chart covers the weight range from 00.26 through 00.32. In the United States this would be a reading of pounds, but in metric countries the digits would have a different significance. The chart consists of a series of tracks A through P, which have apertures cut therein as illustrated. Tracks A through N correspond to the tracks of the scale chart illustrated and described in Allen et al, U.S. Pat. No. 3,557,353. Track O and P are optional odd and even parity tracks respectively.

As described in the Allen patent this chart is used in combination with a light source and a series of photocells, the photocells being illustrated schematically in FIG. 3A by the letters A through P and diagrammatically in FIG. 9 by the reference numerals **901** through

916. In FIG. **9** it is to be understood that chart observation occurs along a slit line such as that indicated at **941**, the chart being movable under the slit. The major portion of the FIG. **9** chart is opaque, but the apertures (represented by shaded areas **917**) provide areas of translucency, which may be sensed by the photocells associated with tracks A-N for reading weight. As described in the Allen patent, the code represented by the illustrated tracks A through N is a Gray code of the binary-cyclic-biquinary type, and the apertures are cut in the chart to provide a transition at midpoints between the weight readings. Although not illustrated in FIG. **9**, the E and G tracks have apertures extending below 0 and beyond 25.00 pounds to provide a signal when the balance position of the scale is below 0 or above its calibrated capacity. Aperture areas **918** and **919** provide even and odd parity checks for observation by photocells positioned at **916** and **915** respectively. Even parity indicating in this instance that the total number of observed bits including the parity bit is even.

In order to understand the operation of the O and P channels, Table IV has been constructed to give the readings of the photocells for weights ranging from 00.26 through 00.32. In each case a one or HI photocell output occurs when an aperture is in front of the associated photocell, while a zero occurs when an opaque area is in front of the photocell. The data of Table IV may be verified by comparison against FIG. **9**. It will be seen that an aperture appears in the O track whenever the corresponding weight reading is represented by an even number of apertures. The aperture in the O track provides a total number of apertures which is odd for an odd parity check. Similarly an aperture appears in the P track, whenever an odd number of apertures appear at corresponding positions in the tracks A through N.

One of the major problems with reading and parity verifying a chart of the type described above is that it is impossible in practice to insure that the parity photocell and the weight reading photocell will consistently change output states at exactly the same chart position (i. e., cell resistance and chart line tolerances). If an attempt is made to check parity at a transition point weight reading, a parity error signal may be generated and cause an unwanted interruption of the computing cycle. That problem is circumvented in accordance with this invention by extending the parity apertures **918** and **919** slightly beyond their proper limits for parity checking, as indicated by the small shaded areas **920**. As a result, whenever the scale comes to rest at a chart transition point between two weight readings, both parity photocells P and O will be lighted. In the preferred embodiment this condition exists over about **25** to **30** percent of the chart range, the extent of such overlapping provided being dependent on the attainable accuracy in positioning and sizing chart apertures in the chart manufacturing process. In an alternative embodiment the parity apertures **918** and **919** could be shortened, so that chart transition positioning would be represented by non-conduction or a LO output from both of photocells **915** and **916**.

As discussed in more detail below, the system computer stores the reading of all photocells and checks the "O" and "P" readings, before making any parity checks. If a one is stored in memory for both the "O" and "P" channels, then the computer makes no parity check on the weight reading and proceeds to use the unverified data as read from channels "A" through "N" for computation of product value. On the other hand, a zero in memory for either of the "O" or "P" channels will cause execution of a parity checking routine and will produce an error condition if an improper parity check is made.

As described above, both of the parity checking tracks have apertures or translucent areas extending into the transition regions for the other tracks. It will be appreciated, however, that such an arrangement is not necessary. As an alternative arrangement there could be provided a single parity checking track having no transition region overlap and a transition indicating track having translucent areas only in the transition regions. For such an arrangement the computer would first check the output of the transsition indicating track and then proceed to perform a parity check on the reading from the parity checking track only if no transition condition is detected.

In still another embodiment there could be a transition indicating track and a single parity indicating track of the type illustrated in the preferred embodiment of FIG. **9**. For this last arrangement the transition condition would be ascertained by observation of the reading from both tracks, while the reading from only the parity indicating track would be used for parity checking. Finally, the system could utilize a single parity track, such as track O and could observe this track with two photocells displaced from each other a distance representing an integral odd number of weight units. Such photocells might be termed O and P photocells and would provide output signals identical to the signals from photocells positioned as at **915** and **916** and viewing the O and P tracks illustrated in FIG. **9**. Such an alternative arrangement is illustrated diagrammatically by the dotted circle **916***a*, which represents the position for a photocell to replace the photocell located at **916**.

COMPUTER ARCHITECTURE AND PROGRAMMING

The computer program in Table V sets forth the sequential operations required for controlling the scale and labeler of the present invention. Table V gives from left to right: 12-bit ROM address locations, 8-bit instructions stored at the indicated ROM locations, mnemonic names for subroutines, mnemonic equivalents of the indicated 8-bit instruction words, and programmer's comments. The Table V program listing is assembled from a programmer's hand prepared listing using an assembly routine available from Intel Corporation, Santa Clara, California. In the Table V program listing the mnemonic instructions and 8-bit codes are in accordance with the instruction description contained in Table II. In using Table II it is to be noted that the RRR indications appearing in connection with the FIM, SRC, FIN, and JIN instructions refer to the address of one of eight index register pairs in the CPU. The RRRR indications appearing in connection with the INC, ISZ, ADD, SUC, LD, and XCH instruction refer to the address of one of sixteen index registers in the CPU. The sixteen index registers may be addressed as one of eight pairs using the RRR form of address or as one of sixteen registers using the RRRR form of address depending upon the instruction used.

In regard to the instructions relating to RAM status characters it will be noted that the RAM chip has four registers, each with twenty 4-bit characters subdivided into 16 main memory characters and four status characters. It should be further noted that as to the input/output and RAM instructions, the RAMs and ROMs operated on are those which have been selected by the last preceding SRC instruction. The register pair designated by the SRC instruction contains 8-bits, and the four highest ordered of these bits indicates the ROM Chip number, that is, the number of one of ROMs **234** through **239** in the present system. These ROMs are designated ROM **0** through ROM **5** respectively. The eight bits in the register pair incorporated into an SRC instruction also indicate a RAM and a main memory character within the RAM. The first two, or highest order, bits indicate the RAM number. (In the case of the present program there is only one RAM, designated RAM **0**.) The next two bits indicate the register number within the RAM, and the last four bits indicate the number of the main memory character within the selected register.

A single SRC instruction may be used for both ROM and RAM designation. Since a ROM or RAM designation once made remains effective until the next SRC instruction is executed. Each ROM has memory capability for storing 256 8-bit instructions, so that six ROMs illustrated in FIG. 2C have a capacity for 1,536 instructions. The program in Table V uses fewer than this number of instructions, the entire Table V program being loaded in ROMs **234** through **238**. Referring again to Table II, it will be seen that the JCN, FIM, JUN, JMS, and ISZ instructions are twoword instructions. Where such two-word instructions are loaded into memory, the program listing of Table V indicates the address of only the first of these two words.

For an understanding of the interaction between the computer and the system hardware components, it is helpful to refer to the OUTD and OUTC subroutines set forth commencing at memory location **733** on page 17 of Table V. The OUTD subroutine is used to outputting system control data such as multiplexer control signals (i.e. multiplexer addresses) print wheel set up pulses, photo sensor exciting signals and price switch selections through the RAM output port. The outputted address data appears as 4-bit codes at the output of inverting amplifiers **260** through **263** for transmission on lines **200** through **203**, **204** through **207**, and **214** through **217**. The OUTD subroutine begins with the instruction SRC PO. This instruction causes RAM addressing in accordance with data previously loaded into register pair **0**, most commonly by a FIM instruction. The data loaded into register pair **0** prior to execution of the OUTD subroutine always has the digits 00 stored in the two most significant digit locations (which are in register **0**), so that a signal selecting RAM **0** (the only RAM used) will be generated by the CPU on line **275**. For execution of the OUTD command, it makes no difference what data is stored in the two least significant locations within register **0** (i.e. bit positions 4 and 5 of the 8-bits within the register pair). However, the data stored in bit positions 0 through 3 are important, because this data is loaded into the accummulator by the instruction LD **1** and becomes the addressing data used by the hardware; this data is output from the RAM by the instruction WMP. After outputing this data the program executes the test instruction JCN **T1** which merely stops the program if a test signal is present at line **1214** of FIG. 2D. Assuming that a test signal is not present, the program then branches back via the BBL instruction to the routine from which an exit had been made to OUTD.

The OUTC subroutine commencing at memory location **739** on page **17** of Table V executes a series of instructions, which cause generation of output signals from ROM port **1** (line **223**) and ROM port **2** (lines **210** through **212**). Prior to execution of the OUTC subroutine register pair **1** is loaded with the bits 0010 in register **2** for addressing ROM **2** (enabling integrated circuit **243**), and other bits in bit positions 0, 1, and 2 of register **3** corresponding to the output desired on lines **210** through **212**. This data in register **3** is loaded into the accumulator and thereafter written onto lines **210** through **212** by the instruction WRR in memory location **741**. The data output on lines **210** through **212** is applied to demultiplexer **720**, as above described, for use by the system hardware.

During the period of time that the OUTC output signals are present on lines **210** through **212**, the FIM **P1 24** instruction in memory location **742** in the OUTC subroutine also loads the binary word 00011000 into register pair **1**. The subroutine then performs the instructions SRC, **P1**, LD **3**, and WRR, which results in enabling of integrated circuit **242** and outputing of a HI signal on line **223** (which the computer views as being the output line for ROM I, bit **3**). This signal on line **223** serves as a data strobe. This strobe is terminated by the instructions LDM O, and WRR. These latter two instructions load 0000 into the accumulator and write the 0 in bit **3** on line **223**.

Data generated by the system hardware is loaded into the computer, as above described through integrated circuit **240** and lines **1210** through **1213**. The data on lines **1210** through **1213** is read into the accumulator at appropriate times on the program by execution of the instruction RDR. Prior to execution of such an instruction, however, it is necessary to execute an SRC instruction, which will select ROM **0** thereby enabling IC **240** via line **1200** and NAND gate **1225**.

EXECUTIVE ROUTINE

FIG. **11** in the drawing illustrates the steps in a normal scale weighing operation in flow diagram form. The FIG. **11** sequence may be regarded as the scale executive program, with the the steps illustrated being performed in each scale weighing operation and with several of the steps illustrated being performed as program subroutines which are described in subsequent figures of the drawings. The flow diagram of FIG. **11** describes an embodiment of the invention employing a programmed special purpose computer, i.e. an integrated circuit microprocessor. The steps of the FIG. **11** flow diagrams could of course be performed by wired dedicated electronic logic circuits in an alternate embodiment of the scale invention. In the present section, flow diagram steps are described both with respect to scale functions and with identification of the program instructions performing the indicated steps. In the description program steps are identified by memory locations, memory locations being the first 12-bit binary word in the left-hand column of the Table V program listing. Additional details regarding instruction addressing and memory location identification are contained in the Intel Users Manual referred to above. Since memory locations are identified by decimal digit numbering in the following description, conversions between binary bits and corresponding decimal digit numbers are indicated for a portion of the instructions on each page of Table V.

Referring now to FIG. **11**, and the program listing of Table V, the scale operation commences with loading a time delay constant of **252** into register pair **7** for subsequent use in a wait operation, this being followed by the outputting of multiplexer control information, i.e. multiplexer addressing, which will connect the ROM dataport with the printer/labeler sensing switch indicating the printing mechanism to be in the home starting position. The printer home position switch status is tested in the decision block **1102**, FIG. **11A**, this test being the instruction JCN at memory location **009** of the Table V program. If the printer is found not to be in the home position, the scale goes into an error condition employing the subroutine at memory location **158** on page 4, Table V. If the printer home position status test is satisfied, the program jumps to the waste time (time delay) subroutine at memory location **752**, page 18 of Table V.

Following the time dealy, a test is made as indicated in the block **1104** of FIG. **11** to determine if the home position test has been performed a sufficient number of times, this test being performed by the ISZ instruction at memory location **013**. The repeated testing of printer home position is incorporated into the program to assure that the computer power supplies and the photocell exciting lamp have reached steady operating condition following power turnon. If the decision in block **1104** indicates the time for reaching steady state conditions has not elapsed, the preceding program steps are repeated as indicated by the path **1106**. Once the decision in block **1104** is satisfied, the program proceeds to the program home position which is identified with the circle **1108** in FIG. **11** and the notation at memory location **015** in the Table V program listing.

Upon leaving the program home position the system interrogates four mechanical switches, the "first-cycle" indicating switch, the "repeat" switch **71**, the "manual start" switch **72** and the "by-count" switch. The "manual start" and "repeat" switches are located on the labeler control panel as shown at **72** and **71** in FIG. **1**. The reading of these control switches is accomplished by sending out the appropriate multiplexer addresses, reading the resulting switch data into the accumulator and transferring the read-in data to storage in the RAM as indicated by block **1109** following program home and by the series of Table V program steps ending with the instruction WRO in memory location **020**. Testing of the "manual start" switch status signal is performed by the JCN instruction in memory location **030** on page 1 of Table V, this test being indicated by the block **1110** in the FIG. **11** block diagram. The OUTA subroutine on page 17 of Table V is used to actually set up the appropriate multiplexer addresses.

The "manual start" status bit is interrogated immediately after the memory storage operation by the two RAL instructions and the JCN instruction at memory locations **021–023**. If the test of block **1110** indicates the "manual start" status bit was set, there follows a series of steps which modify the required number of trips through the motion detect subroutine needed to establish a no-motion condition, it being desirable for the system to accept a manual start command without requiring a prolonged closure of the "manual start" switch by the operator while the motion criteria is satisfied. By adding eight to the "trips through" counter as indicated by the block between blocks **1110** and **1112** in FIG. **11** the normally required sixteen trips through the motion detect sequence without detecting motion is decreased to a lower number enabling a rapid determination of manual start no-motion. As indicated by the steps surrounding the block **1112**, if the addition of eight to the "trips through" counter produces a carry, the program proceeds to the junction **1114**; the program also arriving at junction **1114** where the "manual start" switch status was not set or following the writing of the "trips through" counter sum back into the trips through counter in the block **1113** in the event no carry resulted.

The manual start switch **72** on the labeler control panel in FIG. **1** is provided primarily for use during servicing of the scale system; in addition, this switch may be employed to initiate the printing of a label while the scale is in the weight-dead zone or printing a second label relating to a package which remains on the scale without intervening scale motion. Since most such uses of the manual start switch **72** occur after the scale has become motionless, it is feasible to relax the rather rigorous requirement imposed in the motion detect subroutine for the termination of motion when the scale is operating on a manual start command. This relaxation of the motion cessation requirement allows the manual start switch **72** to be read in real-time while the manual start switch is manually closed as opposed to requiring the use of a flip-flop or memory element to remember the manual start switch closure until needed by the computer program. With the relaxed, no-motion criteria, the computer program interrogates the manual start switch **72** with sufficient frequency to capture a manual start command while the operator holds the switch closed.

Following the junction **1114** the scale prepares for a waiting period wherein the waste time routine at memory location **752** on page 18 of Table V will be employed. This second waste time sequence assures that the program steps prior to motion detect consume sufficient time for the motion detect weight samples to be compatible with the scale mechanical movement as is explained in the specification topic relating to motion detection. The JMS instruction at memory location **062** will provide entry into the waste time routine for this use. The steps immediately following junction **1114** up to the block **1115** in FIG. **11** are concerned with the waste time routine. The instructions performing waste time housekeeping steps are located between memory location **031** and **046** on pages 1 and 2 of Table V.

Commencing at block **1115** in FIG. **11** is a series of instructions which interrogate the printer home position switch to determine if a label has been printed and starting of the label ejector motor is required, use of the ejector motor being necessary if the printer has left the home position. Turning off or maintaining the ejector motor in the off position is appropriate if the printer has not departed home position. In the Table V program the home position steps commencing with block **1115** and ending at block **1118** are performed by the instructions in memory location **047** through **061** on page 2 of Table V.

Following the ejector motor sequence, the waste time subroutine previously prepared for is executed as indicated at block **1118** with instruction JMS WAST at memory location **062** and **063** of Table V providing access to the waste time subroutine. This particular waste time interval is also described in the portion of the present specification titled motion detection and as indicated above serves to make the program repetition cycle and the scale mechanical response time compatible.

The motion detect subroutine follows the waste time sequence indicated at **1118** in FIG. **11**. The motion detect sequence is represented by the blocks **1120** and **1122** in FIG. **11** and is accessed by the JMS MOTN instruction at memory location **064** and **065** on page 2 of Table V. This command provides a jump of program control to memory location **292** on page 7 of Table V. The steps in the MOTN subroutine commencing at memory location **292** are described under the specification title "motion detection" herein. Testing of the "trips through" counter as indicated in the block **1122** of FIG. **11** is performed by the instruction JCN NZA at memory location **067** in Table V.

Upon satisfying the no-motion criteria of the motion detection subroutine, the program performs the series of instructions in memory locations **069** through **080** which determine if the label printed in a previous trip through the program has been removed from the label delivery chute, it being desirable that the scale operation and the printing of a second label be inhibited until the first label has been removed in order that confusion between labels be avoided.

As indicated at the block **1124** in FIG. **11**, if the previous label remains on the label delivery chute, the program branches back to junction B following the decision block **1110** and repeats continuously the steps between this point and the block **1124** until the previous label taken test is satisfied. The steps in this repeated loop make use of the shortened "Manual Start" motion cessation criteria described above in order that repetition of the "previous label taken" test occur at a desirable rate.

When the present scale system is connected to automatic package weighing and label preparing equipment of the type disclosed in Treiber U.S. Pat. No. 3,732,966 wherein packages are conveyed to a scale weighing platform, weighed and appropriately labeled, it is found desirable to condition the start of a weighing and label preparing cycle upon the mechanical movement which places a package on the scale platform rather than depend on the scale detecting a cessation of platter motion as is usually done to start a weighing and label printing cycle. If commencing of a weighing cycle is based exclusively upon motion cessation, it is found, in the instance of two similar packages of small weight, that the scale may appear to come to rest prematurely while a portion of a second package is yet on the package transporting conveyor since little scale travel is needed to change between the first and second package indicating positions. This would, of course, produce an erroneous weight reading and an incorrect label.

By locating a cycle sensing switch in the package transporting equipment in a location responsive to the completion of an operating cycle and interrogating the status of this switch with the computer program, weighing and labeling errors of this type are eliminated. In the present weighing system the name "computer start suppress" is used to identify the switch and program steps which prevent the premature start of a weighing and label preparing cycle before the transported package is fully on the weighing platform.

In FIG. **11**, the block **1126** indicates the program steps associated with the computer start suppress sequence, this sequence involving the instructions at memory location **084** – **087** on page 2 of Table V. If the package transport and weighing equipment is found not to have completed an operating cycle by the decision indicated at block **1126**, the program loops again to the junction "B" immediately following decision block **1110** which was described above in connection with the previous label taken test. Where the scale system of the present invention is used in the stand-alone mode without package transport weighing and labeling equipment, a wired connection is employed to indicate proper positioning of the transport mechanism.

Following the computer start suppress decision are tests for sale by count and label repeat switches as indicated by the blocks **1128** and **1130** in FIG. **11** and as performed by instructions at memory location **091** – **098** on page 3 of Table V. When operated in the sale by count mode, the system supplies a total value quantity from a combination of the price per pound entry knobs and weight on the scale platter. In a similar manner, when the label repeat control switch is actuated by the operator, the system supplies labels having identical numerical values for use in th prepackage mode of operation. The label repeat subroutine is contained at memory location **119** on page 3 of the Table V program listing, as indicated in the second line of the JCN instruction at memory location **098**.

Following the label repeat status test in block **1130** another test is performed to determine if the manual start switch was found closed in the block **1109–1110** sequence, this second manual start test being indicated by the block **1132**; and performed by the JCN CI THRE instruction in memory location **100** –**101** on page 3 of Table V; if this test indicated manual start switch closure the program jumps to the junction E preceding block **1140** in FIG. **11**, it being desired that computation start and a label be produced in response to a manual start command even through one or more of the tests indicated between blocks **1132** and **1140** is not satisfied.

If the manual start switch has not been closed, the program compares the weight value obtained during the motion detect subroutine with lower and upper limit weight values as indicated by the weight dead zone and scale range test of blocks **1134** and **1136** and the instructions commencing at memory location **108** on page 3 of Table V. If the stored weight value is either within the weight dead zone or in excess of the scale range, the program proceeds to the junction F resetting the motion status flag and returning to program home position so that the scale remains locked in a loop which includes one of blocks **1134** or **1136** repeating the steps in this loop indefinitely until an acceptable weight value is provided; printing of a weight and price label being inhibited so long as this loop-locked condition continues.

As indicated by the motion detect status text of block **1138** the scale of the present invention must go through a period of motion followed by a period of no-motion before computation can occur. If the motion status word has not been set by the motion detect subroutine, the test indicated at block **1138** will also provide indefinite looping of the program through the junction F back through the program home position.

In the Table V program listing, the steps indicated by blocks **1132** through **1138** are performed by the instructions at memory location **100** – **118** on page 3, these steps involving use of several subroutines accessed by JCN and JMF instructions, the subroutine addresses being indicated by the latter bits of these instructions as described in the Intel Users Manual.

Between memory location and **119** and **167** in Table V are located a plurality of subroutines including the repeat switch subroutine, the check tare subroutine and the error routine. Each of these subroutines is addressed by a jump instruction from another part of the computer program. Value computation commences with the JMS instruction in memory location **167** and the block **1150** in FIG. **11**. The computation indicated in block **1152** is preceded by tests which determine that a tare entry has been made, i.e., that the touch-tare knob **23** has been touched, that the printer is not in an error condition, that the weight is within the scale range, parity test of the weight chart reading is satisfied, the weight is outside the weight dead zone and the scale has not been identified as a metric scale as indicated by the blocks **1140** - **1150**. The first three of these tests leads to the error subroutine and scale disabling if not satisfied. If the weight is within the weight dead zone in the block **1146** test, a subsequent test is performed as indicated in the block **1148** to examine the manual start switch status, a scale computation cycle being permissible for weight values within the weight dead zone in a manually start cycle. Weight values within the weight dead zone result in indefinite program looping through the block **1148** when the manual start switch has not been depressed. The weight dead zone and manual start tests are performed by the instructions in memory location **182** - **195** on page 5 of Table V.

Upon satisfying either the weight dead zone or manual start test of block **1146** and **1148**, tests for the scale being a five kilogram or ten kilogram metric scale are performed by the series of instructions in memory locations **196** - **205** on page 5 of Table V. These instructions also involve the metric multiplier subroutine at memory location **1280** on page 26 of Table V.

Following the steps relating to a metric scale as indicated in block **1150** of FIG. **11**, the unit price indicating switches, i.e., the price per pound switches in an American embodiment of the invention, are read into memory as indicated by the block **1151** in FIG. **11**, and performed by the instruction in memory location **205** and **206** and the subroutine in memory location **804** on page 19 of Table V. The unit price switches are shown at **31**, **32** and **33** in FIG. **1** and FIG **5B** of the drawings.

The computation of total value, i.e., the multiplication of weight times a quantity read from the unit price switches as indicated in block **1152** of FIG. **11**, is performed by the instructions in memory location **206** - **213** on page 5 of Table V, the JMS MPLY instruction providing a jump to the multiply subroutine at memory location **601** on page 14 of Table V.

Mathematical accuracy of the total value multiplication is verified by dividing the total value quantity resulting from the block **1152** multiplication by the unit price quantity and ascertaining that the resulting quotient equals the original weight value, this division is indicated by the block **1158** with the comparison of quotient and weight values being indicated at block **1160**. This division is preceded by the test indicated in block **1154** which excludes the verified division step in the event the unit price switches are set to zero value, division by zero being impermissible and causing the computer to hang up in an indefinite loop if not excluded. If the decision indicated at block **1154** finds the unit price switches were in fact set to zero value, the program proceeds to the rounding routine as indicated by the path **1159**.

In the Table V program, the FIM instruction at memory location **215** - **217** are used to access the unit price information for non-zero value checking while the DIVO subroutine in memory location **219** - **222** actually performs the zero test and the instructions between memory location **222** and **234** increment the zero test through the digits of the word being tested. The CKPR portion of these instructions provides duplication of the data to be tested in memory location, i.e., RAM word **8**-**15** is a second original computed data will be lost by the division sequence indicated in block **1158**.

The division of block **1158** performed by the instructions in memory location **235** - **242** including the division subroutine at memory location **644** on page **15** of Table V which is accessed by the JMS instruction in memory location **241**. The comparison of block **1160** is performed by the instructions in memory location **234** - **259**, a portion of which are located on the second of the system ROM chips, ROM I. Comparison failures from the block **1160** provide a jump to a central error receiving point on ROM I, memory location **290**, from which point a JUN instruction having two-word jump address capability provides return to the previously used error subroutine at memory location **158** on ROM O as shown on page 4 of Table V. Memory addressing between ROM chips involves address bits located in the four highest bit positions of the address word as indicated in the Intel Users Manual.

Once the total value computation has been mathematically verified, the total value quantity can be rounded in accordance with the currency practice of the locale in which the scale is being used. In the United States, for example, it is desired that the total value be rounded to have two digits, i.e., dimes and cents, on the right of the decimal point with the cents digit being increased by one number from its computed value in response to numbers having a value larger than four occupying the 1/10 cent decimal position. In the present invention, the total value rounding desired is selected by a group of switches or jumpers, which are interrogated by the instructions commencing at memory location **419** on page 10 of Table V. The actual rounding operation is initiated by the instruction at memory location **430** together with the round subroutine commencing at memory location **695** on page 16 of Table V; reading of the round select status and the rounding operation is indicated by the blocks preceding block **164** in FIG. **11**.

In some currencies, it is desirable that the last digit of the total value be either a zero or a five, th half-penny or five-tenths coin being denoted by this numeral five; for such currency, the scale of the present invention is provided with quarter rounding capability which can be activated during scale installation as needed. The JUN instruction at memory location **436** provided a jump to memory location **705** on page 16 of Table V where the quarter-round subroutine is located, the quarter-round subroutine including both a check of quarter-round selection switch status and performance of the quarter-rounding operation. The quarter-round subroutine is a second level subroutine activated by an instruction in the round subroutine.

Following the rounding, the total value quantity is loaded into the memory location used by the input/output subroutines and tested for its being an excessively large value as indicated in the block **1166**. The total value remains in this memory location until utilized by the output to printer subroutine. Once the value overflow test of block **1166** and the output to printer subroutine has been performed, the scale weighing cycle is complete and the scale remains dormant until activated by platform motion or manual start command for a new weighing cycle. The output to printer subroutine described elsewhere in the specification and is accessed by the JUN instruction in memory location **288**; the subroutine commences with the instruction in memory location **888** on page 20 of Table V.

MOTION DETECTION

The sequence of operations which determine whether the scale is in motion or at rest was indicated by the blocks **1120** and **1122** in FIG. **11** and in the specification topic describing the executive routine. A flow diagram which describes the motion detect subroutine in greater detail is shown in FIG. **12** of the drawings. The FIG. **12** diagram also repeats selected portions of the FIG. **11** executive suroutine which are relevant to an understanding of motion detect subroutine operations.

Access to the motion detect subroutine is provided by the JMS instruction in memory location **064** on page 2 of Table V; this instruction providing a program jump to the MOTN subroutine which commences at memory location **292** on page 7 of Table V.

The MOTN motion subroutine commences with bringing a new weight reading from the scale photocells into the computer memory. This is indicated by the block **1202** in FIG. **12** and accomplished by the RDWT subroutine on page 9 of Table V with the new weight reading being stored in RAM words **32–35**, photosensor output bits DCBA being located in word **32**, bits HGFE in word **33**, bits LKJI in word **34** and bits PONM in word **35**. The weight reading being at this time in Gray code form.

An overall view of the FIG. **12** flow diagram indicates that each new weight reading is tested for motion in two different fashions. One of these tests, which is shown in the steps **1204**, **1228**, **1230** etc. aligned along the right hand edge of FIG. **12**, involves a dynamic motion test of the type described in U.S. Pat. No. 3,516,504. The other motion test which is shown in the steps **1206**, **1208** etc. aligned along the left hand edge of FIG. **12** involves a comparison of successive weight readings. The condition of motion can be determined by either of these sequences of steps.

The new weight reading in RAM words **32–35** is first examined by a dynamic motion test which involves the subroutine MOTX commencing at memory location **294** on page 7 of the Table V program and is indicated by the "A and C both light"decision block **1204** in FIG. **12**. If photosensors A and C are found by the MOTX routine, to have each provided a binary one output signal a motion condition is indicated since as explained in the above patent the A and C tracks of the scale chart actually contain no simultaneous translucent areas. The presence of simultaneous A and C signals therefore indicates that alternating light and dark areas in each of these tracks is being integrated by the slow responding photosensor elements to provide quasi ON signals which are interpreted as ON signals by the threshold circuitry.

Once the A and C test has determined that the scale is in motion a series of housekeeping steps is performed by the program. These steps include setting a motion status memory flag as indicated at **1228** in FIG. **12** and performed by the MOTC subroutine on page 8 of Table V, the motion status character being located at status character **1** of register **2** in the RAM. The housekeeping steps also include resetting the time counter located at status character **3** of register **2**, the negative motion counter at status character **2**, register **2** and the positive motion counter at status character **0**, register **2** all performed by the MOTZ routine at page 8 of Table V and indicated at **1230** - **1234** in FIG. **12**. The function of each of these counters is explained below. Information regarding the RAM organization including the status character identification is provided in the previously mentioned Intel Users Manual.

Upon resetting the above counters, the program proceeds to the MOTA subroutine indicated by the block **1236** and commencing at memory location **323** on page 8 of Table V; in the MOTA sequence the new weight reading is transferred from RAM location **40** to location **36** a step which has the effect of updating the previous weight storage at RAM location **36**. Following updating of the previous weight storage, the time counter located at status character **3** of register **2** is incremented as shown at block **1238** in FIG. **12** and a test made to determine if the program has traversed the motion detect sequence a sufficient number of times to have the scale mechanism physically settle out, that is the number of trips through the motion detect routine without detecting motion is compared with the number of trips known to consume the time required for scale settle out. This test is performed by the RD **3** and JCN instructions at memory locations **66–68** at page 2 of the Table V program listing and indicated by the block **1240** in FIG. **12**. Failure to satisfy this test results in a return to Program Home at **1108** in FIG. **11**, this return being indicated by the line **1201** in the motion detect flow diagram of FIG. **12**. Actually the system does not perform the Read Weight sequence of block **1202** immediately upon return via the path **1201** but instead proceeds through the steps **1109–1118** in the executive routine before once again reaching the block **1202** Read Weight sequence; that is, a part of block **1120** in FIG. **11** is performed prior to block **1202**.

Returning now to the A and C photosensor decision operation at **1204** in FIG. **12** and the Table V program, if the MOTX routine finds that at least one of the photosensors A and C is not illuminated the program proceeds into the more sensitive successive comparison of weight reading motion test shown at **1206** etc. along the left hand edge of FIG. **12**. The weight comparison motion test commences with the transfer of Gray Code weight readings to RAM location **40–43**, the address used for performing code change operations, the actual transfer being performed by the MNAC routine at memory location **307** on page 7 of Table V followed by the converting of Gray code weight readings to binary coded decimal form as indicated by the block **1208** and performed by the CDCH routine on page 10 of Table V. The code changed weight reading is placed back in RAM word **40–43**.

Following code change, the current weight reading located in RAM word **40–43** is compared with the previous weight reading located in RAM word **36–39** by the COMP routine on page 13 of Table V, a comparison between these two weight readings indicating the lack of motion and causing the program to jump along the path **1211** to the transfer weight, increment time counter, and time counter examine sequence of steps **1236**, **1238** in the MOTA routine described above in connection with the A and C photosensor test.

If the comparison of current weight reading in RAM word **40–43** with the previous weight reading in RAM word **36–39** finds a difference in these two weight readings, a series of such different readings is examined sequentially to determine if the movement is oscillating in nature or sufficiently small to yet consider the scale being in a no-motion condition. This examination being performed by the MOTT, MNEG and MOTU routines located on page 8 of Table V and indicated along the left hand edge of FIG. **12** at **1212**, **1218** and **1222** respectively. The MOTT routine determines which the weight readings **40** or **36** is larger and places a bit indicating the larger reading in a positive or negative motion counter, a positive motion bit causing the previous negative motion count to be reset and a negative motion bit causing any previous motion count to be reset. It is significant to note that the incremented counter, the positive motion counter for example, is incremented by one count regardless of how much difference is found between the current and previous weight readings, that is, the detection of motion is based upon the concept that several successive weight reading comparisons each indicate a weight change in the same direction and not upon the concept that a single comparison shows a great difference in weight reading. In this respect, the scale of the present invention practices the teachings of the patent of Robert M. Rogers, U.S. Pat. No. 3,921,736 assigned to the assignee of the present invention.

According to this criteria for determining motion, the count in the appropriate motion counter, for example the positive motion counter, will be incremented during each of several successive trips through the MOTT routine and the state of being in motion indicated if this corner attains a predetermined count.

The MOTU routine on page 8 of Table V performs the examination of positive and negative motion counters and indicates the motion or no-motion condition according to one criteria if the scale was previously known to be in motion and according to another criteria if the scale was known to be previously at rest. In the MOTU routine the motion status word from status character **1** of register **2** is added to the contents of the motion counter being examined, i.e. the positive motion counter or the negative motion counter. The motion status word being a one if the scale was previously known to be in motion or a zero if the scale was previously at rest. To the sum of the motion counter and the status word is added a constant **13** which is selected in order that a count of 2 in the motion counter can provide an overflow count of 16 and thereby generate a carry bit which is easily sensed with the available Intel instruction family. Thus, if the scale was previously known to be in motion two successive weight readings each differing in the same direction will be sufficient to produce a motion indicating signal from the MOTU routine. If the scale was not previously in motion, i.e. if the motion status word is a zero, then three successively larger or three sucessively smaller weight readings are required to produce a motion indication from the MOTU routine.

In a weighing situation in FIG. **12** motion detection system could be expected to operate in the following manner. As a result of charge movement following placing an article on the scale platform, the system will make several trips through the right hand portion of FIG. **12** with the A and C photosensor test indicating rapid and dynamic movement of the scale. Each trip through this sequence causes the motion status character to be set and a new weight reading to be placed in RAM location **36** and the time counter left containing a count of one.

When the scale chart ultimately approaches the condition of balance and begins to slow its movement, a point is reached where the A and C photosensor test no longer indicates motion and the program then makes successive trips through the weight comparison test shown at the left hand edge of FIG. **12**. During these initial passes through the weight test each weight reading will differ from the previous reading so that the positive motion counter will be successively incremented at block **1216** and a carry produced when the constant **13** is added to the motion counter contents. At some time, however, the scale chart will slow and ultimately come to rest either at the correct weight reading or in an overshoot position, so that the COMP routine comparison of block **1210** on page 13 in Table V, will indicate coincidence between previous and current weight readings. Actual weight reading coincidence will cause the program to jump to the MOTA routine along the path **1211** and cause the time counter at status character **3** of register **2** to be incremented to a new count. A count of 16 or zero in the time counter has been selected for termination of the motion detect operation. This is detected by sensing the counter contents being 0000 during the 16th count. In the preferred embodiment of the scale, a count of 16 cycles without motion in the time counter has been found to provide satisfactory assurance that the scale has come to rest without imposing an objectionable delay prior to commencing scale operations; obviously counting to some other number to give a different delay time could be selected. Since each trip through the motion detect sequence involves the delay imposed by the waste time sequence **1118** in FIG. **11** executive routine preceding the MOTN routine in FIG. **12**, it is impossible for the time counter to obtain a count of 16 and initiate a computation cycle as a result of a brief pause of the scale chart in an overshoot condition.

Following the previously described upward direction overshoot motion of the scale chart, the chart may move backwards toward the true weight indication and possibly may again overshoot in the negative direction. The negative and positive motion counters of the MNEG and MOTT routines respond to any possible combination of upward, downward or oscillatory movement of the scale chart; depending upon the speed and duration of a particular movement of this response may include sufficient incrementing of a motion counter to generate a motion indicating carry in the MOTU routine. In view of the time delay of the block **1118** waste time routine, however, an oscillatory or overshoot movement of the chart will not be sufficient to increment the time counter through 15 counts and provide a computation start decision. Following the possible succession of negative and positive overshooting movements each successively smaller than the preceding movement as a result of damping apparatus in the scale, the chart eventually will come to rest on a weight reading. With the chart in this position, the condition of no-motion will be indicated either by failure of the positive or negative motion counter to attain a count providing a motion indicating carry bit in the MOTU routine or by coincidence being found in the COMP routine at **1210** in FIG. **12**. When one of these conditions occurs the program jumps to the MOTA routine at **1236** via one of the paths **1211** or **1227** and increments the time counter at **1238** through one of the 15 counts required to initiate a computation cycle.

Once the motion status word at status character **1** of register **2** has been set in the motion detect sequence shown in FIG. **12**, it remains set until late in the scale operating cycle. During the printer routine the motion status word is reset by the instruction JMS MOTY in memory address **909** on page 21 of Table V, this instruction is contained in the printer subroutine indicated at block **1167** in FIG. **11** and is shown expressly at **1542** in FIG. **15**. With the motion status word reset, which typically is the condition existing after a package has been weighed and a label printed, it is necessary for the positive or negative motion counters to reach a count of 3, that is 3 successive weight readings must differ in the same direction before an indication of motion is again provided. Use of this less sensitive motion-detect criteria when the scale has been at rest is found to be desirable for eliminating scale response and the resulting label printing if the scale is mechanically vibrated; this less sensitive criteria is found however, to be undesirable for determining the cessation of motion at the start of a scale operating cycle since any error or tolerance accepted in the motion termination point is in essence a weight reading error.

It is significant to note that even though the scale of the present invention does not initiate a weighing cycle and the printing of a label until the motion test sequence of FIG. **12** has been satisfied, that is, until an indication of no-motion has been achieved, it is also true that initiation of an automatic scale cycle cannot occur until the FIG. **12** sequence has found an indication of motion. The inhibiting of scale operation until one occurrence of motion has been detected is provided by the program step JCN NZA THRE/MOTION indicated at **1136** in FIG. **11** and found in memory location **113** on page 3 of Table V. Until the motion test routine of FIG. **12** has found one indication of motion this JCN NZA instruction will cause the program to loop back to the home position repeatedly rather than enter the computation cycle.

OUTPUT TO PRINTER SUBROUTINE

The subroutine for control of printer operation is set forth beginning at memory location **888**, page 20 of Table V and is entered by execution of the instruction JUN PTR at memory location **288** near the end of value computation on page 7 of Table V. The printer prints four digits of total value and four digits of weight from information stored in RAM words zero through seven in the computer. In the preferred embodiment of the invention there are also four digits of price per unit weight information on the printed label. Number selection for these four digits is controlled by mechanical linkage between the printer and the knobs **31, 32** and **33** in FIG. **1** without intervention by the microprocessor; operator positioning of the price per unit weight knobs is however sensed electrically and used as a multiplication factor during value computation as is described in the value computation portion of the specification.

The printer or labeler contemplated for use with the present embodiment of the invention is more fully described in Allen U.S. Pat. Nos. 2,948,465 and 3,388,758 and the patents therein identified. Generally the electrically controlled portion of this printer contains eight numeral embossed print wheels which are positioned initially in a home position, i.e., that position which prints the numeral nine. The print wheels are rotated from home position by a motor and differential gear arrangement with each print wheel being capable of stopping in any of the nine printing positions following home position. The stopping of the print wheel in a selected printing position is accomplished by actuating or firing a solenoid at the appropriate instant in the print wheel movement cycle. The printer is equipped with photoelectric sensing apparatus indicating location of the print wheels in home position and in each subsequent numeral position. A cam switch signal indicates the printer has progressed through the print wheel setting portion of the operating cycle. As is explained in the above Allen U.S. patents the printer of the preferred embodiment actually employs the stopping of intermediate members by the print wheel solenoids followed by in-unison movement of the print wheels to selected printing positions. For describing the printer portion of Table V the aforementioned simplified printer operating description is sufficient however.

FIG. **15** of the drawings shows a flow diagram of the output to printer subroutine which commences with the instruction in memory location **888** on page 20 of Table V. In general, the output-to-printer subroutine operates first on four digits of weight information and then on four digits of total value information expanding each of these four digit quantities into a matrix of binary one and zero control bits used to actuate print wheel stopping solenoids at the appropriate time instant in the print wheel rotating cycle. The control bits for four digits of weight information are loaded into memory locations **6** through **15** in the RAM by the programs with the 4-bits in register **6** indicating any print wheels which are to be stopped in the numeral nine printing position, the 4 bits in register **7** indicating any print wheels which are to be stopped in the numeral nine or eight printing position, the 4 bits in register **8** indicating the print wheels which are to be stopped in either the numeral nine, eight or seven positions and so on with the print wheels being stopped by the first encountered control bits during the scanning of memory locations **6** to **15** and with the repetition of a previously used control bit in later succeeding memory locations being redundant and having no physical effect on an already closed print wheel solenoid. Once four digits of weight information have been expanded into print wheel solenoid control bits, the same program sequence is reemployed by means of appropriate jumping and looping instructions to operate on the four digits of total value information, these four digits being expanded into solenoid control bits, placed in memory location **54** to **63**.

Once the weight and total value information has been expanded into solenoid control bits in the code converting portion of the printer subroutine, the printer is tested for ability to receive the converted data and the data transferred to the printer in ten sequential trips through a looped transfer routine which commences with the PTR7 series of instructions, each trip through the transfer routine conveying information regarding print wheels which are to be stopped in one numeral position, that is, the first trip through the transfer routine provides solenoid control bits relating to any numeral nine digits to be printed in the weight and total value quantities while the last trip through the transfer sequence provides information relating to any numeral zero digits in the weight and total value quantities. The solenoid control bits transferred during each trip through the transfer sequence are also compared with signals indicating solenoid current flow to verify that the desired connections of solenoids and power supply were in fact accomplished.

Returning now to the output-to-printer subroutine at memory location **888** on page 20 of Table V and to the flow diagram of FIG. **15**, the first three instructions in the output-to-printer subroutine, load into the index register, at the indicated locations, the memory address of storage which is used for the first word of solenoid control bits, i.e., the nines control bit, the first digit weight data and the address of a counter used to determine when four digits of information has been processed, these steps being performed by the FIMP1, FIMP0 and FIMP2 intructions, and indicated by the block **1502** in FIG. **15**.

Commencing with the PTR2, CLB instruction at memory location **983** on page 22 of Table V and the block **1508** in FIG. **15**, and continuing through the ISZ **5** intruction on page 23 of Table V which corresponds with the block **1528** in FIG. **15**, there is set forth the sequence of steps by which one digit of data is examined for correspondence with a current print wheel position, that is, during the first trip through this sequence of steps, the high order digit of weight data is examined for the presence of a numeral nine, during the second trip through this sequence, the second lowest digit of weight information is examined for the presence of a numeral eight, and so on. This sequence of steps includes clearing the accumulator, as indicated by the block **1508** and performed by the CLB instruction in memory location **918**; accessing the hundredths-of-pounds digit of weight information, block **1510** and the SRC P0 instruction in memory location **984**; adding together the numeral one and the digit of accessed information (the lowest order weight digit in the first program pass-through), and adding a constant sufficient to augment a numeral nine digit of data up to a carry producing value of 16 (zero all) as indicated by the blocks **1512**, **1514** and **1516**, and performed by the instructions IAC, ADM and ADD **3**. Following this sequence of steps, there will exist in the accmulator a carry bit identifying the fact that the data digit accessed in the block **1510** step results in a solenoid control bit. This bit is placed in the memory word addressed by the block **1502** step. The absence of a carry in the accumulator at this time indicates that the digit accessed in the block **1510** step, and the digit added in block **1516**, do not sum to produce a control bit; at some later print wheel position when the constant added by the block **1516** step has been incremented to a higher value this data will provide a carry bit.

Once the accumulator contains a carry bit indicating that solenoid control current is to be turned on, the accumulator data is added to the contents of the RAM word addressed in the block **1502** step and the results rotated right by one position to bring the data bit out of the carry position back into a data bit position and this result written back into the RAM word addressed in the block **1502**, these steps being performed in the blocks **1518**, **1520**, **1522** and **1524** which correspond to the instructions SRCP1 RDM RAR WRM commencing at memory location **988** on page 22 of Table V.

Once the solenoid control information has been placed in RAM memory in the block **1524**, the conditions needed to allow repeated use of the sequence indicated by the blocks **1508** - **1524** are set up by a series of steps indicated by the blocks **1526**, and **1528** which respectively increment the addressing used in the block **1510** and **1506** steps in order to access the next weight digit and increment the digit counter of register **5** to indicate that one digit has been processed. If the register **5** counter has not been incremented up to the value of 16 or zero, the ISZ **5** instruction in memory location **993** which is indicated by the block **1528**, provides return to the start of the PTR2 sequence and block **1508** as indicated by the path **1529**, this path being traversed once to examine the tens of units weight digit, a second time to examine the units digit of weight a third time to examine the one-tenths of units digit of weight, and so on; for a domestic scale, these units of course represent pounds. When the counter in register **5** has been incremented up to the zero value, the ISZ instruction in memory location **993** causes the program to proceed to an expansion of total value digits by performing the BBL **0** instruction in memory location **995** and returning program operation to the next instruction following the PTR1 sequence, as indicated by block **1532**, the next instruction being the ISZ3 PTR3 instructions at memory location **894**. The ISZ instruction in location **894** results in program returns along the path **1533** if register **3**, which was initially filled with a count of six in block **1502**, has not yet reached a count of sixteen or zero. Register **3** is incremented from six toward sixteen in the block **1532** for each examination of the four weight or total value digits, that is, register **3** is incremented once following examination for nines, incremented again following examination for eights, and again following examination for sevens, and so on. When the test of block **1532** is satisfied, the printer code coversion subroutine has expanded the four digits of weight information into ten 4-bit words of solenoid pulses which are stored in RAM memory locations **6** through **15**. At this point, as indicated in the blocks **1534** and **1536**, the program loads registers **2** and **3** and register **0** and **1** with data which will cause the PTR1 and PTR2 sequence of block **1506** etc. to expand four digits of total value information into solenoid control bits. The total value solenoid control bits, also comprise 10 words of 4-bits each and are stored in memory locations **54**–**63**. Initiation of the total value data expansion is provided by the path **1539** once registers **2** and **3** and **0** and **1** have been filled with the appropriate initial solenoid bit storage address for total value and register **0** and **1** have been filled with the address of the initial digit of total value information.

Returning now to the block **1530** described above, this block corresponds with the BBL **0** instruction in memory location **995** on page 20 of Table V, and in essence provides two output paths, one leading to the block **1532** and the continued performance of weight digit conversion and a second along the path **1531** leading to the block **1540** to commence expansion of total value digits into solenoid pulses. The loading of registers **2** and **3** and **0** and **1** in preparation for performing total value digit expansion is indicated by the block **1534** and **1536** and is performed by the instructions FIM P1 **54** at memory location **896** and FIM P0 **48** at memory location **898**. The incrementing and testing of register **3** indicated in the block **1540** is performed by the ISZ instruction in memory location **902**, this instruction providing a return along the path **1541** when register **3** has not been incremented by the 10 counts between its initial state of **54** and its terminal state of **63**. One return along the path **1541** is used following examination of the total value digits for nines and another return along this path used following examination for eights and another following examination for sevens, and so on.

When the test of block **1540** is satisfied, both the four digits of weight information and the four digits of total value information have been expanded to binary signals which are spread through 10 memory locations each and ready for application to the print wheel control solenoids when the scanner traveling with the print wheels indicates location of the print wheel in an appropriate printing position. The print wheel scanner data is sampled in the block **1558** and tested in the block **1562** prior to transferring each four solenoid control bits to the printer as is explained below.

Between the expansion of data into solenoid control bits and the outputting of solenoid pulses to the printer as indicated in the blocks **1550** and **1552**, are located several housekeeping steps represented by the block **1542** - **1548** in FIG. **15**. These steps commence with the JMS MOTY instruction in memory location **904** on page 21 of Table V. The JMS MOTY instruction causes the motion status word which was set much earlier in the operating cycle, during the motion detect subroutine, to be reset in order that examination for scale motion be possible during waiting intervals of the printer subroutine. Motion sensed at this time is presumed to be caused by acts attending removal of the first-weighed package and placing of the secondweighed package on the scale platform; resetting the motion status bit as indicated in block **1542** being desirable in order that the occurrence of new motion be discernable. The resetting of the motion status bit is accomplished by a jump resulting from the memory location **904** JMS command to the MOTY sequence located on page 8 of Table V.

Following reset of the motion status bit, a test is performed to determine that the printer is in the home position as indicated in the blocks **1544** and **1546** and performed by the instruction in memory locations **906** - **912** on page 21 of Table V. Location of the printer in home position, i.e., print wheels positioned corresponding to the numeral nine, is necessary before data transfer commences since the first data transferred to the printer results in printing numeral nine data. As indicated at the block **1546**, the program loops via the path **1545** unit this home position requirement is satisified, this testing and looping being performed by the JCN instruction in memory location **911** and **912** of page 21 of Table V. During manual operation of the scale system, it is unlikely that the printer would be found away from home position by the test **1546**, so that this test is not essential, however, during label repeat mode or by-count mode operation of the sytem, where a package to be weighed may be transported by a conveyor to the scale platform, the block **1546** test is necessary since the program may arrive at block **1546** before the printer has had sufficient time to reach home position.

When the home position test is satisfied, the label eject motor is started, if not ready running, and the printer driving clutch is closed as is indicated in the block **1548** and performed by the instruction at memory location **918** and **919** on page 21 of Table V. At this point the first group of four solenoid control bits representing weight data is transferred from memory to printer as indicated by the block **1550** and as performed by the JMS **PTR6** instruction at memory location **924** and the PTR6 subroutine at memory location **996** on page 23 of Table V. Subsequent to this the first four bits of total value solenoid data representing numeral nine digits data is transferred as indicated by the block **1552** and performed by the instructions leading up to memory location **930** and **931** on page 21 of Table V.

Following data transfer, there may ensue a considerable period of waiting while the print wheels of the printer move between adjacent printing positions, i.e., between nines printing and eights printing positions, for example. In order to use this time advantageously there is inserted into the program as indicated in the block **1554** the examination for scale motion described previously in connection with the block **1542**, this examination is performed by the JMS MOTN instruction at memory location **932** on page 21 of Table V which results in a return to the MOTN subroutine on page 7 to Table V. The occurrence of motion at this point in system operation causes the motion status word to be set to condition the scale for another weighing cycle even through data from the previous weighing has not been completely transferred to the printer and to a label.

The motion test indicated by the block **1554** and initiated by the instruction in memory location **932** and **933** of page 21, Table V allows the comparison of two successive weight readings and is accomplished during a single trip through the MOTN subroutine on page 7 of Table V. This single trip ends with the BBL **0** instruction in memory location **334** on page 8 of Table V, which brings the program back to the printer subroutine at the instruction in memory location **934** on page 21 of Table V after this one comparison between two successive weight readings has been performed. Fifteen successful comparisons required to indicate the cessation of motion however it is possible to only realize 10 of these fifteen weight comparisons before the printer subroutine terminates, the ten or less successful comparison results being maintained in the counters of the motion detect subroutine for continued used during the weighing cycle of the next package. Thus, commencement of the motion detect subroutine during the output-to-printer subroutine as shown in the block **1554** has the effect of increasing scale operating speed since a part of the motion detect subroutine for a second package is allowed to occur during wasted time in the printer subroutine of a first package.

Once the motion testing of block **1554** is completed during the data transfer sequence, a series of tests is performed to determine ability of the printer mechanism to accept the next group of solenoid control pulses, these tests ascertaining whether the printer cam switch is closed as a result of the print mechanism having progressed to the end of the solenoid portion of its cycle. The cam switch test is performed by block **1560** and the instruction JCN Cl PCAM in memory location **939** on page 21 of Table V, a successful test indicating that all print wheel control bits have been transferred from memory to printer and all print wheels are positioned for a print event, the successful test providing a jump along the path **1561** in FIG. **15** to the next event in the printing cycle while an unsuccessful test results in an examination of the scanner status bit in block **1562** by the instruction JCN CZ PSCl in memory location **924** to determine if the print wheels have moved to the position for receiving the next solenoid control bits. A positive scanner test leading to the next instruction and a negative scanner test causing a return via the path **1557** to repeat the cam and scan status tests until a positive test of one or the other is achieved. (The printer loops via the path **1557** during whatever portion of the print wheel moving time is not consumed by the motion detect sequence of block **1554**.)

Once the desired scanner status is found in the block **1562**, signals indicating which print wheel solenoids have thus far been energized, i.e., signals generated by current flowing through the resistors **741**–**748** in FIG. **7** of the drawings, are compared with solenoid control bit data which has thus far been transferred to the printer, this comparison being performed by the block **1564** and **1566** and requiring two successive comparisons as indicated by the path **1565**. Solenoid verification is performed by the instructions in memory location **944**–**963** on page 22 of Table V; an unsuccessful comparison resulting in an error as indicated by the path **1567** from the block **1566**. If the two solenoid bit comparison tests, i.e., comparisons for the weight solenoid control bits and the total value solenoid control bits are successful, the condition of the scan counter is examined as indicated in the block **1570** and performed by the instructions ISZ **11** PTR7 in memory location **965**, this test determining whether a sufficient number of solenoid control bits have been transferred from memory to the printer. An unsuccessful test provides a return along the path **1559** for continued outputting of solenoid control bits by the PTR7 sequence commencing at block **1550**.

It is to be noted that the PTR7 sequence commencing at block **1550** transfers four weight related solenoid control bits then four total value solenoid control bits and that the test for cam switch status, scanner status and solenoid verification are performed immediately after each transfer operation. This arrangement thereby verifies the overall condition of the transfer operation up to the current point, each time the PTR7 sequence is repeated. In the case of the solenoid current sampling signals tested in the block **1564** and **1566**, solenoids fired early in the transfer cycle are tested repeatedly each time a return along the path **1559** occurs since as indicated above the solenoid control bits for numerals are repeated when the control bits for numerals eight and numerals seven etc. are outputted.

In the block **1572**, there is indicated a test performed on the printer cam switch and the printer scan counter, this test resulting from the JCN NZA instruction at memory location **969**, page 22 of Table V; this test verifies that the intended number of control bit words have been transferred from memory to printer. A failure to verify control bit transfer results in scale and printer lock-up as indicated at **1573** and the IOER3 jump address in the JCN NZA instruction of memory location **969**. With regard to the possibility that the PCAM sequence commencing with block **1572** at FIG. **15** can be entered either by the path **1561** or the path **1569**, it is intended that this entry be always made along the path **1561** as a result of the print wheel cam switch having closed at the end of the print wheel set up portion of the printer cycle, however the path **1569** is provided in order that program hang-ups be prevented in the event a scanner pulse was erroneously not received and sensed in the blocks **1558** and **1562**. Where entry into the PCAM sequence is made via the path **1569** by the register **11** scan counter containing more than the intended nine scanner pulses, the instruction LD11 and IAC in memory locations **967** and **968** are used to intentionally create a condition which will be recognized as an error by the instruction JCN NZA IOER3, this intentional error is achieved by loading the contents of register **11** into the accumulator, incrementing the accumulator by one count and then performing a jump to the error subroutine location if the accumulator does not have a zero value. It will be noted that since register **11** was loaded with a numeral six by the instruction FIM P5 6 at memory location **920** on page 21 of Table V after nine scanner pulses register **11** should hold a count of fifteen if the transmission was error-free; adding of one to this count of fifteen as performed by the IAC instruction in memory location **968** should therefore provide a count of 16 or zero so that failure to sense such count of 16 or zero in the instruction JCN NZA at memory location **969** results in the jump to error condition.

Following verification that the cam switch is in the desired position and the correct number of scans have been counted, the printer solenoids are reset as are the manual start, repeat and by-count status bits; all this activity being indicated in the blocks **1574** and **1576** and performed by the WRO instruction in memory location **976** on page 22 of Table V. Following the solenoid and status setting, a take label status bit is also set as indicated in the block **1578** and performed by the instruction WR2 in memory location **978** indicating that a label has been printed and must be taken from the label delivery chute before printing of a subsequent label is allowed to occur. In a subsequent cycle, this take-label status will be verified as indicated in the block **1124** in FIG. **11** of the drawings in order that label confusion be avoided.

Following setting of the take-label status, the instruction JUN HOME in memory location **979** and **980** causes the program to jump back to the program home position indicated by the block **1108** in FIG. **11** for processing the weight information obtained from the next package, this processing possibly having already commenced as described above in connection with the sensing of motion during the printer operating cycle.

TOTAL VALUE ROUNDING

The computation apparatus of the present scale includes capability for processing four digits of price per unit weight information and four digits of weight information; following multiplication of these quantities a total value number containing up to eight digits of information will be generated. In an American Scale it is, of course, desired that the portion of the eight digits which may lie to the right of the decimal be rounded into two digits in order that the available four digits of display capability be used for two digits on the right of the decimal and two digits on the left of the decimal. When the scale is installed countries having different currency practices, some alternate arrangement for fitting the eight possible digits of total value into the four display digits may be desired. In the program of Table V, three subroutines are used to operate on the eight digits of total value for the purpose of rounding. These subroutines are named "round status", (page 10 of Table V), "round routine", (page 16 of Table V), and "quarter round" (page 16 of Table V).

The round status subroutine commencing at memory location **419** on page 10 of Table V was briefly described in the executive routine part of this specification while describing block **1163** in FIG. **11**. In FIG. **21** the round status subroutine is shown in greater detail and in a manner correlated with program steps commencing at memory location **419** on page 10 of Table V.

In FIG. **21** the first five blocks of the round status subroutine, blocks **2102**–**2110**, are concerned with reading switches or printed circuit board jumper wires used to select the total value digit to be rounded. The block **2102** and the instruction in memory location **419** relate to supplying multiplexer addresses or control signals which will present the round switch signals at the RAM data port. The outputting of multiplexer control signals is performed by the OUTA subroutine which is accessed by the instruction in memory location **420** and indicated by block **2104** in FIG. **21**. In the round switch data word the two least significant bits define the total value digits to be examined by the rounding subroutine while the high order bit defines the need for quarter rounding; the second highest order bit is unused. Reading the round switch information is indicated in the block **2106**. The information read is placed in status word two of RAM word **1** as indicated by the block **2108** and performed by the **WR2** instruction in memory location **427**. Once the round selection word is thus in memory, the high order bit of the round instruction word as it remains in the accumulator is removed as indicated by the block **2112**, the high order bit being the quarter round instruction which is to be executed later in the program sequence. With the quarter round bit removed, the program proceeds to the round subroutine as indicated in the block **2114** and performed by the JMS instruction in memory location **430**. The remaining portion of the round status routine including the blocks **2120–2124** relate to the quarter round selecting switch and the quarter round subroutine and relate to instructions which are executed following part of the round subroutine as indicated at the block **2216** in FIG. **22**.

The round subroutine commences at memory location **695** on page 16 of Table V with the **RAR** instruction which places the round switch information word, now free of the quarter round instruction bit, back into its normal position in the accumulator. Following this relocation the **XCH** instruction in memory location **696**, places the round status word in the lower half of the same register pair PO which was used to store the address **16** in the **FIM PO 16** instruction of location **424** on page 10 of Table V. Following the **XCH 1** instruction, register pair PO (registers **0** and **1**) will contain the constant **16** loaded by the FIM instruction of memory location **424** plus a binary number between 0 and 3 which was obtained from the round select switches or jumpers. The sum of these two quantities identifies which digit of the total value product stored in memory location **16–24** is to be operated upon for rounding; the possible digits being those stored in locations **16**, **17**, **18**, or **19**, since the two round status switches can generate binary numbers between zero and three. The data in memory locations **16–24** is stored with the low order digit in location **16** and high order digit in location **24**. The memory loading step is indicated at **2204** in FIG. **11**.

At this point a numerical constant of value five is loaded into the accumulator for adding to the total value digit which is to be rounded; the concept underlying this addition being that any data digit having a value of five or greater will, when added to this rounding constant of value five, produce a double digit sum of ten to fourteen which can be detected as indicated in the block **2216**. Sensing of this double digit sum indicates that the original data digit did in fact have a value of five or more thereby causing the next higher digit of the total value quantity to be incremented upward. The total value data to be rounded is accessed by the SRC instruction in memory location **698** as indicated in the block **2208** and is added to the rounding constant by the instruction in memory location **699** indicated by the block **2210**.

Following this addition which is performed with both the round constants and the total value digit expressed in BCD 8421 sequence, the resulting sum is decimal adjusted (wherein the carry bit is given a value of 10 rather than 16 as in binary form) by the DAA instruction in memory location **700** on page 16 of Table V. The DAA instruction is further explained in the Intel Users Manual. The decimal adjusted data is rewritten into the same memory location and examined for the presence of a carry bit as indicated in the blocks **2214** and **2216** and performed by the WRM and JCN instructions in memory locations **701–703**. If as a result of adding five to the digit being examined, no carry is produced, the program returns to the quarter round status test of block **2120** by way of the BBL instruction in memory location **704** as indicated by the left hand exit from block **2216**.

If the decimal adjusted data tested in the block **2216** was in fact double digit data so that a carry bit was present and was sensed in the block **2216** test, this carry must be added to the remaining digits of the total value quantity in the manner of a normal mathematical addition with the possibility of subsequent carries into the higher digits being considered. This addition could of course be performed by an addition arrangement, however in the present situation it is convenient to reuse the program steps **2208–2216** and program looping by the path **2224** to perfrom the necessary addition. As indicated at block **2218**, the carry sensed in the block **2216** test is placed in the accumulator where it replaces the constant five previously loaded at block **2206** during the second and subsequent loops through the block **2208–2216** sequence. In the block **2220** the contents of register **1** are incremented in order that the next higher ordered digit of the total value data be operated upon in the repeated trip through the **2208–2216** blocks. The steps of blocks **2218** and **2220** are performed by the RND **4** subroutine commencing at memory location **726** on page 17 of Table V, and this subroutine is accessed by the JCN instruction in memory location **702** which performs the block **2216** test. When the increment by one operation which results from rounding has rippled through the total value contents until no further carries between lower and higher ordered digits are present, the block **2216** test will indicate the absence of a carry bit, and the program will follow the path out the left hand side of block **2216** to the quarter round status test in the round status subroutine on page 10 of Table V.

The quarter round status test is indicated by blocks **2120–2124** in FIG. **21** and performed by the instructions in memory locations **432–438** on page 10 of Table V. If the need for quarter rounding has been indicated by the condition of the round select switch or printed circuit board jumper, this fact is sensed as indicated at the block **2120** which corresponds to the RD2 instruction in memory location **432** page 10, Table V; the actual test being performed after the quarter round select bit has been rotated left into the carry position in block **2122** by the RAL instruction in memory location **433** and tested in the block **2124** as performed by the JCN instruction of memory location **434**. If quarter rounding is not required, an exit from the block **2124** test to the left causes the program to return to the executive routine, the rounding operation being at this point complete. If quarter rounding is required, exit is made to the right from the block **2124**, and the jump indicated at memory location **436** to the QRD **3** subroutine on page 16 at memory **705** is performed.

The quarter rounding subroutine shown in blocks **2250–2282**, FIG. **22**, is used in scale systems having need for value indications of zero or five in the lowest order digit position. The most common use of this arrangement is in countries which use half-penny coins. Where quarter rounding is performed it is desired that low order total value quantities falling between zero and 2.5 be neglected and that values between 2.5 and 7.5 be rounded to a low order digit value of 5. Low order digit values from 7.5 through 9 are rounded to a value of 10 which of course calls for incrementing the total value digit next higher in order from the low order digit.

The presence of these break points at 2.5 and 7.5 would in most apparatus require testing and processing of two information digits, i.e. one each for the two and five or one each for the seven and five numerals. As explained below, the present apparatus avoids the need for this double digit processing while maintaining the desired quarter and three-quarter break points precisely.

The initial steps in the quarter round subroutine, which commences at memory location **705** page 16, Table V, cause the quarter round selecting bit to again be removed from the round switch memory word in order that the remainder of this word be once again usable to address one of the sixteen possible total value characters. The digit position to be quarter rounded is selected by the round switch output information just as was the digit to be rounded. In the case of quarter rounding, however, the digit next higher in the total value word from the digit selected for rounding is accessed for quarter rounding with the change between the digit selected for rounding and the digit selected for quarter rounding resulting from the incrementing of the round address word in block **2256**. Prior to the address incrementing which accesses the digit for quarter rounding the quarter round status bit is removed, the data returned to its normal location in the accumulator and the round switch status word written in the memory all as indicated by blocks **2250**, **2252**, and **2254** respectively. These operations are performed by the instruction in memory location **705**, **706**, **707** with the incrementing of total value digit address being performed by the instruction in memory location **708**. The address of the character to be quarter rounded is fabricated as indicated in the block **2258** and performed by the instruction XCHI in memory location **709** in a manner similar to that explained above for the XCH instruction in memory location **696**.

The total value character to be quarter rounded is first tested for being either a numeral eight or a numeral nine by adding a constant value of eight to the data digit, the constant of eight being loaded by the instruction in memory location **711** indicated by block **2260**, with the addition being performed by the instruction of memory location **712** as indicated by the block **2262**. If the digit selected for quarter rounding has a value of eight or nine, the addition of the eight will produce a binary carry bit, and this carry bit is sensed in the test of block **2264** which is performed by the instruction in memory locations **713**. The presence of a carry at this point indicates that the digit selected for quarter rounding should be incremented upward to a ten with the one digit of this ten being added to the next higher ordered digit of the total value quantity. These steps are performed by the block **2274–2278**, wherein the carry bit is placed in the accumulator, shifted to the right to the correct position for adding and the zero for writing a ten placed in memory; these steps are performed by the QRD1 sequence commencing at memory location **723** on page 17 of Table V. The addition of a digit one to the total value quantity is performed by the RND2 subroutine in the blocks **2208–2214** which are accessed by the path **2222**. Preparation for use of the RND2 subroutine is made as indicated in blocks **2280** and **2282** and performed by the RND4 subroutine at memory location **726** page 17, Table V.

If no carry is produced as a result of adding the constant eight to the digit selected for quarter rounding, this digit has some value less than eight and should therefore result in a quarter rounded value of either five or zero being placed in the total value word. Testing for a digit value which should result in a quarter rounded value five is performed by adding a constant of 13 to the data digit; a data digit of value three or more provides a sum of 16 and a carry digit when this addition is performed. The test for carry in this instance is performed by the JCN instruction in memory location **718** and indicated by block **2272** in FIG. **22**. The test constant **13** is loaded by the LDM **13** instruction in memory location **715** as indicated by block **2266** and added to the total value digit as indicated in the block **2268**. The result of this addition is erased except for the carry bit by loading a numeral five indicated at block **2270** and performed by the instruction in memory location **717**. This numeral five is in fact the numeral which replaces the digit being quarter rounded in the total value data word.

If no carry is found in the JCN test of memory location **718** and block **2272** the data digit being tested had an original value of zero, one or two, and therefore a zero should be loaded into the data position of the total value word which was being quarter rounded. This loading is indicated by the block **2284**, with the five which should be loaded in the event a carry is found in the block **2274** test being indicated by block **2288** and the actual writing into the total value word being indicated by the block **2286** which corresponds to the instruction in memory location **721**. The rounding sequence ends with a return to the executive routine.

As mentioned earlier in describing the rounding and quarter rounding sequence, quarter rounding break points of 2.5 and 7.5 in the digit being quarter rounded are realized without double digit processing in the quarter rounding operation. This result can be understood by considering an example wherein the total value data word consists of the digits 1623.4750. In the above sequence of steps, this data would be loaded into memory with the last numeral zero digit in memory location **16** and the first numeral one digit in memory location **23**.

If the data in the example is to be rounded to have two digits on the right of the decimal point, the numeral five in memory location **17** would be selected for rounding, with the result of this rounding being the incrementing of the digit seven in memory location **18** to a value of eight. If quarter rounding is then applied to this rounded data for the purpose of making the digit in memory location **18** either a five or zero the quarter rounding routine will change the rounded eight to a value of ten making the total value word read 1623.50; a result which indicates that the original data value of 0.4750 has in fact quarter rounded up to a ten. In other words the break point of 7.5 in the memory location **18** quarter rounding position has been observed. Restating this concept, it may be said that quarter rounding at the 2.5 and 7.5 points is achieved by first performing a rounding and then applying quarter rounding with modified 2.5 and 7.5 break points of 3.0 and 8.0.

WEIGHT DEAD ZONE

After the scale motion and other indicated tests have been made if the by-count subroutine is not entered then the program proceeds to the instruction JMS WTDZ at memory location **102**, page 3 of Table V. This instruction directs the computer to the weight dead zone subroutine at memory location **769** on page 18 of Table V. It will be noted that the by-count subroutine also uses the weight dead zone test with access from by-count operation being provided by the instruction JMS WTDZ at memory location **1047** page 24 of Table V. These weight dead zone tests are indicated at **1134** and in the flow diagram of FIG. **11**. The weight dead zone switches and the weight dead zone program steps are employed in the present scale system in order that the upper limit of the near zero weight zone in which the scale is inoperative can be selected easily during scale installation or scale use. The program steps associated with weight dead zone selection are located in two subroutines, the first of these, the weight dead zone subroutine of page 18, Table V, is concerned with collecting the dead zone selection data from the selection switches while the other of the subroutines, the compare subroutine, performs the weight and selected dead zone limit comparison.

The weight dead zone subroutine is shown pictorially in the flow diagram of FIG. **23**, and commences with loading the RAM address to be used for storing dead zone selection switch data into register **1**, a part of register pair zero. This loading presets register **1** to the count of 12 in order that a count of sixteen be attained after processing four digits. During this loading the dead zone switch memory location is also cleared. The preliminary loading steps are indicated by the blocks **2302**, **2304**, **2306** and are performed by the instructions in memory location **769–774** on page 18 of Table V. The clearing of dead zone switch memory is performed by the zero or clear memory subroutine commencing at memory location **512** on page 12 of Table V this subroutine provides zero contents in RAM locations **8**, **9**, **10**, and **11** and leaves register zero and one with the contents of twelve.

Once these memory related steps are accomplished the dead zone switch selection data is read into the accumulator as indicated in the block **2312** and performed by the WRM instruction in memory location **781**. This reading is preceded by the accumulator having previously been cleared at block **2310** by the CLB instruction of memory location **778** and the data multiplexers addressed or switched to a condition accessing dead zone selection switch signals as indicated in block **2308** and performed by the OUTA subroutine in memory location **730** page 17 of Table V. The OUTA subroutine is accessed by the JMS instruction in memory location **776** page 18 of Table V. Multiplexer addressing or switching is determined by the constant nine which is loaded into the accumulator at memory location **775** page 18, Table V.

The dead zone selection data received in the accumulator as indicated in the block **2312** is comprised of four data bits, one bit from each of the four dead zone switches in the group **341–352** in FIG. **3B** of the drawings. These four bits are regarded as being in binary coded decimal form so the weight dead zone limit can be selected as one of sixteen possible weight values. In a domestic scale the dead zone can end at any 1/10 pound increment between 0.1 and 1.6 pounds by way of the available 16 possible dead zone values. The binary coded decimal form of the weight dead zone value is modified to decimal form (wherein a carry bit has a value of 10) this change being indicated by the block **2316** and performed by the DAA instruction in memory location **780** page 18, Table V. The decimal adjusted data is written into RAM memory location **9** as indicated in block **2316** by the WRM instruction of memory location **781**, the location **9** address being obtained from the LDM **9** instruction of memory location **775**.

The decimal adjusted dead zone switch data remains in the accumulator following the memory writing of block **2316** and is modified for use in a subsequent comparing operation by clearing all but the carry bit which is then moved into the lowest order position of the accumulator as indicated by the block **2320** and performed by the TCC instruction at memory location **783**. This modified form of the switch data is stored in RAM character **10** for addition to the third from lowest data digit of a succeeding weight indication; this third from lowest digit being accessed by incrementing the contents of register **1** from nine to ten as indicated in the block **2318** and performed by the INC instruction in memory location **782** page 18, Table V.

The comparison of a weight indicating signal with the selected dead zone limit value is performed by the COMP subroutine which commences at memory location **577** page 13 of Table V and is indicated at **2330** in FIG. **23** and accessed by the JUN instruction of memory location **792** page 18, Table V. Prior to use of the COMP subroutine, location of the weight data is loaded into registers **0** and **1**, and the dead zone select data loaded into registers **2** and **3** and a digit counter for determining when sufficient comparisons have been made is established in registers **4** and **5**; these steps are indicated by the blocks **2324**, **2326**, and **2328** and are performed by the instructions in memory location **786–791**, page 18, Table V.

COMPARE SUBROUTINE

The compare subroutine indicated in block **2330** of the weight dead zone subroutine of FIG. **23** is shown in flow diagram form in FIG. **24** of the drawings. This subroutine commences at memory location **577** on page 13, Table V with the FIM P3 **16** instruction which designate the character **16** position in RAM word **1** to receive the status word indicating comparison results; this memory location is cleared by the WR O instruction in memory location **581**, page 13, Table V, block **2406**, and accessed by the SRCP3 instruction in memory location **580**. As indicated in the block **2404** the accumulator is also cleared in the preliminary steps.

The first digit of data to be compared is read into the accumulator by the SRC and RDM instructions in memory locations **582** and **583** which are indicated by the block **2408** in FIG. **24**. This first digit is identified as data A in the program comments at memory location **582**. The second digit of information for comparison, identified as data B, is accessed and subtracted from the data A character by the instructions RDM SRC Pl and SBM in memory locations **583**, **584** and **585** indicated by the block **2410**. If the two first accessed digits of data are in fact equal to that their subtraction provides a difference of zero, the housekeeping steps indicated by blocks **2422–2428** are performed and a second digit of data accessed for comparison in the blocks **2408** and **2410**; the second digit access resulting from a "yes" output from the block **2412** test which is performed by the JCN instruction of memory location **586**, page 14, Table V.

A "no" output from the block **2412** decision indicates the first two characters of data were in fact different, a condition which is noted by the loading of an appropriate flag into the status memory designated at block **2406**; this flag is comprised of the binary coded decimal bit one when data A exceeds data B. A flag of binary coded decimal value two is used to indicate data B is greater than data A and is loaded as indicated by the block **2418**; the blocks **2414** and **2418** correspond with the LDM1 and LDM2 instructions in memory location **588** and **591**. The distinction as to which of data A or B is greater is determined by whether a carry bit results from the subtraction performed by the FBM instruction in memory location **585**, and block **2410**; a carry bit indicating that the subtrahend data B, is larger than data A. The carry set test of block **2416** is performed by the JCN instruction in memory location **589**. Once the appropriate flag is loaded into the accumulator the contents of registers **6** and **7** are used to designate the flag storage address and the flag written into this location as indicated by the blocks **2418** and **2420** and performed by the SRC and WRO instructions in memory location **592** and **593**, page 14, Table V. With the appropriate flag bit stored in memory, the program proceeds by the path **2421** to the housekeeping steps commencing with block **2422** and performed by the instructions in the CMP1 subroutine commencing at memory location **594**, page 14, Table V. These instructions cause the accumulator to be cleared, the A and B data addresses and the digit counter to be incremented and the test for last digit to be performed as indicated in the blocks **2422**, **2424**, **2426** and **2428**. The digit counter was preset at a count of twelve by the instruction at memory location **790** page 18, Table V, block **2328** in FIG. **23**.

If the last digit has not been processed as determined by the digit counter test of block **2428** and the ISZ8 instructions of memory location **597** then another digit is accessed and the sequence commencing with block **2408** repeated until the digit counter indicates comparison has been made for a sufficient number of digits. Upon completing all of the digit comparisons the contents of the register **6** and **7** compare status memory will be in one of the two states BCD1 or BCD2 and thereby indicate which of the data words A or B was larger. It is to be noted that during the processing of individual digits the contents of the register **6** and **7** status word will alternate between these two values in response to individual subtrahend numbers being larger or smaller than the minuend number. Since the final contents of the compare status word is set following comparison of the highest order data digit the intermediate status word contents are without significance. A setting of neither the A is greater or B is greater status words indicates the A and B quantities are in fact equal. The results of the comparison subroutine is retained in the designated status word memory until accessed in the executive routine.

READ PRICE SWITCHES

The read price switch subroutine is used to collect data from the price per unit weight switches **31**, **32**, and **33** in FIG. **1** and **520–529** in FIG. **5B** of the drawings. The read price switch subroutine interrogates these switches by applying a pulse of power to one of the switch wiper members, for example, the cents switch wiper **601**, and sensing the ten possible switch output lines **520–529** in groupings or segments of four lines each.

In the Table V program commencing at memory location **804** on page 19 and in the FIG. **25** flow diagram the first examined segment is for the switch positions **1**, **2**, **3** and **4**; in this first segement examination the switch output lines **521–524** are connected through multiplexer circuit **628** of FIG. **6B** into the scale system input terminals **310–313**. From terminals **310–313**, the switch signals pass from the tri-state gate **240** to the RAM port communications module **233** onto the system data buss to the central processor **230**. The sequential pulses which power the FIG. **5B** switches, i.e., the signals connected to the wipers **601–603**, are supplied from the RAM data port along the lines **214–217** through the FIG. **6** decoder **646** to the lines **601–603**. The pulse which supplies power to a switch wiper **601–603** is developed at the block **2522** in the FIG. **25** flow diagram.

Following testing of the switch ouptu lines **521–524** for continuity with a switch wiper which is carrying cents signal coding, the next segment of switch output lines (i.e., the lines **525–528**) are examined for signals originating with the cents switch wiper, and finally the third segment of switch lines (lines **529** and **520**) are examined. After examining these switch lines for signals originating with the cents switch wiper, similar examinations are performed for signals originating with the dime switch wiper and the dollars switch wiper. The indicated examination in groups of four switch output lines is desirable in this arrangement since the Intel **4004** microcomputer is provided with four data input lines.

The name keyboard is used in the Table V program listing in describing the price per unit weight data collection apparatus since the read price subroutine to be described here can be employed either with a keyboard or with the switch and knob arrangement shown in FIG. **1** and FIG. **5B**.

As indicated by the blocks **2502–2516** in FIG. **25**, the initial group of read price switch subroutine instructions at memory locations **804–817** are used to load the working registers of the microcomputer with numerical constants that are needed in performing the collection, testing and storing of price per unit weight switch information. As indicated within these initial blocks of FIG. **25**, register pair P5, i.e., registers **10** and **11**, receive constants of 0 and 12 respectively, register pair P3 a constant of 0, register **4** and **5** a constant of **32** and so on. These constant provide counter presetting, memory multiplexer addressing, and arithmetic computation values as will be understood from the description attending use of the constants in the following text. As indicated by the junction between blocks **2506** and **2508**, a portion of this constant loading is repeated for each character processed; this junction and the path **2581** being used to commence processing of the dollars switch information.

After the working memory constants are loaded, steps for accessing the first segment of switch information (the numerals one through four of cents data) are performed, and this first segment of information is read into the accumulator at block **2528**. The steps indicated in blocks **2516–2526** relate to the accessing sequence. In this sequence, the steps of blocks **2516**, **2518**, and **2520** access the digit select data from registers **6** and **7**. Registers **6** and **7** are initially set at zero in order to select or power the low order or cents digit switch wiper first. The steps through the outputting of register **6** or **7** digit select information are performed by the instructions in memory location **818–820**, page 19 of Table V. Following set-up of the cents switch wiper selection information, the OUTC and OUTD subroutines beginning at memory location **739** on page 17 of Table V are accessed by the instruction in memory location **821** as indicated by the block **2522**. The OUTC subroutine makes use of the constant **32** which was stored in register Pair **1** earlier by the instruction at memory location **814**. Once the switch power supplying pulse (i.e., the switch clock) is established by the OUTC subroutine and enabled by the OUTE subroutine which follows OUTC, the multiplexers which conduct switch data into the input port are switched to the desired condition by the OUTD subroutine of memory location **733** on page 17 of Table V; the OUTD subroutine being accessed by the instruction in memory location **823** and indicated by the block **2524**. After multiplexer addressing has been completed, the accumulator is cleared as indicated by the block **2526** and the instruction at memory location **825**, and the first segment of switch information is read to the accumulator as indicated by the block **2528** and the instruction at memory location **826**. The read-in data is four binary bits representing signals on the switch numeral lines **1, 2, 3** and **4**.

Once in the accumulator the switch line information is converted into binary coded form by the KBP instruction of memory location **827**, this instruction providing a binary coded decimal output of 1, 2, 3 or 4 according to which of the switch line signals contains a data bit and also providing an error indicating output of all ones, i.e., BCD **15**, in the event more than one switch line is activated. Operation of the KBP instruction is explained more fully in the Intel Users Manual. As indicated in the block **2532**, the converted switch data is tested to determine if, in fact, a switch closure was present in the first accessed segment of data. Failure to sense a switch closure at this point indicates that the closed switch may lie in the 5, 6, 7, 8 or 9, 0, segment, a condition which is provided for in the blocks commencing at **2534**. The testing which is performed after finding a switch closure in order to ensure that only a single switch closure was, in fact, present is indicated in the sequence commencing at block **2558**. The decision regarding finding a switch closure indicated by block **2532** is performed by the JCN instruction in memory location **829** on page 19 of Table V.

Assuming first that a switch closure was found in the first accessed segment of switch data, the BCD data resulting from KBP instruction is inverted and tested for all zeros, a result which can only exist under a condition where more than one key closure is sensed and an error indicating binary **15** is generated by the KBP instruction. If the complemented BCD data is in fact all zero the block **2560** test performed by the instruction in memory location **831**, page 19, Table V provides an error signal. If the BCD switch data satisfies the complement test it is recomplemented to its original form as indicated by the block **2562** and instruction in memory location **833**, and a numerical constant is added as indicated at block **2564**. The added constant makes first segment data have a value of 1, 2, 3, or 4 while second segment data has a value of 5, 6, 7, and 8 and third segment data has a value of 9 or 10. Accordingly the constant has a value of zero for the first segment data, four for the second segment data and eight for the third segment data. These respective constant values are stored in register **9**, a register which was initially set to zero as indicated in the block **2508**. The appropriate value for the segment upgrade constant is derived in the program steps indicated by blocks **2534–2544**.

Once the appropriate segment upgrade constant is added as indicated in the block **2564** and performed by the instruction in memory location **834** the resulting data is decimal adjusted by the steps indicated at block **2566** and performed by the instruction in memory location **835**; thereafter the data is placed in memory as indicated in the block **2570**. Memory access and storage is performed by the instructions in locations **836**, and **837** as indicated by the blocks **2568** and **2570** in FIG. **25**. Following memory storage the "character sensed" counter is incremented from its initial zero state to indicate that the first character has been processed and stored and the "active segment found" counter in register **13** is incremented from its initial state of zero, and the accumulator is cleared, all as indicated by the blocks **2572–2576** and the instructions at memory location **838–840**. The "active segment found" counter in register **13** is used to assure that no more than one switch closure is accepted in the processing of a single price per unit weight character. Testing of the "active segment found" counter is performed in the block **2578** described subsequently.

Once the "active segment found" counter steps and accumulator clearing of block **2576** are performed, a return along the path **2577** to the sequence commencing at block **2534** occurs. This sequence is the same as if no switch closure data had been found in examining the **1, 2, 3, 4** switch lines. In the blocks **2534–2544** the register **9** segment upgrade constant is provided with a carefully verified value appropriate to the segment being read. Verification is accomplished by obtaining the constant from two different sources with the two values thereby obtained being compared and an error condition indicated upon comparison failure. The first source of this constant is the instruction of memory location **841** which is indicated by the block **2534**, while the second source is register **12** which was loaded with a value four as part of the FIM P6 64 instruction in memory location **812**. The test comparing these two sources is performed by the JCN instruction in memory location **843** and is illustrated by the block **2538**. Careful verification of this constant is desirable to assure that an incorrect price per unit weight value does not enter scale computation. Once the verified value of four is established, an appropriate multiple of four, as necessary to provide the desired segment upgrade value, is developed and stored in register **9** as indicated by the blocks **2542–2546** and instructions in memory locations **846–848**.

Following development of the segment upgrade constant, the multiplexer address data stored in register **1** is incremented in preparation for accessing the next or 5, 6, 7, 8 segment of switch data, and the segment tested counter of register **8** is incremented from its initial state of 13 to a value of 14. Two more incrementings of this counter are sensed at the block **2552** to indicate that the last segment has been processed, these steps being performed by the instructions in memory location **849** and **850**, with the ISZ8 instruction corresponding to the test of block **2552**.

After making two returns along the path **2551** to collect and process the 5, 6, 7, 8 switch segment data and the **9, 10** switch segment data, the program makes a check (block **2552**) for an affirmative indication that the last of the switch segments has been tested. This provides a test for sensing of all closure positions for the value switches. However for a system configuration having switches **561** and **562** in the position illustrated in FIG. **5B** (non-metric scale), the zero position cannot be sensed. This inability to sense the zero positions is indicated to the microcomputer by an open condition for both of switches **348** and **349** (FIG. 3B) which are tested as indicated by block **1150** of FIG. **11**, a metric scale being indicated by loading of a one bit into register **15**.

As shown by a series of steps beginning at block **2554**, the program checks to determine whether no switch closure has been sensed. If so, then register **15** is checked to determine whether the system has a metric scale. If not, then non-sensing of a price switch closure is interpreted as an indication of a zero price digit.

The indication of "metric scale", a one bit in register **15**, is provided by the metric multiplier subroutine commencing on page **26** of the Table V. The contents of register **15** is tested in the block **2561**. A metric indication in this test results in a left hand exit through the block **2563** where the "active segment found" counter is incremented with an intentional error producing count in order that failure to locate a closed switch in the metric scale be recognized as an error condition. The error condition is actually provoked by incrementing register **13** in the block **2563** and again in the block **2573**; this double incrementing is sensed as an error at block **2578**. In either the metric or non-metric scale versions therefore, failure to locate a closed switch as determined by the block **2556** provides entry to the sequence of steps **2564–2570** which are performed by the instructions in memory location **859-862**. The test of block **2560** is performed by the instruction in memory location **853**.

Upon completing the deduced zero sequence the inputting and storing of data for the first switch (i.e. the cents digit) is complete and testing of this data for authenticity and preparation for collecting a second digit can be performed. These steps are indicated commencing with block **2572** and include developing an address for storing the next digit (per instruction at memory location **863**) and testing of the register **13** "active segment found" counter as shown by blocks **2576** and **2578**. Loading of the constant for performing the authenticity test is indicated by block **2574** and the instruction in memory location **864**. The instructions in memory location **865** and **866** correspond to the functions illustrated by blocks **2576** and **2578**. If more than one active segment has been found in the course of reading the three switch segments, the sum of register **13** plus the constant loaded into the accumulator will result in a sum greater than 16, and an error condition will result from the test of block **2578**. If this error condition is not found, the digit selection counter of register **7** and the character completed counter of register **11** are incremented as indicated at blocks **2580** and **2582** (which correspond to the instructions at memory location **868** and **869**) in preparation for return along the path **2581** to process the second, third and fourth digits of price per unit weight information. Although only three price-per-unit-weight switches are shown in FIG. **1** and FIG. **5B**, provision is made in the present subroutine for four such switches; the fourth and unshown switch being wired to the zero input condition in the present scale.

Upon completing four trips through the character reading sequence, the test of block **2584** and memory location **869** will be satisfied, and an exit along the right hand path from block **2584** to the test for number of characters sensed is performed as indicated by the blocks **2586–2590** and the instructions in memory location **871** and **872**.

The steps indicated in the blocks **2592–2598** relate to certain applications of the present scale system wherein one of the price-per-unit-weight switches is provided with fractional value input capability. These steps are performed by the instructions in memory location **881–887** and involve the fractional key subroutine on page 26 of Table V. The instructions in memory locations **875–877** are for program debugging purposes, and the instruction in memory location **878** provides a jump to the error routine. Upon completing the fractional key routine the price-per-unit-weight switch sequence is complete.

WEIGHT READING PARITY CHECK

In connection with the previous description of the scale weight chart in FIG. **9** the concept of parity verifying the weight readings and inhibiting parity verifying at weight transition points was described. The sequence of steps which perform these parity functions is shown in flow diagram form in FIG. **26** of the drawings. The FIG. **26** steps are accessed by the JMS RPAR instruction in memory location **180**, page **5**, Table V. This instruction and the location of the parity test in the executive routine is shown by block **1145** in FIG. **11**.

The JMS RPAR instruction in memory location **180** in the executive routine leads to the read parity subroutine commencing at memory location **373**, page **9**, Table V where the first instruction, FIM **P1 35** is indicated by the block **2602** in FIG. **26**. Prior to commencing the read parity subroutine, the weight indicating photocell data bits have been read from the scale chart and placed in RAM memory location **32** through **35**, four bits of information being stored in each location with the channel A weight chart bit in the least significant position of location **32**, channel B bit in the next higher position and so on through channel P information which is located in the most significant bit of location **35**. Channel P and channel O information represent the parity bits as is shown in FIG. **9**. This weight data has been previously loaded into these memory locations by the read weight subroutine commencing at memory location **389**, page 9, Table V.

The read parity subroutine of memory location **373**, page 9 is used to determine whether a parity test is in fact appropriate for the data under consideration and also to separately store the parity verifying bits for subsequent use. These functions are performed by accessing the parity data bits from the chart information of RAM locations **32–35**, the parity bits being in location **35**; this accessing is indicated by the blocks **2602** and **2604** and performed by the instructions in memory location **373–375**, page 9, Table V. The accessed data is loaded into a cleared accumulator by the instructions in memory location **377**, the accumulator clearing being performed by the preceeding instruction in memory location **376**; this clearing and loading is indicated by the block **2606**.

Once the first bits of chart information are in the accumulator, the rotate and clear carry instructions in memory location **378–381** are used to bring the channel O and P parity bits into the two lowest order positions of the accumulator, the bits representing channel M and N being cleared or dropped from consideration; this sequence of steps is indicated by the block **2608**, FIG. **26**.

Once the parity indicating data bits are thus isolated in the low order positions of the accumulator, they are loaded into register **10** and reloaded into the accumulator, blocks **2610** and **2612**, by the instructions in memory location **382** and **383** and then examined to determine if a parity test is appropriate. This examination consists of subtracting the numerical constant **3**, i.e. BCD 0011 from the parity indicating bits; the criteria being that if two parity bits are present the data came from a transition region of the weight chart wherein no parity test is to be performed. This concept is also explained in connection with the previous description of FIG. **9**. If the subtraction of numerical constant 3 indicated by the block **2614** leaves the accumulator with zero contents, a transition point weight reading is indicated and a program return to the executive routine at memory location **182**, page 5, Table V is performed; this return is provided by the JCN instruction in memory location **385** which also performs the test of block **2616**, FIG. **26**. If the test of block **2616** finds the subtraction of constant 3 from the parity data did not clear the accumulator the JUN instruction of memory location **387** leads to the check parity subroutine on page 29 of Table V; this condition being indicated by the right hand exit from block **2616** in FIG. **26**.

CHECK PARITY SUBROUTINE

The check parity subroutine commencing at memory location **1407**, page 29, Table V begins with the loading of addressing and computation constants, blocks **2618**, **2620**, and **2622** performed by the instructions of memory locations **1407–1412**. The purpose of these constants is indicated below at the point of use in the processing sequence. Following the loading of constants, the high order bits of the weight data, i.e., the M and N track bits are accessed for parity channel testing at block **2632** in FIG. **26**, the instruction in memory location **1450**, page 30, Table V. If there is data in either the M or N track of the weight chart, the scale is above the 0.00 to 0.10 lb. weight dead zone and the normal parity test rather than the parity channel test is performed as indicated at block **2630**. The accessing of M and N track bits is performed by the instructions of memory location **1413** through **1418** indicated by blocks **2624–2628**; these steps include clearing the accumulator and reading the data word containing bits M and N from memory address **35**. Address **35** is retained for this purpose from the steps performed during the read parity subroutine, page 9, Table V. Once the contents of address **35** are in the accumulator, the two parity indicating bits in the high order locations are removed by a sequence of rotate left and clear carry instruction and the test of block **2630** performed by the instruction of memory location **1419**.

If one of the data tracks M and N did in fact contain a data bit, thus indicating the scale is loaded, the sequence of steps commencing with block **2640** and continuing through the block **2658** is performed to generate in register **6** a numerical sum of the data bits present. The low order bit in memory address **32** is first examined with a return for examining the higher bits in the first word occuring along the path **2659** and with the bit in each subsequent memory address i.e. **33**, **34**, and **35** being accessed by way of returns along path **2667**. Therefore upon completing the test of block **2666** register **6** will contain a sum indicating the number of one bits contained in the weight chart word being examined. In subsequent program steps this register **6** information will be compared with the parity indicating channel data bits with a successful comparison indicating the data read from the chart and the parity indications on the chart are in agreement, i.e. the collected data is safe for use.

Returning now to the block **2640** the constant stored in register **4** and **5** is used as an address and the data located at this address read into memory as indicated by blocks **2640** and **2642** and performed by the instructions in memory location **1421** and **1422**. Once this data is in the accumulator the low order bit is moved to the carry position, for examination by the RAR instructions of memory location **1423**, block **2644**. The remaining higher order bits are stored in memory, block **2646**, as performed by the instructions in memory location **1424** and the carry bit, i.e. the original low order bit, returned to the accumulator for adding to the contents of register **6**. The new contents of the accumulator is then stored again in register **7** all as performed by the instructions in memory locations **1425–1427** and indicated by the blocks **2648**, **2650**, and **2652**.

Once the low order bit is added to the sum of bits in register **6** accessing of the next higher bit commences with the returning of all the remaining bits to the accumulator as performed by the instructions in memory location **1424**, block **2654**, and the register **9**-bit counter tested to determine if four bits have been processed. Register **9** was originally loaded with a constant **12** so that after processing four bits a count of 16 which produces a carry can be sensed. Failure to have yet reached this count of 16 provides a return along the path **2659** to block **2644** where the next bit of the first data word is moved to the carry position and processed. An indication that the count of 16 has been reached in the decision block **2658**, i.e. memory location **1429**, commences the preparatory steps of block **2660**, etc. which set up conditions for accessing the next word of weight bits, i.e. the bits stored in RAM address **33**. These preparatory steps include incrementing the memory address, reloading a value of 12 into register **9**, and incrementing the register **8** character counter from its initial value of 12 all as indicated in the blocks **2660**, **2662**, **2663**, and **2664** and performed by the instructions in memory location **1431–1434**. The test of block **2666** is performed by the ISZ instruction of memory location **1434**.

When the test of block **2666** is satisfied, i.e. when the ISZ instruction of memory location **1434** finds that the character counter has reached a count of 16, the parity bit data which was stored in register **10** during the read parity subroutine on page 9, of Table V is accessed for comparison with the sum which has been accumulated in register **6**. The required parity information could of course be obtained again from RAM address **35** however the use of register **10** to store exclusively parity data bits is found more convenient than the reaccessing of memory address **35**. The parity information stored in register **10** is moved to the accumulator and the odd parity bit moved to the carry position by the instructions of memory location **1436** and **1437**.

The carry position of the accumulator is then tested for the presence of the odd parity bit as indicated by the block **2672** at FIG. **26**.

If the odd parity bit is found to be present, the contents of register **6** (the accumulated sum of weight data and parity bits) should be an odd number. This fact is determined in blocks **2674** through **2678** where the contents at register **6** is moved to the accumulator, the low order bit of the sum rotated into the carry position of the accumulator and its presence tested. The finding of an odd condition as indicated by the presence of the low order sum bit satisfies the parity check test of block **2678**, and initiates the executive program return indicated at the left hand exit of block **2678**.

If the low order sum bit of register **6** is not found to be present in the test of block **2678**, the sum is even and in error as odd parity is needed as was determined in block **2672**.

The steps of loading the bit sum from register **6** moving the low order bit sum to the accumulator carry and testing of the resulting total are performed by the instructions in memory location **1440–1442** and indicated in the blocks **2674–2678**.

If the test of block **2672** finds the odd parity bit was absent in the weight data word being processed, the register **6** count of bits present should be an even number with the low order bit therefore being absent. Testing to determine that the low order bit is in fact absent from the sum of register **6** as indicated by the blocks **2680–2684**, these steps being performed by the instructions of memory location **1445–1448** page 30, Table V. These steps consist of adding register **6** contents to the accumulator, moving the low order bit to the carry position and testing for non-zero contents in the carry position; the finding of non-zero value providing an error condition as indicated by the right hand exit from block **2684**. The test of block **2678** is performed by the JCN instruction of memory location **1447** which provides a jump to the error access instruction in memory location **1459** and **1460** which in turn provides a jump back to the central error routine of the program. If the low order bit is found to be present in the test of register **6** contents the BBL ϕ instruction in memory location **1444** provides a return to the executive routine.

Returning now to the test of weight chart M & N data track bits indicated in block **2630** and performed by the JCN instruction of memory location **1419** page 29, Table V it may be recalled that in connection with the description of block **2614** and the SUB **3** instruction in memory location **384** page 9, Table V that in the presence of both the channel O and channel P parity bits no parity test is performed on the data read from the weight chart since the presence of both parity bits is used as an indication of the chart being at a weight transition point. According to this interpretation therefore if some fault occurs in the parity channel apparatus such that both parity bits remain in the "on" condition no parity testing of the chart data would ever occur.

In order that the occurrence of parity channel malfunction be detected a test of parity channel operations to verify that both the O and P channel data bits can in fact have zero value is incorporated into the scale. This test is indicated commencing with block **2632** and performed by the CPZ series of instructions commencing at memory location **1450** page 30, Table V. The parity channel test is accomplished by arbitrarily making both the O and P channel parity indicating bits opaque at some predetermined location on the scale chart and then testing the signal developed by the parity apparatus whenever the scale chart is located at this predetermined point. In this test the electrical reproduction of the chart parity bits must have zero value to provide the desired assurance that the parity channel signal processing is operative. It will be observed of course that if the parity channel signal processing apparatus fails in a manner which provides continuous zero binary value signals in the parity channels data error will yet be detected since this condition of the parity bit calls for making the parity test which commences with the block **2618** in FIG. **26**.

In the present scale embodiment the chart area adjacent 0.00 lbs. weight indication is selected to contain the absence of both O and P parity bits since this portion of the chart is accessed frequently in normal scale operation; the parity channel test of blocks **2630–2641** therefore consists of determining that the scale chart is located in the zero weight position followed by verification that both parity channel bits are in fact absent in this location. Other locations for the parity channel test could of course be selected wtihin the spirit of the invention.

In FIG. **4** of the above referenced Allen U.S. Pat. No. 3,439,760 there is shown a representation of the scale weight indicating chart similar to FIG. **9** but including the chart data track pattern found at 0.00 lbs. weight indication; for the present purpose it is sufficient to note that in this figure both the M and N tracks are opaque from below zero weight up to approximately one-tenth of a pound weight while the A track contains a light transmitting area extending from approximately minus 0.15 lb. to plus 0.15 lb. and the B track is opaque around 0.00 lb. up to approximately 0.005 lb. where the first graduation commences and the C and D tracks are opaque up to approximately 0.025 and 0.045 lb. weight indications respectively.

In the block **2630** the data bits of the M and N track are examined for having zero value, any value other than zero indicating the chart to be stopped in an above zero weight indication where the parity channel test is not to be performed and therefore the parity testing steps commencing at block **2640** should be performed. Binary values of zero for both the M and N tracks indicate the parity channel test may be possible depending upon the data found in the B, C and D tracks. Once absence of the M and N track bits is determined data in the A B C D tracks is called to the accumulator as indicated in the block **2632** and **2634** and performed by the instructions in memory location **1450** and **1451** and the low order bit of this information, representing channel A data is removed by the instructions in memory location **1446**, block **2636**. After channel A data removal the remaining data, representing channel B C & D, is examined for data presence as indicated by the block **2638** and performed by the instructions in memory location **1453, 1454**. The presence of data in this test indicates the scale has settled on some weight indication between 0.005 and 0.10 lb. where once again the parity channel test is not to be made. This condition is indicated by the right hand exit from the block **2638** which provides a program return. If data is absent from the D C & B channels as is indicated by the left hand exit from the block **2638** then chart positioning at substantially 0.00 lb. is established and the parity channel test can be performed. The parity channel test is implemented by the instructions in memory location **1455** and **1456** which are indicated in the blocks **2639** and **2641**. The test consisting merely of loading the parity bits from register **10** into the accumulator and indicating an error condition if either parity bit is present. An error condition being indicated by the right hand exit from block **2641** and a return to the executive routine. Since at this exit a weight indication of 0.00 lb. has been established no weight information processing is appropriate.

OUTPUT ADDRESS DATA

In memory locations **730–738** page 17, Table V there are stored two subroutines; OUTA and OUTD, which are used throughout the Table V program for the purpose of communicating information from within the central processor to circuits located outside the central processor. For example, these subroutines communicate data signal selection information from the central processor to the multiplexer circuits described previously in this specification. In FIG. 2 of the drawings information resulting from the OUTA and OUTD subroutines appears at output terminals **00, 01, 02,** and **03** of RAM **231** and is conducted through the amplifiers **260–263** and the lines **214–217** to gates **640–643** in FIG. **6**. Gates **640–643** provide this information to the address terminals SA and SB at multiplexer circuits **627, 629, 644,** and **628,** so that the multiplexers connect preselected pairs of their data input terminals to their output terminals for multiplexing of data back into the central processor.

The OUTA and OUTD subroutines are shown in flow diagram form in FIG. **14**. OUTD commences at block **1408** which corresponds with the SRC PO instruction in memory location **733** page **17**, Table V. This instruction provides access to the RAM named in register pair zero (i.e. RAM zero in the present scale where only a single RAM chip is employed) and also provides access to the working registers including Register **1**, which contains the multiplexer address information to be unloaded at the output terminals of RAM **231** as above stated. Instruction LD**1** loads the contents of Register **1** into the accumulator, and the following instruction WMP transfers the multiplexer address information to the RAM output port (i.e. terminals **00, 01, 02,** and **03** of RAM **231**). Block **1412** of FIG. **17** illustrates the transfer to the RAM output port.

Following the outputting of information on the RAM output port the JCN instruction at memory location **736** causes an examination of the signal at line **1214** (test line for central processing unit **230**) to determine whether a delay or program hangup is desired before proceeding with the next instruction. If no delay is desired the program returns to the routine which accessed the output address data subroutine. If the JCN instruction of memory location **736** find the test signal line to be in the "one" condition, a program loop requiring repeated executions of the JCN instruction in memory location **736** is entered until such a time as a zero test signal is found. This looping of course provides the means by which the scale circuitry can interrupt central processor operation as needed. The JCN instruction in memory location **736** and the associated looping is shown at block **1414**.

The OUTA subroutine, as illustrated by block **1402, 1404** and **1406** of FIG. **14** decreases program space requirements in the calling subroutine by enabling multiplexer address information to be carried in the accumulator. The OUTA subroutine, commencing with the instruction at memory location **730,** transfers the information from the accumulator to Register **1** and then clears both the accumulator and Register **0,** as indicated by blocks **1402, 1404, 1406** of RAM. The steps indicated in the blocks **1402–1406** are performed by executing the instructions at memory location **730–732.** After performing these steps, the program is then prepared for executing the SRC PO instruction at memory location **733** as described above.

OUTPUT CLOCK DATA

Commencing with memory location **739** page **17,** Table V there is shown a subroutine which is used to communicate clock pulses from the central processor to the outboard electronics of the scale. Such clock pulses have been described in connection with the weight photocell reading sequence and the printer-labeller operations described elsewhere in this specification. The clock pulses generated by the OUTC and OUTE subroutines appear at the output of the circuit **720** in FIG. 7A and are generated by the three lines of clock addressing information **210, 211,** and **212.** The strobe or enable line **223** is activated by the OUTE subroutine commencing at memory location **744** page **17,** Table V.

The OUTC subroutine supplies information from the ROM data port shown at **243** in FIG. 2E via the lines **210, 211,** and **212** to the demultiplexer circuit **720** shown in FIG. 7A. Signals appearing on these three lines determine which of the possible clock pulses will be generated. Prior to entering the OUTC subroutine information regarding the clock signal to be generated will have been loaded into registers **2** and **3** with register **2** containing a bit in the second lowest position designating the ROM **2** data port **243** in FIG. 2E to receive the clock addressing information. The clock addressing information will have previously been loaded into the three lower bits of register **3.** In the OUTC subroutine the SCR **P1** instruction in memory location **739** provides access to the ROM **2** data port. In block **2002** the data in register **3** is loaded into the accumulator and is placed on the ROM **2** port lines in the blocks **2004, 2006** by the instructions in memory location **740** and **741.**

Once the desired clock data is output from the ROM **2** data port, the pulse which activates the demultiplexer **720** in FIG. 7A is provided on line **223,** from the ROM **1** data port at **242** in FIG. 2E, by the OUTE subroutine shown commencing at memory location **744** and indicated in blocks **2008–2020** in FIG. **20.** In the OUTE sequence the constant **1** in register **2** which was loaded by the instructions FIM **P1 24** in memory location **742** is used to access the ROM **1** data port shown at **242** in FIG. 2E while the constant 8 loaded into register **3** by the FIM **P1 24** instruction in memory location **742** is the data that is output on the ROM **1** data port indicated at **223** in FIG. 2E. In the OUTE sequence the SCR **P1** instruction at memory location **744** provides access to the ROM **1** port while the contents of register **3** is loaded to the accumulator and placed on the data port lines by the instructions in memory locations **745** and **746**; these steps are indicated by blocks **2010, 2012** and **2014** in FIG. **20.**

Once the enable or strobe signal is activated by the WRR instruction of memory location **746** the steps which terminate this strobe commence at blocks **2016** and **2018,** these steps involve loading a constant zero into the accumulator and writing this constant on the ROM I output port as performed by the instructions in memory location **747** and **748** on page **17,** Table V, the writing of zero on line **223** in effect returning this line to the false signal level. After the clock and strobe data has been provided by the OUTC and OUTE sequences, the output clock data subroutine examines the test signal line **1214** in FIG. 2D to determine if a delay or program hangup is desired, this test is performed by the JCN instruction in memory location **749** and is indicated by the block **2020.** An indication that delay is desirable results in an indefinite looping on the instruction JCN in memory location **749** until the test signal line is returned to the logical zero condition. Upon termination of this looping or in its absence a return to the program routine which granted access to the output clock subroutine occurs as performed by the instruction in memory location **751.**

CODE CONVERSION

As mentioned above, conversion of weight data from Gray to BCD format is accomplished by the CDCH routine. Referring now to page **10** of Table V it will be seen that the first steps in the CDCH routine commencing at memory location **439** read the data stored in RAM word **43** and manipulate it to remove the "O" and "P" data bits, which are parity bits. Thereafter the data is replaced in memory with two zeros in lieu of the O and P bits preceding the N and M data bits.

Upon removal of the parity bits the program proceeds with actual code conversion, which must effect the results indicated in Table VI. This table shows the conversion relationship between the special Gray code used on the scale chart and Binary Coded Decimal code (BCD) in columns which are headed A and B. Column A is the BCD conversion for a 4-bit Gray code having an immediately preceding Gray code word which translates into an even number, while the B column is the BCD conversion for a 4-bit Gray code having an odd number as the next higher converted digit. It will be noted that for each case the BCD codes listed adjacent each other in columns A and B are nines complements of each other.

For the scale herein described the first Gray code word, the NM photocell outputs, are preceded by zeros, which are regarded as even numbers so that the conversion of column A is employed; thereafter column B is used if the preceding Gray code word is odd and column B used if the preceding Gray code word is even.

The code conversion table utilized in connection with the CDCH routine is listed on page 11 of Table V commencing at memory location **496**. It will be seen that this conversion table is stored at **16** consecutive ROM addresses. The first four bits of the conversion information stored at each of these addresses corresponding to the four low order bits of the address itself, i.e. the address is comprised of the left-hand column of information having twelve binary bits of data while the memory contents is shown as the second column of information containing eight binary bits. The third column of information duplicates the memory contents with the exception of the letter B following each eighth bit; this third column is a programming entry to flag the accompanying bit pattern in the assembler for direct entry into the ROM.

Ten of the Conversion Table addresses starting at memory location **496** of Table V and in Table VI correspond to Gray code combinations which can be encountered in reading from the scale chart. These ten address entries are all followed on the right by conversion data corresponding to the desired BCD code in both Table VI and in the memory location **496** chart. The remaining six of the Conversion Table addresses at memory location **496–511** and in Table VI do not occur on the scale chart and are therefore unused or don't care about Gray code combinations. (U.S. Pat. Nos. 3,439,760 and 3,516,504 show and describe the particular Gray code used and this don't care feature in detail.) These six unused Gray code combinations (0000, 0101, 0111, 1000, 1101 and 1111) are, however, included in the code conversion charts and are provided there with dummy BCD conversion results of either 0000 or 1001 (i.e., 0 or 9) in order that chart readings which become scrambled during transmission through the multiplexers in the present scale may, nevertheless be employed for motion detection purposes.

Multiplexer scrambling can occur when the weight indication changes slightly between successive multiplexer samples so that a don't care code combination may be generated by samples from two different chart positions. In selecting the dummy BCD conversion fillers, it is desirable that the fillers be different than either adjacent BCD conversion result in order that chart movement between two adjacent Gray code values be always detectable by the motion detector apparatus described herein.

Where the preceding Gray code word in the weight information read from the scale chart is odd, the conversion information of Column A and memory location **496** may nevertheless be used to achieve the code conversion and produce column B conversion results (column A and B referring to Table VI) if one additional step is performed wherein the addressing Gray code information is modified. As an example of this procedure, it will be noted in Table VI that a Gray code word of **0011** should convert to BCD 0001 (1) if preceded by an even digit and to a BCD 1000 (8) if preceded by an odd digit. In Table VI, it will moreover be noted that BCD 1000 (8) is the conversion result provided in column A when the Gray code is 1011; it therefore follows that for at least converting Gray code 0011 to BCD the desired odd conversion information can be obtained from the even conversion table by adding a factor 1000 to the Gray code data. By inspection it can be determined that the relationship noted for Gray code values 0011 and 1011 holds true throughout Table VI and that conversion of any Gray code combination to the column B (preceded by odd) BCD information can be accomplished by adding 1000 (a BCD value of 8) to the Gray code data and using the column A table. The column A table is regarded as continuous for this purpose with the first Gray to BCD conversion pair following immediately after the lower end of the table. The Table VI conversion in continuous form is characterized by the rule that inverting the high order Gray code bit provides a BCD conversion which is the nine's complement of that resulting from the non-high order bit inverted Gray code.

Since the don't care conversion values are also separated by eight Gray code words in Table VI, a valid weight reading will not be converted to a don't-care value by this abbreviated adding BCD**8** conversion procedure, nor will a don't-care value be converted to a normal BCD conversion number.

The code conversion table listed in the program of Table V at page **11** is actually the column A conversion from Table VI with the above-mentioned don't-care values filled in with zeros and nines. In the computer program, the addition of 1000 to the Gray code data is performed by the instructions LDM **8** and ADM at memory locations **459** and **460** page 11, Table V.

In using the code conversion table of memory location **496** the first received Gray code word of weight data (which can be only 0001, 0011 or 0010 since the scale is limited to weights below 30 lbs.) is converted by preceding the code word with the digits 00011111 and using this 12-bits of data as a ROM address. This address will produce an 8-bit ROM output which contains four bits of address checking information and a BCD code which may be

0000, **0001** or 0010. If the BCD code is even, then the next conversion, which is for photocells LKJI is similarly made, but if the BCD code represents an odd number, then the next Gray code is incremented by 8 (i.e., binarily added to 1000) and the sum used as a ROM address. This incremented address produces a nines complement code conversion, which is the desired conversion as indicated by Table VI column B. A similar process is followed for conversion of the stored Gray code information obtained from photocells HGFE and from photocells DCBA.

In the sequence of code change program steps which commence at memory location **439**, page 10, Table V the contents of RAM word **43** (the parity bits having been removed) are read into the accumulator and then put into register **1**. At this time register **0** has the code 1111, because of the preceding instruction FIM PO 240. Thus register pair O which is really register O and register **1** now contains the code 111100NM, where N and M correspond to the readings of photocells N and M respectively.

The computer next executes the instruction FIN P1, which addresses location 111100NM which is in the code conversion table commencing at memory location **496** and reads the BCD code stored there into register pair **1**. Thus if the actual product weight were, for instance 19.67 lbs., the NM photocell outputs would be 11, and the corresponding BCD code read from memory would be 0011 0001. The first four bits of this memory information, the address checking bits, will subsequently be checked against the NM data to assure the correct memory data was accessed while the last four bits are the BCD equivalent of the decimal digit 1.

After this the computer executes the instruction LDM **8**, at memory location **459** which puts a binary 8 into the accumulator, and then executes ADM, which adds to the accumulator the contents of RAM memory character **43** (in this case the NM data 0011). The sum of the addition is put into register **1** for use as an address in the nines complement table lookup performed by the instruction FIN P3 at memory location **462**. The computer then performs the above-mentioned address check by loading the accumulator with the contents of the upper half of register pair **1** (i.e., register **2**, the contents of which is the memory stored Gray code address of 0011 in the above example) and subtracting therefrom the contents of RAM memory character **43** (which is the NM photocell data 0011 in the example). The subtract is performed at memory location **465**. A zero difference provides the desired address check, while a non-zero difference causes the computer to jump into an error routine.

Following the address check the CPU should have the first obtained BCD code in register **3** and the nines complement thereof in register **7**. (The FIN P3 instruction mentioned above places the nines completement code in register pair **3**, the upper half of which is register **7**.) These two code numbers (which should total nine) then are added to a binary number (7) at memory location **469** to produce a sum of 16 or 0000 in the accumulator. If such a result is obtained, then the two independent table lookups satisfy the nines complement test and verify that no bits have been erroneously added or dropped in the lookup chart and its reading. In essence, this verification arrangement approximates the reliability of a dual lookup conversion table followed by data comparison. Upon satisfaction of this test either the original data or its nines complement is known to be accurate for use in assembling a weight reading.

After performing this check, the computer at memory location **477** tests to see whether the BCD digit that was previously obtained was odd or even. If the digit was odd, then the computer proceeds to the ODD subroutine at memory location **480**, which loads the contents of register **7** (the nines complement of the NM data) into the accumulator and thence into memory as the correct BCD conversion. The computer also writes into register **8** the BCD code which was obtained from the conversion in order that this code be available for the next character odd/even test.

If the odd/even test found that the obtained BCD character was even, then the computer at memory location **479** loads the contents of register **3** (the NM data in non-complemented form) into the accumulator for storage in memory as the correct BCD conversion. Again the computer writes into register **8** the BCD code which was obtained from the conversion for use with the next character. Thus the odd/even determination needed for decoding a succeeding Gray code can always be made by loading the contents of register **8** into the accumulator and executing the instruction RAR. If the BCD code in register **8** (i.e., the last decoded character) is odd, then the RAR instruction will produce a 1 in the carry/link position of the accumulator and the computer may proceed to the ODD subroutine. After executing an RAR instruction the odd/even check is actually made by executing the instruction JCN C1 ODDR at memory location **477**.

Again assuming a weight of 19.67 lbs. the Gray code words read from the photocells will be 0011 0001 0110 1010, and the computer will go through four loops successively converting these 4-bit words into the codes 0001, 1001, 0110, and 0111 respectively. For making the necessary four loops register **9** is utilized as a counter, this register having been initially set at **12** by the instruction FIM P4 12 at memory location **449** page 10, Table V. As the computer goes through the four code changing loops, the contents of register **5** which was originally set at **43** in the instruction at memory location **439** are decremented to cause successive reading from memory of the data stored in RAM main memory characters **43, 42, 41,** and **40.** The decrementing is performed by the instructions commencing at memory location **483** page 11, Table V.

TABLE I

Ref. No.	Circuit Type
230	4004
231	4002
232	4008
233	4009
234	1702 A
235	1702 A
236	1702 A
237	1702 A
238	1702 A
239	1702 A
240	SN74126
241	SN74155 N
242	SN74173
243	SN74173
301	SN74153
302	SN74153
303	SN74153
304	SN74153
401	SN74161
624	SN74279
626	SN74153
627	SN74153
628	SN74153
629	SN74153
644	SN74175
645	SN74175
636	SN7442
720	SN74155
721	SN74175
722	SN74175
723	SN74157
805	SN74161
806	SN74109

TABLE II

MACHINE INSTRUCTIONS

MNEMONIC	OPR $D_3D_2D_1D_0$	OPA $D_3D_2D_1D_0$	DESCRIPTION OF OPERATION
NOP	0 0 0 0	0 0 0 0	No operation.
JCN *	0 0 0 1 $A_2A_2A_2A_2$	$C_1C_2C_3C_4$ $A_1A_1A_1A_1$	Jump to ROM address $A_2A_2A_2A_2, A_1A_1A_1A_1$ (within the same ROM that contains this JCN instruction) if condition $C_1C_2C_3C_4$ is true, otherwise skip (go to the next instruction in sequence).
FIM	0 0 1 0 $D_2D_2D_2D_2$	R R R 0 $D_1D_1D_1D_1$	Fetch immediate (direct) from ROM Data D_2, D_1 to index register pair location RRR.
SRC	0 0 1 0	R R R 1	Send register control. Send the address (contents of index register pair RRR) to ROM and RAM at X_2 and X_3 time in the Instruction Cycle.
FIN	0 0 1 1	R R R 0	Fetch indirect from ROM. Send contents of index register pair location 0 out as an address. Data fetched is placed into register pair location RRR.
JIN	0 0 1 1	R R R 1	Jump indirect. Send contents of register pair RRR out as an address at A_1 and A_2 time in the Instruction Cycle.
JUN	0 1 0 0 $A_2A_2A_2A_2$	$A_3A_3A_3A_3$ $A_1A_1A_1A_1$	Jump unconditional to ROM address A_3, A_2, A_1.
JMS	0 1 0 1 $A_2A_2A_2A_2$	$A_3A_3A_3A_3$ $A_1A_1A_1A_1$	Jump to subroutine ROM address A_3, A_2, A_1, save old address. (Up 1 level in stack).
INC	0 1 1 0	R R R R	Increment contents of register RRRR.
ISZ	0 1 1 1 $A_2A_2A_2A_2$	R R R R $A_1A_1A_1A_1$	Increment contents of register RRRR. Go to ROM address A_2,A_1 (within the same ROM that contains this ISZ instruction) if result $\neq 0$, otherwise skip (go to the next instruction in sequence).
ADD	1 0 0 0	R R R R	Add contents of register RRRR to accumulator with carry.
SUB	1 0 0 1	R R R R	Subtract contents of register RRRR to accumulator with borrow.
LD	1 0 1 0	R R R R	Load contents of register RRRR to accumulator.
XCH	1 0 1 1	R R R R	Exchange contents of index register RRRR and accumulator.
BBL	1 1 0 0	D D D D	Branch back (down 1 level in stack) and load data DDDD to accumulator.
LDM	1 1 0 1	D D D D	Load data DDDD to accumulator.

INPUT/OUTPUT RAM INSTRUCTIONS

MNEMONIC	OPR $D_3D_2D_1D_0$	OPA $D_3D_2D_1D_0$	DESCRIPTION OF OPERATION
WRM	1 1 1 0	0 0 0 0	Write the contents of the accumulator into the previously selected RAM main memory character.
WMP	1 1 1 0	0 0 0 1	Write the contents of the accumulator into the previously selected RAM output port. (Output Lines)
WRR	1 1 1 0	0 0 1 0	Write the contents of the accumulator into the previously selected ROM output port. (I/O Lines)
WR0	1 1 1 0	0 1 0 0	Write the contents of the accumulator into the previously selected RAM status character 0.
WR1	1 1 1 0	0 1 0 1	Write the contents of the accumulator into the previously selected RAM status character 1.
WR2	1 1 1 0	0 1 1 0	Write the contents of the accumulator into the previously selected RAM status character 2.
WR3	1 1 1 0	0 1 1 1	Write the contents of the accumulator into the previously selected RAM status character 3.
SBM	1 1 1 0	1 0 0 0	Subtract the previously selected RAM main memory character from accumulator with borrow
RDM	1 1 1 0	1 0 0 1	Read the previously selected RAM main memory character into the accumulator.

INPUT/OUTPUT AND RAM INSTRUCTIONS

MNEMONIC	OPR $D_3D_2D_1D_0$	OPA $D_3D_2D_1D_0$	DESCRIPTION OF OPERATION
RDR	1 1 1 0	1 0 1 0	Read the contents of the previously selected ROM input port into the accumulator. (I/O Lines)
ADM	1 1 1 0	1 0 1 1	Add the previously selected RAM main memory character to accumulator with carry.
RD0	1 1 1 0	1 1 0 0	Read the previously selected RAM status character 0 into accumulator.
RD1	1 1 1 0	1 1 0 1	Read the previously selected RAM status character 1 into accumulator.
RD2	1 1 1 0	1 1 1 0	Read the previously selected RAM status character 2 into accumulator.
RD3	1 1 1 0	1 1 1 1	Read the previously selected RAM status character 3 into accumulator.

ACCUMULATOR GROUP INSTRUCTIONS

MNEMONIC	OPR $D_3D_2D_1D_0$	OPA $D_3D_2D_1D_0$	DESCRIPTION OF OPERATION
CLB	1 1 1 1	0 0 0 0	Clear both. (Accumulator and carry)
CLC	1 1 1 1	0 0 0 1	Clear carry.
IAC	1 1 1 1	0 0 1 0	Increment accumulator.
CMC	1 1 1 1	0 0 1 1	Complement carry.
CMA	1 1 1 1	0 1 0 0	Complement accumulator.
RAL	1 1 1 1	0 1 0 1	Rotate left. (Accumulator and carry)
RAR	1 1 1 1	0 1 1 0	Rotate right. (Accumulator and carry)
TCC	1 1 1 1	0 1 1 1	Transmit carry to accumulator and clear carry.
DAC	1 1 1 1	1 0 0 0	Decrement accumulator.
TCS	1 1 1 1	1 0 0 1	Transfer carry subtract and clear carry.
STC	1 1 1 1	1 0 1 0	Set carry.
DAA	1 1 1 1	1 0 1 1	Decimal adjust accumulator.
KBP	1 1 1 1	1 1 0 0	Keyboard process. Converts the contents of the accumulator from a one out of four code to a binary code.

TABLE II-continued

DCL	1 1 1 1	1 1 0 1	Designate command line.

* C_1 = 1 Invert jump condition
C_1 = 0 Not invert jump condition
C_2 = 1 Jump if accumulator is zero
C_3 = 1 Jump if carry/link is a 1
C_4 = 1 Jump if test signal is a 0

TABLE III

ADDRESS INPUTS		DATA INPUTS				STROBE	OUTPUT
B	A	CO	C1	C2	C3	G	Y
X	X	X	X	X	X	H	L
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

TABLE IV

Photocell Indication					Weight
PO	NM	LKJI	HGFE	DCBA	
01	01	0001	0010	1110	00.26
10	01	0001	0010	1010	00.27
01	01	0001	0010	1011	00.28
10	01	0001	0010	1001	00.29
01	01	0001	0110	1001	00.30
10	01	0001	0110	1011	00.31
01	01	0001	0110	1010	00.32

TABLE V

- 1 -

```
      //
      // POWEP UP & RESET
      //
000000000000 00000000          NOP
000000000001 00000000          NOP
000000000010 00101110 PUP,     FIM P7 252 / TIME DELAY
             11111100
000000000100 11010010          LDM 2
000000000101 01010010          JMS OUTA / X.X.X.HOME
             11011010
000000000111 11101010          RDR
000000001000 11110110          RAR / ACCESS HOME
000000001001 00011010          JCN CZ WTER / HOME? NO,ERROR
             10011101                                              (Location 10)
000000001011 01010010          JMS WAST / TIME DELAY
             11110000
000000001101 01110111          ISZ 7 PUP /LAST?NO,TRY AGAIN
             00000010
000000001111 11010001 HOME,LDM 1
000000010000 01010010          JMS OUTA
             11011010
000000010010 11111101          DCL
000000010011 11101010          RDR              /READ 1ST CYCLY RPT MN
ST BTCT
000000010100 11100100          WRO              /STORE STAT
000000010101 11110101          RAL
000000010110 11110101          RAL
000000010111 00011010          JCN CO STR2  /TEST FOR MNSTRT
             00100001
000000011001 00100000 STR3,    FIM PO 40                           (Location 25)
             00101000
000000011011 00100001          SRC PO
000000011100 11101111          RD3
000000011101 10000001          ADD 1
000000011110 00010010          JCN C1 STR2
             00100001
000000100000 11100111          WR3
000000100001 11011111 STR2,    LDM 15
000000100010 10111110 STR4,    XCH 14
000000100011 11011011          LDM 11
000000100100 01010010          JMS OUTA
             11011010
000000100110 11101010          RDR
000000100111 11100111          WR3
000000101000 11111010          STC
000000101001 11110110          RAR
000000101010 11111010          STC
```

TABLE V-Continued

- 2 -

```
000000101011 11110110        RAR
000000101100 10111111       XCH 15 /LOAD DELAY TIME
000000101101 00101100        FIM P6 128 / TIME DELAY REGISTER
             10000000
//..RESET LABELER STRT & EJ MOTOR ?
000000101111 11010010 STR5,LDM 2
000000110000 01010010       JMS OUTA
             11011010
000000110010 11101010       RDR                                    (Location 50)
000000110011 11110110       RAR  /HOME TO CY
000000110100 11010010       LDM 2 / DO NOT RESET EJ MTR
000000110101 00011010       JCN CZ NREJ /HOME? NO,JMP
             00111000
000000110111 11010000       LDM 0 /RESET EJ MOTOR &START SOLE
000000111000 01010010 NREJ,JMS OUTA
             11011010
000000111010 00100010       FIM P1 39
             00100111
000000111100 01010010       JMS OUTC  /RESET
             11100011
000000111110 01010010        JMS WAST
             11110000
000001000000 01010001 TMTN, JMS MOTN
             00100100
000001000010 11101111        RD3
000001000011 00011100        JCN NZA HOME
             00001111
000001000101 11010000 TKLB, LDM 0
000001000110 01010010        JMS OUTA
             11011010
000001001000 11101110       RD2  / TAKE LABEL STATUS
000001001001 00010100       JCN AZ TKL /HAS LABEL BEEN TAKEN?YES,JM
P
             01010001
000001001011 11101010        RDR                                   (Location 75)
000001001100 11110101        RAL
000001001101 00011010        JCN CO STR3     /TEST FOR TK LABL
             00011001
000001001111 11010000       LDM 0
000001010000 11100110       WR2      /RESET TAKE LABEL STATUS
000001010001 11010010 TKL,  LDM 2
000001010010 01010010        JMS OUTA
             11011010
000001010100 11101010        RDR              /READ CSTRT SUP
000001010101 11110110        RAR
000001010110 11110110        RAR
000001010111 00010010        JCN CI STR3     /TEST FOR CSTR3 SUP
             00011001
000001011001 11101100        RDO
000001011010 11110101        RAL
```

- 3 -

```
000001011011 00011010        JCN CO NBYC     /TEST FOR BYCT
             01011111
000001011101 01000100        JUN BYCT
             00000000
000001011111 11110101 NBYC, RAL                                   (Location 95)
000001100000 11110101        RAL
000001100001 00010010        JCN CI RPTM     /TEST FOR RPT SW
             01110111
000001100011 11110110        RAR
000001100100 00010010        JCN CI THRE     /TEST FOR MAN STRT
             10100111
000001100110 01010011         JMS WTDZ  /CK WEIGHT DEAD ZONE
             00000001
000001101000 11101100         RDO       /0001 =A>B
000001101001 11110110         RAR
000001101010 00011010         JCN CZ RSETM /WT DEAD ZONE? YES,JMP
             01110011
```

TABLE V – Continued

- 3 - Con't

```
000001101100 01010011          JMS WTRG  /CK WT RANGE
             00011010
000001101110 00010010          JCN C1 RSETM /OUT OF RANGE? YES,JMP
             01110011
000001110000 11101101          RD1       / MOTION STATUS
000001110001 00011100          JCN NZA THRE /MOTION? YES,JMP
             10100111
000001110011 01010001 RSETM, JMS MOTY  /RESET MOTION STATUS
             01101110
000001110101 01000000          JUN HOME
             00001111
//
//  REPEAT SWITCH
//
000001110111 00011100 RPTM, JCN NZA EROR    /TEST FOR 1ST CYCLE
             10011110
000001111001 01010000         JMS TTER
             10010001
000001111011 11101010         RDR
000001111100 11110110         RAR             /READ ILA STAT
000001111101 00100101         SRC P2                           (Location 125)
000001111110 11101101         RD1             /READ MTN STAT
000001111111 00011010         JCN C0 RPT2     /TEST FOR ILA PRES
             10000011
000010000001 01000011         JUN WRPT
             11101001
000010000011 00010100 RPT2, JCN AZ TE3  /MOTION?NO,JMP
             10001111
000010000101 01010011         JMS WTRG
             00011010
000010000111 00010010         JCN C1 TE3 /OUT OF RANGE?YES,JMP
             10001111
000010001001 01010011         JMS WTDZ
```

- 4 -

```
             00000001
000010001011 11101100         RDO
000010001100 11110110         RAR
000010001101 00010010         JCN C1 WTER /WT DEAD ZONE?NO,JMP
             10011101
000010001111 01000011 TE3, JUN PTR /OUTPUT TO PRINTER
             01111000
//
// CHECK TARE
//
000010010001 11010000 TTER, LDM 0
000010010010 01010010         JMS OUTA
             11011010
000010010100 11101010         RDR
000010010101 11110101         RAL
000010010110 11110101         RAL                              (Location 150)
000010010111 00010010         JCN C1 EROR   /TEST FOR TARE
             10011110
000010011001 11110101         RAL
000010011010 00010010         JCN C1 EROR     /TEST FOR EROR STAT
             10011110
000010011100 11000000         BBL 0
//
// ERROR
//
000010011101 11111101 WTER, DCL
000010011110 11010100 EROR, LDM 4
000010011111 01010010         JMS OUTA
             11011010
000010100001 00100010         FIM P1 39
             00100111
000010100011 01010010         JMS OUTC        /SET EROR LT & STP EJCT
             11100011
```

TABLE 1 - Continued

- 4 - Con't

```
000010100101 01000000       JUN WTER / STAY IN ERROR TILL RESET
             10011101
//
// START OF COMPUTE TIME
//
000010100111 01010000 THRE, JMS TTER    /CHECK TARE
             10010001
000010101001 00100010 FIVE, FIM P1 0
             00000000
000010101011 01010010       JMS ZERO
             00000000
000010101101 01100000       INC 0
000010101110 01010010       JMS ZERO
             00000000                                (Location 175)
000010110000 01010011       JMS WTRG
             00011010
000010110010 00010010       JCN C1 WTER    /TEST FOR OUT OF RANGE
```

- 5 -

```
             10011101
000010110100 01010001       JMS RPAR
             01110101
000010110110 01010011       JMS WTDZ
             00000001
000010111000 11101100       RDO            /RD WT DEAD ZONE STAT
000010111001 11110110       RAR
000010111010 00100000       FIM P0 0
             00000000
000010111100 00100001       SRC P0
000010111101 11101100       RDO           /READ MAN SRTR STAT
000010111110 00010010       JCN C1 TMET     /TEST FOT > WT DEAD ZO
NE
             11000100
000011000000 11110101       RAL
000011000001 11110101       RAL
000011000010 00011010 NMNS, JCN CO HOME     /TEST FOR MAN STRT
             00001111
000011000100 11101111 TMET, RD3
000011000101 11110110       RAR
000011000110 00010010       JCN C1 JMKG    /TEST FOR 5 KG
             11001011
000011001000 11110110 TIOK, RAR                             (Location 200)
000011001001 00011010       JCN CO RPLB    /TEST FOR 10 KG
             11001101
000011001011 01000101 JMKG, JUN KGST
             00000000
000011001101 01010011 RPLB, JMS RDKB       /READ P/LB SWTCHS
             00100100
/
/COMPUTE VALUE
/
000011001111 00100000 CVAL, FIM P0 40                       (Location 207)
             00101000
000011010001 00100010       FIM P1 0
             00000000
000011010011 01010010       JMS TRN12 / TRANSFER MULTIPICAN
             00000111
000011010101 01010010       JMS MPLY
             01011001
000011010111 00100000       FIM P0 32
             00100000
000011011001 00100010       FIM P1 12
             00001100
000011011011 00100001 DIVO, SRC P0
000011011100 11101001       RDM
000011011101 00011100       JCN NZA CKPR   /JUMP TO CKPR IF NOT "0
"
             11100100
000011011111 01100001       INC 1
```

TABLE V–Continued

- 6 -

```
000011100000 01110011       ISZ 3 DIVO                            (Location 225)
             11011011
000011100010 01000001       JUN JVCK
             00010000
000011100100 00100000 CKPR, FIM PO 16
             00010000
000011100110 00100010       FIM P1 8
             00001000
000011101000 11011000      LDM 8 / CNT=8
000011101001 01010010       JMS TRNS        /STORE PRODUCT
             00001000
/
/CHECK VALUE
/
000011101011 00100000       FIM PO 32                             (Location 235)
             00100000
000011101101 00100010       FIM P1 40
             00101000
000011101111 01010010      JMS TRN12
             00000111
000011110001 01010010       JMS DIVD
             10000100
000011110011 00100000       FIM PO 0
             00000000
000011110101 00100010       FIM P1 24
             00011000
000011110111 00100100       FIM P2 8
             00001000
000011111001 01000001      JUN ROM1 / GO TO ROM1
             00000000
*256 /START ROM1
000100000000 01010010 ROM1, JMS COMP                              (Location 256)
             01000001
000100000010 11101100       RDO
000100000011 00011100       JCN NZA JMPE  /TEST FOR VAL COMP
             00100010
000100000101 00100000       FIM PO 24
             00011000
000100000111 00100010       FIM P1 31
             00011111
000100001001 01010010       JMS ZERO
             00000000
000100001011 00100000       FIM PO 8
             00001000
000100001101 11011000      LDM 8  /CNT=8
000100001110 01010010       JMS TRNS      /REPLACE PRODUCT
             00001000
000100010000 01010001 JVCK, JMS RNDS      /READ ROUND STAT
             10100011
000100010010 00100000       FIM PO 16
```

- 7 -

```
             00010000                                             (Location 275)
000100010100 00100010       FIM P1 48
             00110000
000100010110 00100001       SRC PO
000100010111 11101110       RD2
000100011000 11110010       IAC
000100011001 10110001       XCH 1
000100011010 01010010      JMS TRN12 / VALUE TO I/O
             00000111
000100011100 00100001       SRC PO
000100011101 11101001       RDM
000100011110 00011100       JCN NZA JMPE  /TEST FOR VALUE OVERFLOW
             00100010
000100100000 01000011       JUN PTR / OUTPUT TO LABELER
             01111000
000100100010 01000000 JMPE, JUN EROR
             10011110
```

TABLE V—Continued

- 7 - Con't

```
/
/MOTION
/
000100100100 01010001  MOTN, JMS RDWT                          (Location 292)
             10000101
000100100110 00100000 MOTX, FIM P0 32
             00100000
000100101000 00100010       FIM P1 40
             00101000
000100101010 00100001        SRC P0
000100101011 11101001        RDM      / LITES DCBA
000100101100 11110110        RAR     /  A                      (Location 300)
000100101101 00011010        JCN CO MNAC / IS -A- DARK? YES,JMP
             00110011
000100101111 11110110        RAR
000100110000 11110110        RAR
000100110001 00010010        JCN C1 MOTC / IS -C- LITE? YES,JMP
             01011111
000100110011 01010010 MNAC,JMS TRN12
             00000111
000100110101 01010001       JMS CDCH
             10110111
000100110111 00100000       FIM P0 36      /WT A
             00100100
000100111001 00100010       FIM P1 40      /WT B
             00101000
000100111011 00100100       FIM P2 44
             00101100
000100111101 01010010       JMS COMP
             01000001
000100111111 11101100       RDO
000101000000 00100101 MOTS, SRC P2
000101000001 00011100       JCN NZA MOTT
```

- 8 -

```
             01001111
000101000011 00100000 MOTA, FIM P0 40      /WT B
             00101000
000101000101 00100010       FIM P1 36      /WT A               (Location 325)
             00100100
000101000111 00100100       FIM P2 44
             00101100
000101001001 01010010      JMS TRN1
             00001011
000101001011 11101111       RD3
000101001100 11110010       IAC
000101001101 11100111       WR3
000101001110 11000000       BBL 0
000101001111 11110110 MOTT, RAR
000101010000 00100000       FIM P0 13
             00001101
000101010010 00010010       JCN C1 MNEG     /TEST FOR NEG DIR
             01100111
000101010100 11110000       CLB
000101010101 11100110       WR2            /RESET NMOTN CTR
000101010110 11101100       RDO
000101010111 11110010       IAC
000101011000 11100100       WRO            /INC POMOTN CTR
000101011001 10110000 MOTU, XCH 0
000101011010 11101101       RD1            /READ MOTN STAT
000101011011 10000000       ADD 0          /ADD MOTN CTR
000101011100 10000001       ADD 1          /ADD MOTN CNST
000101011101 00011010       JCN CZ MOTA /MOTION?NO, JMP
             01000011                                          (Location 350)
000101011111 11110111 MOTC, TCC
000101100000 11100101       WR1            /SET MOTN STAT
000101100001 11110000 MOTZ, CLB
```

TABLE V – Continued

- 8 - Con't

```
000101100010 11100100          WR0
000101100011 11100110          WR2
000101100100 11100111          WR3              /RESET MOTN CTRS
000101100101 01000001          JUN MOTA
             01000011
000101100111 11110000 MNEG,    CLB
000101101000 11100100          WR0              /RESET PMOTN CTR
000101101001 11101110          RD2
000101101010 11110010          IAC
000101101011 11100110          WR2              /INC NMOTN CTR
000101101100 01000001          JUN MOTU
             01011001
000101101110 00100000 MOTY,    FIM P0 32
             00100000
000101110000 00100001          SRC P0
000101110001 11110000          CLB
000101110010 11100101          WR1
000101110011 01000001          JUN MOTZ         /RESET MOTN STAT
```

– 9 –

```
             01100001
/
/READ PARITY
/
000101110101 00100010 RPAR,    FIM P1 35
             00100011
000101110111 00100011          SRC P1      /ADD PARIETY        (Location 375)
000101111000 11110000          CLB
000101111001 11101001          RDM           /READ PARIETY
000101111010 11110110          RAR
000101111011 11110001          CLC
000101111100 11110110          RAR
000101111101 11110001          CLC
000101111110 10111010          XCH 10      /STORE PAR BITS
000101111111 10101010          LD 10
000110000000 10010011          SUB 3
000110000001 00010100          JCN AZ RDSP /PARITY CHECK?NO,JMP
             10110110
000110000011 01000101          JUN CPAR
             01111111
/
/ READ WEIGHT
/
000110000101 00100110 RDWT,    FIM P3 0   /ROM/RAM=0  WT SELECT(R7)
             00000000
000110000111 00100100          FIM P2 32 /ROM/RAM=2  MEMORY LOCATION
             00100000
000110001001 00100010          FIM P1 28 /R2 R3.ROM/RAM=1  CNT=4
             00011100
//..
000110001011 00100111 READ,    SRC P3  /RAM=0
000110001100 10100111          LD 7      /CELL SELECT
000110001101 11100001          WMP
000110001110 00100101          SRC P2  /ROM.RAM=2
000110001111 11010000          LDM 0
000110010000 11100010          WRR                                  (Location 400)
000110010001 00100011          SRC P1  /ROM.RAM=1
000110010010 11011000          LDM 8   / CLOCK=8
000110010011 11100010          WRR
000110010100 11010000          LDM 0
000110010101 11100010          WRR
000110010110 00100111          SRC P3  /RAM=0
000110010111 11011000          LDM 8
000110011000 11100001          WMP
000110011001 11101010 RD1,     RDR       /READ PHOTO CELLS
000110011010 00011001          JCN T1 RD1 / TEST SWITCH? YES,JMP
             10011001
000110011100 00100101          SRC P2
000110011101 11100000          WRM     /WRITE WT IN MEMORY
000110011110 01100111          INC 7   /WT CELL SELECT
```

TABLE V – Continued

- 10 -

```
000110011111 01100101        INC 5   /NEXT MEMORY
000110100000 01110011        ISZ 3 READ / LAST?NO,JMP
             10001011
000110100010 11000000        BBL 0      /CLR ACC & EXIT
/
/
/ROUND STATUS
/
000110100011 11011010 RNDS,  LDM 10         /ADDR OF ROUND STAT
000110100100 01010010        JMS OUTA
             11011010
000110100110 11110000        CLB
000110100111 11101010        RDR              /READ ROUND STAT
000110101000 00100000        FIM P0 16
             00010000                                   (Location 425)
000110101010 00100001        SRC P0
000110101011 11100110        WR2               /STORE ROUND STAT
000110101100 11110101        RAL
000110101101 11110001        CLC
000110101110 01010010        JMS RND
             10110111
000110110000 11101110        RD2
000110110001 11110101        RAL
000110110010 00011010        JCN C0 RDSP
             10110110
000110110100 01000010        JUN QRD3
             11000001
000110110110 11000000 RDSP,  BBL 0
/
/ CHANGE CODE
/
000110110111 00100100 CDCH,  FIM P2 43                  (Location 439)
             00101011
000110111001 00100101        SRC P2
000110111010 11101001        RDM
000110111011 11110101        RAL
000110111100 11110001        CLC
000110111101 11110101        RAL
000110111110 11110001        CLC
000110111111 11110110        RAR
000111000000 11110110        RAR
000111000001 11100000        WRM            /REMOVE PARITY BITS
000111000010 00101000        FIM P4 12                  (Location 450)
             00001100
000111000100 00100000        FIM P0 240     /ADRSS OF CHAR TBL
             11110000
000111000110 11110000 CDC,   CLB
000111000111 00100101        SRC P2         /ADRSS CHAR
000111001000 11101001        RDM           /READ CHAR
000111001001 10110001        XCH 1         /STORE FOR FIN INST
```

- 11 -

```
000111001010 00110010        FIN P1
000111001011 11011000        LDM 8
000111001100 11101011        ADM
000111001101 10110001        XCH 1
000111001110 00110110        FIN P3
000111001111 11110001        CLC
000111010000 10100010        LD 2
000111010001 11101000        SBM
000111010010 00011100        JCN NZA JMPE   /CK FOR ADRSS =
             00100010
000111010100 11010110        LDM 6
000111010101 10000111        ADD 7
000111010110 11110001        CLC
000111010111 10000011        ADD 3
000111011000 00011100        JCN NZA JMPE  /CHECK FOR BIT SUM
             00100010
```

TABLE V – Continued

- 11 - Con't

```
000111011010 10101000        LD 8                                          (Location 475)
000111011011 11110110        RAR
000111011100 10100111        LD 7
000111011101 00010010        JCN C1 ODDR /PREV ODD?YES,JMP
             11100000
000111011111 10100011        LD 3
000111100000 11100000 ODDR,  WRM            /WRITE TO MEM
000111100001 10111000        XCH 8          /STORE FOR ODD/EVN CK
000111100010 10100101        LD 5
000111100011 11111000        DAC
000111100100 10110101        XCH 5
000111100101 01111001        ISZ 9 CDC
             11000110
000111100111 11000000        BBL 0
/
/CODE CHANGE TABLE
/
*496
000111110000 00000000 00000000B
000111110001 00010000 00010000B
000111110010 00100010 00100010B
000111110011 00110001 00110001B
000111110100 01000100 01000100B                                             (Location 500)
000111110101 01011001 01011001B
000111110110 01100011 01100011B
000111110111 01111001 01111001B
000111111000 10001001 10001001B
000111111001 10011001 10011001B
000111111010 10100111 10100111B
000111111011 10111000 10111000B
000111111100 11000101 11000101B
000111111101 11010000 11010000B
000111111110 11100110 11100110B
000111111111 11110000 11110000B
```

- 12 -

```
*512 /START ROM2
/
/CLEAR MEMORY
/
001000000000 11110000 ZERO, CLB                                              (Location 512)
001000000001 00100001 ZER1, SRC P0          /ADDRESS MEMORY TO BE C
LEARED
001000000010 11100000       WRM             /WRITE 0 INTO MEMORY
001000000011 01100001       INC 1           /INCREMENT MEMORY ADDRE
SS
001000000100 01110011       ISZ 3 ZER1      /INCREMENT CHARACTER CN
TR
             00000001
001000000110 11000000       BBL 0
/
/TRANSFER MEMORY
/
001000000111 11011100 TRN12,LDM 12  /CNT=4                                   (Location 519)
001000001000 10110101 TRNS,XCH 5 / COUNT IN ACCUM
001000001001 11010000      LDM 0
001000001010 10110100      XCH 4 / R2= 0/CNT
001000001011 00100001 TRN1,SRC P0 /SOURCE ADDRESS
001000001100 11101001       RDM             /READ DATA
001000001101 00100011       SRC P1          /ADDRESS NEW LOCATION
001000001110 11100000       WRM             /WRITE DATA
001000001111 11110000       CLB
001000010000 11101001       RDM
001000010001 00100001       SRC P0
001000010010 11101000       SBM
001000010011 00011100       JCN NZA MJPE
             11111111
```

TABLE V – Continued

- 12 - Con't

```
001000010101 01100001 TRN2, INC 1          /INC OLD DATA ADDRESS
001000010110 01100011       INC 3           /INCREMENT NEW DATA ADD
RESS
001000010111 01110101      ISZ 5 TRN1 / LAST? NO,JMP
             00001011
001000011001 11000000       BBL 0           /RETURN
/
/ADD
/
001000011010 11110000 ADD,  CLB             /CLEAR ACCUMULATOR AND
CARRY                                                    (Location 538)
001000011011 00100001 ADD1, SRC P0          /ADDRESS ADDEND
001000011100 11101001       RDM             /READ ADDEND
001000011101 00100011       SRC P1          /ADDRESS AUGEND
001000011110 11101011       ADM             /ADD AUGEND
001000011111 11111011       DAA             /BCD ADJUST
001000100000 00100101       SRC P2          /ADDRESS SUM
001000100001 11100000       WRM             /STORE SUM
001000100010 01100001       INC 1           /INCREMENT ADDEND ADDRE
```

– 13 –

```
SS
001000100011 01100011       INC 3           /INCREMENT AUGEND ADDRE
SS
001000100100 01100101       INC 5           /INCREMENT SUM ADDRESS
001000100101 01110111       ISZ 7 ADD1      /INCREMENT CHARACTER CN
TR
             00011011                                    (Location 550)
001000100111 11110111       TCC             /TRANSFER CARRY
001000101000 00100101       SRC P2          /ADDRESS SUM
001000101001 11101011       ADM             /ADD LAST CARRY
001000101010 11100000       WRM
001000101011 11000000       BBL 0
/
/SUBTRACT
/
001000101100 00101000 SUBT, FIM P4 10       /LOAD CORRECTION CONST
             00001010
001000101110 11110000       CLB             /CLEAR ACCUMULATOR AND
CARRY
001000101111 00100001 SUB1, SRC P0          /ADDRESS MINUEND
001000110000 11101001       RDM             /READ MINUEND
001000110001 00100011       SRC P1          /ADDRESS SUBTRAHEND
001000110010 11101000       SBM             /SUBTRACT SUBTRAHEND
001000110011 00011010       JCN C0 ADJ      / TEST FOR CORRECTION
REQUIREMENT
             00111110
001000110101 11110001       CLC
001000110110 00100101 SUB2, SRC P2          /ADDRESS DIFFERENCE
001000110111 11100000       WRM             /STORE DIFFERENCE
001000111000 01100001       INC 1           /INCREMENT MIN ADDRESS
001000111001 01100011       INC 3           /INCREMENT SUB ADDRESS
001000111010 01100101       INC 5           /INCREMENT DIFF ADDRESS
001000111011 01110111       ISZ 7 SUB1      /INCREMENT DIGIT CNTR
             00101111
001000111101 11000000       BBL 0           /RETURN
001000111110 10001001 ADJ,  ADD 9           /ADD CORRECTION VALUE
001000111111 01000010       JUN SUB2                     (Location 575)
             00110110
/
/COMPARE
/
001001000001 00100110 COMP, FIM P3 16       /LOAD ADDRESS OF STATUS
 BITS                                                    (Location 577)
             00010000
001001000011 11110000       CLB
```

TABLE V – Continued

- 13 - Con't

```
001001000100 00100111         SRC P3          /ADDRESS STATUS BITS
001001000101 11100100         WRO             /CLEAR COMPARE STATUS
001001000110 00100001 CMP3,   SRC P0          /ADDRESS COMPARE DATA A
001001000111 11101001         RDM             /READ COMPARE DATA A
001001001000 00100011         SRC P1          /ADDRESS COMPARE DATA B
```

- 14 -

```
001001001001 11101000         SBM              /SUBTRACT COMP DATA B
001001001010 00010100         JCN AZ CMP1 /EQUAL?YES,JMP
             01010010
001001001100 11010001         LDM 1 / STATUS= A>B
001001001101 00010010         JCN C1 CMP4 / IS A>B? YES,JMP
             01010000                                         (Location 590)
001001001111 11010010         LDM 2            /LOAD B>A STATUS IN ACC
001001010000 00100111 CMP4,   SRC P3           /ADDRESS STATUS
001001010001 11100100         WRO              /WRITE >OR< STATUS
001001010010 11110000 CMP1,   CLB              /CLEAR ACC & CARRY FOR
NEXT COMP
001001010011 01100001         INC 1            /INCREMENT A ADDRESS
001001010100 01100011         INC 3            /INCREMENT B ADDRESS
001001010101 01110101         ISZ 5 CMP3     /INCREMENT DIGIT CNTR
             01000110
001001010111 00100111         SRC P3
001001011000 11000000         BBL 0            /RETURN
/
/MULTIPLY
/
001001011001 00100000 MPLY,   FIM P0 16                               (Location 601)
             00010000
001001011011 00100010         FIM P1 0
             00000000
001001011101 01010010         JMS ZERO       /CLEAR MEMORY FOR PROD
             00000000
001001011111 00101010         FIM P5 12      /16 COMPLEMENT OF NO MPL
R DIGITS
             00001100
001001100001 00101000         FIM P4 40     /ADDRESS OF MPLR
             00101000
001001100011 00101001 MPY4,   SRC P4         /ADDRESS MPLR
001001100100 11101000         SBM            /GET 16 COMPLEMENT OF MP
LR DIGIT
001001100101 00010100         JCN A0 MPY2    /TEST FOR ZERO
             01110100
001001100111 10111010         XCH 10         /STORE COMPLEMENT OF MPL
R DIGIT
001001101000 00100110 MPY1,   FIM P3 12      /16 COMPLEMENT OF MPLCN
DIGITS
             00001100
001001101010 00100100         FIM P2 19      /ADDRESS OF PRODUCT
             00010011
001001101100 00100010         FIM P1 19      /ADDRESS OF PARTIAL PROD
             00010011
001001101110 00100000         FIM P0 32       /ADDRESS OF MPLCN
             00100000
001001110000 01010010         JMS ADD        /ADD MPLCN TO PARTIAL PR
ODUCT
             00011010                                         (Location 625)
```

TABLE 1 – Continued

- 15 -

```
001001110010 01111010      ISZ 10 MPY1    /INC MPY CNTR
             01101000
001001110100 01101001 MPY2, INC 9        /INC MPLR ADDRESS
001001110101 01111011      ISZ 11 MPY3   /INC MPLR DIGIT CNTR
             01111000
001001110111 11000000      BBL 0
001001111000 00100000 MPY3, FIM P0 17                        (Location 632)
             00010001
001001111010 00100010      FIM P1 16
             00010000
001001111100 11010110     LDM 6  /CNT=10
001001111101 01010010      JMS TRNS      /SHIFT PARTIAL PROD
             00001000
001001111111 11110000     CLB
001010000000 00100011     SRC P1
001010000001 11100000     WRM
001010000010 01000010      JUN MPY4
             01100011
/
/DIVIDE
/
001010000100 00100000 DIVD, FIM P0 24                        (Location 644)
             00011000
001010000110 00100010      FIM P1 8
             00001000
001010001000 01010010      JMS ZERO      /ZERO QUOTIENT MEM
             00000000
001010001010 00101100      FIM P6 8      /ADDRS MOD & SHFT CNTR
             00001000
001010001100 00101110 DIVA, FIM P7 31     /QUOTIENT ADDRS
             00011111
001010001110 00100110      FIM P3 11    /DIGIT CNTR
             00001011
001010010000 00100100      FIM P2 32     /ADDRS OF DIFF
             00100000
001010010010 00100010      FIM P1 40     /ADDRS OD DIVISOR
             00101000
001010010100 00100000      FIM P0 23     /ADDRS OF DIDIDEND
             00010111
001010010110 11110000      CLB
001010010111 10100001      LD 1
001010011000 10011100      SUB 12
001010011001 10110001      XCH 1         /MODIFY DIVIDEND ADDRS
001010011010 11110000      CLB
001010011011 10101111      LD 15
001010011100 10011100      SUB 12
001010011101 10111111      XCH 15     /MODIFY QUO ADDRS
001010011110 01010010      JMS SUBT
             00101100
001010100000 00010010      JCN C1 SHFT
```

- 16 -

```
             10110011
001010100010 00100000      FIM P0 32
             00100000                                        (Location 675)
001010100100 00100010      FIM P1 23
             00010111
001010100110 11110001      CLC
001010100111 10100011      LD 3
001010101000 10011100      SUB 12
001010101001 10110011      XCH 3       /MODIFY PAR DIVND ADDRS
001010101010 11011011     LDM 11 /CNT=5
001010101011 01010010      JMS TRNS
             00001000
001010101101 00101111      SRC P7
001010101110 11101001      RDM
```

TABLE V – Continued

- 16 - Con't

```
001010101111 11110010         IAC
001010110000 11100000         WRM
001010110001 01000010         JUN DIVA
             10001100
001010110011 01101100 SHFT,   INC 12
001010110100 01111101         ISZ 13 DIVA
             10001100
001010110110 11000000         BBL 0
/
/ROUND
/
001010110111 11110110 RND,    RAR
001010111000 10110001         XCH 1               /MODIFY ADDRESS DAT
A TO RND
001010111001 11010101         LDM 5
001010111010 00100001 RND2,   SRC PO              /ADDRESS ROUND DATA
001010111011 11101011         ADM
001010111100 11111011         DAA                              (Location 700)
001010111101 11100000         WRM                 /STORE ROUNDED DAT
A
001010111110 00010010         JCN C1 RND4         /JUMP CONT RND
             11010110
001011000000 11000000         BBL 0
/
/0.25 ROUND
/
001011000001 11110001 QRD3,   CLC                              (Location 705)
001011000010 11110110         RAR
001011000011 11100110         WR2                 /RESET 0.25 RND ST
AT
001011000100 11110010         IAC
001011000101 10110001         XCH 1               /MODIFY ADDRESS OF
 DATA TO RND
001011000110 00100001         SRC PO
001011000111 11011000         LDM 8
001011001000 11101011         ADM                 /ADD ROUND DATA
```

- 17 -

```
001011001001 00010010         JCN C1 QRD1         /JUMP IF >7
             11010011
001011001011 11011101         LDM 13
001011001100 11101011         ADM
001011001101 11010101        LDM 5   / ROUND UP TO 5
001011001110 00010010         JCN C1 QRD2         /JUMP IF >2
             11010001
001011010000 11010000         LDM 0
001011010001 11100000 QRD2,WRM        / WRITE ROUND UP CHAR
001011010010 11000000         BBL 0
001011010011 11110111 QRD1,   TCC
001011010100 11110110         RAR
001011010101 11100000         WRM                 /LOAD 0 IN MEMORY
SAVE CARRY                                                     (Location 725)
001011010110 11110111 RND4,   TCC
001011010111 01100001         INC 1
001011011000 01000010         JUN RND2            /JUMP TO ROUND MOR
E SIG DIGITS
             10111010
/
/ OUTPUT ADDRESS DATA
/
001011011010 10110001 OUTA,   XCH 1                            (Location 730)
001011011011 11010000         LDM 0
001011011100 10110000         XCH 0
001011011101 00100001 OUTD,   SRC PO          /ADDRESS OUTPUT I/O
001011011110 10100001         LD 1            /LOAD DATA TO OUTPUT FR
OM R1
001011011111 11100001         WMP             /OUTPUT TO RAM
```

TABLE V–Continued

- 17 - Con't

```
001011100000 00011001        JCN T1 *
             11100000
001011100010 11000000        BBL 0
/
/OUTPUT CLOCK DATA
/
001011100011 00100011 OUTC,  SRC P1          /ADDRESS OUTPUT ROM
001011100100 10100011        LD 3            /LOAD DATA TO SELECT CL
OCK                                                            (Location 740)
001011100101 11100010        WRR             /OUTPUT CLOCK SELECT DA
TA
001011100110 00100010        FIM P1 24       /OUTPUT CLOCK SELECT DA
TA
             00011000
001011101000 00100011 OUTE,  SRC P1          /ADDRESS OUTPUT CLOCK S
TROBE
001011101001 10100011        LD 3            /LOAD STROBE IN ACC
001011101010 11100010        WRR             /OUTPUT CLOCK STROBE
001011101011 11010000        LDM 0           /RESET CLOCK STROBE
001011101100 11100010        WRR             /OUTPUT RESET STROBE
001011101101 00011001        JCN T1 *
```

- 18 -

```
             11101101
001011101111 11000000        BBL 0                           (Location 750)
001011110000 01111101 WAST,  ISZ 13 WAST
             11110000
001011110010 01111100        ISZ 12 WAST
             11110000
001011110100 01111111        ISZ 15 WAST
             11110000
001011110110 01111110        ISZ 14 WAST
             11110000
001011111000 11000000        BBL 0
*767 /START ROM3
001011111111 01000001 MJPE,  JUN JMPE
             00100010
/WEIGHT DEAD ZONE
/
001100000001 00100000 WTDZ,  FIM P0 8
             00001000
001100000011 00100010        FIM P1 12
             00001100
001100000101 01010010        JMS ZERO
             00000000
001100000111 11011001        LDM 9                           (Location 775)
001100001000 01010010        JMS OUTA
             11011010
001100001010 11110000        CLB
001100001011 11101010        RDR
001100001100 11111011        DAA
001100001101 11100000        WRM
001100001110 01100001        INC 1
001100001111 11110111        TCC
001100010000 00100001        SRC P0
001100010001 11100000        WRM
001100010010 00100000        FIM P0 40
             00101000
001100010100 00100010        FIM P1 8
             00001000
001100010110 00100100        FIM P2 12
             00001100
001100011000 01000010        JUN COMP
             01000001
/
/SCALE RANGE ?
/
```

TABLE V – Continued

- 18 - Con't

```
001100011010 00100100 WTRG, FIM P2 33                          (Location 794)
             00100001
001100011100 00100101       SRC P2
001100011101 11101001       RDM
001100011110 11110110       RAR
001100011111 00011010       JCN CZ WRG1 /OUT OF RANGE?NO,JMP
```

- 19 -

```
             00100011                                          (Location 800)
001100100001 11110110       RAR
001100100010 11110110       RAR
001100100011 11000000 WRG1, BBL 0  /CLR ACC & EXIT
/
/READ PRICE SWS
/
001100100100 00101010 RDKB, FIM P5 12       /CHAR & GP CNTRS
             00001100
001100100110 00100110       FIM P3 0        /KBD DIG SEL
             00000000
001100101000 00100100       FIM P2 32      /ADD OF MEM
             00100000
001100101010 00101000 RDK2, FIM P4 11010000B /SEG CNTR & ADDIT CON
ST
             11010000
001100101100 00101100       FIM P6 64
             01000000
001100101110 00100010       FIM P1 32      /EN KBD DIG SEL
             00100000
001100110000 00100000       FIM P0 4      /ADD KBD INPUT
             00000100
001100110010 00100111       SRC P3         /ADD KBD DIG SEL
001100110011 10100111       LD 7
001100110100 11100001       WMP            /OUTPUT DIG SEL
001100110101 01010010       JMS OUTC       /EN DIG SEL
             11100011
001100110111 01010010 RDK1, JMS OUTD       /ADD INPUT DATA
             11011101
001100111001 11110000       CLB                                (Location 825)
001100111010 11101010       RDR            /READ INPUT
001100111011 11111100       KBP
001100111100 00010100       JCN A0 NSEG    /CHECK FOR NO DIGIT
             01001001
001100111110 11110100       CMA
001100111111 00010100       JCN AZ IOER4 /2 KEYS?YES,JMP
             01101011
001101000001 11110100 RDK3, CMA
001101000010 10001001       ADD 9          /ENCODE KEY
001101000011 11111011       DAA
001101000100 00100101       SRC P2
001101000101 11100000       WRM            /STORE CHAR
001101000110 01101010       INC 10         /CNT CHAR
001101000111 01101101       INC 13
001101001000 11110000       CLB
001101001001 11010100 NSEG, LDM 4
001101001010 10011100       SUB 12
001101001011 00011100       JCN NZA IOER2 /TRNS ERROR?YES,ERR
             01101101
001101001101 11110000       CLB
```

TABLE V – Continued


```
001101001110 10101100          LD 12
001101001111 10001001          ADD 9          /MODIFY ADD CONST
001101010000 10111001          XCH 9
001101010001 01100001          INC 1          /MODIFY INPUT ADD
001101010010 01111000          ISZ 8 RDK1     /INC SEG CNTR     (Location 850)
             00110111
001101010100 10101101          LD 13
001101010101 00011100          JCN NZA RDK6
             01011111
001101010111 10101111          LD 15
001101011000 00010100          JCN AO RDK7
             01011011
001101011010 01101101          INC 13
001101011011 00100101 RDK7,    SRC P2
001101011100 11100000          WRM
001101011101 01101010          INC 10
001101011110 01101101          INC 13
001101011111 01100101 RDK6,    INC 5         /MODIFY STOR ADD
001101100000 11011110          LDM 14          /CHECK FOR 1 SW
001101100001 10001101          ADD 13
001101100010 00010010          JCN C1 IOER2 /
             01101101
001101100100 01100111 RDK4,    INC 7           /MODIFY DIG SEL
001101100101 01111011          ISZ 11 RDK2    /INC DIG CNTR BB N4
             00101010
001101100111 11010100          LDM 4          /CHECK FOR 4 DIGITS
001101101000 10011010          SUB 10
001101101001 00010110          JCN 0110B RDK8
             01110000
001101101011 00000000 IOER4,NOP      /2 KEYS DEPRESSED   (Location 875)
001101101100 00000000 IOER3,NOP   /SCAN CNT / CAM ERROR
001101101101 00000000 IOER2,NOP    /NO KEY
001101101110 01000000 IOER1,JUN EROR / PRINT SOLENOID CHECK
             10011110
001101110000 11011100 RDK8,    LDM 12
001101110001 01010010          JMS OUTA
             11011010
001101110011 11101010          RDR
001101110100 00010100          JCN AO PTR8       /RETURN
             11100011
001101110110 01000100          JUN FRKB
             10000111
/
/OUTPUT TO PRINTER
/
001101111000 00100010 PTR,     FIM P1 6                       (Location 888)
             00000110
001101111010 00100000 PTR3,    FIM P0 0
             00000000
001101111100 01010011          JMS PTR1
```



```
             11010101
001101111110 01110011          ISZ 3 PTR3        /CONVERT WT
             01111010
001110000000 00100010          FIM P1 54
             00110110
001110000010 00100000 PTR4,    FIM P0 48
             00110000
001110000100 01010011          JMS PTR1                         (Location 900)
             11010101
001110000110 01110011          ISZ 3 PTR4        /CONVERT VALUE
             10000010
001110001000 01010001          JMS MOTY          /RESET MOTN STAT
             01101110
001110001010 11010010          LDM 2
001110001011 01010010          JMS OUTA
             11011010
```

TABLE V–Continued

- 21 - Con't

```
001110001101 11101010 PTR5, RDR                /READ HPOS STAT
001110001110 11110110       RAR
001110001111 00011010       JCN C0 PTR5        /TEST HPOS STAT
             10001101
001110010001 01100001       INC 1
001110010010 01010010       JMS OUTD
             11011101
001110010100 00100010       FIM P1 39
             00100111
001110010110 01010010       JMS OUTC           /STRT PTR & EJECT
             11100011
001110011000 00101010       FIM P5 6
             00000110
001110011010 00100010 PTR7, FIM P1 37
             00100101
001110011100 01010011       JMS PTR6           /OUTPUT WT DATA
             11100100                                    (Location 925)
001110011110 00100010       FIM P1 36
             00100100
001110100000 11010011       LDM 3
001110100001 10111010       XCH 10
001110100010 01010011       JMS PTR6           /OUTPUT VAL DATA
             11100100
001110100100 01010001       JMS MOTN
             00100100
001110100110 11010010 PSCT, LDM 2
001110100111 01010010       JMS OUTA
             11011010
001110101001 11101010 PSC1, RDR               /RD SCAN/CAM STAT
001110101010 11110101       RAL
001110101011 00010010       JCN C1 PCAM
             11000111
001110101101 11110101       RAL
001110101110 00011010       JCN CZ PSC1 /SCAN?NO,JMP
```

- 22 -

```
             10101001
001110110000 00100100 PSCK, FIM P2 14
             00001110
001110110010 10100100 PSK1, LD 4
001110110011 11100001       WMP
001110110100 00100010       FIM P1 32
             00100000
001110110110 01010010       JMS OUTC                              (Location 950)
             11100011
001110111000 00100001       SRC P0
001110111001 11010011       LDM 3
001110111010 11100001       WMP
001110111011 11110000       CLB
001110111100 11101010       RDR
001110111101 00101011       SRC P5
001110111110 11101000       SBM
001110111111 00011100       JCN NZA IOER1  /SOLENOID ERROR?YES,JMP
             01101110
001111000001 10111010       XCH 10
001111000010 01100100       INC 4
001111000011 01110101       ISZ 5 PSK1
             10110010
001111000101 01111011       ISZ 11 PTR7
             10011010
001111000111 10101011 PCAM, LD 11
001111001000 11110010       IAC
001111001001 00011100       JCN NZA IOER3 /SCAN OR CAM ERROR
             01101100
001111001011 00100010       FIM P1 38
             00100110
```

TABLE V – Continued

- 22 - Con't

```
001111001101 01010010        JMS OUTC        /RESET KEY SOL
             11100011
001111001111 00100001        SRC P0                          (Location 975)
001111010000 11100100        WRO             /RESET MAN STRT, RPT,B
YC
001111010001 11011111        LDM 15
001111010010 11100110        WR2    /SET TAKE LABEL STATUS
001111010011 01000000        JUN HOME
             00001111
//
// CONVERT BCD CODE TO LABELER CODE
//
001111010101 00100100 PTR1,  FIM P2 12                       (Location 981)
             00001100
001111010111 11110000 PTR2,  CLB
001111011000 00100001        SRC P0
001111011001 11110010        IAC
001111011010 11101011        ADM
001111011011 10000011        ADD 3
001111011100 00100011        SRC P1
```

- 23 -

```
001111011101 11101001        RDM
001111011110 11110110        RAR
001111011111 11100000        WRM
001111100000 01100001        INC 1
001111100001 01110101        ISZ 5 PTR2
             11010111
001111100011 11000000 PTR8,  BBL 0
//
// OUTPUT TO PRNT SOLENOIDS
//
001111100100 00101011 PTR6,  SRC P5                      (Location 996)
001111100101 11101001        RDM
001111100110 11100001        WMP
001111100111 01000010        JUN OUTC
             11100011
//
//   ILA REPEAT
//
001111101001 00010100 WRPT,  JCN AZ WRP4 /MOTION?NO,JMP  (Location 1001)
             11110101
//..
001111101011 01010011 WRP2,  JMS WTRG
             00011010
001111101101 00010010        JCN C1 WRP4 /OUT OF RANGE?YES,JMP
             11110101
//..
001111101111 01010011 WRP3,  JMS WTDZ
             00000001
001111110001 11101100        RDO
001111110010 11110110        RAR
001111110011 00010010        JCN C1 PTR / WT DEAD ZONE?NO,JMP
             01111000
001111110101 01000000 WRP4,  JUN HOME
             00001111
*1024 /START OF ROM4
/
/BY COUNT
/
010000000000 00000000 BYCT,  NOP
010000000001 00000000        NOP                         (Location 1025)
010000000010 00000000        NOP
010000000011 00000000        NOP
010000000100 01010000        JMS TTER / CHECK P P LBS SW
             10010001
```

TABLE V – Continued

- 23 - Con't

```
010000000110 00100000        FIM P0 48 / ADDRESS VALUE
             00110000
010000001000 00100010        FIM P1 12 / CNT=12
             00001100
010000001010 00100001 BYC3,  SRC P0
010000001011 11101011        ADM
```

- 24 -

```
010000001100 00011100        JCN NZA BYC / NON-ZERO?YES,JMP
             00010011
010000001110 01100001        INC 1        /NEXT VALUE
010000001111 01110011        ISZ 3 BYC3   /LAST? NO,JMP
             00001010
010000010001 01000000 BYER,  JUN ERROR    /GO TO ERROR
             10011110
//
// BY COUNT PROGRAM
//
010000010011 01010011 BYC,   JMS WTRG / CHECK WEIGHT RANGE
             00011010
010000010101 00010010        JCN C1 BYC1 / OUT OF RANGE?YES,JMP
             00011101
010000010111 01010011        JMS WTDZ
             00000001
010000011001 11101100        RDO
010000011010 11110110        RAR                                    (Location 1050)
010000011011 00010010        JCN C1 BYC2 / WEIGHT DEAD ZONE?NO,JMP
             00011111
010000011101 11011111 BYC1,  LDM 15
010000011110 10111110        XCH 14
//..
//..
010000011111 01010011 BYC2,  JMS RDKB  / READ KEYBOARD
             00100100
010000100001 01010010        JMS OUTA  / ACCUM=0
             11011010
010000100011 11101010        RDR       / EJECT.TARE.ERROR.ILA
010000100100 11110110        RAR
010000100101 11011100        LDM 12
010000100110 01010010        JMS OUTA
             11011010
010000101000 11101010        RDR       / X.X.VAR WT,FIX VAL.X
010000101001 10111101        XCH 13    /SAVE IN R13
010000101010 00010010        JCN C1 BMST / ILA?YES,JMP
             01000100
010000101100 10101101        LD 13
010000101101 11110110        RAR
010000101110 11110110        RAR
010000101111 00010010        JCN C1 BMST / VAR WT FX VAL?YES,JMP
             01000100
010000110001 10101110        LD 14
010000110010 00010100        JCN A0 BYER   /TEST FOR > WTDZ
             00010001                                           (Location 1075)
010000110100 00100001        SRC P0
010000110101 11101100        RDO
010000110110 11110110        RAR
010000110111 11110110        RAR
010000111000 00010010        JCN C1 BYER   /TEST FOR RPT
```

TABLE V —Continued


```
             00010001
010000111010 00100000  BYC8, FIM P0 0
             00000000
010000111100 00100010       FIM P1 12
             00001100
010000111110 01010010       JMS ZERO      /ZERO WT
             00000000
010001000000 01000011 BYC7, JUN PTR      /PRINT LABEL
             01111000
010001000010 01000000 BYC5, JUN HOME
             00001111
//
// CHECK FOR MANUAL START
//
010001000100 11101100 BMST, RDO    / BY CT.STRT.REPEAT.I ST CYCLE
010001000101 11110101       RAL
010001000110 11110101       RAL
010001000111 00010010       JCN C1 BYMS / START?YES,JMP
             01010000
010001001001 00100101  BYLA, SRC P2
010001001010 11101101       RD1
010001001011 00010100       JCN A0 BYC5    /TEST FOR MTN
             01000010                                    (Location 1100)
010001001101 10101110       LD 14
010001001110 00011100       JCN NZA BYC5    /TEST WTRG, WTDZ
             01000010
010001010000 10101101 BYMS, LD 13
010001010001 11110110       RAR
010001010010 11110110       RAR
010001010011 00011010       JCN CZ BYC8 / VAR WT /FIX VAL STAT
             00111010
010001010101 00100000  BYC6, FIM P0 40
             00101000
010001010111 00100010       FIM P1 0
             00000000
010001011001 00100100       FIM P2 44
             00101100
010001011011 01010010       JMS TRN1   / TRANSFER
             00001011
010001011101 01000100       JUN BYC7
             01000000
//
//
//
010001011111 00100000 FRK,  FIM P0 32  /ADDRESS PRICE PER POUND
             00100000
010001100001 00100001       SRC P0
010001100010 11110000       CLB
010001100011 11010001       LDM 1
010001100100 11101000       SBM
```

- 26 -

```
010001100101 00010100       JCN A0 FRK1                    (Location 1125)
             01101101
010001100111 11110000       CLB
010001101000 11011001       LDM 9
010001101001 11101000       SBM
010001101010 00010100       JCN A0 FRK2
             01110000
010001101100 11000000       BBL 0
010001101101 11010010 FRK1, LDM 2
010001101110 11100000       WRM
010001101111 11000000       BBL 0
010001110000 11011000 FRK2, LDM 8
010001110001 11100000       WRM
010001110010 11000000 FRK3, BBL 0
```

TABLE V—Continued

- 26 - Con't

```
//
// FRACTIONAL KEY
//
* 1159 / START FRACTIONAL KEY PROGRAM
010010000111 00000000 FRKB, NOP                                 (Location 1159)
010010001000 00000000       NOP
010010001001 00000000       NOP
010010001010 00000000       NOP
010010001011 11110110       RAR
010010001100 00010010       JCN C1 FRK / FRACTIONAL KEY MODE?YES,J
MP
             01011111
010010001110 11000000       BBL 0      / EXIT
/
/
/METRIC MULTIPLIERS
/
*1280  / START OF ROM5
010100000000 11110111 KGST, TCC                                 (Location 1280)
010100000001 10111111       XCH 15
010100000010 11101111       RD3
010100000011 11110110       RAR
010100000100 00010010       JCN C1 KG5      /TEST FOR 5KG
             01000010
010100000110 01010101 KG10, JMS KMNS
             01001010
010100001000 01010101       JMS KBPT
             01010000
010100001010 00100010       FIM P1 01011011B
             01011011
010100001100 10100010 KG,   LD 2
010100001101 11110001       CLC
010100001110 10000011       ADD 3
010100001111 00011100       JCN NZA KGE
             01000000
010100010001 10100010       LD 2
```

- 27 -

```
010100010010 00100000       FIM P0 32
             00100000
010100010100 00100001       SRC P0                              (Location 1300)
010100010101 11100000       WRM
010100010110 00100000       FIM P0 33
             00100001
010100011000 00100010       FIM P1 9
             00001001
010100011010 01010010       JMS ZERO
             00000000
010100011100 01010010       JMS MPLY
             01011001
010100011110 00100000       FIM P0 16
             00010000
010100100000 00100010       FIM P1 40
             00101000
010100100010 01010010       JMS TRN12 / TRANSFER 4
             00000111
010100100100 00100001       SRC P0
010100100101 11101001       RDM
010100100110 00011100       JCN NZA KGE     /TEST FOR OVERFLOW
             01000000
010100101000 01010011       JMS RDKB
             00100100
/
/TEST FOR >MIN PPLB
/
```

TABLE V –Continued

- 27 - Con't

```
010100101010 11010111 MINP,LDM 7
010100101011 01010010      JMS OUTA
             11011010
010100101101 11101010       RDR           /READ MIN PPLB  (Location 1325)
010100101110 00100000       FIM P0 30
             00011110
010100110000 00100001       SRC P0
010100110001 11100000       WRM
010100110010 00100000       FIM P0 32
             00100000
010100110100 00100010       FIM P1 28
             00011100
010100110110 00100100       FIM P2 12
             00001100
010100111000 01010010       JMS COMP
             01000001
010100111010 11101100       RDO           /READ COMP STAT
010100111011 11110110       RAR
010100111100 00011010       JCN C0 KGE    /TEST FOR >MIN PPLB
             01000000
010100111110 01000000       JUN CVAL
             11001111
010101000000 01000000 KGE,  JUN EROR
```

- 28 -

```
             10011110
010101000010 01010101 KG5,  JMS KMNS
             01001010
010101000100 01010101       JMS KBPT
             01010000
010101000110 00100010       FIM P1 00101110B             (Location 1350)
             00101110
010101001000 01000101       JUN KG
             00001100
010101001010 00100111 KMNS, SRC P3
010101001011 11101100       RDO
010101001100 11110110       RAR
010101001101 00011010       JCN C0 TZRO   /TEST FOR <WTDZ
             01110001
010101001111 11000000       BBL 0
010101010000 00100010 KBPT, FIM P1 10111111B
             10111111
010101010010 00100000       FIM P0 5
             00000101
010101010100 11110000       CLB
010101010101 10100001 KBP2, LD 1        /5, 10, 15
010101010110 11111100       KBP
010101010111 10010011       SUB 3
010101011000 00011100       JCN NZA KGE   /2 KEY CODE CK
             01000000
010101011010 11010100       LDM 4
010101011011 10000001       ADD 1
010101011100 10110001       XCH 1
010101011101 00011010       JCN C0 KBP2
             01010101                                    (Location 1375)
010101011111 11110000       CLB
010101100000 10110001       XCH 1
010101100001 10100001 KBP1, LD 1          /0, 1, 2, 4, 8, CK
010101100010 11111100       KBP
010101100011 10010000       SUB 0
010101100100 00011100       JCN NZA KGE   /0, 1, 2, 3, 4, CK
             01000000
010101100110 01100000       INC 0
010101100111 11110101 KBP3, RAL
010101101000 01110011       ISZ 3 KBP3
             01100111
010101101010 10110001       XCH 1
```

TABLE 1 –Continued

- 28 - Con't

```
010101101011 10100000        LD 0
010101101100 11110100        CMA
010101101101 10110011        XCH 3
010101101110 01110010        ISZ 2 KBP1
             01100001
010101110000 11000000        BBL 0
/
/TEST FOR 0 FIELD
```

- 29 -

```
/
010101110001 00100000 TZRO,  FIM P0 40
             00101000
010101110011 00100010        FIM P1 12
             00001100
010101110101 00100001 TZR1,  SRC P0
010101110110 11101001        RDM
010101110111 00010100        JCN A0 TZR2   /TEST FOR ZERO
             01111011                                (Location 1400)
010101111001 01000000        JUN NMNS
             11000010
010101111011 01100001 TZR2,  INC 1
010101111100 01110011        ISZ 3 TZR1
             01110101
010101111110 11000000        BBL 0
/
/CHECK PARITY
/
010101111111 00101000 CPAR,  FIM P4 11001100B /CHAR AND BIT CTR
             11001100
010110000001 00100110        FIM P3 0      /BIT STOR AND CNTR
             00000000
010110000011 00100100        FIM P2 32      /MEM ADD
             00100000
010110000101 11110001        CLC           /CLEAR PAR EN
010110000110 11101001        RDM          /READ MEMORY
010110000111 11110101        RAL
010110001000 11110001        CLC
010110001001 11110101        RAL
010110001010 11110001        CLC          /REMOVE PAR BITS
010110001011 00010100        JCN A0 CPZ
             10101010
010110001101 00100101 CPB,   SRC P2
010110001110 11101001        RDM           /READ DATA
010110001111 11110110 CPA,   RAR           /ROTATE TO BIT CNT
010110010000 10110111        XCH 7         /STOR REMAINING BITS
010110010001 11110111        TCC                     (Location 1425)
010110010010 10000110        ADD 6         /ADD BITS ACCUMULATED
010110010011 10110110        XCH 6
010110010100 10100111        LD 7          /GET REMAINING BITS
010110010101 01111001        ISZ 9 CPA     /INC BIT CNTR
             10001111
010110010111 01100101        INC 5         /MODIFY MEM ADD
010110011000 11011100        LDM 12        /ADJUST BIT CNTR
010110011001 10111001        XCH 9
010110011010 01111000        ISZ 8 CPB     /INC CHAR CNTR
             10001101
010110011100 10101010        LD 10
010110011101 11110110        RAR
010110011110 00011010        JCN C0 EVNP
```

TABLE V—Continued

- 30 -

```
             10100101
010110100000 10100110       LD 6
010110100001 11110110       RAR
010110100010 00011010       JCN CO PARE
             10110011
010110100100 11000000       BBL 0
010110100101 10000110 EVNP, ADD 6
010110100110 11110110       RAR
010110100111 00011010       JCN CO PARE
             10110011
010110101001 11000000 PARC, BBL 0
010110101010 00100101 CPZ,  SRC P2                    (Location 1450)
010110101011 11101001       RDM        /READ WT DIGIT
010110101100 11110110       RAR
010110101101 00011100       JCN NZA PDZ /CHECK FOR ZERO WT
             10110010
010110101111 10101010       LD 10
010110110000 00011100       JCN NZA PARE  /CHECK ZERO WT PAR
             10110011
010110110010 11000000 PDZ,  BBL 0  / EXIT
//....
010110110011 01000000 PARE, JUN EROR
             10011110
/
```

TABLE VI

Gray Code	A BCD if Preceded by Even	B BCD if Preceded by Odd
0000	X (zero filled)	X
0001	0000 (0)	0101 (9)
0010	0010 (2)	0111 (7)
0011	0001 (1)	1000 (8)
0100	0100 (4)	0101 (5)
0101	X (nine filled)	X
0110	0011 (3)	0110 (6)
0111	X (nine filled)	X
1000	X (nine filled)	X
1001	1001 (9)	0000 (0)
1010	0111 (7)	0010 (2)
1011	1000 (8)	0001 (1)
1100	0101 (5)	0100 (4)
1101	X (zero filled)	X
1110	0110 (6)	0011 (3)
1111	X (zero filled)	X

While the methods and forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods and forms of apparatus, and that changes may be made therein without departing from the scope of the invention.

What is claimed is:

1. A scale system comprising:

a platter which moves in accordance with the weight of a commodity placed thereon,

a chart connected to said platter for movement together therewith, said chart having a series of weight indicating tracks provided with weight indicating areas arranged for weight indication and a parity indicating track provided with parity indicating areas arranged for indicating parity for corresponding weight indicating areas on said weight indicating tracks,

a series of photocells, including weight detecting photocells and a parity detecting photocell, observing said areas in said tracks and providing a corresponding series of weight indicating signals and a parity indicating signal,

transition detecting means for generating a transition signal indicating a positioning of said chart such that one of the photocells observing a weight indicating track is observing an edge of one of said weight indicating areas,

display means for presenting a visual representation of said weight indicating signals,

parity checking means for checking said weight indicating signals against said parity indicating signal and inhibiting the operation of said display means whenever a parity error is detected,

parity check suppressing means for interrupting inhibiting control of said display means by said parity checking means whenever said (threshold) transition signal is generated (.), and

function control means connected with said transition detecting means, display means and parity checking means for sequentially enabling events in the operating cycle of said scale system.

2. A scale system according to claim **1** further comprising a second parity indicating photocell positioned for viewing said parity indicating track and generating a second parity indicating signal which indicates opposite parity from the first aforesaid parity indicating signal.

3. A scale system according to claim **2** wherein said threshold detecting means includes a lengthwise addition to the weight (indicating) verifying graduated areas on said parity indicating track and means for generating said threshold signal whenever said parity indicating photocells each sense lengthwise addition areas and thereby have a common output.

4. A scale system according to claim **3** wherein said lengthwise additions are extensions of said chart parity indicating areas so that said common output is caused by observation of a parity indicating area by one of said photocells and observation of one of said extensions by the other of said photocells.

5. A scale system according to claim **4** wherein said extended length parity indicating areas and said weight indicating areas are translucent areas in said chart.

6. A scale system according to claim **1** wherein said transition detecting means comprises a threshold indicating track having translucent areas arranged thereon for indication of a positioning of said chart at a transition point between weight readings, means for directing light through said translucent areas, and a threshold indicating photocell for detection of said light.

7. A weighing scale system comprising:

a platter which moves in accordance with the weight of a commodity placed thereon,

a chart connected to said platter for movement therewith, said chart having a series of weight indicating tracks provided with weight indicating graduations and a parity indicating track with parity indicating graduations arranged for parity verification of the corresponding weight indicating graduations and for identification of weight transition points therein;

signal generating means for generating electrical weight indicating signals, a parity indicating signal and a transition signal from said chart graduations,

parity checking means for checking said weight indicating signals against said parity indicating signal and inhibiting the operation of said scale system whenever a parity error is detected,

parity check suppressing means for suppressing the inhibiting function of said parity checking means whenever said transition signal indicates chart positioning near a weight transition point, and

function control means connected with said signal generating means, and parity checking means for sequentially enabling events in the operating cycle of said weighing scale system.

8. A scale system according to claim **7** wherein said parity track graduations are of greater length than the corresponding weight indicating track graduations and overlap portions of the adjacent weight graduations for controlling generation of said transition signal by said signal generating means.

9. A scale system according to claim **8** wherein said signal generating means includes two transducer elements located along the same parity indicating track.

10. A scale system comprising:

a platter which moves in accordance with the weight of a commodity placed thereon,

a chart connected to said platter for movement together therewith, said chart having a series of weight indicating tracks, a parity indicating track, and a transition indicating track, all of said tracks comprising alternate opaque and translucent areas, the areas on said weight indicating tracks being arranged to indicate commodity weight, the areas on said parity checking track being arranged to indicate parity for corresponding areas on the weight indicating tracks, and the areas on the transition indicating track also being arranged to indicate opaque to translucent transition regions between the areas on the weight indicating tracks,

a light source directed against said chart,

a series of photocells for detecting light passing through the translucent areas in said tracks,

means connected to said photocells for generating a digital representation of said commodity weight and parity as indicated by said tracks and detected by said photocells,

parity checking means for checking the parity of said digital weight representation against the indication of said parity indicating track as detected by said photocells,

error indicating means connected to said parity checking means for indicating detection of a parity error,

parity check suppressing means for inhibiting the operation of said parity checking means when said photocells detect a transition indication by said transition indicating track, and

function control means connected with said parity checking means for sequentially enabling parity checking and predetermined other events in the operating cycle of said scale system.

11. A scale according to claim **10** wherein said parity checking track further comprises areas to indicate opaque/translucent transition regions between the areas on the weight indicating tracks, and said parity check suppressing means comprises means for inhibiting operation of said parity checking means only when said photocells produce output signals indicative of light passage through both said threshold indicating track and said parity indicating track.

12. A scale according to claim **11** wherein said transition indicating track further comprises areas to indicate parity for an alignment of areas on said weight indicating tracks, said parity being opposite the parity indicated by said parity indicating track, and said parity checking means comprises means to check the parity of said digital weight representation against the indication of said threshold indicating track and means to signal an error in said parity check to said error indicating means.

13. In a computing scale system which generates a series of weight indications, improved scale motion monitoring apparatus comprising:

comparing means for comparing a current weight indication with a next preceding weight indication and generating a positive difference indication when said current weight indication exceeds said next preceding weight indication and a negative difference indication when said next preceding weight indication exceeds said current weight indication,

counting means for counting said negative and positive difference indications, a negative difference indication resetting the positive count and a positive difference indication resetting the negative count,

motion indicating means for generating a first motion indication when said counting means reaches a predetermined first count of either negative or positive indications and subsequent motion indications whenever said counting means thereafter reaches a predetermined second count of negative or positive indications,

count adjusting means for causing said second count to be lower in number than said first count,

timing means for indicating elapsed time since generation of a motion indication by said motion indicating means,

reset means for resetting said timing means and said counting means whenever said motion indicating means generates a motion indicating signal, and

motion cessation indicating means for indicating a motionless scale condition when said first motion indication has been generated and said timing means has thereafter indicated a predetermined elapsed time.

14. In the system of claim 13 wherein said counting means comprises a positive difference counting register and a negative difference counting register.

15. In the system of claim 13 wherein said timing means comprises a timing counter, means for incrementing said timing counter each time said comparing means successfully compares a current weight indication with a next preceding weight indication, and a waiting counter for controlling the time between said comparisons of weight indications.

16. In the system of claim 15 further including means also incrementing said timing counter in response to a current weight indication which neither compares with the preceding weight indication nor generates a motion indication.

17. In the system of claim 15 wherein said timing means further comprises manually operable selection means for adjusting the number of counts made by said waiting counter and thereby controlling the time lapse between a motion indication and a indication of a motionless scale condition.

18. A computing scale system comprising:
- a scale providing an output signal indicative of the weight of an article placed thereon,
- means for communicating a price per unit weight of said article to said scale,
- means for multiplying said weight by said price per unit weight to obtain a total value,
- means for indicating said total value,
- means defining a weight dead zone in said scale and inhibiting said indication of total value when said output signal indicates a weight within said weight dead zone,
- manually operable selection means for adjusting the size of said weight dead zone and
- function control means for sequentially enabling events in the operating cycle of said scale system.

19. The scale system of claim 18 wherein said means defining a weight dead zone also inhibits said means for multiplying when said output signal indicates a weight within said weight dead zone.

20. In a computing scale of the type having a deflectable platter for weighing articles, transducer means providing signals indicative of platter deflection, function control means for determining an operating cycle, computation means for calculating weight-related information from the transducer signals and motion detecting means inhibiting the computation means until the platter and transducer have reached a stable position, the improvement comprising:
- means for altering the motion sensitivity of said motion detector appratus between a first sensitivity condition for determining cessation of motion while the scale is settling out from a moving condition and a second lesser sensitive condition for determing the commencement of motion while the scale is in a substantially motionless condition.

21. Motion detecting apparatus for a weight scale comprising:
- means for periodically generating electrical signals indicative of scale loading;
- first counting means responsive to value increase of said electrical signals over a preceding signal without an intervening smaller signal;
- second counting means responsive to value decrease at said electrical signals from a preceding signal without an intervening larger signal;
- means for excluding from said first and second counting means electrical signals equal in value to preceding electrical signals
- function control means for controlling said motion detecting apparatus; and
- motion signal generating means responsive to attaining a predetermined count in said first or second counting means.

22. The apparatus of claim 21 further including second counting means for counting to a second predetermined number the occurrence of said first or second motion signals said first predetermined number of times.

23. Scale apparatus for generating verified weight signals comprising:
- a multiple track encoder member positionable in a plurality of weight indicating positions in response to scale platter weight, coded indications in said tracks identifying each possible position of said encoder member;
- means parity verifying the code indications in said tracks according to a predetermined convention;
- means identifying instances wherein said parity verification and said code indications may be inconsistent; and
- function control means for sequentially enabling the operating cycle of said scale apparatus.

24. The apparatus of claim 23 wherein said means identifying inconsistent instances includes a parity data track with exaggerated code indications each extending beyond the corresponding weight indicating track code indication to encoder track regions predictably free of data transitions.

25. Scale apparatus for generating substantiated weight signals comprising:
- a multiple track encoder member positionable in a plurality of weight indicating positions in response to scale platter weight, coded indications in said tracks identifying each possible encoder member position;
- verifying means including a parity data track for substantiating the code indications read from the weight indication tracks in accordance with a predetermined convention;
- means including a predetermined parity data track code at a predetermined weight location on said encoder member for testing the operation of said verifying means; and
- function control means connected with said verifying means and said means for testing for sequentially enabling events in the operating cycle of said scale system.

26. The apparatus of claim 25 wherein said predetermined parity data track code is located at the zero weight indicating position of said encoder member.

27. The apparatus of claim 25 wherein said predetermined parity data track code comprises the absence of parity information.

28. The apparatus of claim 25 further including means inhibiting the operation of said verifying means while said encoder member is remote from said predetermined weight location.

29. The apparatus of claim 25 including two parity data tracks one each for odd and even parity verification, and wherein both of said parity data tracks are omitted at chart positions adjacent zero weight indication.

30. The apparatus of claim 29 wherein each of said parity data tracks includes exaggerated code indications each extending beyond the corresponding weight indicating track code indication to overlap each other and wherein the operation of said verifying means is inhibited in response to encoder positions containing said overlapped parity track indications.

31. Weighing apparatus comprising the combination of:

a weight receiving scale platter;

a multiple track weight encoding member coupled with said platter and movable in response to the weight of articles placed thereon, graduations along said multiple tracks identifying each possible weight value stopping positions thereof;

transducer means adjacent said encoding member for generating electrical signals representing the graduations proximate said transducer means in each weight value position;

means parity verifying the correctness of said electrical signals;

means responsive to said electrical signals for generating a motion signal indicative of mechanical movement of said encoding member, and

function control means connected with said means for parity verifying and said means for generating a motion signal and sequentially enabling events in the operating cycle of said weighing apparatus.

32. The combination of claim 31 wherein said encoding member is an optical encoder with light and dark graduations along said tracks, said encoder being illuminated by a light source and wherein said transducer means includes photo-electric cells.

33. The combination of claim 31 wherein said means parity verifying the correctness of said electrical signals includes an additional track of graduations on said encoding member, the graduations in said additional track being encoded to parity verify each set of plural track graduations along said plural tracks.

34. The combination of claim 31 wherein said motion signal generating means includes means for testing said electrical signals in accordance with two different criteria.

35. The combination of claim 31 wherein said motion signal generating means includes motion testing with two different degrees of motion sensitivity.

36. A method for operating a weighing scale of the type having a platter movable chart with corresponding weight indicating, parity indicating, and weight transition points indicating, graduations comprising the steps of:

generating electrical weight indicating, parity indicating and transition point indicating signals from said chart graduations;

checking said weight indicating signal against said parity indicating signal and inhibiting the operation of said scale whenever a parity error is detected; and

suppressing said inhibiting step whenever said transition signal indicates chart positioning near a weight transition point.

37. The method of claim 36 further including the step of testing said checking step with predetermined parity graduations located at a predetermined weight position on said chart.

38. A method for detecting motion in a computing scale comprising the steps of:

generating a sequence of scale deflection signals;

examining a plurality of said deflection signals for representations of rapid deflection change in accordance with a predetermined fast movement criteria, a first motion signal being generated thereby;

testing a plurality of said deflection signals for sample-to-sample differences according to a predetermined difference criteria, a second motion signal being generated thereby;

combining said first and second motion signals in accordance with a predetermined convention to generate a no-motion indicating signal; and

inhibiting weight related computation in the scale until said no-motion signal is received.

39. The method of claim 38 wherein said predetermined convention comprises the absence of both said first and second motion signals for a time interval.

40. The method of claim 38 wherein said predetermined fast movement criteria includes sensing the high frequency signal components in said periodic sequence of scale deflection signals, fast scale movement producing signals of high frequency component.

41. The method of claim 38 wherein said testing of deflection signals includes comparing the number of deflection signals indicating weight difference with a first predetermined number when the scale has previously been determined to be in motion and with a second predetermined number when the scale has previously been determined to be not in motion.

42. The method of claim 41 wherein said first predetermined number is smaller than said second predetermined number, the scale being more sensitive to continuing motion after motion is once detected.

43. The method of claim 41 further including selecting between said first and second predetermined numbers in said testing step in accordance with information developed from said examining step.

44. The method of claim 38 wherein said predetermined difference criteria includes accommodation for modifications introduced in said deflection signals by signal multiplexing.

45. The method of claim 38 further including inhibiting weight related computation in said scale until after one of said first and second motion signals has appeared and both motion signals have disappeared.

46. The method of claim 38 further including performing the generation of said first and second motion signals at time intervals correlated with the settle-out rate of the weighing scale.

47. The method of claim 38 wherein said predetermined convention for combining said first and second motion signals includes the disappearance of said first motion signal.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,091,449

DATED : May 23, 1978

INVENTOR(S) : Robert C. Meckstroth & Edwin E. Boshinski

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 5, line 4, "opened" should be --operated--.

Col. 6, lines 20 and 21, "designed" should be --designated--.

Col. 6, line 22, "and" should be --are--. (second occurrence)

Col. 7, line 3, insert --data-- before "codes".

Col. 8, line 17, "operating" should be --operation--.

Col. 9, line 54, "applied" should be --applies--.

Col. 18, line 57, "SUC" should be --SUB--.

Col. 19, line 27, "twoword" should be --two-word--.

Col. 24, line 14, "th" should be --the--.

Col. 26, lines 9 & 10, "234-259" should be --243-259--.

Col. 26, line 39, "164" should be --1164--.

Col. 26, line 41, "th" should be --the--.

Col. 26, line 46, "provided" should be --provides--.

Col. 28, line 25, "the line" should be --the dotted line--.

Col. 29, line 54, "charge movement" should be --chart movement--.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,091,449

DATED : May 23, 1978

INVENTOR(S) : Robert C. Meckstroth & Edwin E. Boshinski

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 30, line 1, "weight test" should be --weight comparison test--.

Col. 30, line 27, "in Fig. 11" should be --in the Fig. 11--.

Col. 33, line 9, "intruction" should be --instruction--.

Col. 33, line 14, "high" should be --low--.

Col. 33, line 25, "information" should be --information,--.

Col. 33, line 31, "accmulator" should be --accumulator--.

Col. 35, line 32, "unit" should be --until--.

Col. 35, line 46, "ready" should be --already--.

Col. 36, line 48, "924" should be --942--.

Col. 40, line 50, "in" should be --of--.

Col. 44, line 58, "to" should be --so--.

Col. 46, line 15, "outpu" should be --output--.

Col. 47, line 34, "or 9" should be --or the 9--.

Col. 47, line 48, "binary 15 is" should be --binary 15 signal is--.

CERTIFICATE OF CORRECTION

PATENT NO. : 4,091,449 Page 3 of 4

DATED : May 23, 1978

INVENTOR(S) : Robert C. Meckstroth & Edwin E. Boshinski

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 48, line 65, "position" should be --positions--.

Col. 56, line 36, "SCR" should be --SRC--.

Col. 58, lines 60 and 61, should be continued in the same paragraph.

Col. 110, line 42, "(threshold)" should be omitted.

Col. 110, line 43, "(.)" should be omitted.

Col. 110, line 55, "threshold" should be --transition--.

Col. 110, line 56, "(indicating)" should be omitted.

Col. 110, line 58, "threshold" should be --transition--.

Col. 111, line 2, "threshold" should be --transition--.

Col. 111, line 6, "threshold" should be --transition--.

Col. 112, line 21, "threshold" should be --transition--.

Col. 112, line 31 "threshold" should be --transition--.

Col. 113, line 52, "appratus" should be --apparatus--.

Col. 113, line 56, "determing" should be --determining--.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,091,449 Page 4 of 4

DATED : May 23, 1978

INVENTOR(S) : Robert C. Meckstroth & Edwin E. Boshinski

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 114, line 43, "indication" should be --indicating--.

Col. 115, line 14, "each possible" should be omitted.

Col. 115, line 15, "value stopping positions thereof" should be --values at each possible stopping position of said encoding member--.

Col. 115, lines 20 & 21, "said electrical" should be --said transducer electrical--.

Col. 115, line 22, "said electrical" should be --said transducer electrical--.

Signed and Sealed this

Twenty-second **Day of** *May 1979*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

DONALD W. BANNER
Commissioner of Patents and Trademarks

FIG. 1

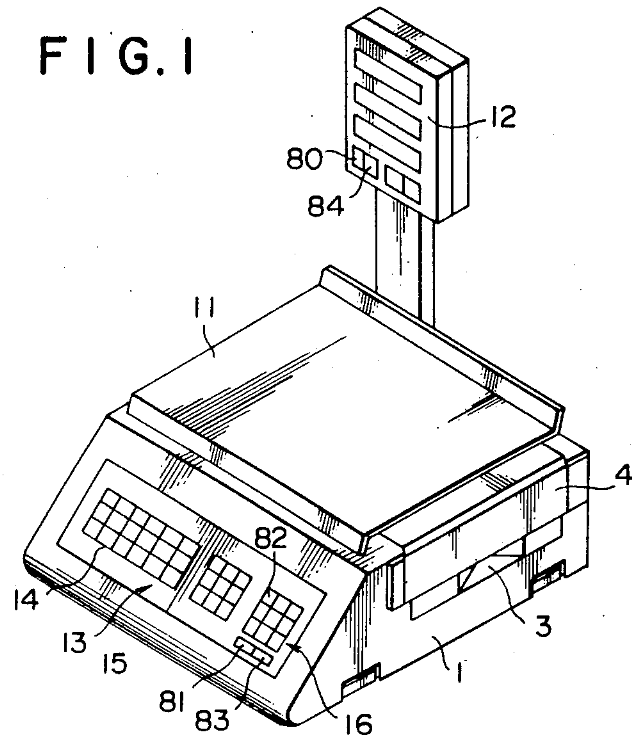


FIG. 2

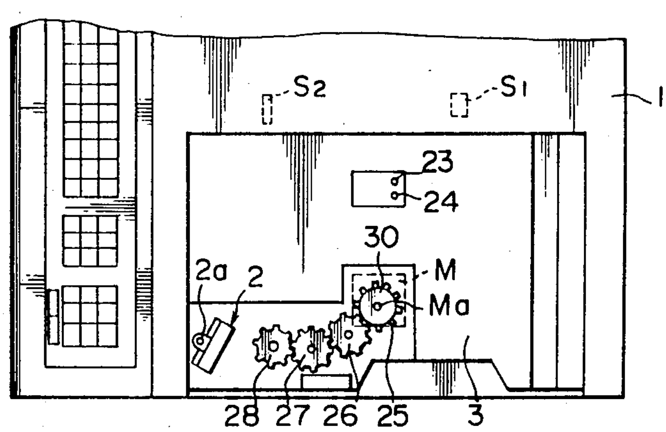


FIG. 3

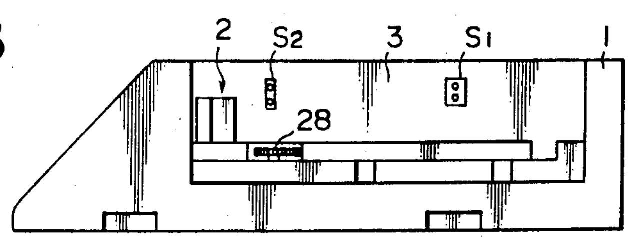


FIG. 4

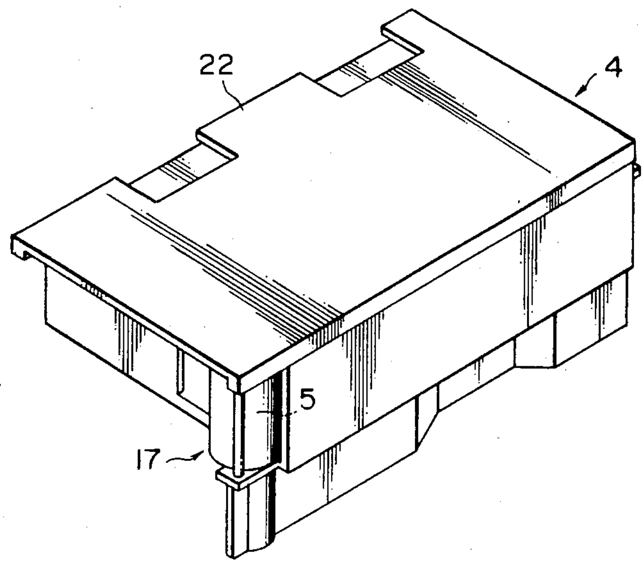


FIG. 5(a)

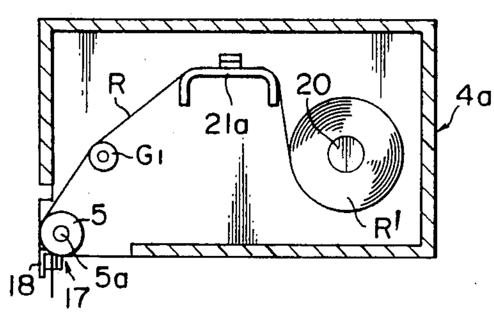


FIG. 6(a)

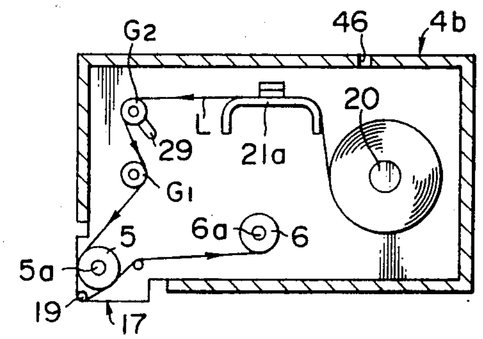


FIG. 5(b)

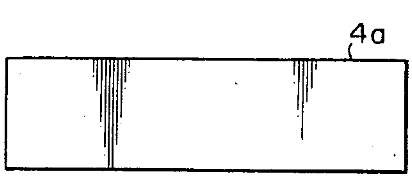
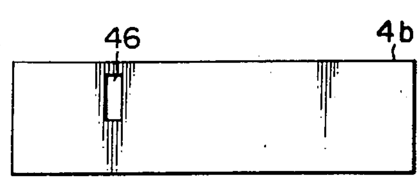
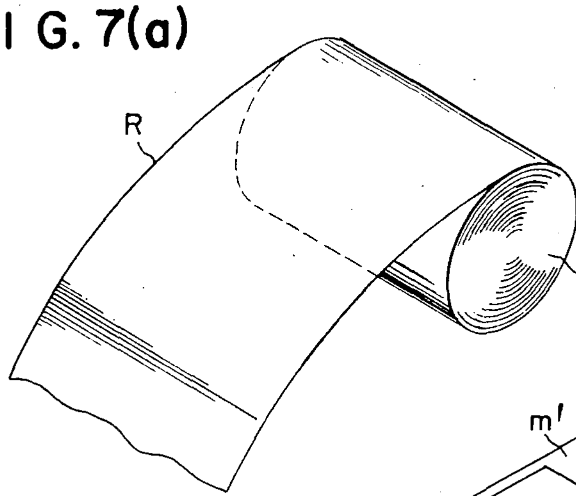


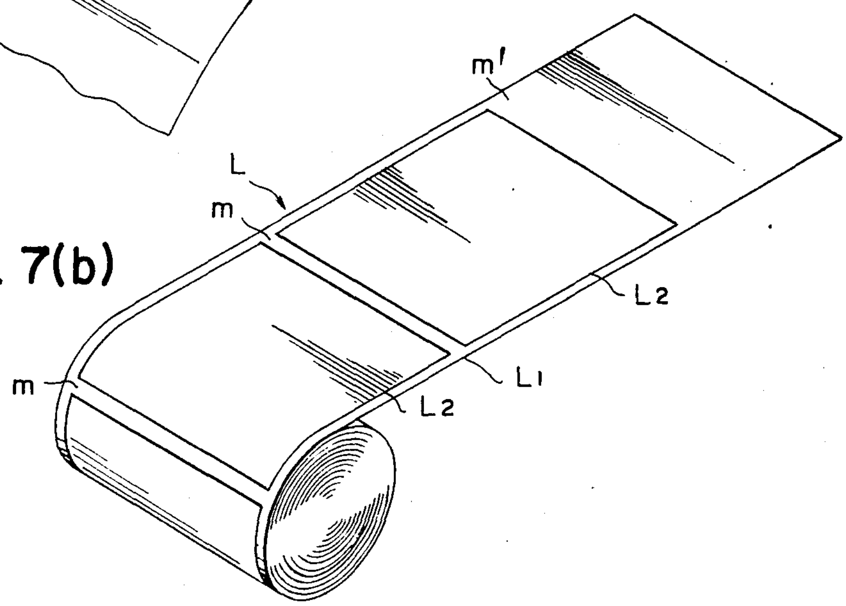
FIG. 6(b)



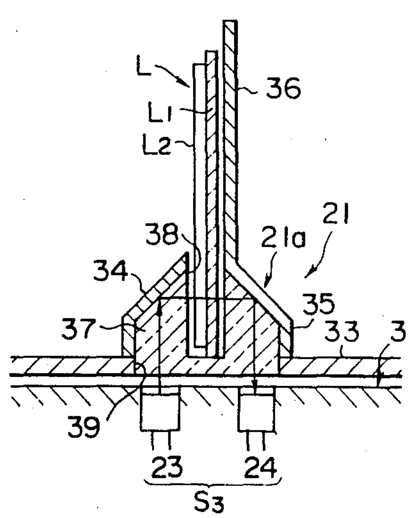
F I G. 7(a)



F I G. 7(b)



F I G. 8



F I G. 9

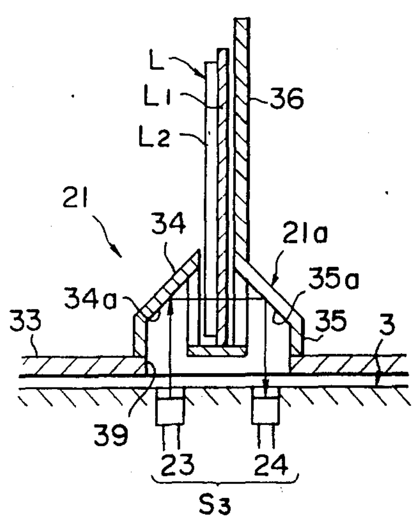


FIG. 10

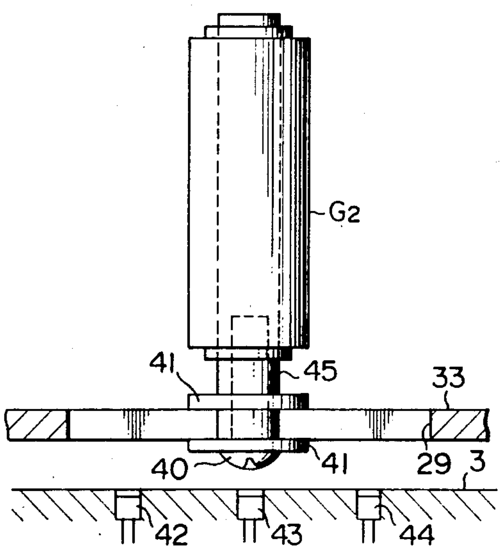


FIG. 11
PRIOR ART

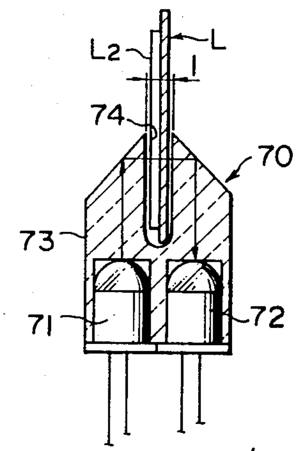


FIG. 12

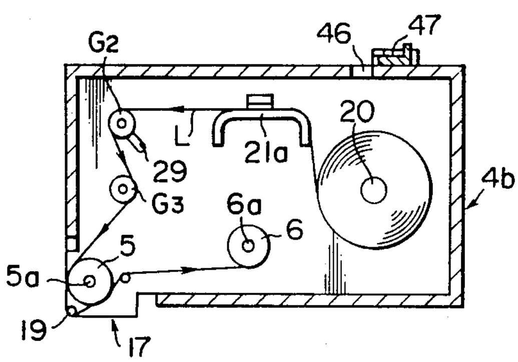


FIG. 14

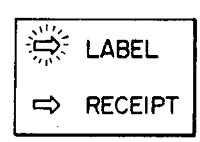


FIG. 13

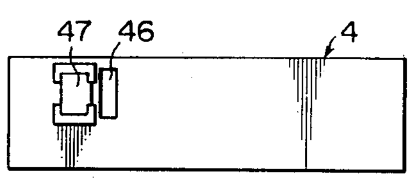


FIG. 15

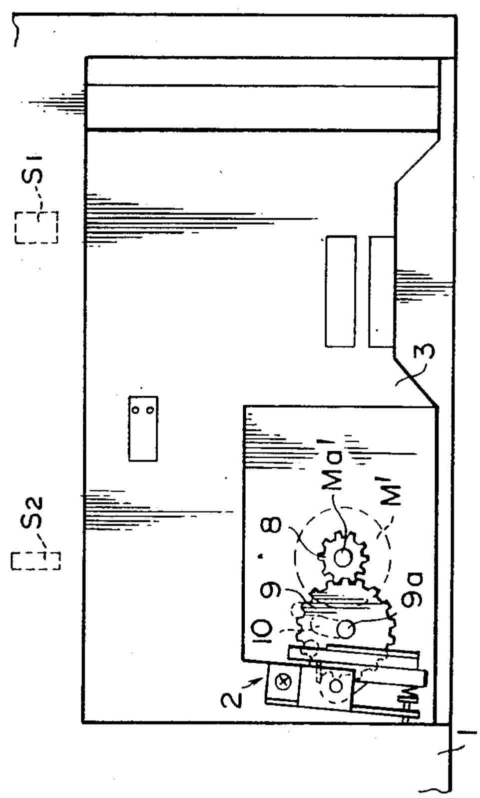


FIG. 16

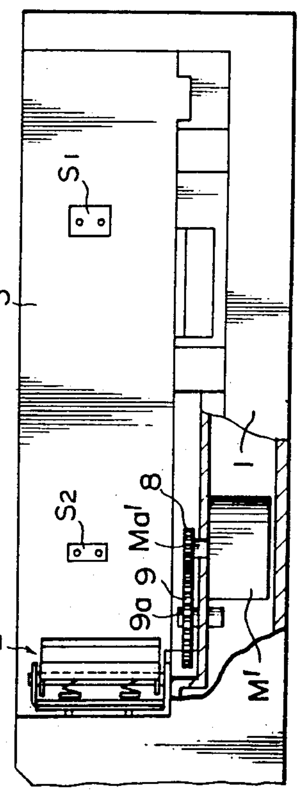


FIG. 17

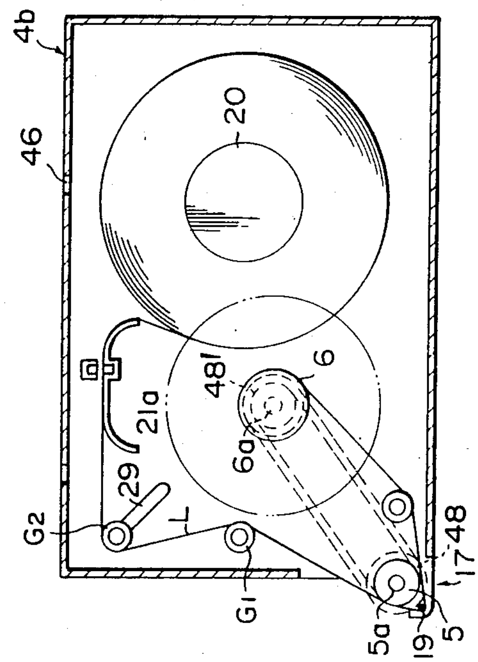


FIG. 18

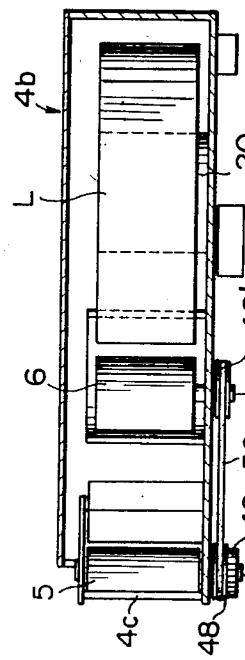
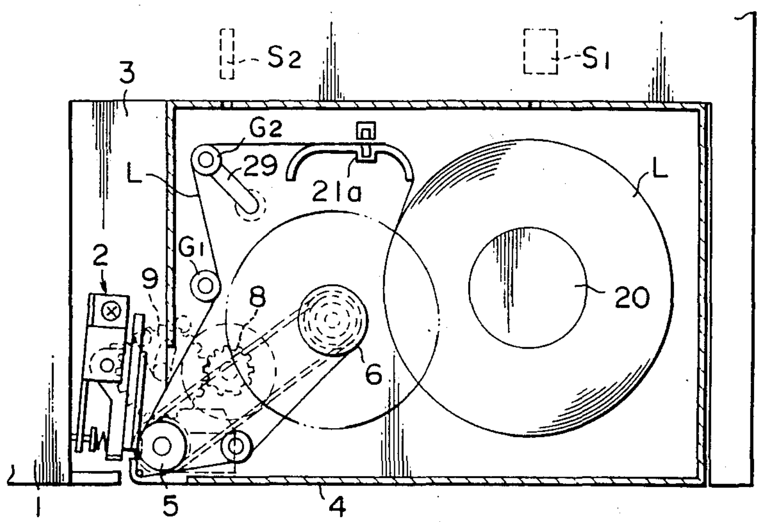
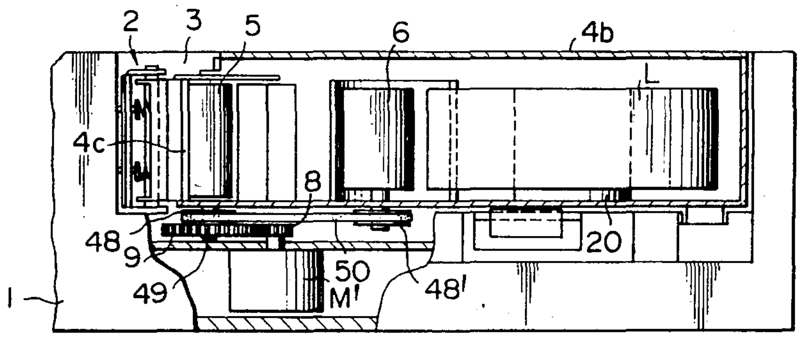


FIG. 19

F I G. 20



F I G. 21



F I G. 22

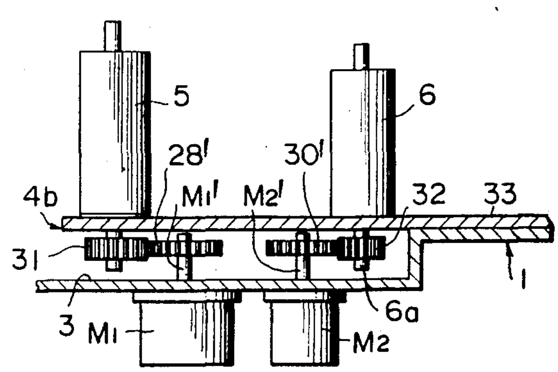


FIG. 23

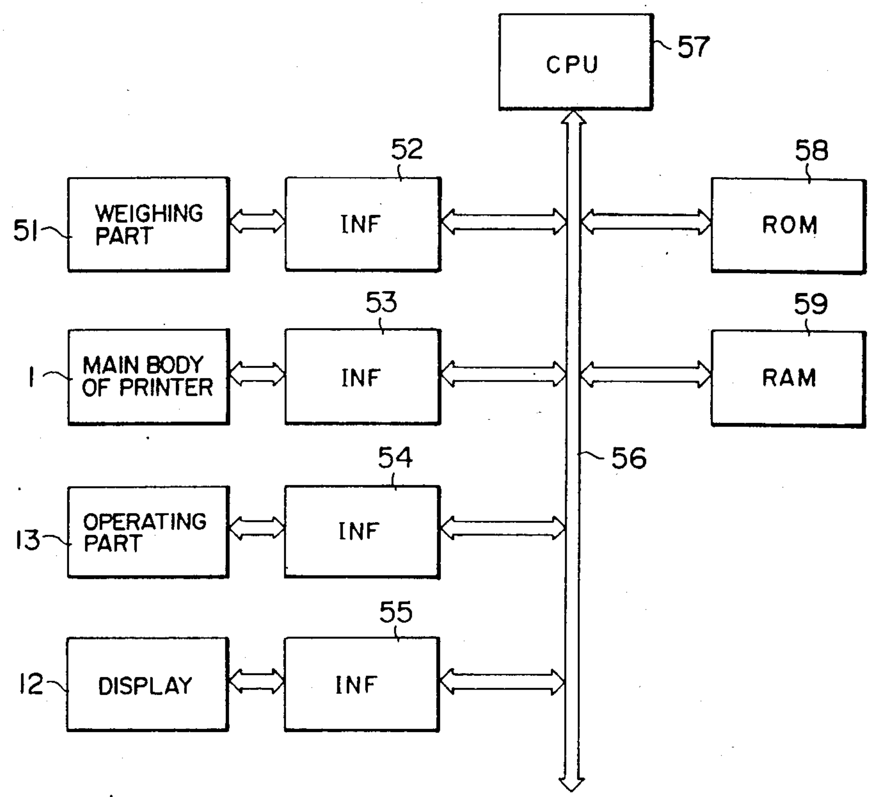

CPU
57
52
58
51
WEIGHING PART
INF
ROM
53
59
1
MAIN BODY OF PRINTER
INF
RAM
56
54
13
OPERATING PART
INF
55
12
DISPLAY
INF

FIG. 27

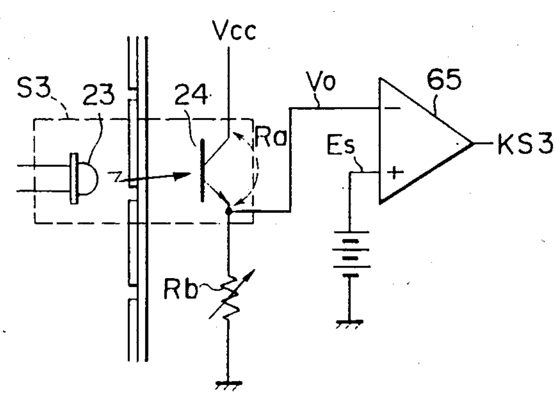

Vcc
S3
23
24
Vo
65
Ra
Es
KS3
Rb

FIG. 24

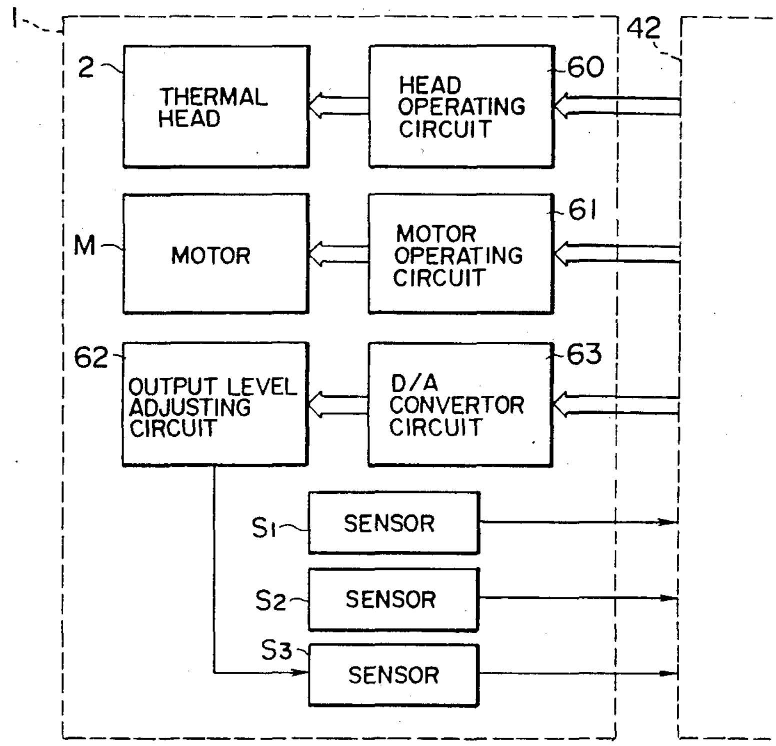

1
2
THERMAL HEAD
HEAD OPERATING CIRCUIT
60
42
M
MOTOR
MOTOR OPERATING CIRCUIT
61
62
OUTPUT LEVEL ADJUSTING CIRCUIT
D/A CONVERTOR CIRCUIT
63
S1
SENSOR
S2
SENSOR
S3
SENSOR

FIG. 25

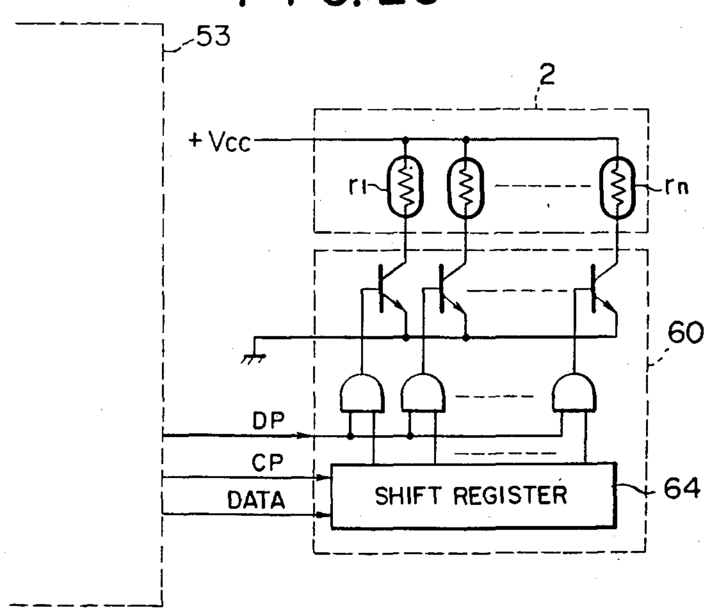
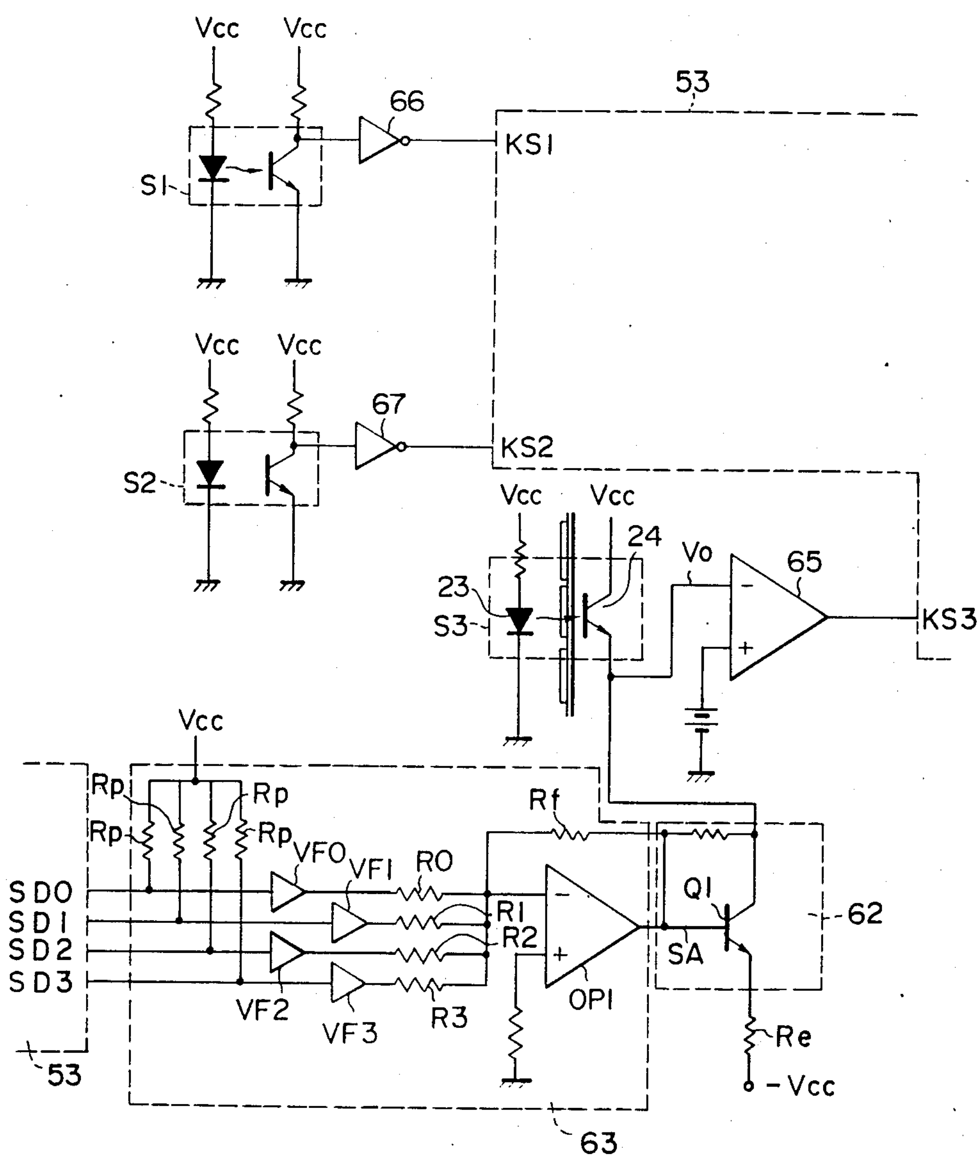

53
2
+Vcc
r1
rn
60
DP
CP
DATA
SHIFT REGISTER
64

FIG. 26



Vcc
Vcc
66
53
KS1
S1
Vcc
Vcc
67
KS2
S2
Vcc
Vcc
24
Vo
65
23
S3
KS3
Vcc
Rp
Rp
Rp
Rp
Rf
VF0
VF1
R0
SD0
SD1
SD2
SD3
R1
R2
Q1
62
SA
VF2
VF3
R3
OP1
Re
-Vcc
53
63

FIG. 28(a)
FIG. 28(b)
FIG. 28(c)
FIG. 28(d)

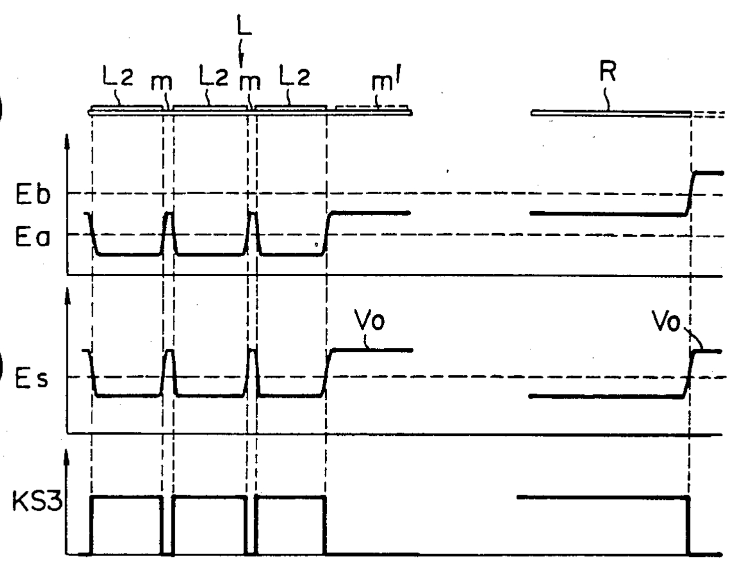
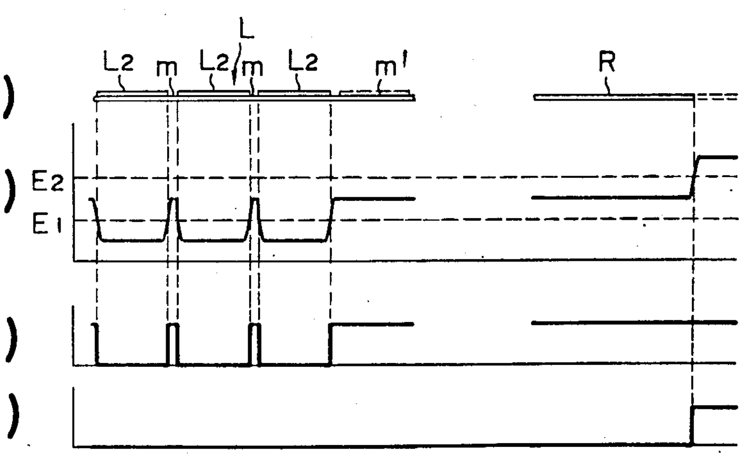
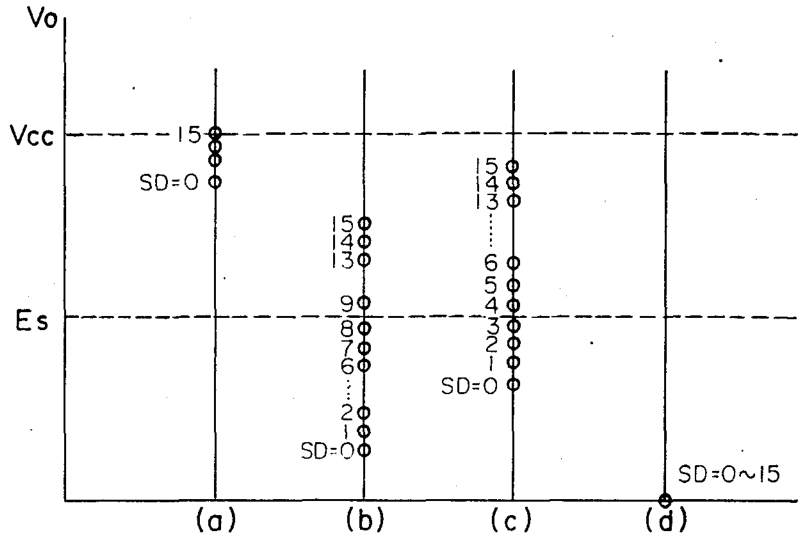


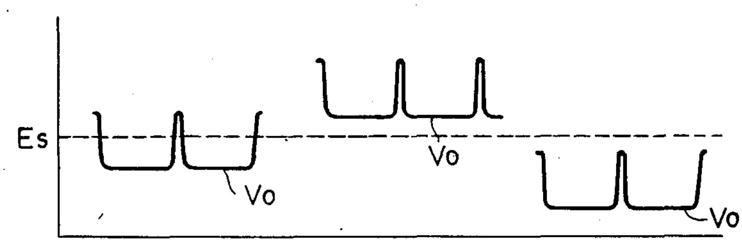
FIG. 29(a)
FIG. 29(b)
FIG. 29(c)
FIG. 29(d)



F I G. 30



F I G. 32(a)



F I G. 32(b)

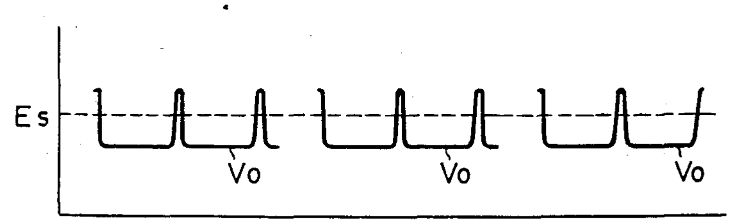


FIG. 31

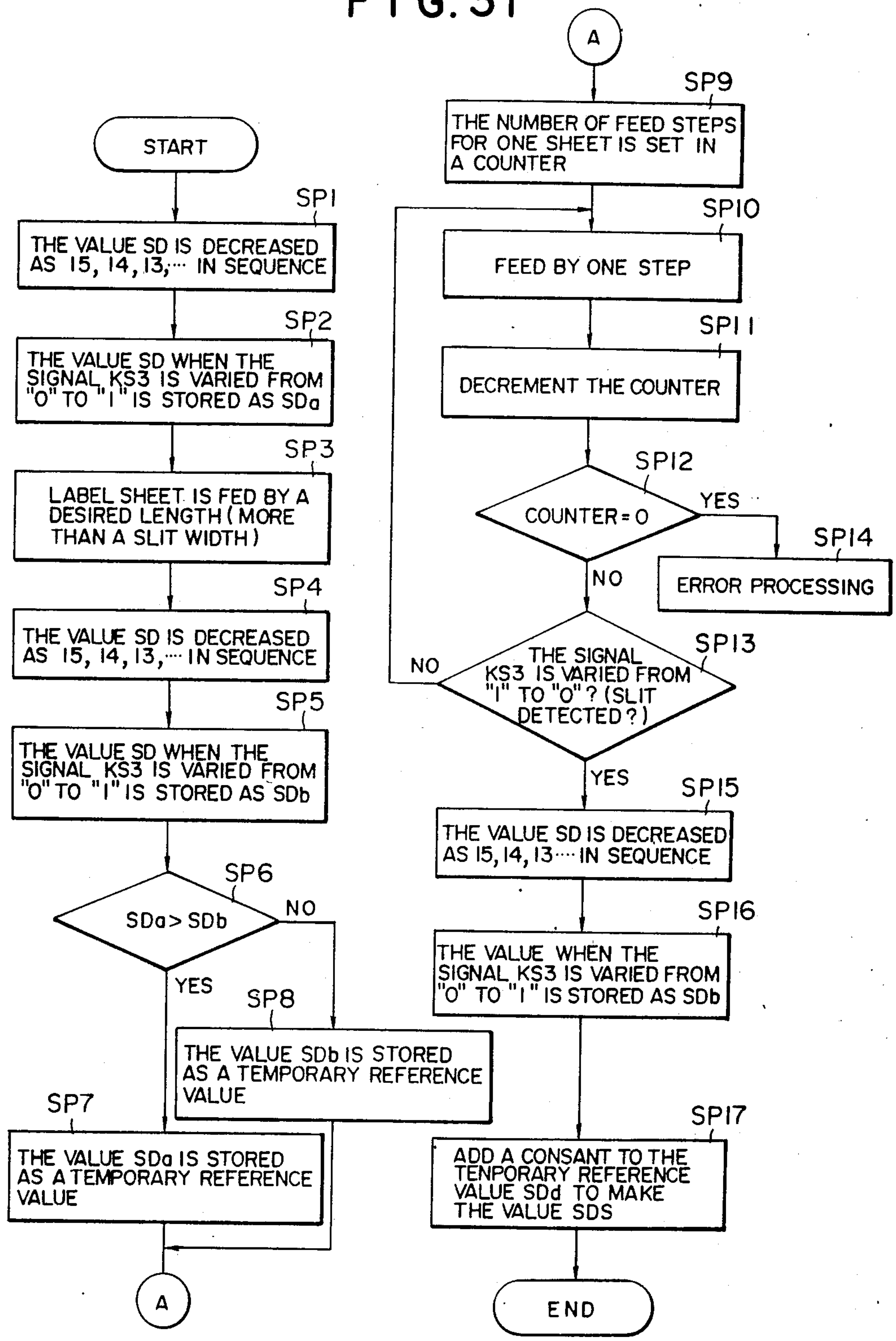

START
SP1
THE VALUE SD IS DECREASED AS 15, 14, 13,··· IN SEQUENCE
SP2
THE VALUE SD WHEN THE SIGNAL KS3 IS VARIED FROM "0" TO "1" IS STORED AS SDa
SP3
LABEL SHEET IS FED BY A DESIRED LENGTH (MORE THAN A SLIT WIDTH)
SP4
THE VALUE SD IS DECREASED AS 15, 14, 13,··· IN SEQUENCE
SP5
THE VALUE SD WHEN THE SIGNAL KS3 IS VARIED FROM "0" TO "1" IS STORED AS SDb
SP6
SDa > SDb
NO
YES
SP8
THE VALUE SDb IS STORED AS A TEMPORARY REFERENCE VALUE
SP7
THE VALUE SDa IS STORED AS A TEMPORARY REFERENCE VALUE
A
A
SP9
THE NUMBER OF FEED STEPS FOR ONE SHEET IS SET IN A COUNTER
SP10
FEED BY ONE STEP
SP11
DECREMENT THE COUNTER
SP12
COUNTER = 0
YES
SP14
ERROR PROCESSING
NO
SP13
THE SIGNAL KS3 IS VARIED FROM "1" TO "0"? (SLIT DETECTED?)
NO
YES
SP15
THE VALUE SD IS DECREASED AS 15, 14, 13··· IN SEQUENCE
SP16
THE VALUE WHEN THE SIGNAL KS3 IS VARIED FROM "0" TO "1" IS STORED AS SDb
SP17
ADD A CONSANT TO THE TENPORARY REFERENCE VALUE SDd TO MAKE THE VALUE SDS
END

FIG. 33

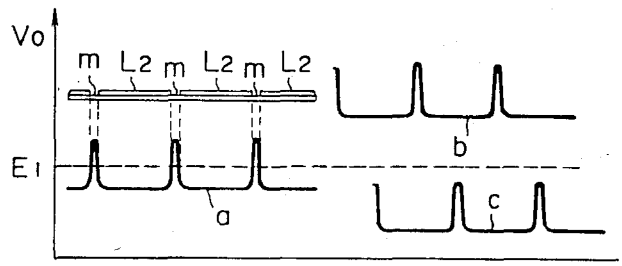


FIG. 34

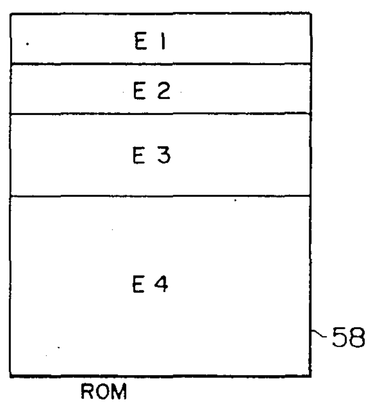


FIG. 36

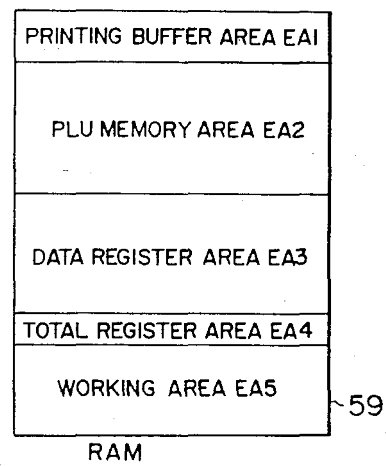


FIG. 37

NO. OF ITEM	UNIT PRICE	APPRECIATION PERIOD	— — — —	ITEM NAME FOR LABEL PRINTING	ITEM NAME FOR RECEIPT PRINTING
			— — — —		
			— — — —		
⋮	⋮	⋮	⋮	⋮	⋮
0152	550	3	— — — —	ROAST BEEF STEAK	ROAST BEEF
			— — — —		

100

EA2

FIG. 35(a)

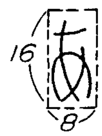


FIG. 35(b)

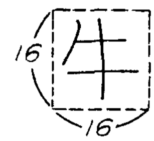


FIG. 35(c)

FIG. 38

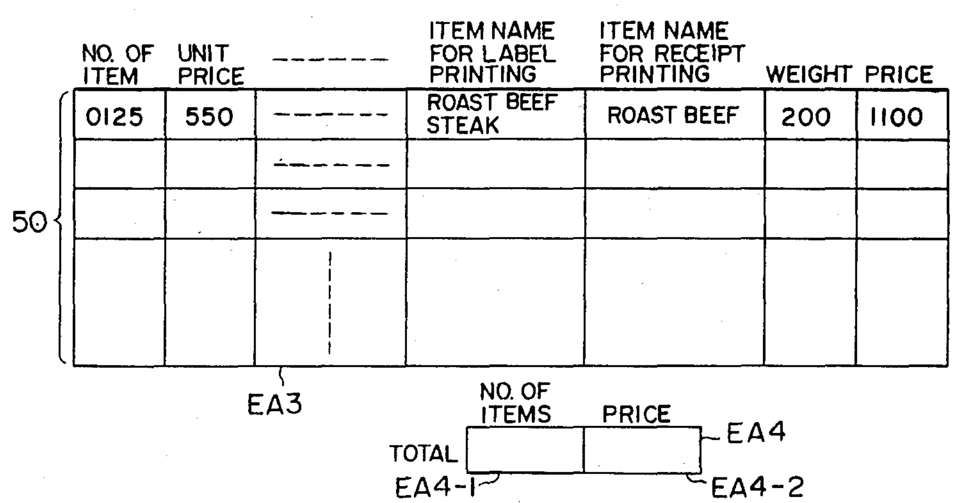


FIG. 39(a)

FIG. 39(b)

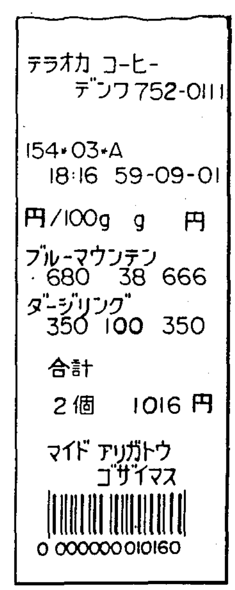
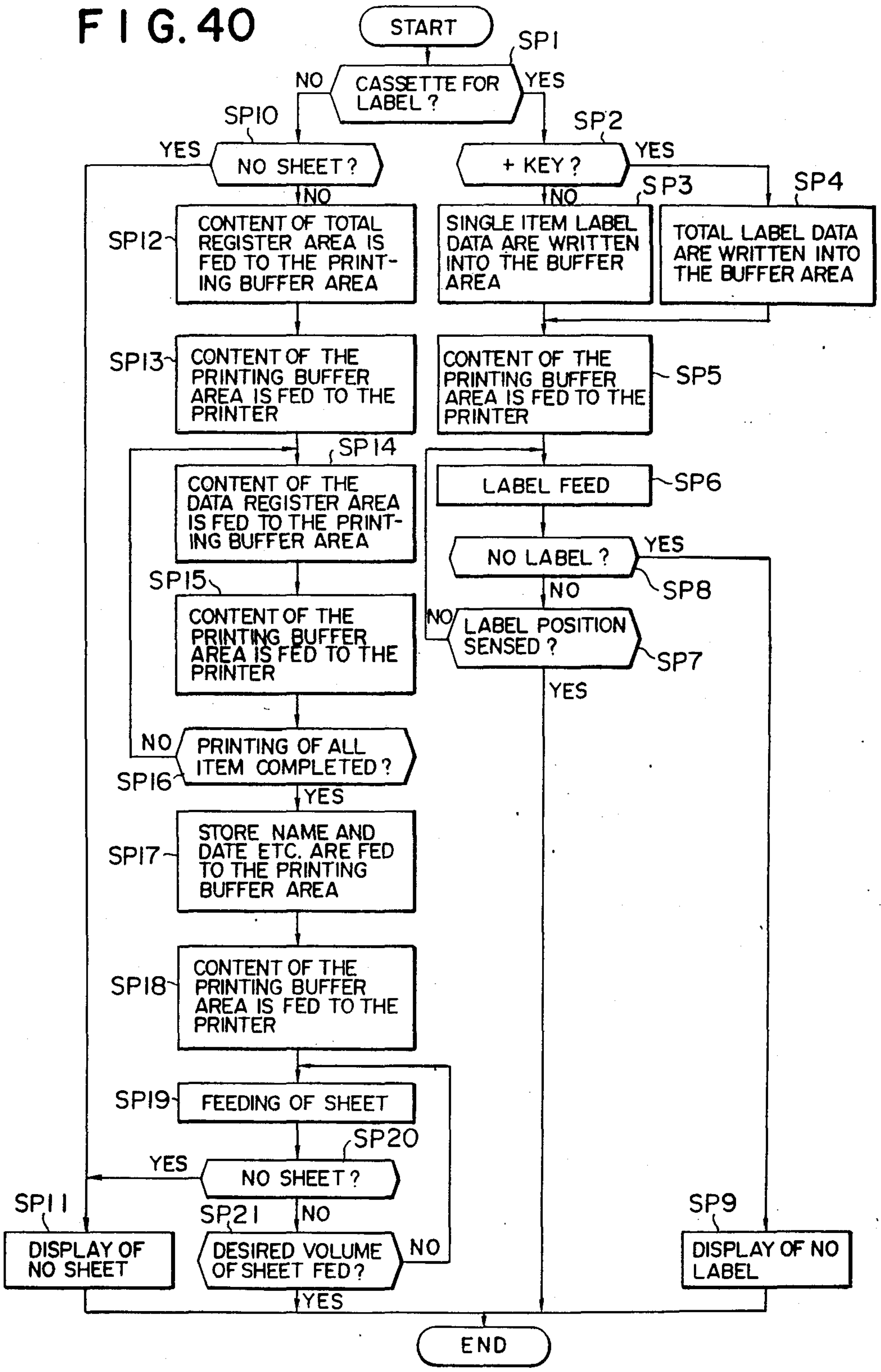


FIG. 40


START
SP1
CASSETTE FOR LABEL ?
NO
YES
SP10
NO SHEET ?
YES
NO
SP2
+ KEY ?
YES
NO
SP3
SP4
SP12
CONTENT OF TOTAL REGISTER AREA IS FED TO THE PRINTING BUFFER AREA
SINGLE ITEM LABEL DATA ARE WRITTEN INTO THE BUFFER AREA
TOTAL LABEL DATA ARE WRITTEN INTO THE BUFFER AREA
SP13
CONTENT OF THE PRINTING BUFFER AREA IS FED TO THE PRINTER
CONTENT OF THE PRINTING BUFFER AREA IS FED TO THE PRINTER
SP5
SP14
CONTENT OF THE DATA REGISTER AREA IS FED TO THE PRINTING BUFFER AREA
LABEL FEED
SP6
NO LABEL ?
YES
NO
SP8
SP15
CONTENT OF THE PRINTING BUFFER AREA IS FED TO THE PRINTER
NO
LABEL POSITION SENSED ?
SP7
YES
NO
PRINTING OF ALL ITEM COMPLETED ?
SP16
YES
SP17
STORE NAME AND DATE ETC. ARE FED TO THE PRINTING BUFFER AREA
SP18
CONTENT OF THE PRINTING BUFFER AREA IS FED TO THE PRINTER
SP19
FEEDING OF SHEET
SP20
YES
NO SHEET ?
SP11
SP21
NO
SP9
DISPLAY OF NO SHEET
DESIRED VOLUME OF SHEET FED ?
NO
DISPLAY OF NO LABEL
YES
END

ELECTRONIC SCALE PRINTER

This is a continuation of application Ser. No. 705,533 filed Feb. 26, 1985, U.S. Pat. No. 4,598,780.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an electronic scale printer, and more particularly a printer in which the printer is connected electrically to an electronic scale used in a department store or supermarket etc. and the desired data are printed in a printing sheet which is issued under an instruction from the electronic scale.

2. Description of the Prior Art

In the conventional type of an electronic scale printer used in a store such as supermarket, the unit has been applied for direct face-to-face selling between the customer and the store personnel and in one case that the receipt should be issued and in the other case that the label should be issued in accordance with the object of use of the unit.

However, the conventional type of the printer may be classified into two types: a label printer and a receipt printer for use in printing the desired printing mode on the desired printing sheet, that is, the weight of the article is weighed by an electronic scale, the price of the article is calculated in reference to the result of weighing and the unit price (price per unit weight), either one of the label or the receipt is issued in view of the result of calculation.

Although the two units have similar functions, a manufacturer should prepare two types of printers only due to the fact that they have different objects to be printed, resulting in that they are quite inefficient in their operation.

Also, the customer should replace the electronic scale itself or the printer causing an inconvenient practice when he desires to replace the receipt printer already in use with the label printer when, for example, the size of the store was expanded. Further, for example, when a daily totalization is to be performed with the label printer, a separate exclusive totalization printer should be connected or the roll of used label sheets should be removed upon completion of the daily work to replace it with the roll of receipt sheets and to print out the accumulated data, resulting in a troublesome operation. Resetting the roll of label sheets upon printing-out of the accumulated data caused an issuing of useless labels, resulting in an uneconomical practice.

Since the printer was quite thin in view of its function and design, it was hard to perform a replacement of a roll of printing sheets upon completion of the roll of the printing sheets. Therefore, if the roll was completely used during meeting with a consumer, the store personnel must keep the consumer waiting for the replacement of the roll.

A way of displaying in the label to be attached to an item packed is defined under a rule of the Food Sanitation Act or the Food Fair Competition Rule etc. and the character of item name to be printed on the label is defined more than the desired size. In turn, the character of item name to be printed on the receipt (usually Japanese KANA character) is quite small in a usual ECR (electronic register) due to complicated printing item data or a sheet width of the printing sheets to be used. Thus, in the above-mentioned printer are applied characters in reference to the size of the sheet width.

FIG. **39**(a) shows one example of a label and (b) illustrates one example of a receipt. As shown in the figure, the item name character **N1** in the label is substantially larger than the item name character **N2** in the receipt normally used, and therefore it is practically impossible to issue the receipt having the characters for a label or to issue the label having the characters for a receipt. In the conventional type of the printer, only one kind of item name was defined in correspondence with one item and thus it was impossible to issue both a label and a receipt.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a printer in which disadvantages of the prior art printer described above are eliminated and both labels and receipts can be issued with only one printing means, and more particularly an electronic scale printer in which a cassette storing a printing sheet for a label is properly replaced with a cassette storing a printing sheet for a receipt, whereby either a label or a receipt corresponding to the kind of printing sheet in the cassette is printed and then issued.

It is another object of the present invention to enable the item name characters to be printed under the same condition as that of the prior art label printer or receipt printer and to provide a practical electronic scale printer in which the item name code for label and the item name code for receipts are stored in response to each of the item names stored in the memory in advance, and in case of issuing a label where the cassette storing a label sheet is installed in the main body of the printer, the label is printed with the item name character pattern corresponding to the item name code for a label. In turn, in the case of issuing receipts where the cassette storing a receipt is installed, the receipt is printed with the item name character pattern corresponding to the item name code for a receipt.

A fundamental arrangement of the printer of the present invention described above is made in an electronic scale printer in which the main body of the printer is electrically connected to the electronic scale, the desired data are printed on the printing sheet under an instruction from the electronic scale which is then issued. The cassette for storing the printing sheet for label or receipt is provided. The main body of the printer is provided with a mounting part whereby the cassette is removably arranged. Also, each of the label printing control means and the receipt printing control means is provided as a printing control means, the above-mentioned control means can be selected in response to the kind of printing sheet stored in the installed cassette. A practical arrangement is constructed such that it may be provided with:

the first memory having the item name code for a label and the item name code for a receipt stored in correspondence with each of the items in advance,

the second memory having several kinds of character patterns:

control means for reading out the above-mentioned item name code for label in response to an issuing instruction, transforming the read item name code for label into the character pattern through said second memory and outputting it to a printing part when the cassette storing said label sheet is installed in said cassette installing part, and in turn when the cassette storing said receipt sheet is installed at said cassette installing part, said item name code for said receipt is read out in response to the issuing instruction, the read item name code for receipt is transformed into a character pattern through said second memory and then outputted, and

a printing part for printing said label sheet or receipt sheet.

The arrangement in which the replacement of the label sheet and the receipt sheet is performed under an installation of the cassette as described above has some mechanical and electrical problems to be solved in the sheet sensing means for detecting the position or presence or absence of the label or detecting the presence or absence of the receipt which are not reviewed in the conventional type of the label printer or receipt printer.

The mechanical and technical problems consist in the structure of the label position sensor.

In the conventional type of the label printer, as shown in FIG. **11**, a label position sensor **70** having a transparent type photoelectric sensor is applied. The sensor is constructed such that a light emitting element **71** and a light receiving element **72** are stored and arranged at one end of the substantial -shaped prism **73**. A label sheet L before printing is passed through a groove **74** formed at the other end of said prism **73**, thereby either the front end or rear end of the label L2 is detected and the printing position of the label is controlled.

In the case where the above-mentioned detector **70** is arranged at the cassette installing part of the main body of the printer of the present invention, if the cassette is slid along the installing part to perform its installation, the presence of the detector may hinder the installation of the cassette. Thus, if the cassette is fitted over the installing part, an insertion and arrangement of the detector **70** in the cassette may be theoretically possible under an arrangement of opening at the bottom part of the cassette. However, in this case, it is difficult to perform a positive insertion of the label sheet L in respect to the groove **74** having the width **1** to be set at a quite small value under consideration of attenuation of light and it is not practical process.

Thus, it is yet another object of the present invention to eliminate the above-mentioned techanical problems and to provide an electronic scale printer having a structure of a label position sensing part without any troubles in installing and operation of the cassette and showing a superior practical and operative characteristic.

It is optional that the above-mentioned label position sensor performs the function of detecting the presence or absence of the receipt when the receipt is to be issued.

The present invention which should accomplish the above-mentioned objects is characterized in that a sensing element composed of a light emitting element and a light receiving element is arranged at the cassette installing part of the main body of the printer in the above-mentioned fundamental or practical constitution, a sensing part, through which the printing sheet is passed before printing, is arranged at the position in said cassette where it faces against said sensing element, and the sensing part is provided with a reflection means for causing the light from said light emitting element to be crossed with a running passage of the printing sheet at one side thereof and then reflecting the light in such a direction as incidental to the light receiving element.

The electrical and technical problems found in the sheet sensing means are based upon the fact that the electronic scale printer of the present invention deals with both the label sheet and the receipt sheet and further the position, presence and absence of the label and the presence and absence of the receipt are detected by one sheet sensing means.

In order to clarify the technical problems more, one example of the receipt sheet and label sheet is shown in FIG. 7, wherein FIG. *7a* illustrates one example of the receipt sheet R in which a thermosensitive sheet having a desired width is wound as a roll, FIG. *7b* illustrates a part near terminal end of the label sheet L in which the thermosensitive labels L2, L2 . . . are adhered on the base sheet L1 and wound as a roll.

Between each of the labels L2 is formed a sensing slit m having a width of about 2 mm, and at the rear part of the final label L2 is also arranged a terminal end m' which has no label L adhered thereon.

When the label L2 is to be printed, it is necessary to confirm the position of each of the labels L2. The check of the position is usually performed by sensing the thickness of sheet due to the fact that the part of label L2 is overlapped on the base sheet L1 to make a double sheet and the part of the slit m is occupied by the base sheet L1 only.

For example, as a sheet sensing means the above-mentioned passing-through type photoelectric sensor is applied and the label sheet L is passed between the light emitting element and the light receiving element, resulting in that the amount of passing-through light is decreased at the part of the label L2 and the amount of passing light is increased at the slit m, thus it is possible to judge the position of the label L2. That is, since the output of the light receiving element becomes "Low" level when the label L2 is sensed and the output becomes "High" level when the slit m and the terminal end m' are detected, it is possible to judge the presence or absence of the label by assigning "0"/"1" signals to these levels.

In turn, when the receipt sheet R is passed through said photoelectric sensor, an amount of passing-through light is decreased when the receipt sheet R is present and in turn increased when the sheet is not present, so that the presence or absence of the receipt sheet R may also be judged by this operation.

However, in this case, since the thickness of the base sheet L1 and the receipt sheet L or an amount of passing-through light substantially coincide, it is difficult to detect the label position and to detect the receipt sheet by one photoelectric sensor.

FIG. **29** is a view for illustrating the reason for the above case. FIG. **29***a* illustrates a condition of either the label sheet L or the receipt sheet R. FIG. **29***b* illustrates the output of the photoelectric sensor when these sheets L and R pass through the photoelectric sensor. FIGS. **29***c* and **29***d* illustrate a level of a two-value signal detected when the slice level (a reference voltage of comparator: hereinafter called as a reference voltage) is defined as E1 and E2, respectively.

As is apparent from these figures, the output levels of the photoelectric sensor when the base sheet L1 and the receipt sheet R are present substantially coincide to each other (FIGS. **29***a* and **29***b*). When the label L2 is present, the value is decreased lower than the level when the base sheet L1 is present, and when the receipt sheet R is not present, it is increased more than the level when the base sheet L1 is present. Therefore, the output level of the photoelectric sensor becomes a low (when the label L2 is present), medium (when the base sheet

L1 or the receipt sheet R is present) and high (when the sheets R and L are not present) level, respectively. When the reference voltage is set to E1 under the presence or absence of label L2 so as to cause the signal level to be changed over to "0"/"1", the signal becomes "1" signal irrespective of the presence or absence of the receipt sheet R (FIG. **29***c*), and in turn when the reference voltage is set for example to E2 so as to cause the signal level to be changed over to "0"/"1" under the presence or absence of the receipt sheet R, the signal becomes "0" signal irrespective of the presence or absence of the label L2 in case of applying label sheet L (FIG. **29***d*). This results in that only either the position sensing of label L2 or the presence or absence of the receipt sheet R may be detected.

It is an object of the present invention to overcome the above-mentioned technical problems, by providing a printer in which the sensing of label sheet and the sensing of receipt sheet can be performed with one sheet sensing means (sensor) and improve a practical characteristic of the electronic scale printer in which the label sheet is replaced with the receipt sheet.

The present invention to accomplish the above-mentioned objects is characterized in that under the above-mentioned fundamental arrangement or practical constitution an output level of the sensor is varied in response to the condition whether the sheet installed in the main body of the printer is the label sheet or the receipt sheet or not.

Another electrical and technical problem found in the sheet sensing means consists in that there are several kinds of label sheets, thickness and rate of transparency are also versatile, so that the output level of the sheet sensing means (label position sensor) is varied in reference to the kind of label sheet.

FIG. **33** shows a wave-form illustrating this condition, wherein the wave-form shown by a symbol a is aligned in respect to the reference voltage E1, and in turn if the label L2 and the base sheet L1 are thin, its level is increased too much as shown by the wave-form b and if they are thick, it is decreased as shown by the wave-form c, so in both cases it is not possible to discriminate the label L2 from the slit m.

It is still another object of the present invention to overcome the above-mentioned technical problems and to provide an electronic scale printer in which the output level of the level position sensor (sensor) is automatically adjusted in response to the label sheet, the sensing of the label position may always be positively performed and a high accuracy is maintained.

The present invention to accomplish such objects as above has a change-over means for varying the output level of the sensor in a step-wise manner and a comparator for comparing the output signal from this sensor with the reference value under the above-mentioned fundamental arrangement or the practical constitution and has as its object to set the output level of the sensor in reference to the output of the comparator when the output level is varied in sequence.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view for illustrating an outer appearance construction of an electronic scale assembled with the printer of the present invention.

FIG. **2** is a top plan view of a main body of the printer with its substantial part being enlarged.

FIG. **3** is a side elevational view of FIG. **12**.

FIG. **4** is a perspective view for showing a cassette.

FIG. **5***a* is a sectional view for showing a receipt cassette.

FIG. **5***b* is a rear view of FIG. **5***a*.

FIG. **6***a* is a sectional view for showing a label cassette.

FIG. **6***b* is a rear view of FIG. **6***a*.

FIG. **7***a* is a perspective view for showing a receipt sheet.

FIG. **7***b* is a perspective view for showing a label sheet.

FIG. **8** is a sectional view for showing a fixing structure for a sensor **21**.

FIG. **9** is a sectional view for showing a modified form of the sensing part **21***a* of the sensor.

FIG. **10** is a sectional view for showing an adjusting means for a guide roller G_2.

FIG. **11** is a sectional view for showing the conventional type of structure of the sensor.

FIG. **12** is a sectional view for showing a modified form of means for sensing the kind of cassette.

FIG. **13** is a rear view of FIG. **12**.

FIGS. **14** and **15** are a front elevational view for showing one example of means for displaying the kind of printing sheet.

FIGS. **16** to **21** illustrate some modified forms of the main body of the printer.

FIG. **16** is a top plan view of an installing part.

FIG. **17** is a sectional view of FIG. **16** with a part being broken away.

FIG. **18** is a sectional top plan view of a cassette.

FIG. **19** is a longitudinal section of the cassette.

FIG. **20** is a sectional view in top plain for showing an installing part where the cassette is installed.

FIG. **21** is a side elevational view of FIG. **20** with a part being broken away.

FIG. **22** is a sectional view for showing a modified form of a platen roller and means for driving a take-up reel.

FIG. **23** is a block diagram for showing an electrical arrangement of the electronic scale.

FIG. **24** is a block diagram for showing an electrical arrangement of the main body of the printer.

FIG. **25** is a circuit diagram for showing in detail a thermal head of the main body of the printer and the driving circuit therefor.

FIG. **26** is a circuit diagram for showing the sensors S1 to S3 and their peripheral circuit arrangements.

FIG. **27** is a view for illustrating the operation of the output level adjusting circuit **62**.

FIG. **28***a* is a view for showing a condition of the label sheet and the receipt sheet.

FIG. **28***b* is a view for showing an output level of the sensor S3 when the output level is not adjusted.

FIG. **28***c* is a view for showing the output level of the sensor S3 after the output level is adjusted.

FIG. **28***d* is a view for showing the wave-form of a signal KS3 produced from the comparator **62**.

FIG. **29***a* is a view for showing a condition of the label sheet and the receipt sheet.

FIG. **29***b* is a view for showing an output wave-form of said sensor when each of the sheets is passed through a photoelectric sensor.

FIG. **29***c* is a wave-form when the output wave-form is sliced by the voltage E1 shown in FIG. **2***g*.

FIG. **29***d* is a wave-form when the output wave-form is sliced with the voltage E2 shown in FIG. **29***b*.

FIG. 30 is a view for showing an example of variation in level of the output voltage Vo of the sensor S3 when the value SD is modified.

FIG. 31 is a flow chart for illustrating an operation for adjusting the output level of the sensor S3 automatically in reference to a difference in thickness of label sheet.

FIG. 32*a* is a view for showing a condition of level of the output voltage Vo before an automatic level adjusting operation is performed.

FIG. 32*b* is a view for showing a condition of a level of the output voltage Vo after the automatic level adjusting operation is performed.

FIG. 33 is a view for showing a variation of the output level of the sensor S3 in reference to the thickness of the label sheet.

FIG. 34 is a view for showing an area arrangement of ROM58.

FIG. 35 is a view for showing one example of a character pattern.

FIG. 36 is a view for showing an area arrangement of RAM59.

FIG. 37 is a view for showing memory data of PLU memory area EA2 in FIG. 36.

FIG. 38 is a view for showing memory data in data register area EA3 and a total register area EA4.

FIG. 39*a* and FIG. 39*b* are a view for showing one example of a label and a receipt, respectively.

FIG. 40 is a flow chart for illustrating a printing control of an electronic scale.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is an outer appearance view for showing an electronic scale in which a printer of the present invention is integrally assembled, wherein **1** designates the main body of the printer, **3** designates a cassette installing part and **11** designates a weighing pan to which a weighing sensor (not shown) such as a load cell is connected to form a weighing part **51** (see FIG. 23).

Printer **1** includes element **12** which designates a displaying part for displaying various data such as weight, unit price and selling price etc. of the weighed item and element **13** which designates an operating part comprising preset keys **14**, ten keys **15** and function keys **16**. The preset keys **14** are keys for use in calling up preset data such as preset unit price for each of the items, the ten keys **15** are keys for use in inputting various numerical data and the function keys **16** are keys for use in correcting operation.

Element **4** denotes a cassette for storing receipt sheets R or label sheets L shown in FIG. 7 and the cassette is removably attached to the cassette installing part **3** of the main body **1** of the printer. For conveniences of description, the receipt cassette for storing the receipt sheet R is designated as **4***a*, the label cassette for storing the label sheet L as **4***b* and they are totally called cassette **4** as shown in FIGS. **5**(*a*), (*b*) and **6**(*a*), (*b*).

The receipt cassette **4***a* is formed with an opening of sheet issuing port **17** at one corner of a shallow box as shown in FIG. **5**, and a platen roller **5** for use in printing and feeding the sheet is arranged at the inside of the issuing port **17** and also a cutter **18** for use in cutting the receipt sheet having printing operation completed is arranged near the issuing port **17**.

As shown in FIG. **5**(*a*), the cassette **4***a* includes a set shaft **20** for supporting a roll R' having a receipt sheet R wound therein, and a sensing part **21***a* and a guide roller G1 arranged along a transporting direction of the receipt sheet arranged between the set shaft and the issuing port **17**. As shown in FIG. **4**, the plate on the upper surface of the cassette **4***a* is a cap plate **22** arranged to be opened or closed. Upon opening of this cap plate **22**, the roll R' is set on the set shaft **20**, the receipt sheet R is pulled out and then loaded so that the sheet may pass through the sensing part **21***a*, guide roller G1, platen roller **5** and the cutter **18** and finally through the issuing opening **17**.

The sensing part **21***a* cooperates with a sensing element part S3 arranged at the installing part **3** of the main body **1** of the printer so as to construct the sensor **21** and to detect the presence or absence of the receipt sheet R, and their details will be described in detail later.

The shaft **5***a* of the platen roller **5** is projected downward of the cassette **4***a* and is provided with a gear (not shown) to be engaged with a power transmitting gear **25** of the installing part **3**.

The label cassette **4***b* is applied for storing a label sheet L in a shallow box as shown in FIG. **6**, and within the cassette **4***b* is arranged a label peeling-off dispensor **19** in place of the cutter **18** of the above-mentioned cassette **4***a*. Label cassette **4***b* includes a take-up reel **6** for winding up the base sheet L1 having the label peeled off and an adjusting guide roller G2 capable of being moved along an elongated hole **29** and fixed at any position.

Within the cassette **4***b* is also arranged a sensing part **21***a* having the same structure as that of the sensing part **21***a* for the cassette **4***a*, and the presence or absence of the label L2 and the position of the label are detected by this sensing part **21***a* and the sensing element part S3 (their details will be described later).

In the case where the label L2 having a different length is to be applied, the guide roller G2 is moved along the elongated hole **29**, thereby the distance from the sensing part **21***a* to the platen roller **5** can be varied in response to the length of the label roll.

The shaft **5***a* of the platen roller **5** is projected out of the cassette **4***b* and is provided with a gear (not shown) to be engaged with the gear **28** for use in transmitting power from the installing part **3**. Similarly, the shaft **6***a* of the take-up reel **6** is projected out of the cassette **4***b* and is provided with a rubber wheel (not shown) to be press contacted with a friction wheel **30** of the installing part **3**.

FIGS. **2** and **3** illustrate an installing part **3** for installing the cassette **4**. When the cassette **4** is installed at the installing part **3**, the thermal head **2** is arranged at a position corresponding to the platen roller **5** and arranged such that it may be rotated around the fulcrum shaft **2***a* by a certain amount. The thermal head **2** is of a structure in which it may be pushed against the platen roller **5** with the desired printing pressure under an action of spring (not shown) etc.

Below the installing part **3** is arranged a stepping motor M and the motor shaft Ma is projected out of the upper surface of the installing part **3** and then is provided with a gear **25** and the friction wheel **30**. The gear **25** is engaged with a gear of the platen roller **5** when the gears **26**, **27** and **28** are engaged and the cassette **4***b* is installed and then the platen roller **5** may be rotated by the desired number of rotations. The friction wheel **30** is abutted against the rubber wheel of the cassette **4***b* to cause the take-up reel **6** to be rotated and to take-up the base sheet.

In the case of the receipt cassette **4**a, the platen roller **5** is driven only with a gear **28**.

The installing part **3** of the main body **1** of the printer is provided with a sensing element part S3 which is positioned opposite from the sensing part **21**a of the cassette when the the cassette **4** is installed.

The sensing element part S3 is composed of a light emitting element **23** and a light receiving element **24**, the light emitting element **23** and the light receiving element **24** being composed of a semiconductor element, respectively, and the former being composed of a light emitting diode and the latter being formed of a phototransistor. They are arranged in parallel and buried in the bottom wall and connected to a control unit (not shown) for controlling the driving of the stepping motor M.

The sensing part **21**a of the cassette **4** which constitutes the sensor **21** along with the sensing element part S3 will be described in detail in reference to FIGS. **8** to **10**.

The sensing part **21**a is provided with a pair of raised walls **34** and **35** as shown in FIGS. **8** and **9**, which are raised from the bottom wall **33** of the cassette **4**. The raised walls **34** and **35** are bent at an angle 45° in a direction crossing each other, and the label sheet L or the receipt sheet R (for the sake of convenience of description, the label sheet will be described) will pass through between these raised walls **34** and **35**. To the upper end of one of the raised walls **34** and **35**, for example, the raised wall **35** is connected a vertical raised guide wall **36** integrally, and the label base sheet L1 is guided by this guide wall **36**.

Within the sensing part **21**a is arranged a reflecting means for reflecting a light from the light emitting element **23** across the passing path of the label sheet L at one side thereof and in a direction incident to the light receiving element **24**. The reflecting means is composed of a prism having a shape to be fitted in the sensing part **21**a. The prism **37** is provided with a groove **38** for passing the label sheet L at its intermediate part, its lower end is fitted to the opening hole **39** of the bottom wall **33** of the cassette and is flush with the outer surface of the bottom wall **33**.

The sensing part **21**a is operated such that when the cassette **4** is installed in the main body **1** of the printer during its use, one label L2 subsequent to the proceeding label L2 positioned at the printing part (between the platen roller **5** and the thermal head **2**) is positioned in the sensing part **21**a. A light from the light emitting element **23** is reflected against a reflection means in the sensing part **21**a, i.e. a prism **37** and incident on the light receiving element **24**. After crossing the passing path of the label L2, the intensity of light incident on the light receiving element **24** varies in response to the presence or absence of the label L2, thereby either the front end or rear end of the label L2 is detected and the sensing of the label position is performed. The sensing sensitivity can be improved by a method wherein the opposed surface of the prism **37** facing both sides of the groove **38** acting as the passing path of the label L2 is made narrow. That is, a narrow width of the opposed surfaces may cause a converged part therein to enable the intensity of light to be increased.

The above-mentioned light reflecting means is not limited to the prism **37** above, but, for example, as shown in FIG. **9**, it may be constructed such that the inner surfaces of the bent parts **34**a and **35**a of the raised walls **34** and **35** in the sensing part **21**a are of a mirror surface.

In turn, if a displacement of the printing position of the label L2 is detected by sensing the position of the label, the printing position of the label L2 is modified. In order to modify the printing position, the number of steps of the stepping motor M for driving the platen roller **5** is varied or the length of the passing path of the lavel **1** is elongated or shortened by displacing the guide roller G2 as described above, and so in the present preferred embodiment, the latter means is employed as described above. Detailed illustration of the guide roller G2 is given with respect to FIG. **10**, wherein the guide roller G2 has its fulcrum shaft **45** slidably fitted in the elongated hole **29** in the cassette bottom wall **33** and engaged in the bottom wall **33** through screw **40** and washer **41**.

In FIG. **10**, the unit is constructed such that the kind of label L2 being used at present can be recognized by detecting the position of the guide roller G2.

That is, the bottom wall **33** of the installing part **3** of the main body **1** of the printer below the elongated hole **29** is provided with the number of sensing elements corresponding to the kind of label L2, for example, if the length of the label has three kinds, three sensing elements **42**, **43** and **44** are arranged. These sensing elements **42**, **43** and **44** are applied to detect the screw **40** for the guide roller G2, the sensing element being of a reflection type sensor, a microswitch and a magnetic switch such as hole element etc., and the elements are connected to a display means (not shown) and the result of sensing operation is displayed in the display means.

In the case where a magnetic switch is applied as the elements **42**, **43** and **44**, the screw **40** for the guide roller G2 is made as a magnet.

In the above description concerning the sensor **21**, the sensing of label position has been described, wherein the label sheet L or the receipt sheet R is sensed for its presence or absence and the completion of these sheets is sensed.

As found in the above-mentioned preferred embodiment, the sensor **21** is divided into the sensing part **21**a and the sensing element part S3, the sensing part **21**a is arranged in the cassette **4**, the sensing element part S3 is arranged at the installing part **3** of the main body **1** of the printer, and when the label sheet L or the receipt sheet R is installed at the cassette **4**, the sheet L or R is passed through the sensing part **21**a, so that mere installation of the cassette **4** enables the sheet L or R to be set in the sensor **21**. Therefore, the unit may provide effective attachment or removal of the cassette **4** as well as its replacement and also no projecting member of the cassette **4** may provide such an effect as the installing direction of the cassette is not restricted.

Sensing means for sensing if the printing sheet loaded in the cassette **4** is a label sheet or receipt sheet will be described.

This sensing means is operated such that the sensor S1 is arranged in advance at the installing part **3** of the main body **1** of the printer, the kind of the cassette **4** is detected by the sensor and thereby the sheet is judged if it is the label sheet L or the receipt sheet R. For this reason, the cassette **4**a and the cassette **4**b are provided with different marks, e.g. openings therein. In the preferred embodiment, a hole **46** is made at the rear surface of the label cassette **4**b and the receipt cassette **4**a is not provided with any openings (see FIGS. **6** and **5**).

The above-mentioned sensor S1 is of a reflection type sensor which is installed at the abutting portion 3' of the installing part 3 to detect the presence or absence of the hole 46 when the cassette 4 is installed and judges if the cassette is the label cassette 4*b* or the receipt cassette 4*a* by the presence or absence of the hole.

If the cassette 4*b* is detected, the printing sheet is a label sheet L and in turn if the cassette 4*a* is detected, the loading of the receipt sheet R in the main body 1 of the printer is electrically detected.

The sensor S2 provided in the installing part 3 senses if the cassette 4 is positively installed in the installing part 3 or not (FIGS. 2 and 3).

Thus, when the cassette 4 is inserted at the side opening of the installing part 3 and up to the abutting position of the installing part 3, it may be fixed by a leaf spring (not shown). The thermal head 2 is abutted against the platen roller 5 and pressed with a desired pressure and at the same time it may be engaged with the driving gear 28 of the platen roller 5 and the driving rubber wheel of the take-up reel 6 is abutted against the friction wheel 30. The sensor S2 detects if the cassette 4 is positively installed or not and the sensor S1 recognizes the kind of printing sheet in the cassette 4.

In the preferred embodiment of the present invention, since the two kinds of printing sheets, i.e. a label sheet and a receipt sheet are applied, the kind of the sheet can be detected by the presence or absence of the hole 46, and if there are more than three kinds of printing sheets to be sensed, two holes 46 are made and a combination of the presence or absence of each of the holes may detect the kind of sheet.

That is, the kind of the printing sheet is defined for each of the combinations of hole:hole, hole:non-hole, non-hole:hole, non-hole:non-hole etc.

In case of the sensing means applied with an opening 46 made in the cassette 4, a compatibility of the cassette is not assured.

Thus, as shown in FIGS. 12 and 13, a sliding plate 47 is arranged at the hole 46 of the cassette 4 to open and close the hole 46, resulting in that a compatibility of the cassette can be improved and no trouble is found in storing of the receipt sheet R in the label cassette 4*b* and in storing of the label sheet L in the receipt receipt cassette 4*b*.

Some modified forms of means for detecting the kind of sheet are as follows:

(1) Sensing is performed by the presence of absence of the projection by arranging it in place of the hole 46;

(2) Arranging a reflection plate in place of the hole 46, arranging the light emitting and light receiving sensors at the installing part and the detecting operation is performed by the presence or absence of the reflection plate;

(3) A bar code label having storing content printed on it is adhered on the surface of the cassette and at the same time a scanner is arranged at the installing part to detect the bar code; the sensing not by the casseete but by the direct sensing of the sheet may also be available;

(4) The light transmitting type sensors are arranged to hold the sheet therebetween which is pulled out of the roll in the cassette, the desired amount of sheet is fed when the cassette is installed, the sheet is sensed by a variation in output in the sensor if the sheet is for a label or a receipt and at the same time the kind of printing sheet is detected in reference to the rate of light transmittance.

The kind of the printing sheet in the cassette 4 sensed in this way is displayed as shown in FIGS. 14 and 15 by indicating the kind by an arrow or illuminating it. The display is not limited to the display part 12, but it may be arranged at a place where it may easily be seen or it may be indicated by sound.

Some modified froms of driving means for the above-mentioned platen roller 5 and the take-up reel 6 are illustrated in FIGS. 16 to 22 and for the sake of convenience of description, the same component elements as that of the above-mentioned members are designated by the similar reference symbols and their description will be eliminated.

FIGS. 16 to 21 illustrate a system in which the platen roller 5 is driven and the take-up reel 6 is driven by power from the platen roller 5.

In the figures, the installing part 3 has a stepping motor M' below it, a shaft Ma' of the motor M' is projected out of the upper surface of the installing part 3, a gear 8 for use in transmitting power is mounted and at the same time a gear 9 is engaged with the gear 8. A shaft 9*a* of the gear 9 is slidably installed in an arcular groove 10 around the motor shaft Ma' and biased in one direction by a spring (not shown).

The cassette 4*b* is constructed such that the shaft 5*a* of the platen roller 5 is projected out of the cassette, a pulley 48 and a gear 49 are coaxially attached to the shaft 5*a* and at the same time the shaft 6*a* of the take-up reel 6 is similarly projected out of the cassette, a pulley 48' is fixed to the shaft 6*a*, a rubber belt 50 is wound around both pulleys 48 and 48' so as to transmit power from the shaft 5*a* to the shaft 6*a*.

The gear 49 is engaged with the gear 9 at the installing part 3 to accept the power from the stepping motor M'.

The cassette 4*b* is slid and installed at the side opening in the installing part 3. In case that the gear 49 of the cassette 4*b* is not engaged with the gear 9 of the installing part 3, the gear 9 is moved along the arcualar groove 10 while being rotated around the outer circumference of the gear 8, so that the installation of the cassette 4*b* causes the gear 9 to be engaged with the gear 49. Since the direction of escaping of the gear 9 is opposite to the rotational direction of the motor M', the rotation of the motor M' causes the gear 9 to be pressed against the gear 49, resulting in that a positive transmitting of power force can be assured.

The preferred embodiment of the present invention is constructed such that the platen roller 5 is driven, so that the printing can be performed by feeding the printing sheet even in case that the take-up reel is required and also in case that the take-up reel is not required.

If the cutter required for the receipt sheet and the dispenser required for the label sheet are arranged at the main body 1 of the printer or the cassette 4, the cassette may be of the same construction, the cost is not expensive and it is possible to provide a quite convenient product.

FIG. 22 illustrates a structure in which a driving source is connected to each of the platen roller 5 and the take-up reel 6. The stepping motor M1 and the DC motor M2 are mounted in the main body 1 of the printer, and the gears 28' and 30' are rotatably driven by and attached to the shafts M1' and M2' of the motors M1 and M2.

In the figure, a gear 31 engaging with the gear 28' is mounted on the shaft 5*a* of the platen roller 5 of the cassette **4***b*, and a gear **32** engaging with the gear **30'** is mounted on the shaft **6***a* of the take-up reel **6**.

Then, an electrical arrangement of an electronic scale having the main body **1** of the present invention will be described in reference to FIGS. **23** to **26**.

In FIG. **23**, each of the weighing part **51**, the main body **1** of the printer, operating part **13** and the display part **12** having the above-mentioned constitution is connected to a bus **56** and CPU **57** through interface circuits **52**, **53**, **54** and **55**.

Element **58** in the figure denotes ROM (read-only-memory) for storing programs and element **59** designates RAM (random-access-memory) to be applied in various calculations.

The main body **1** of the printer is, as shown in FIG. **24**, composed of the following component elements:

(1) the thermal head **2** and the head driving circuit **60** for driving the thermal head:

(2) stepping motor M and a motor driving circuit **61** for controlling its driving:

(3) sensors S1 and S2 for discriminating the receipt cassette **4***a* and the label cassette **40**:

(4) sensor S3 for checking the receipt sheet R or the label sheet L and sensing their presence or absence and label position, and an output level adjusting circuit **62** and D/A (digital/analogue) convertor circuit **63**:

The thermal head **2** and its driving circuit **60** described in the above item (1) of the component elements are illustrated in detail in FIG. **25**, wherein the thermal head **2** is composed of the heating resistors rl to rn of 128 dots, the shift registor **64** is comprised of a dot pattern corresponding to one line, the printer interface circuit **53** generates in reference to the control data fed from the CPU **57** a printing instruction signal DP to the driving circuit **60**, a clock pulse CP for shifting the printing data to the shift register **64** and the printing data (serial dot data), respectively.

The fundamental circuits for the sensor S3, output level adjusting circuit **62** and D/A convertor circuit **63** of the above-mentioned component element (4) are illustrated in FIG. **26**. (In this figure, the sensor S1 and S2 are also shown in addition to these elements).

In FIG. **26**, D/A convertor circuit **63** is applied for converting SD0 to SD3 of four-bit signals fed from the printer interface circuit **53** to the analogue signal SA, and is composed of an adder circuit mainly having a calculation amplifier (hereinafter called as OP amp) OP1. To the resistors R0 to R3 for adder are applied the signals SD0 to SD3 through the voltage followers VF0 to VF3. The values of resistors R0 to R3 are, for example, weighted by 8K, 4K, 2K and 1KΩ, correspond to sixteen SD values defined by four bit signals SD0 to SD3 and thus the analogue signal SA of sixteen levels can be outputted. In this figure, the resistor Rf is a resistor for use in feeding-back operation, the resister Rc is a resistor for accommodation and the resistor Rp is a resistor for pull-up operation.

Then, the output level adjusting circuit **62** is composed of the transistor Q1 and an equivalent resistance between the collector and emitter of the transistor Q1 is varied. The collector of the transistor Q1 is connected to the emitter of the light receiving element (phototransistor) of the sensor S3, and this connecting point is connected to the inverted input terminal of the comparator **65**. As a result, the voltage at the inverted input terminal of the comparator **65**, i.e. the output voltage Vo of the sensor S3 is, as shown in FIG. **27**, determined by a ratio between an equivalent resistor Ra of the light receiving element **24** and the equivalent resistance Rb between the collector of the transistor Q1 and the ground (this value is a sum of an equivalent resistance value between the collector and the emitter of the transistor Q1 and the resistance value of the resistor Re between the emitter and the ground). That is, if the resistance Rb is constant, light receiving amount of the light receiving element **24** is increased, as the resistance Ra is decreased, the output voltage Vo is increased, and if the light receiving amount of the light receiving element **24** is constant (at this time, the resistance value Ra is constant), the more the resistance Rb, the more the output voltage Vo.

In the present invention, when the label sheet L is used, the amount of light received is decreased, so that the resistance value Rb is increased to raise up the level of the output voltage Vo, and in turn when the receipt sheet R is used, the amount of light received is increased and so the resistance value Rb is decreased and the level of the output voltage Vo is decreased. For example, in case of applying the label sheet L, all the signals SD0 to SD3 are applied as "1" signal, and the output signal SA of the D/A convertor circuit **63** is decreased (since the OP amp OP1 forms an inverted adder, the more the values of SD0 to SD3, the less the output SA), thereby the resistance value Ro is increased. When the receipt sheet R is used, all the signals SD0 to SD3 are set to "0" signal to increase the signal SA and then the resistance value Ra is decreased. In this way, the level of the output voltage Vo is adjusted approximately constant (see FIG. **28**(*c*)) and approaches to the upper and lower values of the reference voltages Es fed to the non-inverted input terminal of the comparator **65**. Then, the comparator **65** produces the signal KS3 which becomes "High" level ("1" signal) when a relation of $Vo<Es$ is found and in turn becomes "Low" level ("0" signal) when a relation of $Vo>Es$ is found (see FIG. **28**(*d*)).

The outputs from the sensors S1 and S2 are inverted by the invertors **56** and **57** to become the signals KS1 and KS2. As a result, the signals KS1 and KS2 become "1" signal ("High" level) when the light receiving elements of the sensors S1 and S2 accept the light, and in turn become "0" signal when they do not accept the light.

Then, the operation of the preferred embodiment of the prresent invention will be described.

At first, when the cassette **4** is installed in the installing part **3**, the cassette is judged if it is a receipt cassette **4***a* or a label cassette **4***b*. That is, if it is a receipt cassette **4***a*, the light receiving elements of the sensors S1 and S2 receive the light, the signals KS1 and KS2 become a "1" signal and if it is a label cassette **4***b*, only the sensor S1 receives the light, the signal KS1 becomes a "1" and the signal KS2 becomes a "0" signal. When these signals KS1 and KS2 are supplied to CPU57 through the printer interface circuit **53** and the bus **56**, CPU57 discriminates the cassette **4**, and sets all the signals SD0 to SD3 to "0" signal when it is a receipt cassette **4***a*, and sets all the signals SD0 to SD3 to "1" signal when it is a label cassette **4***b*. With this arrangement, as described above, when the cassette is a receipt sheet R cassette, the output level of the sensor S3 is decreased and if it is a label sheet L cassette, the above-mentioned output level is increased and it is adjusted such that both levels are subtantially equal. That is, in case of no output level adjusting circuit **62**, the output of the sensor S3 kept at the level shown in FIG. **28***b* is transferred to the level shown in FIG. **28***c* by the output level adjusting circuit **62** in correspondence with the label sheet **1** and the receipt sheet R shown in FIG. **28***a*, the "High" level of the output voltage Vo of the sensor S3 becomes sufficiently higher than the reference voltage Es and the "Low" level becomes sufficiently lower than the reference voltage Es. As a result, the signal KS3 becomes "1" signal when the label L2 is detected in case of the label sheet L and becomes a "0" signal when the base sheet L1 (i.e. slit m and terminal end m') is detected, and in turn in case of the receipt sheet R, it becomes a "1"/"0" signal in response to the presence/absence of the receipt sheet R. In this way, it is possible to detect the presence or absence of and the position of the label L2 and the presence or absence of the receipt sheet R by the sensor S3.

Returning now to FIG. **26**, the resistance value Rb is increased as the level of the analogue signal SA is decreased, and the level of the signal SA is decreased as the value SDs of the signals SD0 to SD3 are increased, so that these relations are as follows:

SD ↓→SA ↓→RB ↑→Vo ↑

in turn,

SD ↓→SA ↑→Rb ↓→Vo ↓

When the thick label sheet L is used under a condition that the installation of the label cassette **4***b* is confirmed by the sensors S1 and S2, the value SD is increased to raise the output voltage Vo and in turn when the thin label sheet L is used, the value SD is decreased and the output voltage Vo is decreased and these voltages Vo are oscillated between the values over and below the reference voltage Es (see FIG. **32***b*). If the output voltage Vo is adjusted as above, the output signal KS3 of the comparator **65** becomes "High" level ("1" signal) when a relation of Vo<Es is found and in turn it becomes "Low" level ("0" signal) when a relation of Vo>Es is found.

Therefore, when the cassette **4***b* is installed at the installing part 3, the CPU57 judges that this cassette is a label cassette at first in reference to the signals KS1 and KS2, and then automatically adjusts the value SD of the signals SD0 to SD3 in response to the thickness of the label sheet L so that the output voltage Vo of the sensor S3 is oscillated between the values of over and below the reference voltage Es when the base sheet L1/label L2 is detected.

FIG. **30** is a view for showing how the level of the output voltage Vo is varied and illustrates each of the cases, i.e. (i) the sensor S3 has no sheet at its sensing point, (ii) the label L2 is found, (iii) the base sheet L1, i.e. either the slit m or the terminal end m' is found, (iv) item completely shield the light, respectively.

As apparent from this figure, if the value SD is set to a proper value, a relation between the output voltage Vo and the reference voltage Es can be defined as Vo<Es when the label L2 is found, and in turn as Vo>Es when the base sheet L1 is found. For example, in case of this arrangement shown in this figure, if the value SD equals to 6, the relation can be assured. The CPU57 may perform the following process in order to set the value SD as above.

(1) The value SD is decreased in sequence from 15, 14, 13 . . . and the value when the signal KS3 is changed from "0" to "1" signal, i.e. the initial value SD showing a relation of Vo<Es is stored as the value SDa (flow chart in FIG. **31**, the steps SP1 to SP2). In this case, the sensing point of the sensor S3 has a label L2 or base sheet L1, so that SD=8 (in case of label L2) or SD=3 (in case of base sheet L1) in FIG. **30** is stored as SDa under the above-mentioned process.

(2) Then, the label sheet L is fed by the desired length (more than the width of the slit m), the label L2 comes to the sensing point when the slit m is placed at the sensing point, the same process as that of the step (1) is performed and the initial value SD having a relation of Vo<Es is stored as SDb (steps SP3 to SP5). Also, in this case, for example, the above-mentioned value SD=8 or SD=3 is set as the value SDb in response to a condition whether the label L2 is positioned at the sensing point or the base sheet L1 is positioned at the sensing point.

(3) The value SDa and the value SDb are compared and the higher value is set as a temporary reference value SDc (steps SP6 to SP8). Thereby, the value in case of label L2 becomes a temporary reference value SDc. For example, SDc equals to 8 in case of that shown in FIG. **30**. In case that the terminal end m' of the label sheet L is initially positioned at the sensing point, the value found in case of the label L1 becomes a temporary reference value SDc, and in this case an error is detected in the step SP12 described later.

(4) Then, CPU57 rotates the platen roller **5** in step-by-step and feeds the label L to find the slit m. That is, the number of steps for one label L2 is initially set in a counter in the CPU57 (step SP9), the label sheet L is fed by one step while the value in this counter is decremented (steps SP10 to SP11) to search the point where the signal KS3 is changed from "1" signal to "0" signal and to detect the slit m (step SP13). In this case, if the signal KS3 is not varied even if the value in the counter becoems 0, it is judged that the terminal end m' is sensed, the process is transferred from the step SP12 to the step SP14 to perform an error processing such as producing alarm output.

(5) Thus if the presence of the slit m is confirmed, the value SD is decreased again in sequence from 15, 14, 13 . . . and the value SD when the signal KS3 is changed from "0" to "1" is stored as a new temporary value SDd (steps SP15 to SP16). This process is performed in order that the level adjustment is performed again at the slit m having no printed matter due to the fact that the printed names such as store name or frame are printed in advance at the label L12 and the temporary reference value SDc set at the label L2 is not stable. In this way, if the value SD is set as SDd (in the above example, SDd equals to 3) which is found when the signal KS3 at the slit m is varied from "0" to "1", i.e. the output voltage Vo is varied from a relation of Vo>Es to a relation of Vo<Es, a constant n (for example, 3) is added to the value SDd and this constant becomes a reference value SDs. In the above example, a relation of SDs=3+3=6 is attained.

In this way, the level of the output voltage Vo of the sensor S3 is automatically adjusted in response to the thickness of the label sheet L and the level of Vo is adjusted in such a way as it may show substantially a constant value. That is, in the case where the output level adjusting circuit **62** is not present, as shown in FIG. **32***a*, the level of output voltage Vo which is varied in response to the thickness of the label sheet L is changed to the level shown in FIG. **32***b* after adjustment of level, "High" level of the output voltage Vo becomes sufficiently higher than the reference voltage Es and "Low" level becomes sufficiently lower than the value Es. As a result, the signal KS3 is positively changed over to "1"/"0" in response to the presence or absence of the label L2 and a positive sensing can always be performed.

Thus, when the value SD is set at the proper value SDs, similar operation is performed in the same manner as that of the conventional system, the printing and issuing of the label 4 are performed.

In the above description, the level adjustment is performed when the cassette is installed, and the level adjustment may also be performed after the key operation at the operating part, for example, the feed key in the function key is performed. With this arrangement, it is possible to prevent the label from being uselessly applied under a level adjustment for every installation of cassette.

Then, ROM **58** and RAM **59** in a block diagram of FIG. **23** will be described in detail.

ROM **58** has areas E1 to E4 as shown in FIG. **34**, each of the areas E1 to E3 has a label printing program, a receipt printing program and a control program stored therein, and the area E4 has various characters (numbers, symbols etc. are contained) and patterns (dot-patterns) stored therein. FIGS. **35**(*a*) to (*c*) illustrate one example of character pattern, and the area E4 has Japanese kana characters (46 characters) of 16×8 dots configuration shown in FIG. **35**(*a*), numbers (ten characters) of 16×8 dots configuration, Japanese kana characters (46 characters) of 16×8 dots configuration. Chinese characters (100 characters) of 16×16 dots configuration shown in FIG. **35**(*b*), Japanese kana characters (46 characters) of 7×5 dots configuration shown in FIG. **35**(*c*) and numbers (ten characters) of 7×5 dots configuration and various character patterns. In this case, the character patterns of 16×8 dots and 16×16 dots are mainly applied for a label printing operation and the character pattern of 7×5 dots configuration is mainly for a receipt printing operation. Each of the character patterns is assigned with each of the character codes, and each of the character patterns is read out in reference to the character code. RAM **59** is provided with a buffer area **EA1** PLU (Price Look Up) memory area EA2, data register area EA3 and a total register area **EA4** as shown in FIG. **36**, respectively, and at the same time a working area **EA5** is arranged in it. In this case, the printing buffer area **EA1** is an area where character pattern to be printed on the label or receipt is written and this area has a capacity corresponding to the printing section of the maximum label. PLU memory area EA2 is an area where item number, unit price and appreciation period of each of the products and item name for label printing and item name for receipt printing are set, respectively and area for storing 100 items is kept. In this case, the item name to be printed is stored by a character code for each of the characters in the item name column for a label printing and the item name column for a receipt printing, respectively. For example, if the item name for the label printing for the item number "0152" is "roast beef steak" and the item name for the receipt printing is "roast beef", the character codes of Chinese character "ushi (beef)" of 16×16 dots, Japanese kana "ロ", "–" and "ス" of 16×8 dots are stored in sequence. In turn, in the item name column for the receipt printing are stored in sequence each of the character codes of the Japanese kana "ﾛ", "ｰ", "ｽ" of 7×5 dots. The writing in the PLU memory area EA2 is performed by, for example, a host computer or a key operation at the operating part **13**.

The data register area EA3 is an area in which data concerning the product purchased by a consumer and as shown in data of 50 items can be written. The total register area **EA4** has, as shown in FIG. **38**, an area **EA4-1** and an area **EA4-2** where the number of items and total price of the items purchased by a consumer are written.

The input operation for the above-mentioned RAM **59** will be described in reference to an example of a face-to-face selling.

The face-to-face selling used herein is a selling process in which sales personnel moves along with the consumer while the consumer moves in a selling spot, the sales personnel utilizes a near-by electronic scale everytime the consumer purchases the product and issues a label indicating a price, adhering the label on the package of the product (at this time, money is not exchanged) and lastly the product is checked at the checkout counter to receive the money.

(1) In case that the label cassette **4***b* is utilized:

In this case, the sales personnel sets the label cassette **4***b* at the installing part **3** of the main body **1** of the printer and then a correct installation of the cassette is confirmed by the display lamp **80** of the display part **12**. The label cassette **4***b* sensed by the sensor **S1** is written into the working area **EA5** of RAM **59** through CPU57 for its cassette data. Then, the sales personnel mounts the product on the weighing pan **11** and inputs the item number of the product through the operating part **13**. When the product is mounted on the weighing pan **11**, the weight data WD corresponding to the weight of the product are outputted from the weighing part **51** (FIG. **23**). When the item number is inputted, CPU57 reads out from the PLU data area EA2 of RAM **59** shown in FIG. **37** PLU data corresponding to the inputted item number (i.e. unit price, appreciation period, label printing item name and receipt printing item name), then transmits them to the working area EA5 and transfers the weight data WD to the working area EA5. Then, the CPU57 calculates the price of the product in reference to the weight data WD and the unit price data in the working area EA5 and stores the calculated price data in the working area EA5. Then, the CPU57 outputs the weight data WD, unit price data and price data in the working area EA5 to the display part **12**. Thereby, each of the above-mentioned data is displayed in the display part **12** (FIG. **1**).

In case a single item label (one item label) is to be issued, the sales personnel depresses the print key **81** at the operating part **13**. In turn, in case that a total label (label having a total price of several items printed thereon) is to be issued, the sales personnel depresses the plus key **82** at the operating part **13**. When this plus key **82** is depressed, each of the PLU data, weight data WD and price data in the working area **EA5** is transferred to the data register area EA3 (FIG. **38**) of RAM **59**, the data in the area **EA4-1** (initially reset) of total register area (FIG. **38**) are incremented and the price data transferred from the working area EA5. Then, the sales personnel removes the product from the weighing pan **11**, puts the next product on the weighing pan **11** and then inputs the item number. Thereby, in the same manner as described above, weight data etc. are displayed at the display part **12**. When sales personnel depresses the plus key **82**, each of the data concerning the second product is stored, the data in the area **EA4-1** of the total register area EA4 (in this case "1") are incremented and the price data are added to the data in the area **EA4-2**. Similar processing will be repeated in sequence. The sales personnel performs operation of the plus key **82** for the last item and then depresses the print key **81**.

Thereafter, the print key **81** is depressed and the operation shown in FIG. **40** will be performed.

(2) In case that the receipt cassette **4***a* is to be used:

In this case, when the sales personnel correctly installs the receipt cassette **4***a* on the installing part **3** of the main body **1** of the printer, the cassette data are written into the working area EA5 of RAM **59** through CPU57 in the same manner as described above. Then, the sales personnel puts the first item on the weighing pan **11** in a quite same manner as above for the total label printing, inputs the item number, depresses the plus key **82** and then puts the second item on the weighing pan **11**, inputs the item number, depresses the plus key **82** and then repeats this process subsequently and finally depresses the plus key **81** upon completion of the operation of depressing plus key for the final item (n-th item). The processing performed by the CPU57 corresponding to each of the above operations is the same as that of the total label printing operation described above.

Thereafter, when the print key **81** is depressed, the processing of the CPU57 is the same as that shown in FIG. **40**.

Thus, the case in which the printer of the present invention shown in FIG. **40** issues the label or receipt will be described Prior to the starting of the printer, the feed key **83** in the function keys **16** shown in FIG. **1** is depressed in advance, and the sensor S3 of the main body **1** of the printer detects the position of the label and detects the presence or absence of the label sheet L and the receipt sheet R in advance.

In situations in which a label is to be issued, the following occurs.

When the sales personnel depresses the print key **81**, the CPU57 advances to the step SP1 shown in FIG. **40** and checks that the above-mentioned data in the working area EA5 are a label cassette **4***b* and then advances to the step SP2. In the step SP2, the CPU57 judges if the plus key **82** is depressed or not. If the plus key **82** is not depressed (in case of a single item label), the CPU57 advances to the step SP3, and performs a writing operation for the single item label data into the printing buffer area EA1.

That is, the unit price data, appreciation period data and the label printing item name data in the working area EA5 are read out, and each of the read data is transformed into the character pattern with the character patterns in the area EA4 of ROM **58** which is written into the printing buffer area EA1 under the same arrangement as that of the characters when the label printing is to be performed. In turn, when the result of judgement in the step SP2 is "YES" (when the plus key is depressed), the CPU57 advances to the step SP4 to perform a writing of total lable data into the printing buffer area EA1. That is, the total data in the total register area EA4-2 are transformed into the character pattern and written into the printing buffer area EA1. In this case, the writing of the unit price and the item name are not written into it.

Then, the CPU57 advances to the step SP5, the content in printing buffer area EA1 is outputted in sequence at the main body **1** of the printer. Thereby, the label printing is performed at the main body **1** of the printer, and for example, the label (single item label in this example) shown in FIG. **39***a* is automatically issued. Upon completion of the label printing operation, the feeding of the label sheet is performed (step SP6) and the processing is completed upon reaching of the next label to the specified position, i.e. detecting of the slit width m by the sensor S3 (sensing of label position: step SP7).

In the step SP7 described above, when the position of the label is not detected, that is, the slit m is not detected even if the desired amount of sheet is fed, the terminal end m' of the label sheet L is detected and no label condition is detected (step SP8).

When the condition of no label is detected in the step SP8, "YES" is displayed it by illuminating the cassette empty light **84** of the display part **12** (step SP9).

In situations in which a receipt is to be issued, the following occurs.

When the sales personnel depresses the above-mentioned print key **81**, the result of judgement in the step SP1 in this case is "NO" and therefore the CPU advances to the step SP10. In the step SP10, the presence or absence of the receipt sheet R is detected by the sensor S3, and when no receipt is found (step SP10-YES), the cassette empty light **84** in the display part **12** is illuminated (step SP11).

In the step SP10, when the presence of the receipt sheet is confirmed (SP10-NO), the CPU advances to the step **12**, and in the step SP12, each of the data stored in the total register area EA4-1 and EA4-2 is transformed into the character pattern and then written into the printing buffer area EA1.

Then, the CPU advances to the step SP13, the content in the printing buffer area EA1 is outputted in sequence to the main body **1** of the printer. Thereby, both the total number of items and the total price are printed on the receipt sheet.

Then the CPU advances to the step SP14, the unit price data in the n-th line, receipt item name data, weight data, and price data in the data register area EA3 shown in FIG. **38** are read out in sequence and transformed into the character pattern and written into the printing buffer area EA1. Then, the CPU advances to the step SP15, and the content of the printing buffer area EA1 is outputted in sequence to the main body **1** of the printer. Thereby, the unit price, item name, weight and price of the product of the n-th order are printed on the receipt sheet.

Then, the CPU advances to the step SP16, it is judged if the printing of all items written into the data register area EA3 is completed or not. If the result of this judgement is "NO", the CPU returns back to the step SP14, a printing for the item in the (n-1)th order is performed and the above-mentioned process is repeated. When the result of judgement in the step SP16 becomes "YES", the CPU advances to the step SP17. In the step SP17, the store name, date etc. are transformed into the character pattern and written into the printing buffer area EA1 and in the step SP18 the content in the printing buffer is outputted at the main body **1** of the printer and then in the step SP19 the receipt sheet is fed. During feeding of the sheet in the step SP19, the presence or absence of the sheet is detected by the sensor S3 (in the step SP20) and when the condition of no sheet is detected (in the step SP20-YES), the CPU advances to the above-mentioned step SP11 to illuminate the cassette empty light **84** in the display part **12** and in turn when the presence of the sheet is detected (in the step SP20-NO), the desired amount of sheet is fed (in the step SP21), then the processing operation will be finished.

The above-mentioned sheet issuing operation is similarly applied to one item or a plurality of items. When the receipt is to be printed in the above-mentioned preferred embodiment, the system in which the total number of items and the total price are printed in advance compared with that of the item data is employed. The printing order is opposite to that of the receipt which is issued by a usual ECR, and this is employed in relation with the label printing control operation and it is apparent that this invention is not limited to such arrangement as above.

The cassette empty light in the display part **12** is also illuminated when the cassette **4** is not installed at the installing part **3**, and is not correctly installed even if it is set in it, i.e. no output signal is produced through the sensor S2.

The above-mentioned preferred embodiment is described and illustrated in reference to the case in which the printer is integrally assembled in the electronic scale and it is apparent that the printer of the present invention can be constructed in separate from the electronic scale and they may be electrically connected to each other.

What is claimed is:

1. A printer for printing data on a printing sheet comprising:

(a) means for selectively storing different types of printing sheets, said storing means being removably attached to said printer;

(b) first detecting means for detecting the type of printing sheet which is selectively stored in the storing means when said storing means is mounted to the printer; and

(c) printer control means operatively connected to said printer and which comprise means for controlling printing in response to detection by the detecting means.

2. The printer according to claim **1** further comprising installing means for receiving said storing means.

3. The printer according to claim **2** wherein said installing means comprises first sensing means for sensing the presence of said storing means.

4. The printer according to claim **3** wherein said selective storing means comprises:

(a) a receipt cassette for storing a receipt printing sheet; and

(b) a label cassette for storing a label printing sheet.

5. The printer according to claim **4** further comprising:

(a) driving means located on an upper surface of said installing means;

(b) a source of driving power located below said installing means within said printer for driving said driving means;

(c) a platen roller rotatably connected to said storing means, said platen roller having a shaft; and

(d) power driven means for rotating said platen roller, said power driven means positioned outside of said storing means, wherein when one of said cassettes is installed in said installing means, said printing sheet is moved at a given speed by rotation of said platen roller, and said platen roller being rotated by said power driven means and said driving means.

6. The printer according to claim **5** wherein said cassette is removably attached to said installing means and is adapted to be slid transversely into said installing means.

7. The printer according to claim **5** wherein:

(a) said source of driving power comprises a stepping motor and a DC motor arranged side-by-side below said installing means;

(b) said driving means comprises first and second motor shafts projecting into said installing means from said stepping motor and said DC motor, respectively;

(c) a first driving wheel is attached to said first motor shaft;

(d) a second driving wheel is attached to said second motor shaft;

(e) said receipt cassette comprises a driven wheel adapted to be engaged with said first driving wheel at said platen roller shaft; and

(f) said label cassette comprises a first driven wheel adapted to be engaged with said first driving wheel at said platen roller shaft and a second driven wheel adapted to be engaged with said second driving wheel at a take-up reel shaft.

8. The printer according to claim **5** wherein said label cassette comprises a guide roller for varying the length of the path traveled by said label printing sheets between said fourth sensing means and said platen roller, wherein the length of the path is varied by moving said guide roller, said label cassette further comprising fifth sensing means for sensing the position of said guide roller.

9. The printer according to claim **5** wherein:

(a) said source of driving power comprises a driving motor; and

(b) said driving means comprises a motor shaft projecting into said installing means.

10. The printer according to claim **9** wherein:

(a) a first driving wheel is coaxially attached to said motor shaft;

(b) a second drive wheel is arranged through gear means in spaced relationship to said first driving wheel;

(c) said receipt cassette comprises driven means adapted to be engaged with said second driving wheel at said platen roller shaft; and

(d) said label cassette comprises:

(1) a take-up reel having a shaft for receiving a roll of label backing after labels are printed and removed from said roll;

(2) a first driven wheel adapted to be engaged with said first driving wheel at said take-up reel shaft; and

(3) a second driven wheel adapted to be engaged with said second driving wheel at said platen roller shaft.

11. The printer according to claim **9** wherein:

(a) a driving wheel is attached to said motor shaft;

(b) said receipt cassette comprises a driven wheel adapted to be engaged with said driving wheel at said platen roller shaft; and

(c) said label cassette comprises a driven wheel adapted to be engaged with said driving wheel at said platen roller shaft, and power transmitting means arranged between said platen roller shaft and a take-up reel shaft.

12. The printer according to claim **9** wherein said driving motor is a stepping motor.

13. The printer according to claim **12** further comprising a driving wheel comprising a first gear coaxially attached to said motor shaft and a second gear engaged with said first gear, said second gear being slidably arranged along an arcular groove around said motor shaft.

14. The printer according to claim 4 wherein said first detecting means comprises second sensing means for determining the type of cassette which is installed in said installing means.

15. The printer according to claim 14 wherein:
(a) said label cassette comprises:
(1) an opening for indicating the type of printing sheet stored therein;
(2) means for selectively closing said opening for allowing interchangeability of the type of printing sheet stored in a given cassette;
(b) said receipt cassette does not include any opening for indicating the type of printing sheet; and
(c) said second sensing means comprises third sensing means for sensing said opening.

16. The printer according to claim 15 wherein said third sensing means for sensing said opening comprises a photoelectric sensor.

17. The printer according to claim 14 wherein:
(a) said receipt cassette comprises:
(1) an opening for indicating the type of printing sheet stored therein;
(2) means for selectively closing said opening for allowing interchangeability of the type of printing sheet stored in a given cassette;
(b) said label cassette does not include an opening for indicating the type of printing sheet; and
(c) said second sensing means comprises third sensing means for sensing said opening.

18. The printer according to claim 17 wherein said third sensing means for sensing said opening comprises a photoelectric sensor.

19. The printer according to claim 14 wherein said printing control means comprises:
(a) first memory means for storing a plurality of codes corresponding to each of a plurality of items:
(b) second memory means for storing a plurality of character patterns corresponding to said plurality of codes; and
(c) control means for reading one of said plurality of codes in response to an issuing instruction, converting said one code to one of said plurality of character patterns corresponding to said one code and outputting said one of said character patterns to said printer.

20. The printer according to claim 19 wherein said plurality of codes comprises a plurality of receipt item codes and a plurality of label item codes, and wherein when a receipt cassette is installed in said installing means, said one code is a receipt item code and when a label cassette is installed in said installing means, said one code is a label item code.

21. The printer according to claim 14 further comprising sheet sensing means comprising:
(a) a sensor positioned in said installing means comprising a light emitting element and a light receiving element; and
(b) fourth sensing means positioned in said storing means so as to face said sensor when said storing means is installed in said installing means and so as to receive a printing sheet passing therethrough, wherein said fourth sensing means comprises reflection means for reflecting light from said light emitting element at one side of a passing path of said printing sheet across the path toward a direction incident to said light receiving element.

22. The printer according to claim 21 wherein said reflection means comprises a prism.

23. The printer according to claim 21 wherein said reflection means comprises two mirror surfaces crossing each other with a 90° angle.

24. The printer according to claim 21 wherein said sheet sensing means comprises change-over means for automatically varying an output level of said sensor responsive to the type of printing sheet installed in said installing means, wherein said sheet sensing means and said change-over means comprise means for detecting the presence of a label and a receipt when a label cassette or a receipt cassette is installed in said installing means, respectively.

25. The printer according to claim 21 wherein said sheet sensing means comprises:
(a) change-over means for varying an output level of said sensor in a step-wise manner; and
(b) a comparator for comparing said output level with a reference value, wherein said output level of said sensor is set with reference to an output signal from said comparator and said output level is varied sequentially when a label cassette is installed in said installing means, and said output level is automatically adjusted to a substantially constant value in response to the thickness of the label printing sheet.

26. The printer according to claim 25 wherein said label printing sheet comprises a plurality of labels and a base sheet on which said plurality of labels are removably attached and wherein said output level is automatically adjusted to a substantially constant value in response to the presence or absence of one of said plurality of labels.

27. The printer according to claim 25 wherein the value of the output level of said sensor is automatically determined and set based upon the result of said comparator examining the value of said output level varied in a step-wise manner in response to the presence or absence of a label.

28. The printer according to claim 25 wherein said output level of said sensor is adjusted when one of said cassettes is installed.

29. The printer according to claim 25 wherein said output level of said sensor is adjusted in response to a key operation performed by a user of said printer.

30. A method for operating a printer for printing data on a printing sheet comprising the steps of:
(a) generating a first signal responsive to detecting means when means for storing receipt sheets is attached to said printer;
(b) generating a second signal responsive to said detecting means for storing a plurality of blank label sheets is attached to said printer;
(c) printing receipt data on one of said blank receipt sheets in response to generation of said first signal and a first issuing instruction; and
(d) printing label data on one of said plurality of blank label sheets in response to generation of said second signal and a second issuing instruction.

31. A method according to claim 30 wherein the step of printing receipt data comprises the steps of:
(a) reading one of a plurality of receipt item name codes from a first memory means corresponding to one of a plurality of items;
(b) reading one of a plurality of character patterns from a second memory means corresponding to said one of said plurality of receipt item name codes; and

(c) outputting said one of said plurality of character patterns on printing means.

32. A method according to claim **30** wherein the step of printing label data comprises the steps of:

(a) reading one of a plurality of label item name codes from a first memory means corresponding to one of a plurality of items;

(b) reading one of a plurality of character patterns from a second memory means corresponding to said one of said plurality of label item name codes; and

(c) outputting said one of said plurality of character patterns on printing means.

33. A printer for printing data on a printing sheet comprising:

(a) means for selectively storing different types of printing sheets in said printer, said storing means being removably attached to said printer;

(b) a plurality of printer control means provided in accordance with each of said types of printing sheets; and

(c) means for selecting one of said plurality of printer control means in accordance with the type of printing sheet which has been selectively stored and positioned within said printer.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,700,791

DATED : October 20, 1987

INVENTOR(S) : Yoshitaka IWASAKI et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

At column 3, line 22 of the printed patent, change "substantial" to ---substantially---; and insert ---]--- before "-shaped".

At column 3, line 41 of the printed patent, insert ---a--- after "not".

At column 3, line 43 of the printed patent, change "techanical" to ---technical---.

At column 4, lines 61-62 of the printed patent, delete "to each other".

At column 5, line 27 of the printed patent, change "whether" to ---of whether or not---.

At column 6, line 33 of the printed patent, change "plain" to ---plan---.

At column 10, line 9 of the printed patent, change "lavel" to ---label---.

At column 11, line 45 of the printed patent, delete second "receipt".

At column 11, line 59 of the printed patent, change "casseete" to ---cassette---.

At column 12, line 7 of the printed patent, change "froms" to ---forms---.

At column 12, line 40 of the printed patent, change "arcualar" to ---arcular---.

At column 13, line 32 of the printed patent, change "registor" to ---register---.

At column 14, line 47 of the printed patent, change "prresent" to ---present---.

At column 17, line 27 of the printed patent,

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 4,700,791

DATED : October 20, 1987

INVENTOR(S) : Yoshitaka IWASAKI et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

change "." to ---,--- after "configuration".

At column 19, line 28 of the printed patent, insert ---.--- after "described".

At column 19, line 56 of the printed patent, change "lable" to ---label---.

At column 20, line 11 of the printed patent, delete "it".

Signed and Sealed this

Fourth Day of October, 1988

Attest:

DONALD J. QUIGG

Attesting Officer

Commissioner of Patents and Trademarks

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,700,791

DATED : October 20, 1987

INVENTOR(S) : Yoshitaka Iwasaki, et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

The term of this patent subsequent to July 8, 2003, has been disclaimed.

Signed and Sealed this

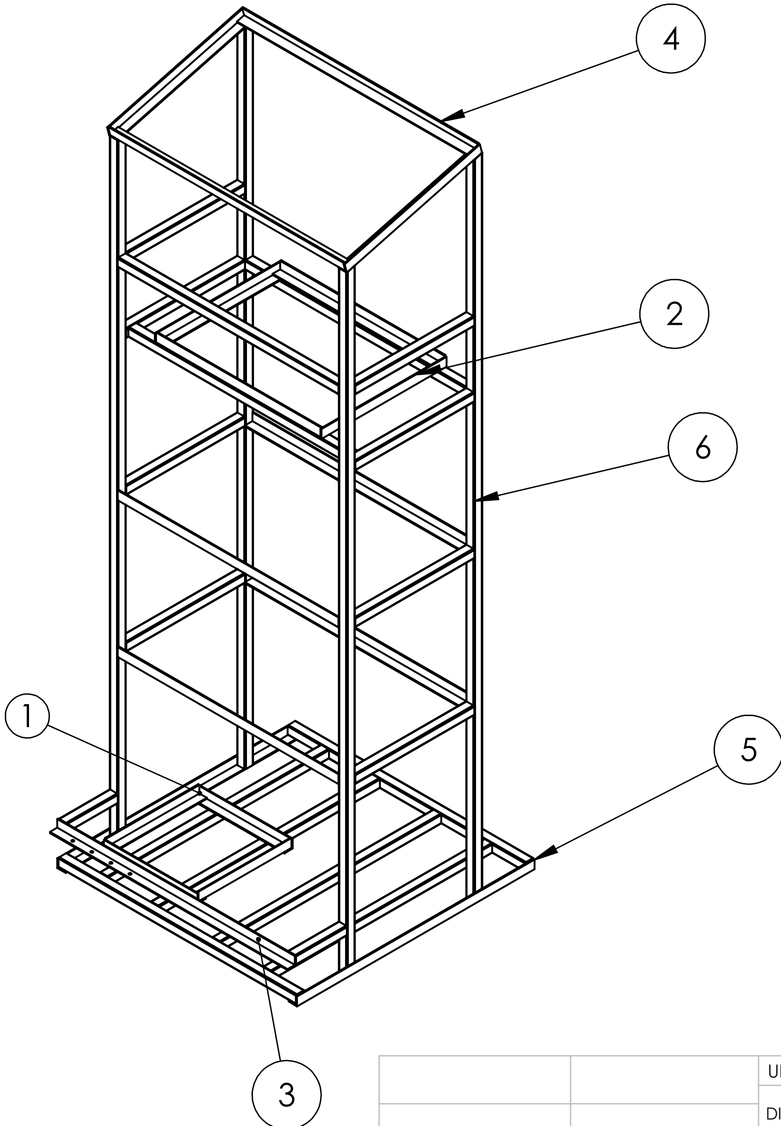
First Day of March, 1988

Attest:

DONALD J. QUIGG

Attesting Officer

Commissioner of Patents and Trademarks



SUB ASSEMBLIES:

1. BOTTOM SCALE FRAME
2. TOP SCALE FRAME
3. BOTTOM INDICATOR MOUNT
4. TOP SHELF
5. CART BASE
6. CART FRAME

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

NEXT ASSY	USED ON
APPLICATION	

PROPRIETARY AND CONFIDENTIAL

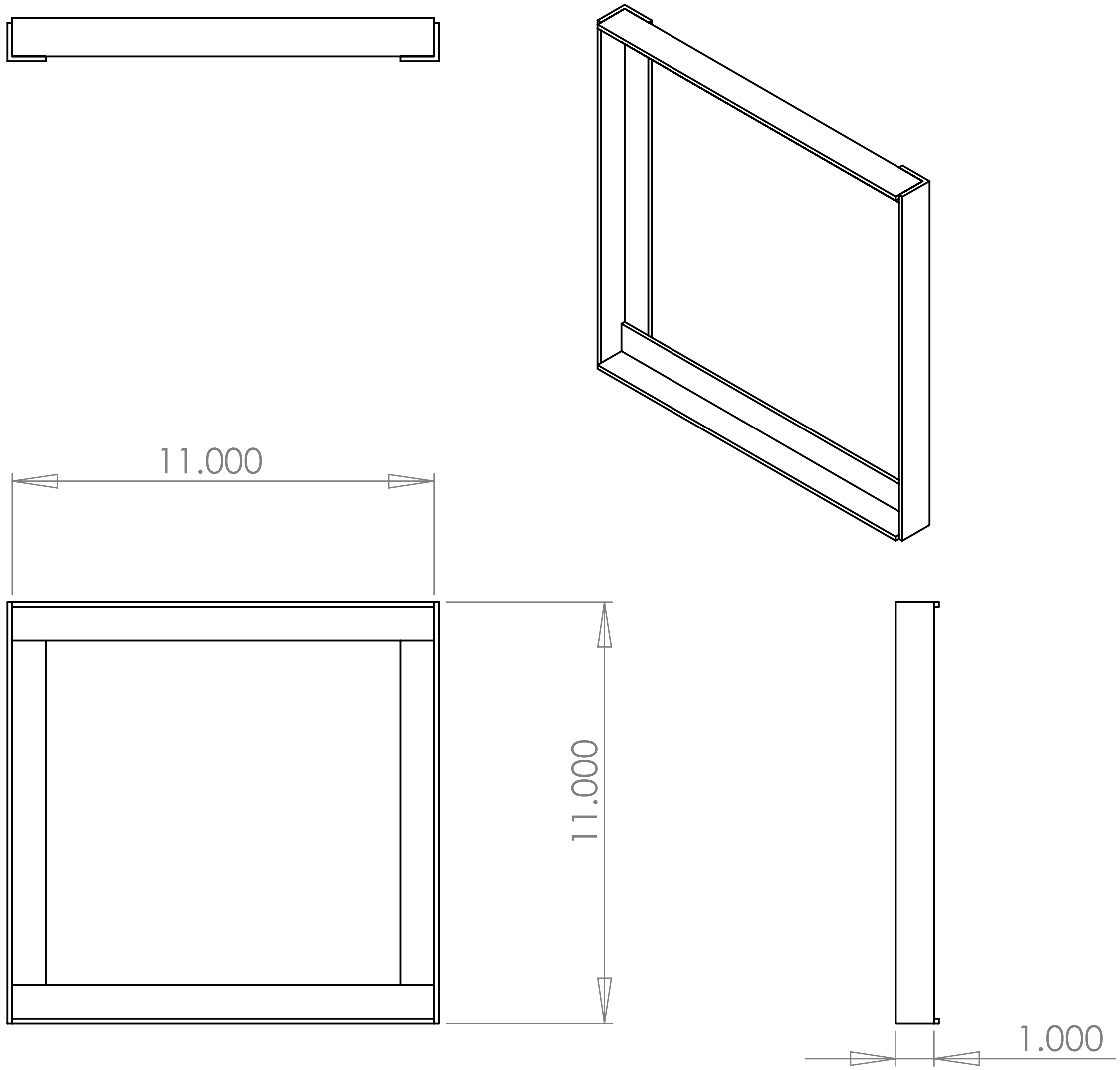
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.

TITLE:

SIZE	DWG. NO.	REV
A	0.0 - Ass.	

SCALE: 1:24 WEIGHT: SHEET 1 OF 1

5 4 3 2 1



PROPRIETARY AND CONFIDENTIAL

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

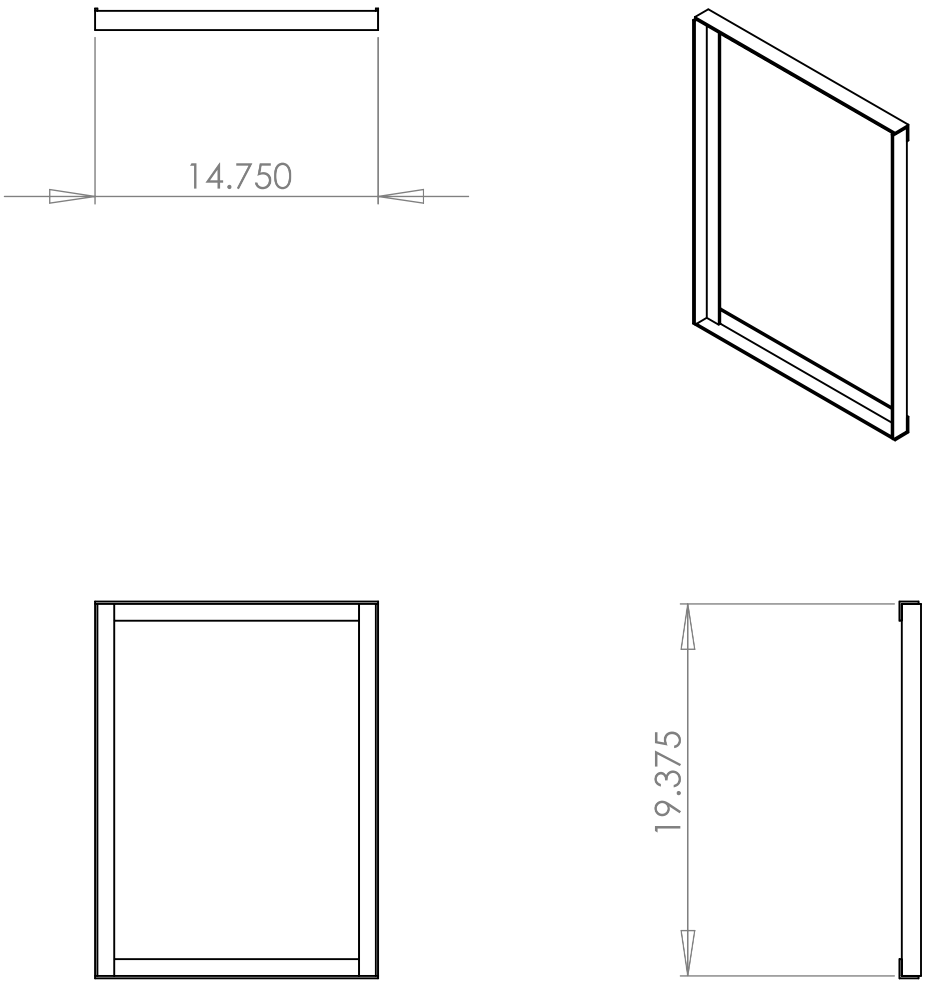
COMMENTS:

TITLE:

SIZE	DWG. NO.	REV
A	1.0	

SCALE: 1:5 WEIGHT: SHEET 1 OF 1

5 4 3 2 1



		UNLESS OTHERWISE SPECIFIED:
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±
		INTERPRET GEOMETRIC TOLERANCING PER:
		MATERIAL
NEXT ASSY	USED ON	FINISH
APPLICATION		DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

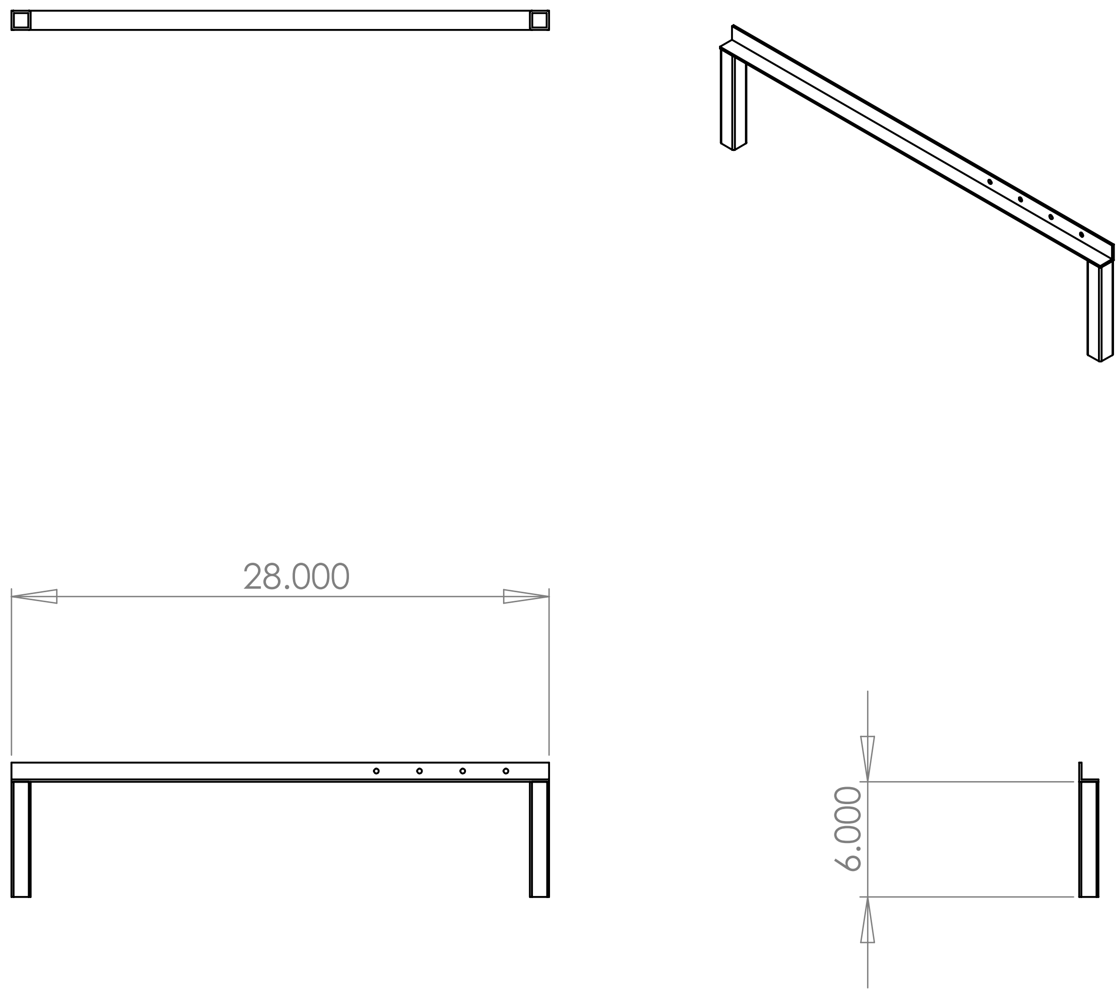
PROPRIETARY AND CONFIDENTIAL

TITLE:

SIZE	DWG. NO.	REV
A	2.0	

SCALE: 1:10 WEIGHT: SHEET 1 OF 1

5 4 3 2 1



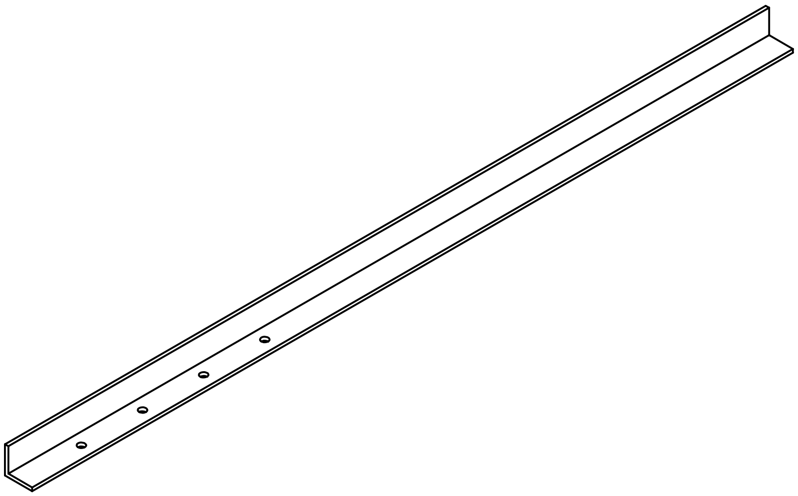
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

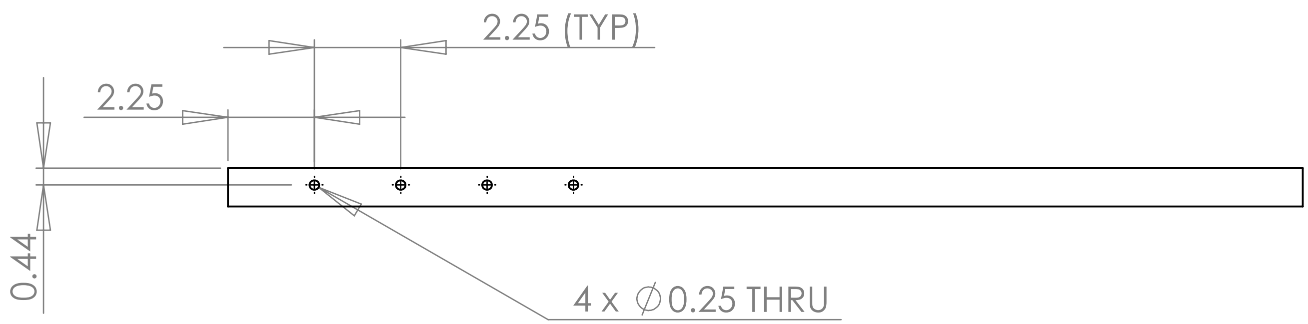
TITLE:

SIZE A | DWG. NO. 3.0 | REV

SCALE: 1:10 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1





		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

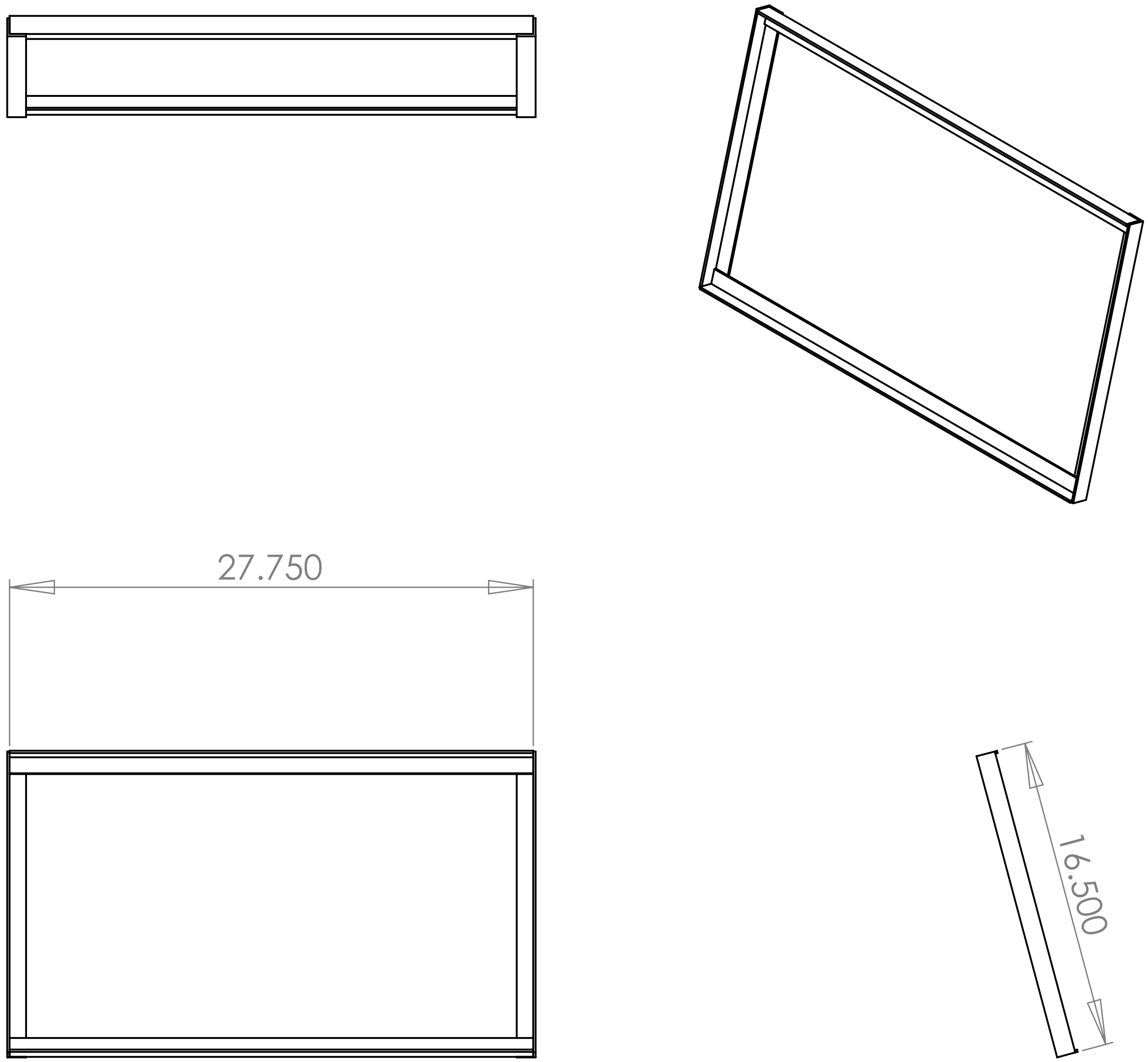
PROPRIETARY AND CONFIDENTIAL

TITLE:

SIZE	DWG. NO.	REV
A	3.1	

SCALE: 1:10 WEIGHT: SHEET 1 OF 1

5 4 3 2 1



NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

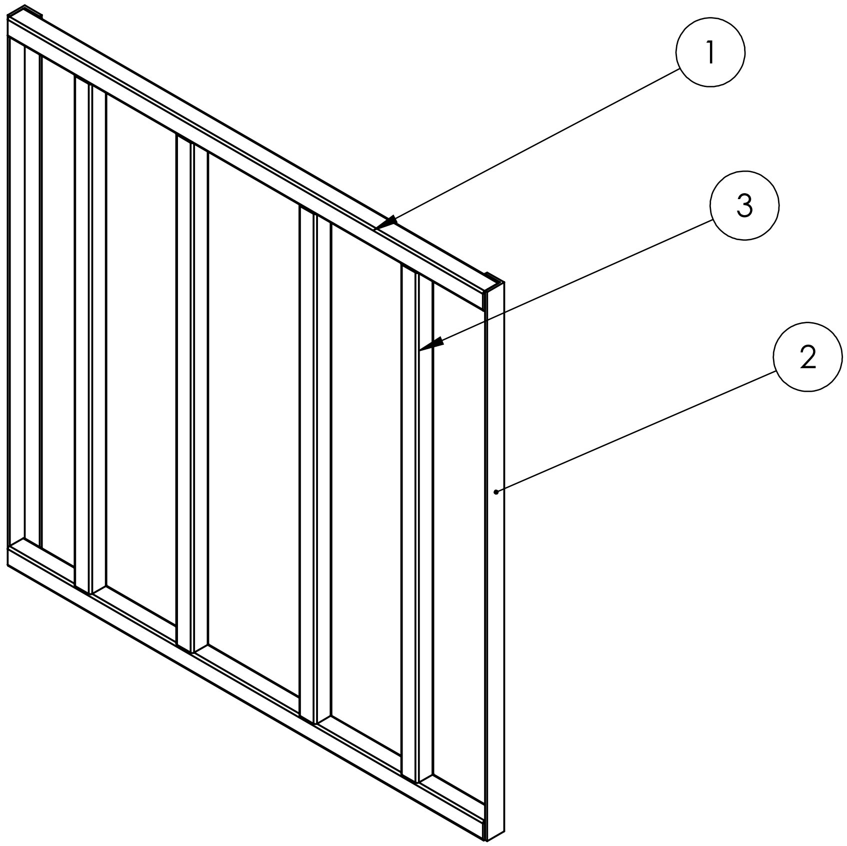
COMMENTS:

TITLE:

SIZE	DWG. NO.	REV
A	4.0	

SCALE: 1:10 WEIGHT: SHEET 1 OF 1

5 4 3 2 1

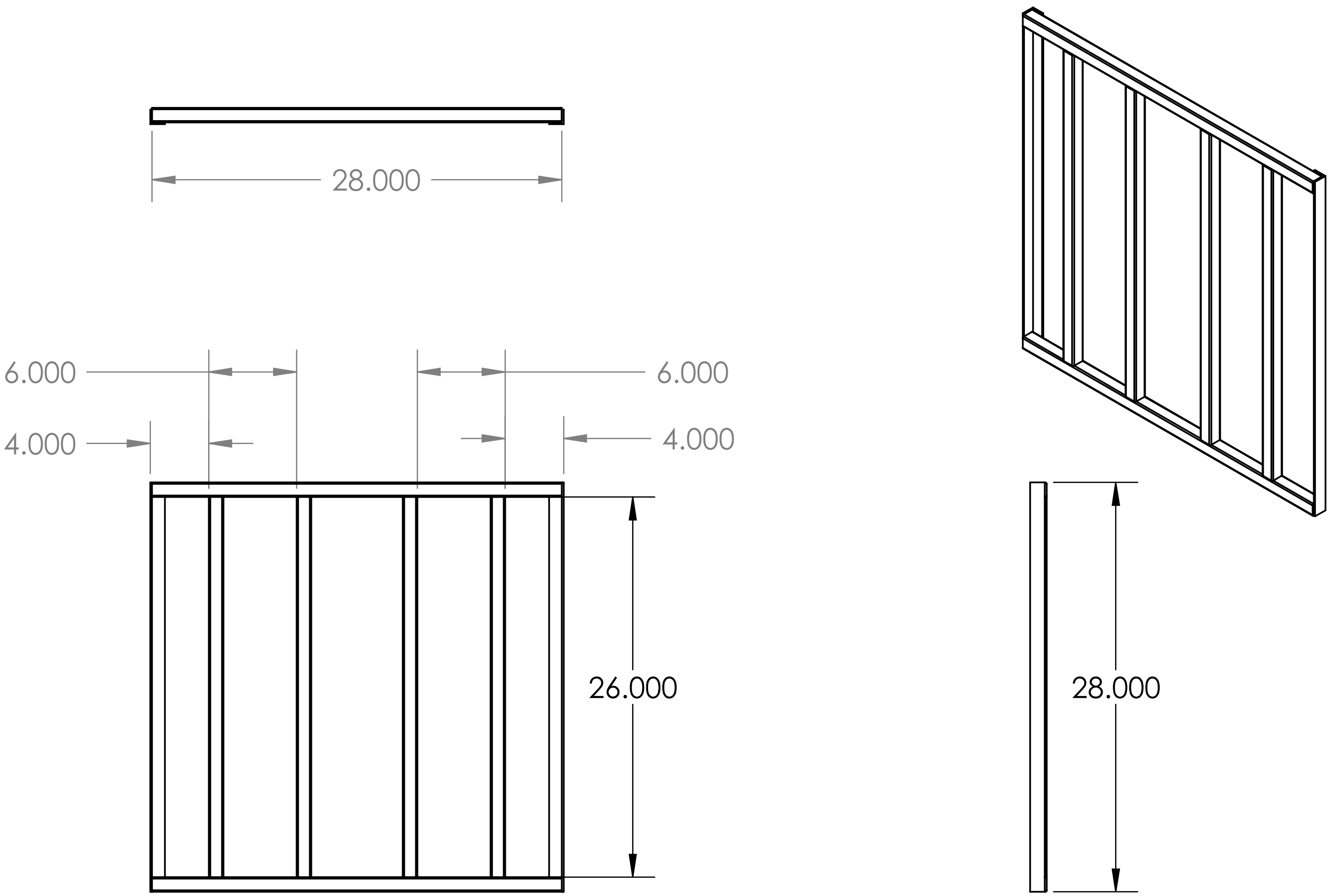


5.0 BASE - BOM

1. 28" SQUARE TUBING (1"X1") - QTY 2
2. 28" ANGLE (1"X1"X0.125") - QTY 2
3. 26" SQUARE TUBING (1"X1") - QTY 4

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN			TITLE:
			CHECKED			
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL	COMMENTS:			SIZE A DWG. NO. 5.0 - A REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:12 WEIGHT: SHEET 2 OF 2

5 4 3 2 1



5.0 CART BASE

TITLE:

SIZE	DWG. NO.	REV
A	5.0 - B	

SCALE: 1:12 WEIGHT: SHEET 1 OF 2

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

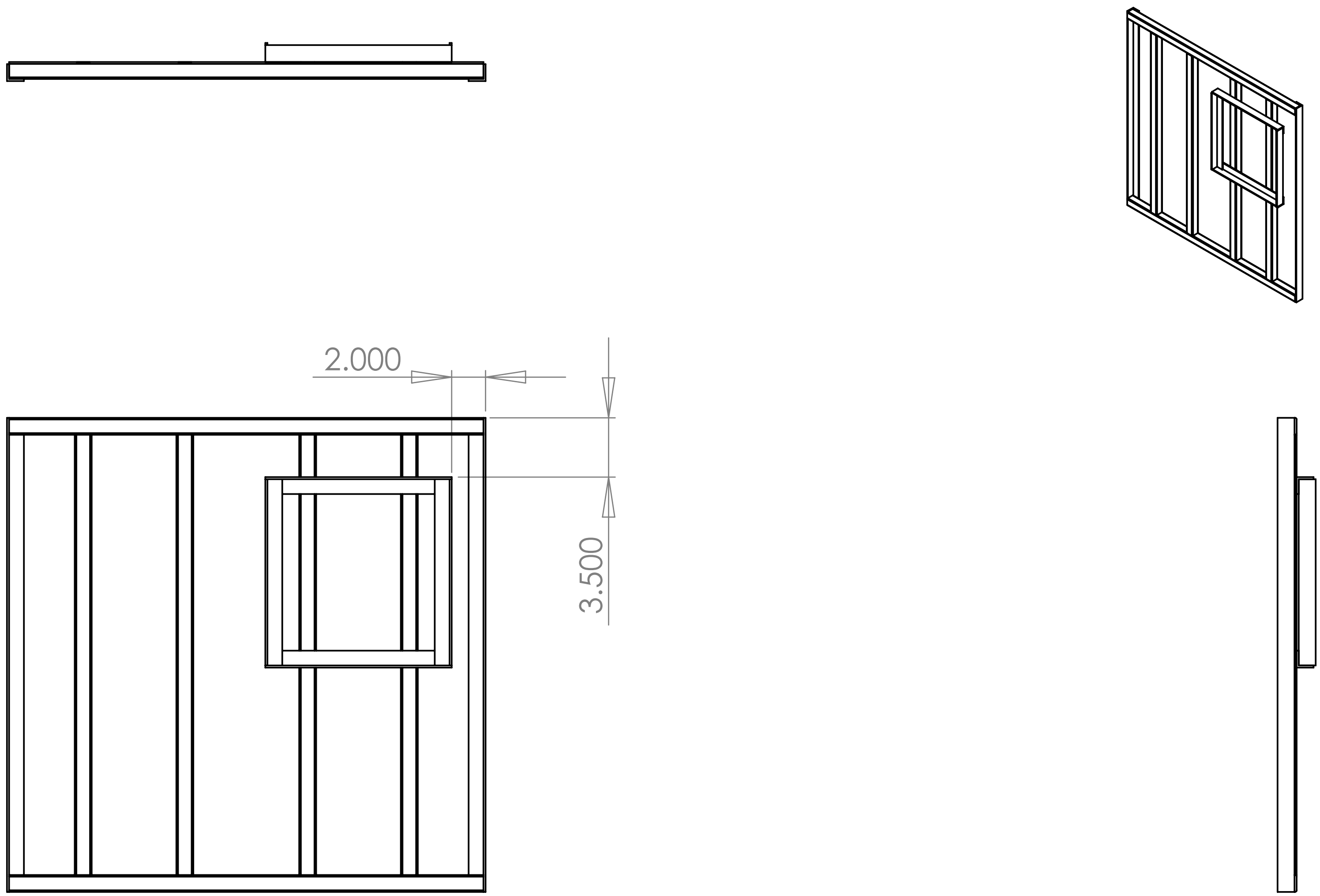
MATERIAL

FINISH

DO NOT SCALE DRAWING

NEXT ASSY	USED ON
APPLICATION	

5 4 3 2 1



UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

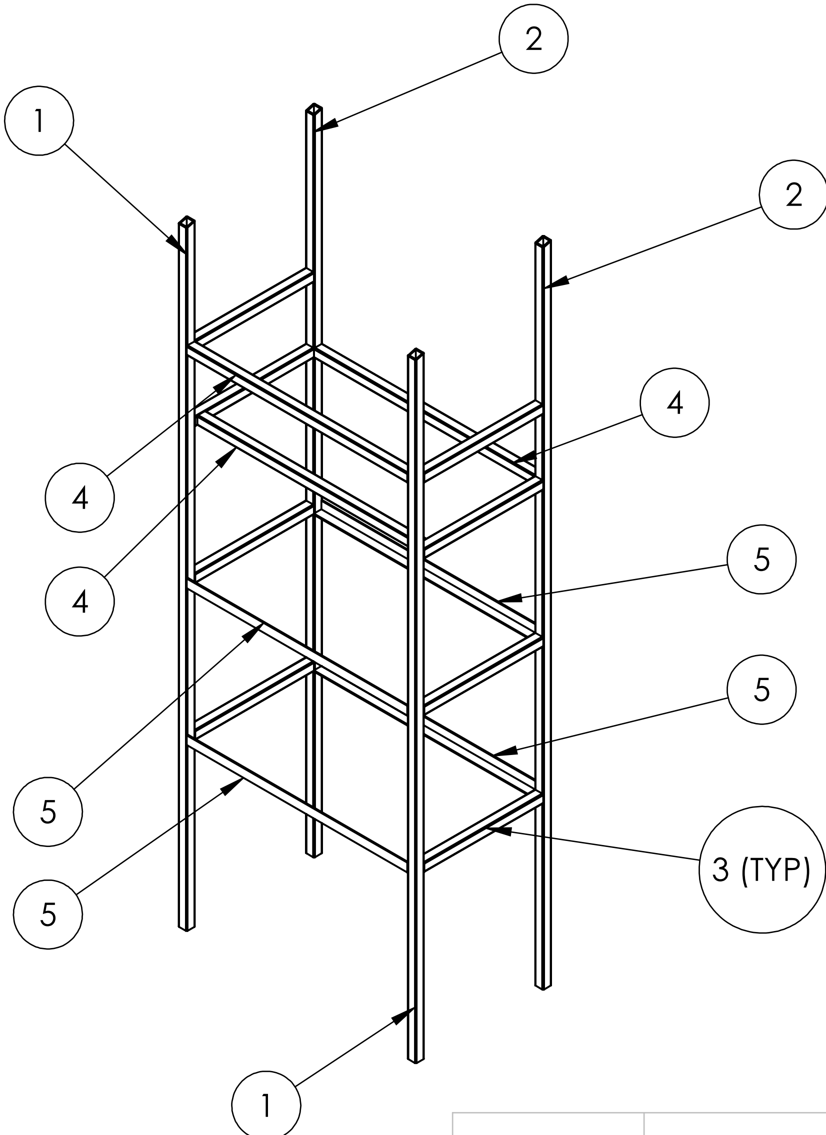
NEXT ASSY	USED ON
APPLICATION	

TITLE:

SIZE A | DWG. NO. 5.1 | REV

SCALE: 1:10 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1

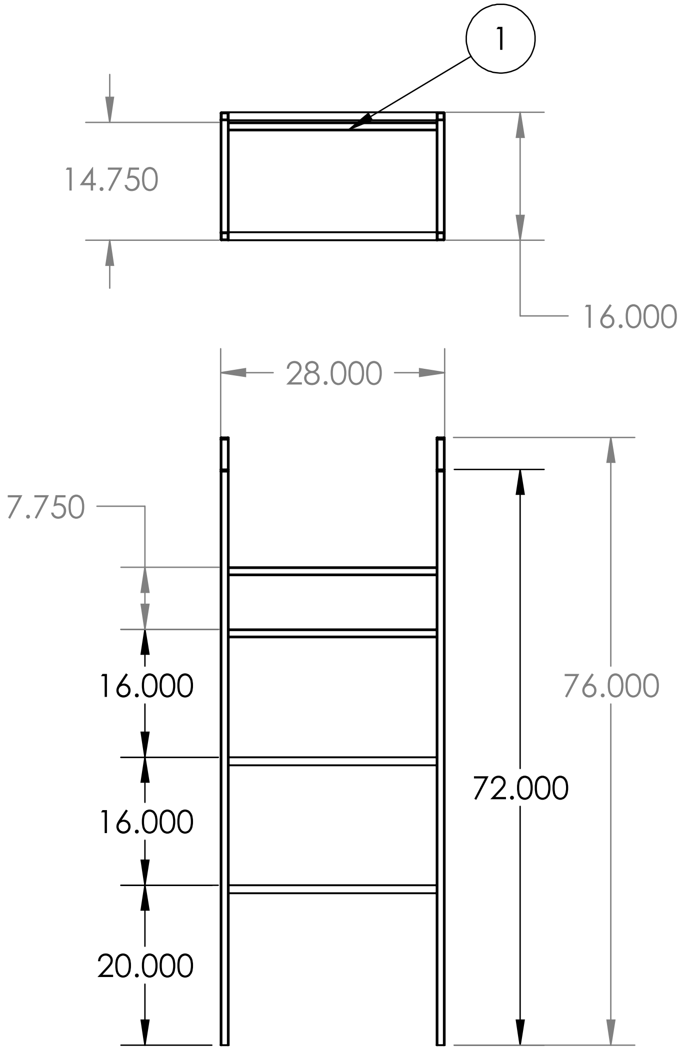


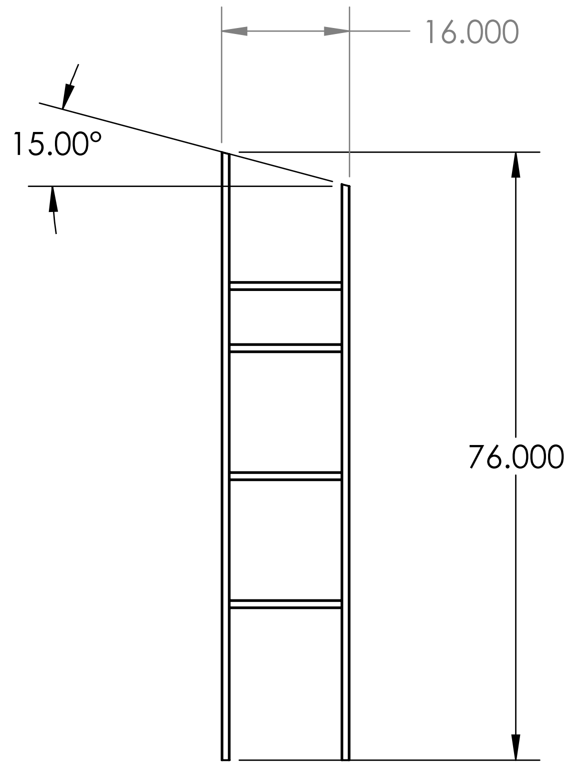
FRAME BOM:

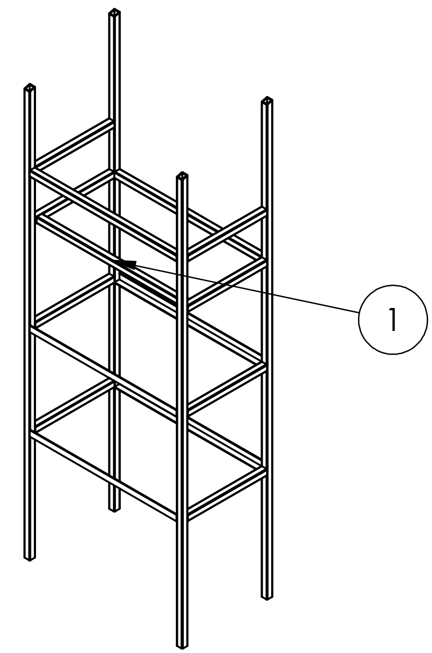
1. 72" SQUARE TUBING (1"X1") - QTY 2
2. 76" SQUARE TUBING (1"X1") - QTY 2
3. 14" SQUARE TUBING (1"X1") - QTY 8
4. 26" SQUARE TUBING (1"X1") - QTY 3
5. 26" ANGLED STEEL (1"X1"X0.125") - QTY 4

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN			
			CHECKED			TITLE:
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL	COMMENTS:			SIZE A · DWG. NO. 6.0 - A · REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:24 · WEIGHT: · SHEET 2 OF 2

5 4 3 2 1







NOTES:
1. THIS PIECE OF SQUARE TUBING IS NOT FLUSH WITH THE 72" VERTICAL FRAME. THIS DIMENSION IS SET TO MATCH THE WIDTH OF THE TOP SCALE FRAME. SEE TOP VIEW DIMENSION.

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

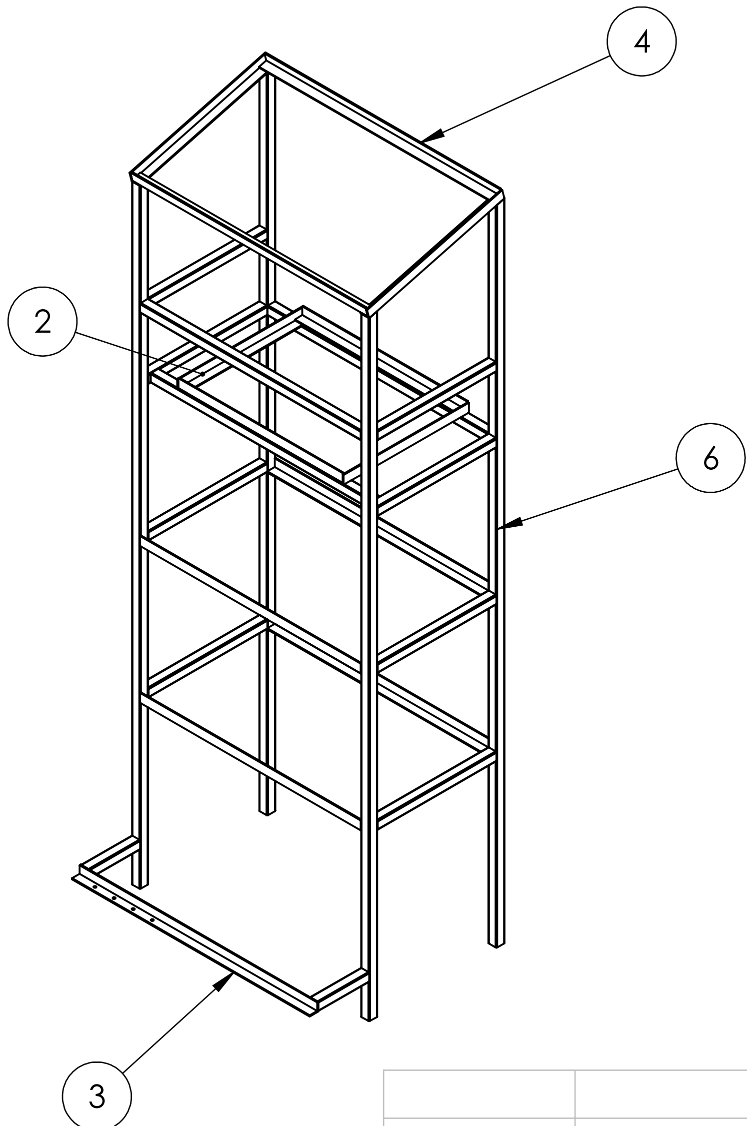
COMMENTS:

TITLE:

SIZE	DWG. NO.	REV
A	6.0 - B	

SCALE: 1:24 WEIGHT: SHEET 1 OF 2

5 4 3 2 1

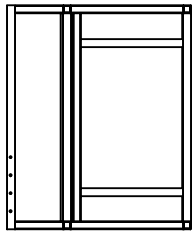


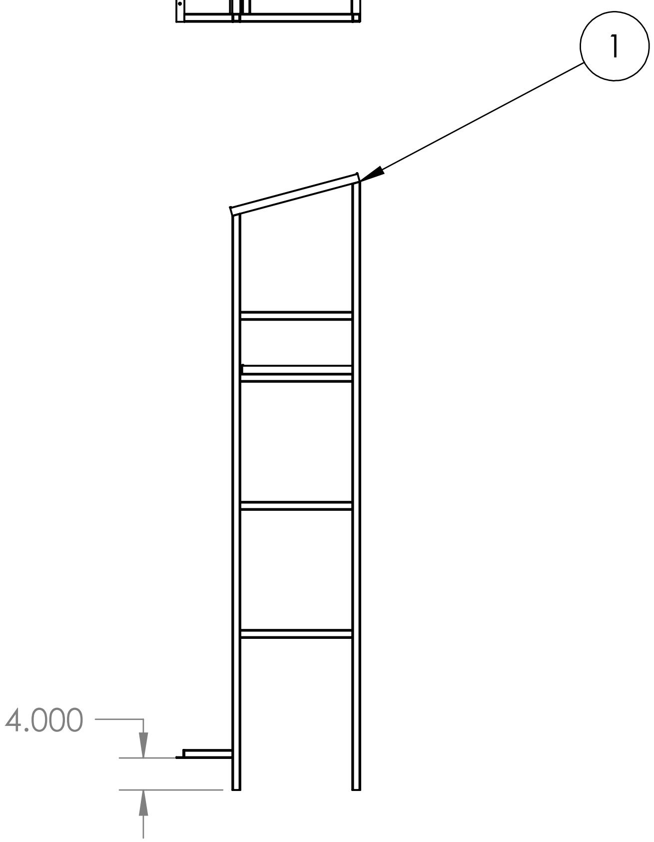
6.1 CART FRAME w/ SUB ASSEMBLIES

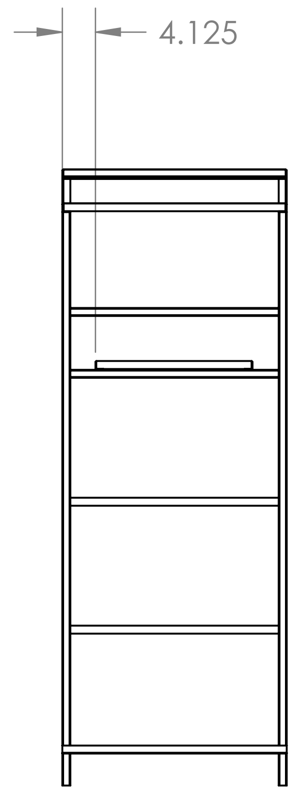
2. TOP SCALE FRAME
3. BOTTOM INDICATOR MOUNT
4. TOP SHELF
6. CART FRAME

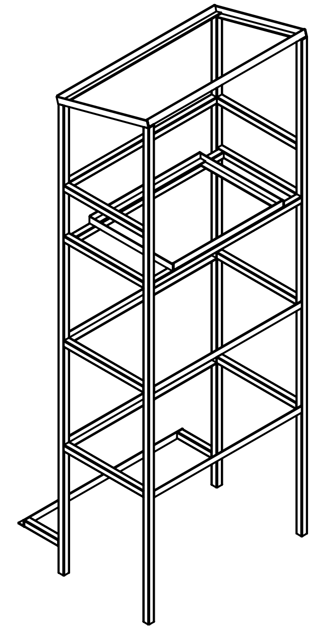
		UNLESS OTHERWISE SPECIFIED:		NAME / DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN CHECKED ENG APPR. MFG APPR. Q.A.	TITLE:
		INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:	
NEXT ASSY	USED ON	MATERIAL		SIZE A DWG. NO. 6.1 - A REV
APPLICATION		FINISH		
		DO NOT SCALE DRAWING		SCALE: 1:24 WEIGHT: SHEET 1 OF 2

5 4 3 2 1









NOTE:
1 Weld top shelf
to top of frame

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

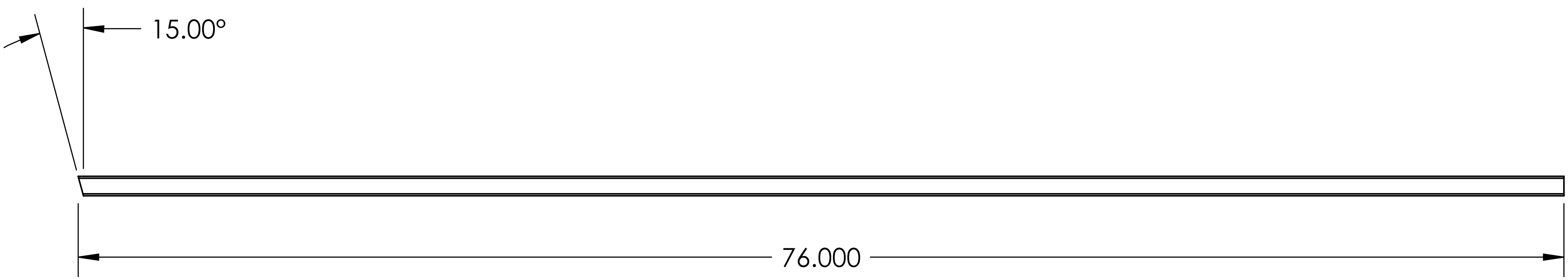
	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

TITLE:

SIZE	DWG. NO.	REV
A	6.1 - B	
SCALE: 1:24	WEIGHT:	SHEET 2 OF 2

5 4 3 2 1



NOTES:

QTY: 2

PROPRIETARY AND CONFIDENTIAL

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

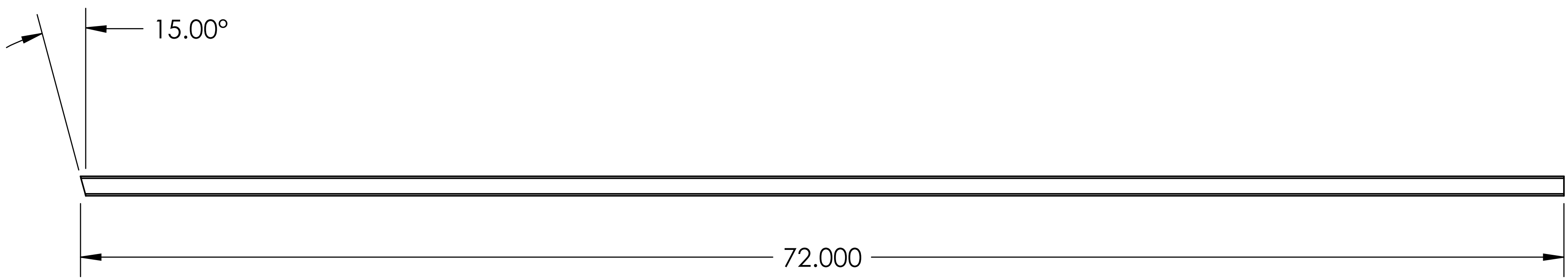
1" X 1" Square Steel Tubing

TITLE:

SIZE	DWG. NO.	REV
A	6.2 - A	

SCALE: 1:24 WEIGHT: SHEET 1 OF 1

5 4 3 2 1



NOTES:

QTY: 2

PROPRIETARY AND CONFIDENTIAL

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

1" X 1" Square Steel Tubing

TITLE:

SIZE A DWG. NO. 6.2 - B REV

SCALE: 1:24 WEIGHT: SHEET 1 OF 1

5 4 3 2 1

Sub Assembly		Part	Qty
1.	Bottom Scale Frame	11" Angled Steel	4
2.	Top Scale Frame	19.375" Angled Steel	2
2.	Top Scale Frame	14.75" Angled Steel	2
3.	Bottom Indicator Mount	28" Angled Steel	1
3.	Bottom Indicator Mount	6" Square Tubing	2
4.	Top Shelf	27.75" Angled Steel	2
4.	Top Shelf	16.5" Angled Steel	2
5.	Cart Base	28" Square Tubing	2
5.	Cart Base	28" Angled Steel	2
5.	Cart Base	26" Square Tubing	4
6.	Cart Frame	76" Square Tubing	2
6.	Cart Frame	72" Square Tubing	2
6.	Cart Frame	14" Square Tubing	8
6.	Cart Frame	26" Square Tubing	3
6.	Cart Frame	26" Angled Steel	4
NOTE: All Square Tubing 1" x 1"			
NOTE: All Angled Steel Right Angle 1" x 1" x 0.125"			
TOTAL SQUARE TUBING - 658"			
TOTAL ANGLED STEEL - 388.75"			

Baja Salmon with Mushrooms

Mushroom and Egg Wrap

Grilled Portabella Caps with Stuffed with Herb Cheese

Mushroom Facts

Bella Corp

Brady Brewer   Stephen Eller

Michelle Jones   David Haury

J-M Farms

- Main Facility – Miami, OK
- Established 1973
- 5 Satellite Farms
- White & Portabella Mushrooms
- Cover OK, TX, AK, MS, NM, KS, MO, IA.

Photo Available at :
http://www.jmfarms.com/index.html

Bella Corp

Project Significance

Walmart

Save money. Live better.

Sustainability Index

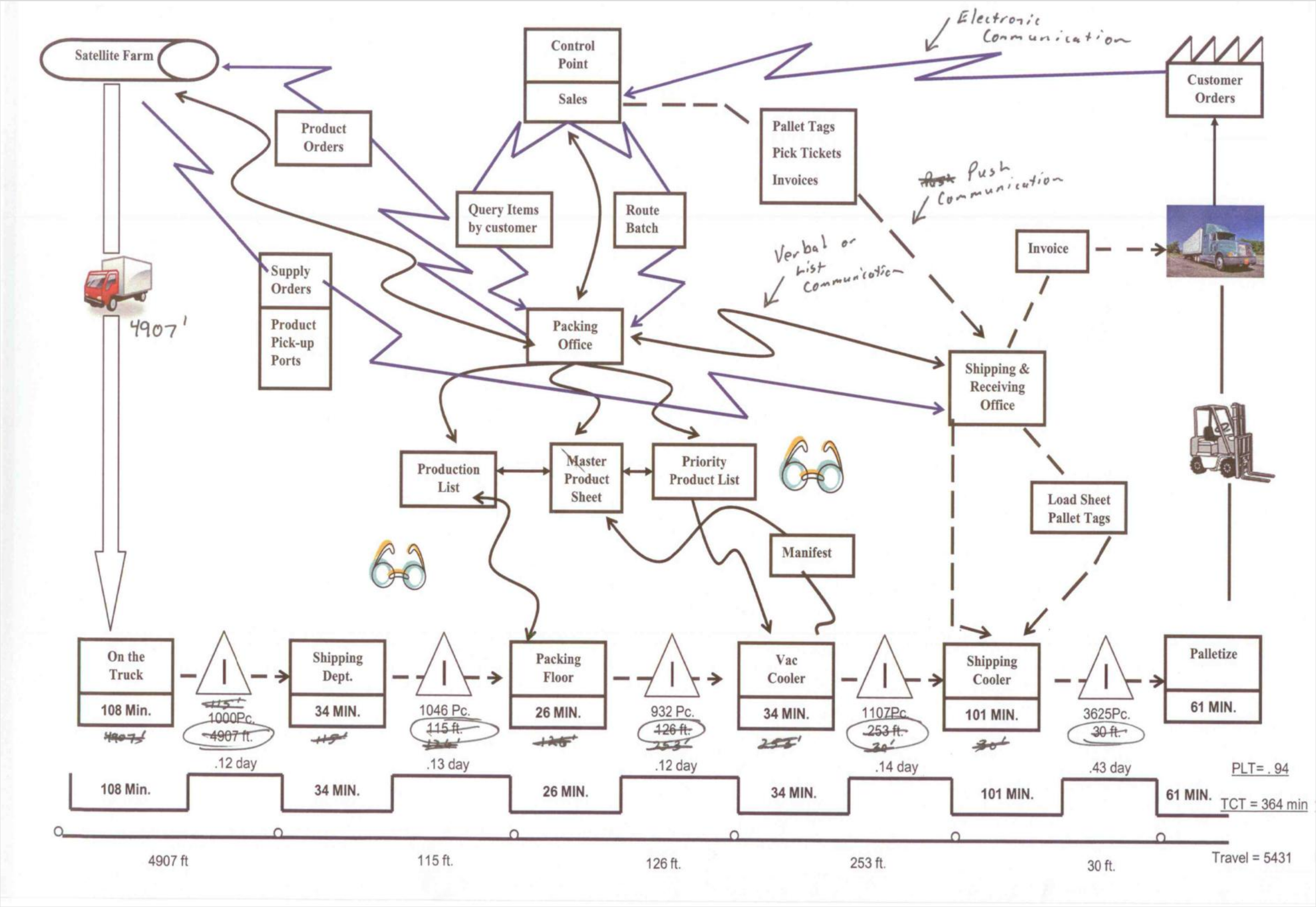
Photo Available at :
http://www.flashbackinfo.org/images/Walmart_New_Logo.png

Bella Corp

Project Description

- Improve efficiency and quality of mushroom packaging process
- New cart was suggested
- We examined the entire packaging process
- Process Flow
- Machine Design

Current Process



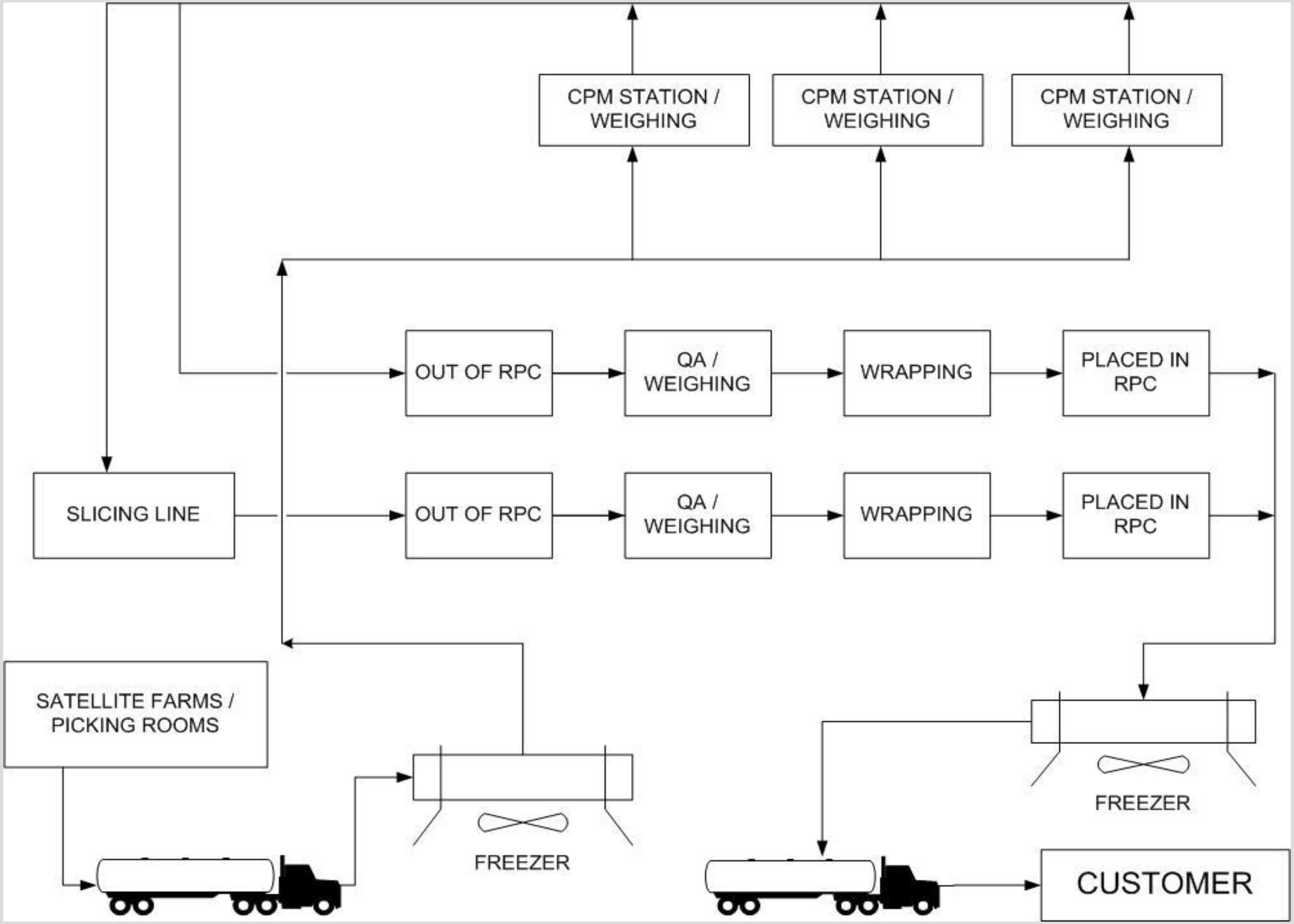
Nomenclature

Till

RPC

Bella Corp

Current Process



Harvesting Room

Bella Corp

Picker Cart

Bella Corp

Mushroom Harvesting

Bella Corp

CPM Station

Bella Corp

Quality Control

Bella Corp

Lost Product

Bella Corp

Engineering

- Interdisciplinary Problem
  - Food Handling
  - Industrial Engineering / Ergonomics
  - Mechanical Design
- Increase Efficiency
- Increase Product Quality

Bella Corp

Engineering Concepts

- Industrial/Ergonomic Ideas
  - 1. CPM Weighing Station at Satellites
  - 2. Packing Line at Satellites
  - 3. Redesign Packaging Process at Main Farm
  - 4. Redesign/Alter Slicing Line at Main Farm
- Mechanical Design Ideas
  - 1. Picker Cart with Scales
  - 2. Packaging Cart (using snap-on lids)

Bella Corp

Package Alternative

- Package Mushrooms by Count

Photo available at:
http://www.linpac.com/PageFiles/179/Library/Tomato-tray-collage.jpg

Bella Corp

Design Solution

- Redesign existing cart
- Frame
  - Square tubing
  - Angle steel
- Bases for scales
  - Bulk platform
  - Till platform
- 5 inch casters

Bella Corp

Design Solution

- Scales
  - Food-grade
  - Washdown
- Precision
- Data Recording
- Printer
- Power Source
  - Battery power

Photo available at:
http://www.1800scales.com/Adam_CPWplus_150.html

Bella Corp

Design Solution

- Picker Application
  - Tare for individual tills
  - Bulk
- Shelving for completed boxes
- Benefits
  - Ability to incorporate snap-on lids
  - Pick by weight, not volume

Bella Corp

Finished Prototype

Bella Corp

Industry & Competition

- Industry Analysis
  - Premium goods dominate the industry
    - Emphasis on quality
    - Consumer behavior
- Competitive Analysis
  - Specialization
  - Regional
  - National
    - Monterey Mushrooms

Bella Corp

Business Plan

- S.W.O.T. Analysis
- Marketing Strategy
  - Product
  - Price
  - Place
  - Promotion

Bella Corp

Financial Analysis

- Prototype cart cost: $676.32
- Food grade cart cost estimated at: $3,549.32
- Reduction of processes
- Cost savings from engineering solution
  – Per pound cost for current process: $1.62.
  – Per pound cost for proposed process: $1.56.
- Estimated $0.06 per pound savings

Bella Corp

Applicable Scales

Company	Model	Price
Alliance Scale	Defender 5000 Xtreme	$1,229
Cardinal	EB-15 / EB-30 SS Bench Scales	$900
Cardinal	Admiral Series SS Bench Scales	$1,190
Central Carolina	Cardinal Nautilus Series	N/A
Central Carolina	SURVIVOR® CW-80 Checkweigher	N/A
Emery Winslow	Bench Scale Model 437	$2,495
Fairbanks	NexWeigh Bench Scales	$1,395
Gainco	GS-9700	$1,595
GSE	250-X	$750
InterWeigh Systems Inc.	FS-I Checkweigher (10x10)	$980
InterWeigh Systems Inc.	The Ultimate Checkweigher	$1,227
M&D Controls	Enviro Scale 12x12 - 30#	$2,295
Ohaus	Defender™ 5000XW - D51XW10WR3	$1,397
Ohaus	Defender™ 7000XW - D71XW10WR3	$1,541
RiceLakes	CW-90X	$1,595

Bella Corp

Prototype Cart Cost

5 In. Caster Wheels	$	63.96
Angle Iron	$	22.00
Steel Tubing	$	63.36
Acculab Scale	$	312.00
Adam Equip. Scale	$	215.00
Total	**$**	**676.32**

Bella Corp

Financial Analysis

- Decrease in picker efficiency
  - Current picker average is around 80 pounds per day, we expect this to drop at least 10 pounds per day
  - To counter this, we increase the pay scale for pickers
- Additions to the $0.06 savings
  - Does not include any reduction overhead which would further decrease the costs

Bella Corp

Financial Analysis

- Return on Investment Calculations
  - Prototype cart costs $676.32
  - Saves an estimated $0.06 per pound
  - Each cart picks a new average of 70 pounds per day
- Average of 200 operating days to pay off prototype cart

Bella Corp

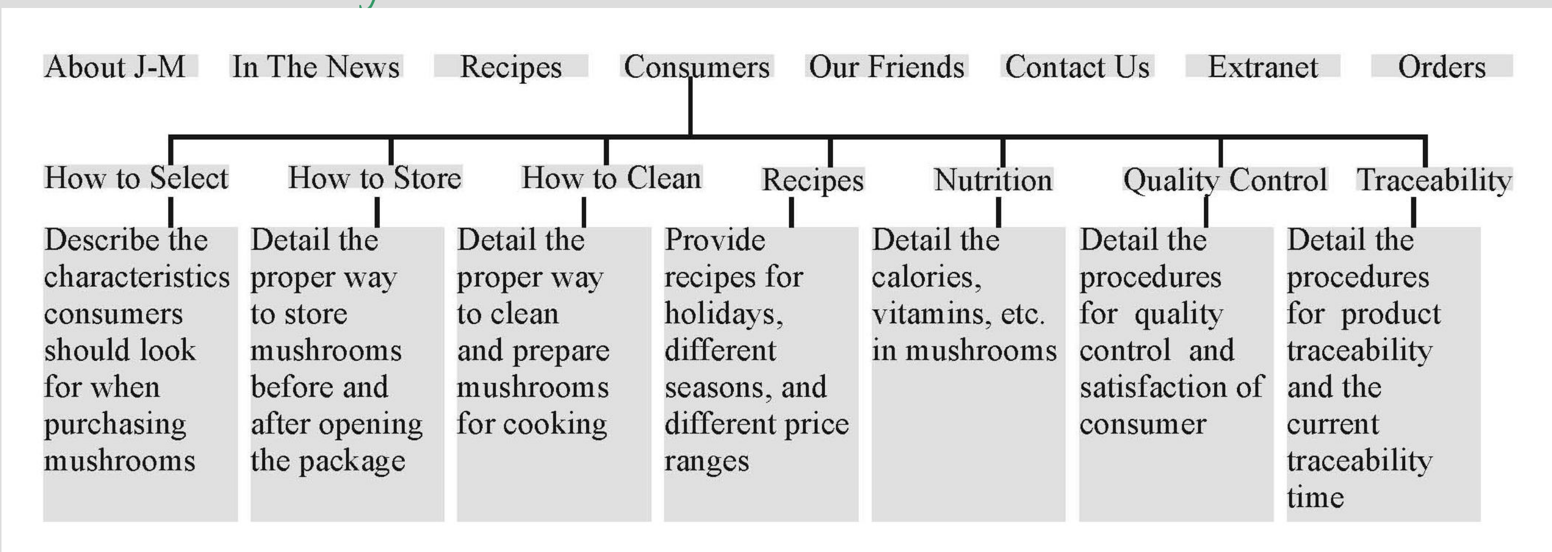
Communications Plan

- Business-to-Business
  - Mushroom shoppers are valuable to retailers. The average shopping basket with mushrooms is double the value of shopping baskets without mushrooms.
- Business-to-Customers
  - Customers tend to be highly educated and wealthy
  - Hispanic and Asian purchases increasing
  - Response to point of source materials

Bella Corp

Business-to-Customers

- Web page
  - Recipes
  - Storage and handling procedures
  - Quality control
  - Traceability statistics



Bella Corp

Business-to-Customers

- Recipe Cards
  - Recipes
  - Storage and handling procedures

Baja Salmon with Mushrooms

Preparation Time: 7 minutes • Cooking Time: 8 minutes
Serves: 4 • Average cost per serving: $3.21

1 tablespoon olive oil, divided
6 ounces white button mushrooms, quartered or halved
1 packet dry citrus marinade
3/4 cup frozen white sweet corn kernels, thawed
1/2 cup red onion, diced, run under cold water
1/2 cup red bell pepper, diced
1/4 cup cilantro leaves, minced
2 tablespoons lime juice, freshly squeezed
1/2 teaspoon kosher salt
4 salmon filets (about 5 ounces each)
1/4 cup water

Heat a large sauté pan over medium high heat. Add 2 teaspoons oil and swirl to coat bottom of pan. Add mushrooms and sauté 2 minutes. Add 1 tablespoon of dry citrus marinade mix to the mushrooms and continue cooking another 3 minutes. Remove mushrooms from the pan and place in a large mixing bowl. Add the corn, onion, red pepper, cilantro, lime juice and salt to the cooked mushrooms and toss to combine. In same sauté pan, add remaining teaspoon of oil and swirl to coat pan.

Sprinkle the top of each salmon filet with 1 teaspoon dry citrus marinade mix. Add salmon, seasoned side down, to hot pan and sear 1 minute. Flip over and add water to the pan. Cover and cook another 2 minutes, or until done to taste preferences. Remove from the heat and uncover.
Place a spoonful of the mushroom salsa on each serving plate, top with a salmon filet. Garnish with a sprig of cilantro and a lime wedge.

Photo and recipe courtesy of the Mushroom Council and mushroominfo.com

Bella Corp

Business-to-Customers

Grilled Portabella Caps Stuffed with Herb Cheese

Preparation Time: 2 minutes • Cooking Time: 13 minutes
Serves: 4 • Average cost per serving: $3.00

4 Portabella mushrooms, stems removed
1 tablespoon olive oil
2 Roma tomatoes, diced
1 cup baby spinach, rough chopped
1/2 cup spreadable reduced fat herb cheese
1/3 cup buttery crackers, lightly crushed

Heat grill to 400°. Brush both sides of mushrooms with oil. Mix tomatoes and spinach with herb cheese. Spread the gill side of each mushroom with 2 tablespoons of herb cheese mixture. Sprinkle with buttery cracker crumbs.
Place mushrooms, gill side up, on grill. Close cover and cook 13 minutes. For a more quiche-like consistency, cook 2 minutes more.

Photo and recipe courtesy of the Mushroom Council and mushroominfo.c

Mushroom and Egg Wrap

Preparation Time: 3 minutes • Cooking Time: 2 minutes
Serves: 1 • Average cost per serving: $1.25

1/4 cup potato, pepper and onion blend, diced, frozen
Pinch of kosher salt
1/2 cup white button mushrooms, sliced
1 egg, beaten
2 tablespoons (1/2 ounce) reduced fat cheddar cheese, shredded
1/2 teaspoon black pepper, freshly ground (to taste)
1 8–inch flour tortilla
2 tablespoons prepared salsa

Place potato, pepper, and onion blend in a 2–cup microwaveable measuring cup, loosely cover and microwave on high for 1 minute, stirring once and adding a pinch of salt at the 30 second mark.
Add mushrooms and microwave on high for another minute, stirring at the 30 second mark. Drain off excess liquid before stirring in the egg, then cover and microwave on high for 30 seconds. Remove from microwave and stir in cheese and pepper.
Spoon mixture into a warmed wrap and add salsa on top. Fold the botton of the wrap over the eggs, and then roll the remaining sides around.

Wrap in waxed paper and refrigerate until ready to eat. When ready to serve, place wrap in microwave on high for 45–60 seconds, just until heated through. Grab it and go! Individually, these wraps will hold in the refrigerator up to 3 days.

Photo and recipe courtesy of the Mushroom Council and mushroominfo.com

Bella Corp

Business-to-Customers

- Fact Cards
  - Nutritional facts
  - Storage and handling tips

Mushroom Facts

Nutrition:
Serving size: 5 medium mushrooms
Calories: 20
Total Fat: 0 grams • Protein: 3 grams
Vitamin C: 2% • Iron: 2%
Riboflavin: 20% • Selenium: 10%
Copper: 10% • Vitamin D: 4%

Care and Handling:

How to Select

- Firm with a fresh, smooth appearance
- Dry surface and plump appearance
- Closed veil under cap indicates delicate flavor, while an open veil and exposed gills mean a richer flavor

How to Store

- Store up to a week in the refridgerator
- Store in original packaging until use
- Once opened, store in porous paper bag for a prolonged shelf-life; avoid storing in air tight containers
- Never freeze fresh mushrooms

How to Clean

- Brush off dirt with damp paper towel or fingers
- Rinse briefly under runnign water and pat dry with paper towel
- Trim end of stem before using

Photo and recipe courtesy of the Mushroom Council and mushroominfo.com

Bella Corp

Walmart Packaging

Photo available at:
http://www.walmart.com/ip/J-M-Fresh-Sliced-Mushrooms-16-oz/10534524

Bella Corp

Questions?

Bella Corp

Thank You!

Bella Corp

Design Proposal Report

J-M Farms

Bella Corp

Brady Brewer Stephen Eller

David Haury Michelle Jones

TABLE OF CONTENTS

Introduction to the Problem

PROBLEM STATEMENT

Our project is to improve the harvesting and packaging efficiency at J-M satellite farms. The most important factors affecting design are: ergonomics, cost effectiveness, maintenance, and simplicity.

MISSION STATEMENT

Our mission is to provide a quality solution to improve J-M Farm's packing efficiency.

STATEMENT OF WORK

Objectives

Provide a quality solution to improve J-M Farms packing efficiency.

Task Background

J-M Farms is a mushroom production business located in Miami, Oklahoma. J-M Farms has a central mushroom production facility, along with five satellite farms located at various distances from the main facility. The five satellite farms grow primarily white mushrooms and harvest the majority of J-M Farms total product.

All of the mushrooms from J-M Farms are handpicked and placed into containers, known as tills. Tills are typically a foam material, but some are clear plastic containers, similar strawberry and other small fruit containers. Tills fit into returnable plastic containers, RPCs, which are rented and used to ship the mushrooms to corporate buyers, such as Wal-Mart. An RPC can hold twelve, six ounce tills. RPCs are the primary method used to ship mushrooms. Bulk mushroom orders are sold in five or 10 pound boxes. Currently, all of the mushrooms harvested at the satellite farms must be shipped to the main facility for packaging. This increases the amount of time it takes to get mushrooms directly to a supermarket shelf. Additionally, bruising is much more likely since the mushrooms are handled multiple times before it is a finished product, resulting in a shorter shelf life. At this time, mushrooms also are picked by volume, not weight. Therefore, the mushrooms must go through a Quality Assurance weighing station in the packing room. If pickers were able to pick by weight, not volume, the Quality Assurance line could be eliminated at the main facility.

If J-M Farms were able to use a mechanism, device, or cart that would package mushrooms in the picking room, the above mentioned problems would be eliminated.

Figure 1 on page 3 is a diagram of the production process and information flow at J-M Farms. Each segment of the production process is broken down by the time and distance it takes to complete each task. Figure 2 on page 4 is a diagram of the packing floor process. This displays the flow of mushrooms through the packing floor to distribution.

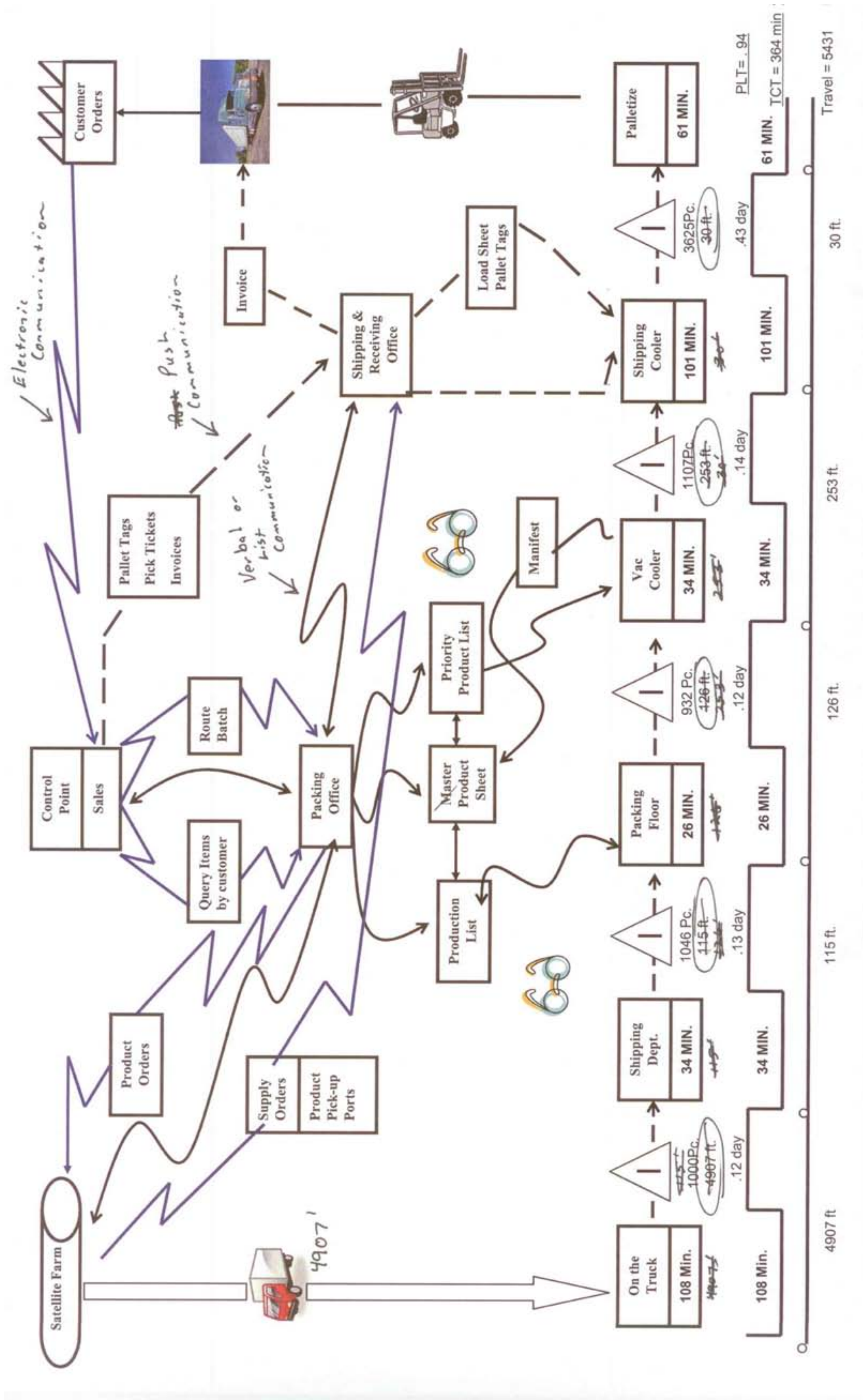


Figure 1 Production process and information flow courtesy of J-M Farms

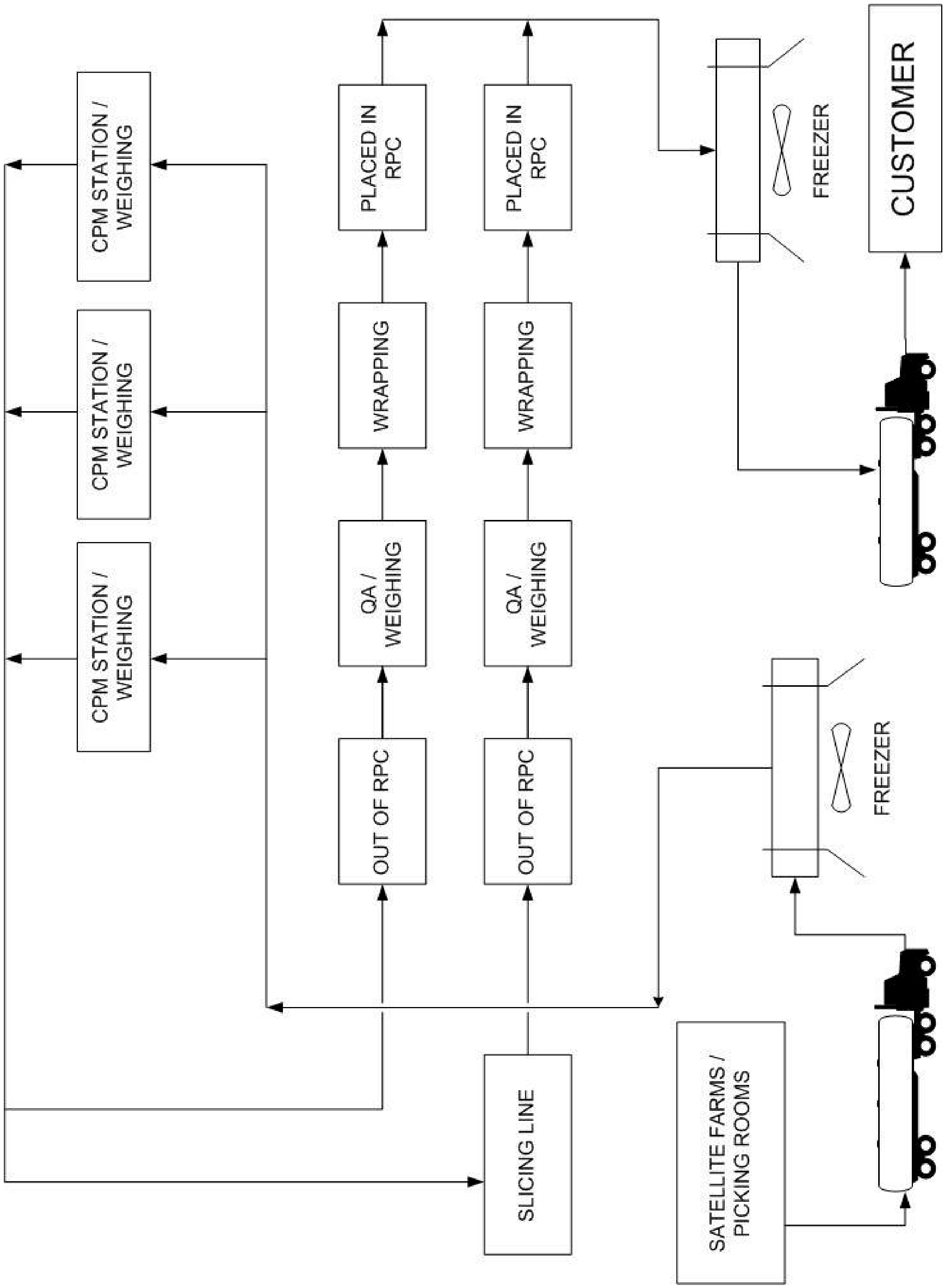

CPM STATION / WEIGHING
CPM STATION / WEIGHING
CPM STATION / WEIGHING
PLACED IN RPC
PLACED IN RPC
WRAPPING
WRAPPING
QA / WEIGHING
QA / WEIGHING
OUT OF RPC
OUT OF RPC
SLICING LINE
FREEZER
FREEZER
CUSTOMER
SATELLITE FARMS / PICKING ROOMS

Figure 2

Packing Line Detail

This project is primarily focused on the packaging and labeling of mushrooms in tills. Bulk packages are not as much of a packaging and handling issue as eight ounce, 12 ounce, and 16 ounce tills. Mushrooms picked at the satellite farms are shipped to the main facility, where they enter a cooling room. Next, they go to the Crop Production Measurement (CPM) line where each individual RPC is weighed. Here, the picker's data and traceability data is recorded. After weighing, the RPCs are moved to the packing line. The tills are then taken off the RPC, weighed for quality assurance, and go through a plastic wrapping machine to be properly sealed. A sticker is mechanically applied to each package. The tills are put back into RPCs, ready for shipping.

One problem with the current packing line is traceability. Once tills come off the RPC for packaging, traceability is lost. There is then no way to tell who picked the mushrooms in each individual till since the current labeling methods label RPCs and not individual tills.

Ideally, the mechanism produced by Bella Corp will eliminate the entire process above, or provide the means for it to take place at the satellite farms. Additionally, it will allow J-M to weigh the mushrooms by individual tills with proper labeling so the traceability is not lost.

Limitations

Mushrooms produce a thick brown film or grimy residue that is a major sanitation issue, especially with the added amounts of moisture present in the harvesting rooms. This brown residue creates major complications for moving or mechanical parts. Consequently, the number of moving parts that can be in the harvesting room is limited.

The next limitation is space. The rows in the picking rooms are only three feet apart. Today, J-M's current plastic wrap machine will not fit in the limited space. Other packaging mechanisms are likely to be large and prohibit flexible and quick movement throughout the picking room.

The final limitation is cost. There are over 100 pickers who work for J-M. If J-M were to adopt this method of picking and packaging mushrooms, there would need to be over 100 of these mechanisms or carts made. Since the cost of 100 carts is likely to be high, this will require a major capital investment.

Deliverables

Initially, Bella Corp viewed the project as a machine design project, where the deliverables would include a compact and moveable weighing and packing line, so each picker could package his or her mushrooms in the picking room. However, with the most recent trip on October 29, 2009, the team realized this problem may be too complicated with the limitations listed above.

As machine design was the initial concern, ergonomics was focused on very minimally. However, as Bella Corp keeps the big picture in mind, the team realizes the best way to accomplish the objectives will include some modifications to the packing line at J-M Farm's main facility. With the latest trip, the team has noticed there are significant losses in the packing room. Potential ergonomics studies include a temperature study, handling study, time-motion studies, and activity based costing.

Bella Corp is not dismissing any ideas or possibilities, but is looking for other opportunities to accomplish our purpose of improving J-M's packing line efficiency.

At this time, deliverables are in question, because the team is seeking to look for other ways to solve the problems. Each of the ideas will be presented to J-M Farms in early December, and deliverables will be decided based on our sponsor's recommendations.

Period of Performance
Project start date: August 17, 2009.
Project completion date: May 7, 2010.

Delivery Requirements
Deliverables schedule:

Item	**Delivery Date**
Competitive analysis report	Oct. 26, 2009
Statement of work	Oct. 30, 2009
Work breakdown structure	Nov. 2, 2009
Task list	Nov. 6, 2009
Design proposal report draft	Nov. 23, 2009
Design proposal report	Dec. 4, 2009
Design proposal oral presentation	Dec. 4, 2009
Self and peer evaluations	Nov. 30 - Dec. 4, 20009
Team web site	Dec. 7 - Dec. 11, 2009
Project notebooks	Dec. 7 - Dec. 11, 2010
Project leader interview	Dec. 7 - Dec. 11, 2011
Business draft	April 5, 2010
Campaign elements drafts	April 5, 2010
Working prototype	April 5, 2010
Finalized campaign elements	May 7, 2010
Final product	May 7, 2010

Table 1

The Bella Corp team leader will provide weekly updates to class professors on the progress of engineering, business, and communications deliverables.

WORK BREAKDOWN STRUCTURE

Communications

- Web Site
  - Pictures of Team
  - Conceptual Drawing
  - Execution
- Reports
  - Drafts
  - Editing
  - Review a Week Early
- Materials
  - Recipe Cards
  - Informational Cards

Engineering

- Design Concepts
  - Patent / Journal Article Search
  - Full evaluation of current system
  - Develop List of Pros/Cons for each Concept
  - Select Design based on input from J-M Farms
- Build Prototype(s)
  - Send designs to BAE lab for machining and parts acquisition
  - Acquire any needed electronics or non-structural parts
  - Assemble
- Testing
  - Run initial tests to make sure prototype is structurally sound and systems operate as expected
  - Transport to J-M Farms and leave for workers to use
  - Bring prototype back after trial run and make modifications based on input
  - Iterate until acceptable product is produced or time expires
- Draw up final plans for Product that will be produced by/for J-M Farms
- Gantt Chart

Economics

- Competitive Analysis
  - Market Research
  - J-M's Capabilities
  - Competition
- Business Plan
  - Cost Breakdown
  - Costly Processes that need to be redesigned
  - Overall Flow of System
- Proposed Budget for Prototype

TASK LISTS

Communications—Michelle

- Web Site
  - Pictures of Team—Completed on Friday, November 6, 2009

- Conceptual Drawing—Complete by Monday, November 23, 2009
- Execution—Complete by Monday, December 7, 2009
  - Build index page—Complete by Wednesday, December 2, 2009
  - Build team page—Complete by Friday, December 4, 2009
  - Build JM page—Complete by Saturday, December 5, 2009

- Reports
  - Drafts—Complete by Monday, November 23, 2009
    - Receive materials by Wednesday, November 18, 2009
    - Receive updated/corrected materials by Tuesday, December 1, 2009
  - Editing
    - First Draft—Complete by Sunday, November 22, 2009
    - Final Draft—Complete by Friday, December 4, 2009
- Materials
  - Recipe Cards—March 2010
    - Cost—January 2010
    - Recipes—February 2010
    - Method of Delivery—February 2010
  - Informational Cards—March 2010
    - Cost—January 2010
    - Information/Facts—February 2010
    - Method of Delivery—February 2010
  - Buyer Web page
    - Design—February 2010
    - Completed—March 2010
  - Package Recipe/Information Card—March 2010
    - Cost—January 2010
    - Recipes and Information—February 2010
    - Design—March 2010

Engineering—Stephen/David

- Design Concepts—Completed
  - Existing Documents
    - Journal Article Search
    - Patent Search
  - Full evaluation of current system
  - Develop List of Pros/Cons for each Concept
  - Conceptual Drawings/Sketches
- Develop Alternatives
  - List of Alternatives—Complete by Wednesday, November 18, 2009
  - Select Project based on input from J-M Farms—December 2009
- Project Planning
  - Work Breakdown Structure
  - Task List
  - Gantt Chart
    - First Draft—Completed by Monday, November 23rd
    - Final Draft—After Project is defined, December 2009

- Build Prototype(s)
    - Draw SolidWorks model(s) of Project parts needed to be fabricated—Completed by January 22, 2010
    - Send designs to BAE lab for machining and parts acquisition—January 2010
    - Acquire any needed electronics or non-structural parts—January 2010
    - Assemble
- Testing—February 2010
    - Run initial tests to make sure prototype is structurally sound and systems operate as expected
    - Transport to J-M Farms and leave for workers to use
    - Bring prototype back after trial run and make modifications based on input
    - Iterate until acceptable product is produced or time expires
- Draw up final plans for Product that will be produced by/for J-M Farms—April 2010

Economics—Brady

- Market Research
    - Industry Analysis—Completed
    - Consumer Research—Completed
- J-M's Capabilities
    - Management—Completed
    - Products—Completed by Monday November 23rd
- Competitive Analysis—Completed by Monday November 23rd
    - Internal Competition—Completed by Monday November 23rd
        - Picking Competition
        - Packing Line Competition
    - External Competition—Completed
        - Regional Competition
        - National Competition
- Cost Breakdown
    - Activity Based Costing for Entire Process
    - Overall Flow of System/Process Flow Chart—Completed
    - Identify Costly Processes that need to be redesigned—Completed by December 4th
    - Cost Saving from proposed redesign of project—Completed two week after final project is selected
- Proposed Budget for Prototype of Chart—Completed by two weeks after final project is selected
- Proposed Budget for Project—January 2010
- Business Plan—Compile all material by February

Revised Competitive Analysis/Market Research/Patent Search

Industry Analysis (from IBIS World)

THE ECONOMIC CONDITIONS AFFECTING THE MUSHROOM INDUSTRY ARE

Economies of Scale
Economies of scale in production generate cost savings for greenhouse growers. Specifically, economies of scale result in lower per unit growing costs that ultimately result in higher net returns.

Production of Premium Goods/Services
Farmers who produce premium fruit and vegetables can find buyers in the fresh produce market, where prices are highest as compared to the processing market, as well as generate brand loyalty.

Ability to Alter Goods and Services Produced in Favor of Market Conditions
The ability to alter the balance between various food crops in response to changes in market conditions is important for a farm's viability. Farmers need to be able to change their production mix to maximize farm returns.

Establishment of Export Markets
The ability to identify and market food crops to customers overseas reduces a farmer's dependence on the local market.

Appropriate Physical Growing Conditions
The presence appropriate growing conditions (such as sunshine and temperature levels) play a critical role in shaping the success of growing food crops under cover. Growing conditions influence harvest levels and crop quality.

Access to the Latest Available and Most Efficient Technology and Techniques
The success of farmers in this industry depends on using the latest available technology, to ensure efficient production of high quality fruit and vegetable.

Availability of Irrigation Water
Water access issues can impact on the quality of harvests and the area of land devoted to greenhouse production.

KEY SENSITIVITIES

The key sensitivities affecting the performance of the Mushroom & Tomato Production industry include:

Domestic Price - Horticulture - Mushrooms
An increase in the price of mushrooms impacts positively on returns at the farm gate. Price fluctuations reflect supplies levels, final consumer levels, global demand, and a

host of other factors.

Domestic Price - Horticulture - Vegetables
An increase in the price of food crops grown under cover impacts positively on returns at the farm gate. Price fluctuations reflect supplies levels, downstream vegetable processing activity, global demand, and a host of other factors.

Downstream Demand - Supermarkets & Grocery Stores in the US
Farmers of crops grown under cover rely on supermarkets and groceries for sales as mush of their produce is sold as part of forward contracts. Retailers will respond to a rise in retail demand by increasing their orders of food grown under cover. Rising demand generally results in greater activity in this US industry.

Exchange Rates - Trade Weighted Index
Base Year 1973 - historical and forecast data and analysis.
Exchange rate levels affect the price competitiveness of US exports of food crops grown under cover. An appreciation of the US dollar raises the price of the industry's output in international markets, thereby eroding the industry's price competitiveness.

Nutrition - Vegetables Consumption
Increased public concern about nutrition and diet is having a positive impact on the consumption of horticulture (including that grown under cover). According to the USDA, Americans need to increase their vegetable consumption by about 25% in order to meet health recommendations.

Quarantine Restrictions (Overseas) - Mushroom & Tomato Production
The presence of quarantine restrictions and other artificial barriers to trade adversely impact on US vegetable and fruit exports. Countries like Australia have traditionally imposed tight restrictions on horticultural imports, seriously inhibiting exporting efforts by US growers.

INDUSTRY SIZE AND GROWTH

Inflation Adjusted	2005	2006	2007	2008	2009	
Industry Revenue	*1,221.8	*1,187.6	*1,230.2	*1,291.5	*1,338.9	$Mil
Industry Gross Product	*568.1	*546.3	*553.6	*590.1	*612.8	$Mil
Number of Establishments	*326	*335	*330	*328	*324	Units
Number of Enterprises	*320	*329	*325	*232	*319	Units
Employment	*1,680	*1,700	*1,667	*1,750	*1,785	Units
Exports	*26.7	*28.9	*44.3	*58.6	n/a	$Mil
Imports	*97.7	*98.2	*97.3	*89.3	n/a	$Mil
Total Wages	*175.6	*176.5	*187.9	*182.1	n/a	$Mil
Domestic Demand	*1,292.8	*1,256.9	*1,283.2	*1,322.2	NC	$Mil
Mushroom production	*853.2	*843.4	*851.5	n/a	n/a	Million Pounds (lb)

Table 2

Real Growth	2005	2006	2007	2008	2009	
Industry Revenue	*1.0	*-2.8	*3.6	*5.0	*3.7	%
Industry Gross Product	*-1.7	*-3.8	*1.3	*6.6	*3.9	%
Number of Establishments	*5.8	*2.8	*-1.5	*-0.6	*-1.2	%
Number of Enterprises	*6.0	*2.8	*-1.2	*-28.6	*37.5	%
Employment	*7.0	*1.2	*-1.9	*5.0	*2.0	%
Exports	*-13.7	*8.2	*53.2	*32.2	NC	%
Imports	*16.1	*0.5	*-0.9	*-8.2	NC	%
Total Wages	*-2.5	*0.6	*6.5	*-3.1	NC	%
Domestic Demand	*2.4	*-2.8	*2.1	*3.0	NC	%

Table 3

RELEVANT TRADE PUBLICATIONS

Citrus and Vegetable
The Packer

Customers/ Buyer Information

CONSUMER RESEARCH

Please see appendix

CONSUMER ANALYSIS

Please see appendix

ECONOMIC STATUS OF YOUR CUSTOMERS/BUYERS

Mushroom Buyers Tend to be Wealthier and Highly Educated.

- Income of about $70, 000 or more
- Households tend to be more educated with bachelor's degrees as well as masters and doctorates.

DEMOGRAPHIC CHARACTERISTICS OF CUSTOMERS/BUYERS

Ethnicity of Mushroom Buyers

- Majority of consumers are Caucasian with an increase towards Asian households

Purchasing Characteristics of Mushroom Buyers

- Mushroom consumers tend to purchase mushrooms four to five times per year.
- Average consumer spends $10 a year on mushrooms.

Demographic Profile by Region

- West
  - Income $70,000 or more
  - Two member household
  - Empty nesters, living comfortably, childless younger couples
    - Affluent
    - Asian
- Central

- Income $70,000 or greater
- Childless younger couples, middle aged singles, older singles, younger singles, childless younger couples, established families
  - Affluent
  - Hispanic

- East
  - Income $70,000 or above
  - Three to four member households
  - Older Female head of household, new families, empty nesters
    - Affluent
    - Asian
- South
  - Income $50-70,000 or more
  - Five member or greater household
  - Kids less than six years old
  - Childless younger couples, empty nesters living comfortably
    - Affluent
    - Asian, Hispanic & Other Race

Buyer Distribution by Region

The buyer distribution by region is almost equal with the South having the largest buyer distribution of 28 percent.

- West 25%
- East 23%
- Central 24 %
- South 28 %

Buyer Distribution by Mushroom Type

- Packaged Mushrooms
  - West 20%
  - East 24%
  - Central 25%
  - South 31%
- Raw Mushrooms
  - West 44%
  - East 20%
  - Central 14%
  - South 22%

The demographics of mushroom buyers are very important because it identifies the type of customer currently purchasing mushrooms as well as new customers to pursue in the market.

CHARACTERISTICS OF BUYING FIRMS/GOVERNMENT AGENCIES

Customer Influence on Buying Firms

- Mushroom shoppers are valuable to retailers. The average shopping basket with mushrooms is double the value of shopping baskets without mushrooms.
- Specific products are usually purchased with mushrooms
  - Fresh carrots, packaged salads, lettuce and fresh potatoes

    - Sour cream, shredded cheese, yogurt and fresh eggs
    - Spaghetti/ marinara sauce, canned soups, margarine and spreads
- Target customers and customer preference per region
    - West
        - Bulk items or smaller package sizes
        - Position in high end, perhaps part of gourmet meal solution
        - Asian recipes for point of source materials
    - Central
        - Offer larger package sizes
        - Position in high end, perhaps part of gourmet meal solution
        - Hispanic recipes for point of source materials
    - South
        - Offer larger package sizes
        - Position in high end, perhaps part of gourmet meal solution
    - East
        - Some bulk with moderate package sizes
        - Position in high end, perhaps part of gourmet meal solution
        - Asian and Hispanic recipes for point of source materials.

Penetration & Buy Rate by Market

- Penetration is highest among the San Francisco, Los Angeles, and Chicago markets.

Deal Activity

- A greater percentage of mushroom dollars is sold by deals (features, displays, store coupons, manufacturer coupons, and other deals such as price packs or bonus packs) than other vegetables. Almost a third of all packaged mushroom sales are associated with deals.
- The East region has the highest deal activity followed by the Central region, followed by the South region, and finally the West region.

Buying Channel

- Grocery Stores – 1
- Super Centers – 2
- Mass – 3
- Warehouse Club – 4
- Fruit Stand – 5, portion of raw mushroom consumers purchase here.

PSYCHOGRAPHIC CHARACTERISTICS OF CUSTOMERS/BUYERS (HOW DO THEY THINK?)

Convenience

- Today's cooks want to cook 15 minutes for less
- Ease of preparation is very important
- Low price is only moderately important
- Speed of Consumption is only moderately important
- Ready-to-eat/ no preparation is moderately important
- Portability is slightly important
- Ready-to-heat ingredients are very important
- Mushrooms are an impulse purchase

Obstacles

- I don't like or have time to get them ready
- I forget to buy them
- I don't know how to use them
- I don't know how to store them

HOW IS THE PRODUCT USED? HOW COULD IT BE USED?

Cooking Facts

- Mushrooms are very easy to cook
- They are very, very fast to cook
- They go with most every food
- They are available all year
- They come in varieties

Nutritional Facts

- They are low in carbohydrates
- They are low fat

AVAILABLE MARKET RESEARCH- PROMOTIONAL PROGRAMS AND CURRENT CAMPAIGNS

Current Programs

- Placement next to bagged salad section
- Secondary displays
  - Inside bagged salad section
  - Meat alternative healthy section
  - Organic produce section
- Proper assortment and display
  - Larger displays of sliced, minimum 50 percent of display
  - Feature browns at eye level and minimum 20 percent of display
- Promote frequently and across the different sub-categories
- Cold chain temperatures are key to fresher product, longer shelf-life, better sales and less shrink

Possible Programs

- Targeted programs on usage and preparation. In store demos and point of source material with recipes are recommended to boost penetrations.
  - These should be formed with Hispanic and Asian population in mind.
- Point of Source materials
  - Recipe booklets/labels
  - Informational signs
  - Informational Web site.
- Place mushrooms in a variety of food areas based on what they can be served with which increases purchasing. Place in meat sections, salad sections, etc.
- Consumers purchase for specific occasions, may need to create more occasions and options
  - Summer grilling recipes/themes
  - Holiday recipes

The customer information and market research suggests programs need to be implemented to inform current and potential customers with more information about mushroom, including nutritional analysis, handling and storage, preparation, and recipes. Using point of source materials looks to have the most potential for reaching the customers with this information.

Client Company and its Resources

MANAGEMENT TEAM (EXPERIENCE AND KEY PEOPLE)

Pat Jurgensmeyer
President, J-M Farms
PatJ@JMFarms.com
918-533-3520

Terry Jurgensmeyer
President, Miami Industrials Supply
TerryJ@MiamiIndustrialSupply.com
918-533-4005 Cell
918-542-6311 Office

Steve Engelbrecht
Satellite Farm Owner
EFI@jmfarms.com
918-533-0390

Eric Riley
Satellite Farm Manager
JMCI@jmfarms.com
918-533-5485

John Tune
Satellite Farm Manager
QMI@jmfarms.com
918-533-8863

MANUFACTURING EXPERTISE AND CAPACITY

J-M Farms, Inc
7001 S 580 Rd
Miami, Oklahoma 74354-6501

- Stock Symbol: J-M Farms, Inc
- Line of Business: Covered Food Crops Farm Mfg Food Preparations
- Estimated Annual Sales: $12,800,000
- Estimated # of Employees: 320
- Year Founded: 1979
- Estimated Employees for This Location: 320

http://www.allbusiness.com/companyprofile/J-M_Farms_Inc/F2AEFBE73033412DBB40834BBF346057-1.html

Competitor Analysis

MAJOR PLAYERS IN MARKET SEGMENT

The US Food Crops Grown Under Cover Industry is characterized by the presence of privately owned farms, with an average harvested area of less than 10 acres. Apart from Monterey and Sylvan, some large establishments do operate in this industry, and these are often forward-integrated into grading and packaging.

Top Companies by Sales

1. Monterey Mushrooms, Inc
2. Creekside Mushrooms, Ltd
3. Amycel, Inc
4. C P Yeatman & Sons Inc
5. Elite Mushroom Co Inc
6. J-M Farms, Inc
7. Gino Gaspari & Sons Inc
8. To-Jo Mushrooms, Inc
9. Leo, John C & Son, Llc
10. Gourmet's Delight Mushroom Co Inc

AllBusiness has profiles of 258 companies in Mushroom Production. Taken together these companies have estimated annual sales of $591,848,493 and employ an estimated 10,063 people.
http://www.allbusiness.com/companyindex/Mushroom_Production/669801A3F365CB68179C6534632FB340-1.html

Monterey Mushrooms

260 Westgate Drive
Watsonville, Ca 95076
Tel: (800) 333-Mush (6874)
Fax: (831)763-0700
www.montereymushrooms.com

Overview

Monterey Mushrooms, Inc. was established in 1971 as a single farm operation in Royal Oaks, California. Today, this multi-site business is headquartered in Watsonville, California, and has production, sales and administrative offices, internationally. Monterey is the country's largest and only national marketer of fresh mushrooms, supplying products for sale to supermarkets, foodservice and ingredient manufacture operations, and for preparation of processed, canned, and frozen mushroom products. Monterey Mushrooms has15 percent Market Share (estimated $350 Million annual revenues).

The following map is a distribution map for the Monterey Group of Mushroom Farms. As demonstrated by the map, Monterey has distribution across the United States and Mexico

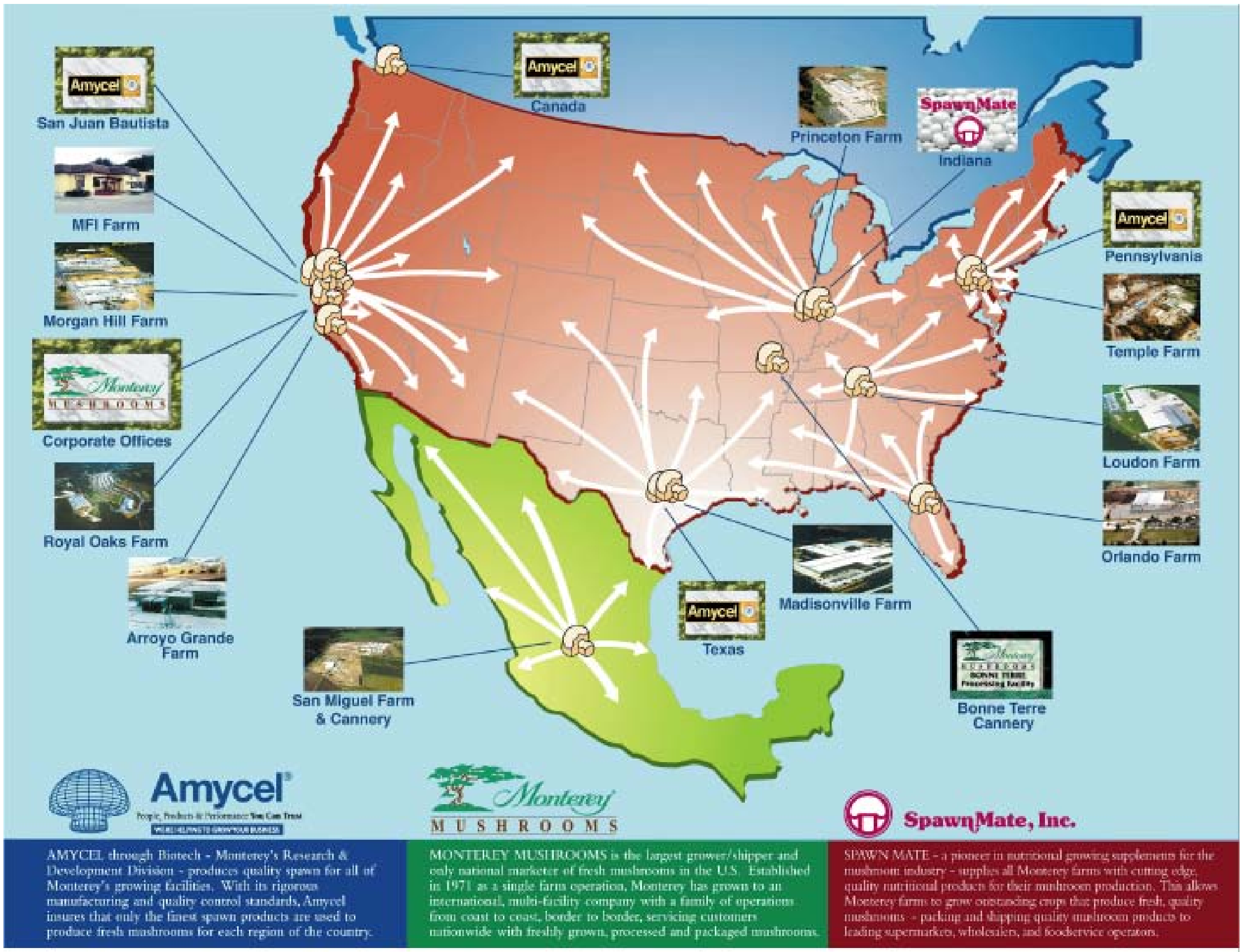


Figure 3 http://www.montereymushrooms.com/overview.htm

Products

- Retail
    - Clean N Ready® Mushroom
    - Clean N Ready® Bagged Packs
    - Gourmet White Mushrooms
    - Gourmet Portabella Mushrooms
    - Baby Bellas / Brown Mushrooms
    - Gourmet Specialty Mushrooms
    - Fresh Dried Mushrooms
    - Organic Mushrooms
- Processed
    - Canned Stems & Pieces Mushrooms
    - Canned marinated Mushrooms
    - Fresh Jarred marinated Mushrooms

- Frozen Sauces
- Refrigerated Quick Blanched Mushrooms
- Services/Product Development/Private Label

Regional Productions Sites

- Royal Oaks, CA
- Las Lomas, CA
- Morgan Hill, CA
- Arroyo Grande, CA
- Madisonville, TX
- Loudon, TN
- Temple, PA
- Princeton, IL
- Orlando, FL
- San Miguel, Mexico

Creekside Mushrooms Ltd.

One Moonlight Drive
Worthington, PA 16262-9730
724-297-5491
http://www.creeksidemushrooms.com/contact.htm

Overview

Creekside Mushrooms Limited is the world's largest underground mushroom farm, 300 feet under the earth, in a 150-mile web of tunnels originally created by limestone mining. Creekside is the world's largest mushroom growing facility and the only underground mushroom farm in the United States. Creekside is comprised of over 500 people from the local community. Creekside's major market focus is retail and foodservice with our commitment to provide long term partnerships with each and every customer.

Products

QTY.	OVERWRAP WHITES	QTY.	OVERWRAP SPECIALTY	QTY.	JARED & CANNED
	4oz. Miniatures - 6		3.5oz. Oyster - 6		8oz. Jars Marinated - 12
	4oz. Mini-Sliced - 6		3.5oz. Shitake - 6		8oz. Jars Garlic Italian - 12
	8oz. Sliced - 6		3.5oz. Enoki - 6		8oz. Jars Sweet Italian - 12
	8oz. Sliced - 12		4oz. Gourmet Blend - 6		8oz. Jars Zesty Salad- 12
	8oz. Whole - 12		6oz. Baby Bella - 6		8oz. Jars Mixed Pack - 12
	10oz. Whole - 10		6oz. Baby Bella's sliced		4oz. Cans Stems&Pieces - 24
	12oz. Whole - 10		10oz. Baby Bella's - 10	**QTY.**	**DRIED MUSHROOMS**
	14oz. Moon-Bello's - 8		6oz. Portabella Caps - 6		.5oz. Dried Combo #1 - 10
	16oz. Whole - 8		6oz. Portabella Sliced - 6		.5oz. Dried Combo #2 - 10
	24oz. Family Pak - 6		7oz. Portabella n' Sauce - 6		.5oz. Dried Combo #3 - 10
			14oz. Portabella Caps - 4		.5oz. Dried Combo

QTY.	BULK WHITES		3.2oz. Bella Burgers - 6	QTY.	WILD MUSHROOMS
	3 lb. Fancy large		8oz. Exotic Tri-Pac - 5		2oz. Chanterelle - 6
	5 lb. Medium		2.5oz. Beech - 6		2oz. Hedgehog - 6
	5 lb. large		3.5oz. Maitake - 6		1oz. Black Trumpet - 6
	5 lb. Sliced		Variety Pack - 6		2oz. Woodear - 6
	5 lb. Sliced Tubs x 1				.75oz. Morel - 6
	5 lb. Sliced Tubs x 2	**QTY.**	**BULK SPECIALTY**		1.5oz. Porcini - 6
	10 lb. small		2 lb. Enoki		2oz. Lobster - 6
	10 lb. medium		3 lb. Oysters		5 lb. Chanterelle
	10 lb. Large		3 lb. Shiitake #1's		5 lb. Hedgehog
	10 lb. Jumbo		3 lb. Shiitake #2's		5 lb. Black Trumpet
	10 lb. Sliced 3/16"cut **thick**		4.5 lb. Combo Pack		5 lb. Woodear
	10 lb. Sliced 1/4"cut **thick**		3 lb. Port Caps 3 1/2"		1 lb. Morel
	10 lb. Value Pack		3 lb. Port Caps 4 1/2"	**QTY.**	**ORGANIC MUSHROOMS**
	10 lb. Fresh matures		5 lb. Baby Portabellas		8oz. White Whole - 6
	10 lb. Fresh Pieces		5 lb. Portabella Sliced		8oz. White Whole - 12
			5 lb. Portabella Small		8oz. Baby Bellas - 6
			5 lb. Portabella		8oz. Port. Sliced - 6
			10 lb. Baby Portabellas		8oz. Port. Caps - 6

Table 4

Amycel Inc.

260 Westgate Drive
Watsonville, CA 95076
831-763-5300
831-763-0700 or 763-0700 Fax
http://www.amycel.com

Overview

Mushroom spawn is produced by Amycel Inc. at one of its 2 locations in the United States, San Juan Bautista California and Madisonville Texas.
Amycel San Juan Bautista is also the site for production of the inoculums used at all Amycel spawn plants. Culture maintenance and inoculum production activities are conducted by technicians with many years of experience in all phases of spawn production. Master cultures are preserved in liquid nitrogen for long term stability with duplicate cultures stored at the Biotechnical Research Laboratory.
Amycel San Juan Bautista is the home office for the company, not only for inoculum production, but for business administration and process development.
Amycel produces a full range of mushroom spawn including off white hybrids, brown strains for Portabella / Crimini production, in addition to Pleurotus (oyster) and Shiitake strains.

Logos:

Figure 4 and 5

C P Yeatman & Sons Inc.

600 North Baker Station Rd.,
West Grove, PA 19390
610-869-7211
http://www.organicmushrooms.com

Divisions of C P Yeatman & Sons Inc.

- Mother Earth Organic Mushrooms
- Mother Earth Country Store
- Mushroom Specialties Marketing Division

Overview

Organic refers to an "earth friendly" method of growing and processing foods. Weeds and pests are controlled using environmentally sound practices which sustain the health of our planet. Our Organic Mushrooms are grown to these strict standards to insure you a healthy, delicious product.

Logo:

Figure 6

Phillips Mushroom Farms

1011 Kaolin Road
Kennett Square, PA 19348
1-800-722-8818
www.phillipsmushroomfarms.com

Phillips Mushroom Farms is located in eastern Pennsylvania. They are not a direct competitor with J-M Farms as they do not sell east of the Mississippi River. They recently converted all of their production facilities to new, state of the art facilities that supposedly add shelf life to the mushroom once it is harvested. Phillips also has another legal entity under its ownership call Phillips Gourmet Mushrooms. This entity specializes in gourmet blends and specialty orders.

Strict Quality Control

- Trained lab technicians inspect all mushroom spawn to ensure pure mushroom cultures.
- All Phillips mushrooms are hand picked, graded and packed swiftly to maintain freshness.
- Phillips Mushroom Farms sells over 35 million pounds of specialty mushrooms per year, more than any other mushroom farm in the United States.
- Phillips Mushroom Farms is capable of shipping to every major city in the United States and Canada.

State Of The Art Equipment

- Phillips Mushroom Farms has invested millions of dollars to build research facilities and expand production capabilities. (Over 1 million square feet of growing space.)
- Post-Harvest Vacuum Cooling helps to keep Phillips mushrooms fresher longer.
- Research Mycologists work to bring new varieties to the marketplace.
- Computer-controlled growing environments help to maintain quality and consistent production of Phillips specialty mushrooms

Logos:

PHILLIPS MUSHROOM FARMS, L.P.

Figure 7

PHILLIPS GOURMET MUSHROOMS

Figure 8

Packaging Photos:

Figure 9 and 10

OTHER PLAYERS

Eurofresh (estimated market share: 4 percent)

Established in Pennsylvania in 1992, Eurofresh now operates one of the largest greenhouses in the US, located in Arizona over 265 acres. The company is one of the biggest producers of greenhouse tomatoes, with annual sales of about $55 million. According to its web site, Eurofresh has a 20 percent share of the greenhouse tomato market in the US, producing up to 600,000 pounds of tomatoes each week. The company has been introducing new varieties, such as the Campari tomato, in an effort to increase its share of the foodservice market.

Village Farms (estimated market share: 2 percent)

Since it began operations in 1991, Village Farms expanded their greenhouses from 10 to over 130 acres, relocating from Pennsylvania to Texas, in order to supply tomatoes year-round. The company also grows peppers and cucumbers.

Mountain Meadow Mushrooms (estimated market share: less than 1 percent)

Mountain Meadow Mushrooms is primarily engaged in the production of mushrooms. At its central 17-acre facility in California, the farming operation grows white button, brown crimini and Portobello mushrooms for sale and distribution across the US. According to reports, Mountain Meadow harvests up to 17,000 pounds of mushrooms every day of the year, with annual sales of about $7.5 million.

Technical Analysis

SCIENTIFIC LITERATURE REVIEW

Introduction

- There is not much technical or scientific research available on mushroom packaging or packing lines. Additionally, research on mushroom production, harvesting and handling techniques, and bruise elimination is limited as well. Therefore, research on similar fruits and vegetables, such as apples, peaches, strawberries, tomatoes, etc. will have to be sufficient for investigation. The articles below cover a variety of topics, and will be broken into several categories. Some articles are applicable to more than one research area, but will only be listed on one category.
- The authors and abstracts of each article are available in alphabetical order by article title in the appendix material.

Scientific Articles

- Mushroom Production
    - "Design of a Shitake Mushroom Packing Line"
    - "Grading of Mushrooms using Machine Vision System"
- Packing Lines
    - "Peach Physical Characteristics for Orientation"
    - "A Procedure for Testing Padding Materials In Fruit Packing Lines Using Multiple Logistic Regression"
    - "Sorting Table Illumination on Stonefruit Packing Lines in California"
- Packing Line Impact/Damage Evaluation
    - "Analysis of the Factors Implied in the Fruit to Fruit Impacts on Packing Lines"
    - "Analysis of the Mechanical Aggressiveness of Three Orange Packing Systems: Packing Table, Box Filler and Net Filler"
    - "Assessment of Apple Damage on Packing Lines"
    - "Fruit Damage Assessment in Peach Packing Lines"
    - "Impact Bruise Estimates for Onion Packing Lines"
    - "Impacts Recorded on Avacado, Papaya, and Pineapple Packing Lines"
    - "Instrumented Sphere Impact Analysis of Tomato and Bell Pepper Packing Lines"
    - "Packing Line Bruise Evaluation for 'Walla Walla' Summer Sweet Onions"
- Packing Line Impact/Damage Reduction
    - "Apple Packing Line Damage Reduction"
    - "Reduction of Mechanical Damage to Apples in Packing Lines Using Mechanical Devices"
- Packaging/Shipping
    - "Analysis of Automatic Weight-Fill Bagging Machinery for Fresh Citrus"
    - "Suspended Tray Package for Shipping Soft Fruit"
- Bruise Estimation and Evaluation Articles
    - "Apple Impact Damage Thresholds"
    - "Fruit and Vegetable Bruise Threshold Prediction Using Theory of Elasticity and Failure Tissue Properties"

- Mechanical Harvesting Articles
    - "Mechanical Harvesting System for Burley Tobacco"
    - "Multi Purpose, Vegetable Production Machine Investigation"

PATENT SEARCHES

Electronic Scale

If we incorporate a scale into the cart design, there will likely need to be an integrated printer that can print a barcode sticker to label each till. These four patents deal with the design of a scale, some of them including a printer.

- *Electronic Scale Printer*
    - **United States Patent # 4,700,791**
    - http://www.google.com/patents?id=8cg5AAAAEBAJ&pg=PA1#v=onepage&q=&f=false
    - This invention provides an electronic scale printer, and more particularly an electronic scale printer in which a printer is connected electrically to the electronic scale used in a department store or supermarket etc., and required data are printed on a printing sheet under an instruction from the electronic scale and issued from the printer. The invention provides a printer capable of issuing both a label and a receipt through one printing means and more particularly an electronic scale printer in which either a label or a receipt corresponding to the kind of printing sheet stored in a cassette is printed and issued under proper replacement of the cassette having printing sheet for label stored therein with a cassette having a printing sheet for receipt stored therein.

- *Computing Scale System*
    - **United States Patent # 4,091,449**
    - http://www.google.com/patents?id=_9QvAAAAEBAJ&pg=PA1#v=onepage&q=&f=false
    - Disclosed is a computing scale system utilizing an integrated circuit microcomputer for computing the value of a product being weighed and for controlling the operation of a label printer associated therewith. The microcomputer operates with 4-bit words, and there is provided a multiplexing network for multiplexing weight, price, and status information into the microcomputer. Weight readings are made by a bank of photo sensors, which read the position of a chart moveable in response to weight on the scale platter. Means are provided for performing a parity check on the data read by the weight photocells, and the data so read is converted from Gray code to BCD code by a table lookup routine. The scale system may print labels having weight and computed value, zero weight and fixed value, or weight and fixed value. The scale has both selectable price and weight dead zone capability with adjustable range. There is a motion detection routine employing a variable settling time.

- *Digital Electronic Scale*
    - **United States Patent # 4,153,125**
    - http://www.google.com/patents?id=UxcvAAAAEBAJ&pg=PA1#v=onepage&q=&f=false
    - A platform type weighing scale is provided having a horizontally disposed base, a vertically disposed column mounted on an extension of said base with a hollow base portion in said column and a load beam mounted in said hollow base portion connected through a lever to a weighing mechanism beneath said platform, said load beam having one or more electrical strain gauges mounted thereon which are connected to a read-out meter mounted on said column to show measurements in units of weight. The housing for the read-out meter is preferably adapted to rotate horizontally or to tilt from the vertical or both and can also be removed so as to provide a number of options including a high level scale, a waist high personal scale, or a desk top or wall mounted remote unit.

- *Portable Electronic Scale of Minimal Thickness and Weight*
    - **United States Patent # 4,800,973**
    - http://www.google.com/patents?id=qK42AAAAEBAJ&pg=PA1#v=onepage&q=&f=false
    - A portable electronic scale of minimal thickness and weight is provided which is suitable for measuring the weight of an individual or object and which can be easily carried hi a bag, stored in a cabinet or hung on a wall. The scale comprises a single load-bearing composite plate of composite (sandwich) construction with its principle strength concentrated on its top and bottom surfaces, and including a center core plate which includes a number of small cavities for electronic components. A plurality of shallow supporting feet exert a force from below on a plurality of mechanically deformable elements embedded rigidly in the composite plate, which force is measured and translated by electronic transducers such as strain gauges into electrical signals. These signals are summed in a Wheatstone bridge configuration, amplified and converted electronically to a digital display of the weight. The electronic circuitry fits within the composite plate and consumes very small amounts of current when in use so that the need for a thick battery is eliminated. The scale (excluding the shallow feet) is less than £" in thickness and weighs less than one pound.

Wireless Communications

Depending on what electronics are used on the cart, they may need to communicate with the J-M server to update the CPM system remotely. Since the carts must be moved throughout the satellite farm, a wireless connection would be necessary.

- *Network Address Management for a Wired Network Supporting Wireless Communication to a Plurality of Mobile Users*
    - **United States Patent # 5,159,592**

- o http://www.google.com/patents?id=MiAhAAAAEBAJ&pg=PA1#v=onepage&q=&f=false

- o Apparatus and method for managing bidirectional transmission of information between a wired network and at least one mobile communication unit (10) in wireless communication with the wired network. The wired network is of the type wherein users of the network are each assigned a unique network address such as in, for example, a TCP/IP network. In accordance with the invention there is provided a local gateway (16) coupled between a wireless LAN and the wired network for communication with a mobile communication unit. There is also provided a global gateway (18) coupled to the local gateway and to remote users of the network. The global gateway functions to maintain a plurality of network addresses and, in response to a request for an assignment of a network address from the mobile communication unit, assigns one of the plurality of network addresses to the requesting mobile communication unit. The global gateway also buffers and routes data received from a remote user, the data being directed to an address corresponding to the assigned network address, to the mobile communication unit having the assigned address.

- *Wireless Local Area Network Communications System*
  - o **United States Patent # 5,276,703**
  - o http://www.google.com/patents?id=-qQgAAAAEBAJ&zoom=4&pg=PA1#v=onepage&q=&f=false
  - o A local area network including at least one hub unit, at least one associated station unit and a wireless communication link between each hub unit and its associated station units. The communication link includes a wireless down-link channel for transferring information from each hub unit to its associated station units and a wireless up-link channel for transferring information from each station unit to its associated hub unit. Communication is conducted in accordance with a combination time division multiplexing and contention based protocol. A synchronized common slotted time frame between each hub unit and its associated station units is imposed by the hub unit.

Packaging
To weigh the tills individually, they must be filled individually. Perhaps a good way to close the package and apply a sticker would be to do it at the same time. Also, till design must be conducive to efficient cooling, as shelf life increases as cooling time decreases.

- *Package Closing Label*
  - o **United States Patent # 5,866,183**
  - o http://www.google.com/patents?id=cQ8XAAAAEBAJ&pg=PA1#v=onepage&q=&f=false

    - A packaging label includes a first portion with permanent pressure sensitive adhesive on its bottom face and a second portion substantially perpendicular to the first portion and having permanent pressure sensitive adhesive on the bottom lace remote from the first portion. The second portion typically includes nutritional information and bar coding since the label is typically used with clam shell plastic packages for fruits or other food items. The first portion of the label is adhesively secured to the lid of a clam shell container and after the container is filled with food items, the lid is closed, the second portion of the label is unfolded from a compact position which facilitates stacking and transportation, and the adhesive on the second portion is secured to the bottom of the container, holding the lid closed. The bar coding is preferably on the top face of the second portion opposite the adhesive so that it can be scanned merely by dragging the bottom of the container over a scanner (e.g. in a grocery store).

- *Method and Container for the Improved Packing and Cooling of Produce*
    - **United States Patent # 5,738,890**
    - http://www.google.com/patents?id=VwMdAAAAEBAJ&zoom=4&pg=PA1#v=onepage&q=&f=false
    - Method for improved packing and cooling of produce by improving the flow of ventilation air to the produce, and apparatus to practice the method. According to the present invention, baskets for the packing of fruit are provided with ventilation channels disposed upon a lower surface of the basket Vent apertures communicate between the ventilation channels and the produce stored in the baskets. After packing the baskets with produce, they are loaded into trays. The trays are provided with tray vents which align with the ventilation channels. In this manner, entire pallets of produce-filled baskets can be efficiently chilled by introducing a flow of cooling air into the tray vents, through the ventilation channels and thence through the produce packed inside. The trays and baskets are sized so as to occupy all of the surface area of a standard shipping pallet, and to minimize the movement of the baskets within the trays, and of the trays with respect to one another.

- *Tray for the Improved Packing and Cooling of Produce*
    - **United States Patent # 6,007,854**
    - http://www.google.com/patents?id=UC0YAAAAEBAJ&pg=PA1#v=onepage&q=&f=false
    - Method for improved packing and cooling of produce by improving the flow of ventilation air to the produce, and apparatus to practice the method. According to the present invention, baskets for the packing of fruit are provided with ventilation channels disposed upon a lower surface of the basket. Vent apertures communicate between the ventilation channels and the produce stored in the baskets. After packing the baskets with produce, they are loaded into trays. The trays may be provided with tray

vents which align with the ventilation channels. Alternatively, the trays may be formed without tray vents to improve some cooling regimes. In this manner, entire pallets of produce-filled baskets can be efficiently chilled by introducing a flow of cooling air into the baskets and thence through the produce packed inside. The trays and baskets are sized so as to occupy all of the surface area of a standard shipping pallet, and to minimize the movement of the baskets within the trays, and of the trays with respect to one another.

Definition of Customer Requirements & Development of Engineering Specifications

CUSTOMER REQUIREMENTS

J-M Farms "hired" our team to improve the efficiency and quality of their mushroom packaging process, specifically at their satellite farms. Their suggestion at the beginning of the project was a new cart that would be able to carry out all of the functions of the packaging line in a compact unit.

This new picking/packaging cart was not a requirement, but it is one of the possibilities we have considered. As we have collected more data and assessed the situation more in-depth, we realized we are more of a consultant team than a design team.

This actually means we have a greater ability to help J-M Farms better their product and productivity, because our view isn't narrowed to a single facet of the harvesting or packaging process. Our end product will still be to improve the efficiency and quality of the mushroom packaging process, but it might be as much of a process refinement as a new machine.

RADICAL IDEAS

Team Pay Groups

The current system pays the picker by the pound and the packing line workers at an hourly rate. In this system, the picker is paid for the mushroom he has picked, even if some of them get dropped or spilled later down the line. Instead of approaching it as "you do your job, I do mine," the workers could be reorganized into team pay groups. The team would get paid based on what goes onto the truck, ready to ship out. This would increase motivation to decrease waste and would foster teamwork among the members across the different steps in the harvesting process.

Sell Tills by Count, not by Weight

Mushroom tills sold in stores today must meet a certain minimum weight. This unfortunately leads to unsold product, as the customer doesn't pay for whatever excess is in the container. Meat, on the other hand, has a variable price determined by what the weight is. This allows for a larger range of acceptable values, while assuring that the entire product is being paid for.

This concept could be applied to mushrooms by packaging tills by the number of mushrooms inside, not by a goal weight. The till could be weighed once, yielding a sticker to show what weight the box is. If a store still insists mushrooms be sold by weight, the weight would be available, but the process of packing would be much simplified. As it is now, each till must be weighed three times to assure it meets minimum weight. Placing a certain number of mushrooms inside a till would be easy for the picker to do without any fancy equipment.

Proposed Media/Communications Plan

MEDIA MATERIALS

The communications plan for J-M Farms includes both business-to-business elements as well as business-to-customer elements. While the business-to-business relationship is already developed, there are areas of improvement. Based on customer analysis, the best way to reach the customer is through point of source materials.

Business-to-Business

- Web page
  - J-M Farms already has a very good Web site. An additional Web page for buyers to access information about J-M Farms such as quality control, traceability statistics, efficiency data, recycling and conservation efforts may increase orders or reach new buyers.
- Flier or Brochure
  - An informative brochure to distribute to all current buyers and potential buyer explaining J-M's dedication to quality mushrooms, next-day service, traceability standards, recycling and conservation effort. This provides the buyer with quality information to pass on to the customer. Also, this option will make the buyer a more satisfied customer of J-M farms, and may lead to an increase in sales or new buyers.

Business-to-Customers

Customer analysis shows most people do not know how to store, handle, and prepare mushrooms which prevents them from purchasing mushrooms. Research also shows people are willing to learn how to include mushrooms in their diet.

- Web page
  - An additional Web page for customers to learn about J-M Farms efforts to produce a quality product, recipes, storage and handling procedures, recycling and conservation efforts, and traceability statistics. This provides customers with around-the-clock access about J-M Farms and mushrooms.
- Recipe/Fact Booklet Label
  - This would be similar to the label booklet sometimes found on strawberry containers that have recipes and information when you unfold the booklet. This would serve as a point of source material with recipes and facts about mushrooms. As the product would go directly to the customer, J-M Farms would not have to worry about buyer providing the information to customers.
- Recipe Cards
  - This would serve as another point of source material. The card would have recipes including mushrooms for consumers to expand their experience with mushrooms. The delivery method for the recipe cards has two alternatives, including mail and displays with the mushrooms. The main problem with both alternatives is the recipe card actually reaching the customer.
- Fact Cards

- This would include information such as storing, handling, and preparing mushrooms as well as nutritional facts. The delivery method has the same possibilities and problems as the recipe card.

Proposed Business Plan/Financial Analysis

BUSINESS MATERIALS

Executive Summary

- The executive summary will give a one page overview of the entire business plan. It will give the main purpose for the business plan and tell the reader the main points and arguments made.

Industry Analysis

- The industry analysis is obtained from IBIS WORLD and is a general overview of the industry. It will include the past trends for the mushroom and covered vegetable industry, as well as provide a forecast for industry growth in upcoming years.

Competitive Analysis

- The competitive analysis will detail all of the major competitors in the mushroom market at the present time as well as detail all internal competitions to the proposed engineering solution.
    - Internal Competition-This portion of the competitive analysis is going to detail the completion that is our possible engineering solutions face within the business.
    - External Competition-The external competition will be focused on regional/local completion and national competition. It will provide a detailed look at each of the competitors that J-M Farms faces. Besides a detailed look at each competitor, it will provide a summary and analysis of what each competitor does best that could be incorporated by J-M and what each competitors does not do good.

S.W.O.T Analysis

- The S.W.O.T. analysis will give an in depth look at what J-M does best, where they need to improve, and where there are areas elsewhere that they could take advantage of.

Marketing Analysis

- The marketing analysis will detail where the current product is sold and where there are holes in the market that could be exploited to gain business both by penetration of a new market and saturation of a current market.

Conclusion

Generation of Design Concepts

FEASIBILITY EVALUATION AND DETERMINATION OF POSSIBLE SUITABLE DESIGNS

Ergonomic/Industrial Ideas

- Crop Production Measurement, CPM, Weighing Station at Satellite Farms
  - Description
    - This design idea will involve implementing a CPM weighing station at some or all of J-M's satellite farms. The mushrooms will be weighed at each satellite farm once they are picked. This will eliminate all but one CPM station at the main facility.
  - Advantages
    - The major advantage to this implementation is that it would make the processes at the main facility less condensed. By taking away the weighing stations at the main farm, the space of the packaging floor will increase. This would allow the company to easier implement some changes on the packaging floor if deemed necessary.
    - Another advantage will be a deepened relationship with management. Since the growers at the satellite farms are able to maintain closer relationships with the pickers than at the main facility, the QA team will likely be the same way.
  - Disadvantages
    - Initial cost and capital investment required to put the new equipment in the satellite farms is the major disadvantage.
    - A potential, but not certain, disadvantage is space. Bella Corp does not know if each satellite farm has the current space requirements required for the equipment.
  - Feasibility
    - The feasibility of this idea is high. J-M Farms has contemplated this idea in the past, but never had the opportunity to do it. This idea has the easiest implementation of all ergonomics ideas listed.
- CPM Station and Packing Line at Satellite Farms
  - Description
    - This idea will require the implementation of a CPM weighing station and mushroom packaging line at some or all of J-M's satellite farms. The mushrooms picked at the satellite farms will be weighed and packaged on site. They will be ready for shipment when leaving the satellites. This will eliminate all but one CPM station at the main facility, and decrease the volume of packaging at the main facility.
  - Advantages
    - With this implementation, the mushrooms would be ready for shipment at the satellite farms.
    - This will decrease the work load of those at the main facility.
    - This will increase the amount of space available on the main packaging room floor. This extra space will allow the main facility

to focus primarily on sliced mushrooms. Since there is a lot of loss associated with the sliced mushrooms, this will be very beneficial.
    - If Bella Corp was to streamline, or redesign the current packaging process, the satellite farms could be used to test the feasibility of the new design.
  - Disadvantages
    - Initial cost and capital investment required to put the new equipment in the satellite farms is the major disadvantage.
    - The next disadvantage is space. Having a CPM weighing station and packaging line at the satellites will require a substantial amount of floor space.
  - Feasibility
    - Feasibility for this alternative is lower than the feasibility of a CPM weighing station at the satellite farms since it will require an additional amount of extra floor space, but that doesn't mean that it is infeasible. This idea has been mentioned by administrators of J-M Farms.
- Redesign/Alter Packing Floor at Main Facility
  - Description
    - This design concept will involve streamlining the packaging process at the main facility. This will be done by altering the layout of the packing room floor.
  - Advantages
    - This will eliminate redundant and unnecessary processes resulting in increased efficiency.
    - This could also minimize mushroom loss in the system.
  - Disadvantages
    - This implementation would disrupt the repetition cycles of the current workers at the main facility. It would require the workers to adjust to the new set up. It may take several weeks for these people to get used to the changes.
    - Depending on the changes implemented, a shut down day may be required to get all the equipment moved and set up in the correct location.
  - Feasibility
    - This ergonomic idea is feasible for J-M Farms. Moving all of the equipment to the proper location will require the most work and the most inconvenience for J-M Farms, but these changes could be implemented with a night crew, without requiring the company to stall production.
    - One worker in the packaging process at J-M Farms mentioned to the team that J-M administration has alluded to streamlining/redesigning the process for several years.
- Redesign/Alter Slicing Line at Main Facility
  - Description

        - This design concept will involve streamlining the slicing line to a packaging line at the main facility. This may require altering the layout of the packing room floor. This idea may involve a machine design component, if necessary, to catch mushrooms that are currently being dropped, since there are substantial losses associated with the slicing line.
    - Advantages
        - Streamlining the mushroom slicing line to the packaging line would increase the efficiency by eliminating some unnecessary steps in the current process.
        - Mitigating dropped mushrooms associated with the slicing line will significantly increase total production.
    - Disadvantages
        - This implementation would disrupt the repetition cycles of the current workers at the main facility. It would require the workers to adjust to the new set up. It may take several weeks for people to adjust to the changes.
        - Depending on the changes implemented, a shut down day may be required to get all the equipment moved and set up in the correct location.
    - Feasibility
        - This idea is feasible. Moving all of the equipment to the proper location will require the most work and the most inconvenience for J-M Farms, but these changes could be implemented with a night crew, without requiring the company to stall production.
        - Likewise, the slicing line is not always running at the same times as the packaging line. The slicing line could easily be worked on while production continued.
- Temperature/Time Studies of Entire Operation
    - Description
        - This study would determine where the mushrooms see the highest temperatures, and sit for the longest periods of time. This study could also show the length of time it takes for a mushroom to go through the entire system, from picking to shipment. Focus would be given to Mondays and Fridays, and late in the evening when worker productivity is expected to be at its lowest.
    - Advantages
        - Weaknesses in the system would be pointed out for future improvements.
    - Disadvantages
        - None
    - Feasibility
        - This option is feasible for the team, depending on the selection of design concepts and which direction the team is encouraged to pursue next semester.

Machine Design Ideas

- Picker Cart with Scales
  - Description
    - This design will focus on altering the current picker cart, to one that has scales, where the pickers are able to pick mushrooms based on weight and not volume.
  - Advantages
    - This will allow the pickers to pick mushrooms by weight and not volume.
    - This will increase the shelf life of the mushrooms because of decreased handling.
    - This would likely get rid of the QA lines in the packaging line. With this alternative, the tills will already have the appropriate weight of mushrooms when shipped to the main facility. Once arriving, these mushrooms will get weighed for CPM data, and will go directly to the packaging process.
  - Disadvantages
    - The carts will be exposed to lots of dirt and grime in the picking rooms. The electronic and mechanical components of the scales will have to be able to handle this harsh environment.
    - Since the carts get washed and sanitized every day, the components will have to be removed prior to washing, or able to withstand getting wet.
    - By adding scales to the cart, the size will likely have to be increased. Increased size of the cart will restrict the flexibility of movement and speed of transportation in the picking rooms and around the satellite farms.
    - If a new cart is designed, the old cart will have to be shucked. A new cart design will require a large capital investment for J-M Farms. One hundred (100) carts will have to be fabricated, since this is roughly the number of pickers working for the company.
    - A new cart will require more work out of the pickers, so they will have to be paid more.
    - Implementing a new cart could require the design of a new plastic container for shipment around the facility. This will require a substantial capital investment, while still renting the RPCs for shipment to and from their current market.
    - J-M Farms will likely have produce and manufacture a new cart in house. Producing large numbers of these will require a hefty time input, and will be inconvenient.
  - Feasibility
    - The team has observed that the current cart used at J-M Farms works great. A new cart design may or may not be as satisfactory as their current design. Of the cart designs, this is the most likely to be successful because of the overwhelming disadvantages with a cart that weighs and packages mushrooms.

- Weighing/Packaging Cart (using tills with plastic wrap)
    - Description
        - This design will focus on altering the current picker cart, to one that has scales and a packaging line that wraps the tills in plastic. This design is focused on 'field packaged' produce.
    - Advantages
        - Once the mushrooms come out of the picking room, they will be completely ready for shipment.
        - This will increase the shelf life of the mushrooms because of decreased handling.
        - The produced could be marketed as 'One-Touch' products.
        - This will get rid of the entire CPM station, packaging line, and QA line at the main facility.
        - Costs of labor will be decreased at the main facility.
    - Disadvantages
        - The carts will be exposed to lots of dirt and grime in the picking rooms. The electronic and mechanical components of the scales will have to be able to handle this harsh environment.
        - Since the carts get washed and sanitized every day, the components will have to be removed prior to washing, or able to withstand getting wet.
        - By adding scales and a packaging process to the cart, the size will have to be increased, likely doubled. Increased size of the cart will substantially restrict the flexibility of movement and speed of transportation in the picking rooms and around the satellite farms.
        - If a new cart is designed, the old cart will have to be shucked. This cart design will require the heaviest capital investment for J-M Farms. One hundred (100) carts will have to be fabricated, since this is roughly the number of pickers working for the company.
        - Of the three cart options, this will require the most work out of the pickers. This option will increase their work load substantially. The satellite farms would probably have to make a few manual labor additions to cover the increased work load of the pickers.
        - Implementing a new cart could require the design of a new plastic container for shipment around the facility. This will require a substantial capital investment, while still renting the RPCs for shipment to and from their current market.
    - Feasibility
        - The team has observed that the current cart used at J-M Farms works great. A new cart design may or may not be as satisfactory as their current design. Of the cart designs, this is the least likely to be successful because of the overwhelming disadvantages with a cart that weighs and packages mushrooms.
- Weighing/Packaging Cart (using tills with snap on lids)
    - Description

    - This design will focus on altering the current picker cart, to one that has scales and a packaging line, but instead of wrapping the tills in plastic, the tills have a snap on lid. This design is focused on 'field packaged' produce.
- Advantages
    - Once the mushrooms come out of the picking room, they will be completely ready for shipment.
    - The decreased handling will increase the shelf life of the mushrooms.
    - The produced could be marketed as 'One-Touch' products.
    - This will get rid of the entire CPM station, packaging line, and QA line at the main facility.
    - Costs of labor will be decreased at the main facility.
- Disadvantages
    - The carts will be exposed to lots of dirt and grime in the picking rooms. The electronic and mechanical components of the scales will have to be able to handle this harsh environment.
    - Since the carts get washed and sanitized every day, the components will have to be removed prior to washing, or able to withstand getting wet.
    - By adding scales and a packaging process to the cart, the size will be increased, likely doubled. This significant size increase of the cart will substantially restrict the flexibility of movement and speed of transportation in the picking rooms and around the satellite farms.
    - If a new cart is designed, the old cart will have to be shucked. A new cart design will require a large capital investment for J-M Farms. This cost of this cart will be between the other two mentioned. One hundred (100) carts will have to be fabricated, since this is roughly the number of pickers working for the company.
    - A new cart will require more work out of the pickers, so they will have to be paid more. The satellite farms would probably have to make a few manual labor additions to cover the increased work load of the pickers.
    - Implementing a new cart could require the design of a new plastic container for shipment around the facility. This will require a substantial capital investment, while still renting the RPCs for shipment to and from their current market.
- Feasibility
    - The team has observed that the current cart used at J-M Farms works great. A new cart design may or may not be as satisfactory as their current design. This is less likely to be successful than a cart that just weighs the tills because of the added disadvantages with the packaging side.

    - One way to make this idea more feasible is to require the pickers to put the lids on the tills, but this added responsibility will decrease their speed at picking mushrooms. This disadvantage of the pickers will have to be compensated for somewhere in the system.

IMPACTS OF PROPOSED DESIGN SOLUTIONS

Societal

- Successfully redesigning the packing room floor will decrease the number of necessary workers in the packaging room. Some jobs may be removed.
- A successful design of a new cart will increase the number of workers needed at the satellite farms, so jobs will be created. Adversely, some jobs involved with latter parts of the mushroom packaging process may be eliminated, depending on the design, but it is possible these jobs will simply transfer to the satellite farms.

Environmental

- The design of a new cart may encourage J-M Farms to use snap on plastic lids instead of plastic wrap. These lids have a higher recyclable rating than the current plastic. Here, the entire mushroom package will be 100 percent recyclable.

Global

- No global impacts could be determined.

Project Schedule

GANTT CHART

Below is Bella Corp's project schedule using a Gantt Chart.

ID		Task Name	Duration	Start	Finish	Predecessors	Resource Names
37		Full Evaluation of Current S	1 day?	Fri 10/30/09	Fri 10/30/09		
38		Develop List of Pros/Cons f	18 days?	Fri 10/30/09	Mon 11/23/09		
39		Conceptual Drawings/Sketc	18 days?	Fri 10/30/09	Mon 11/23/09		
40		**Develop Alternatives**	**13 days?**	**Thu 11/19/09**	**Fri 12/4/09**		
41		List of Alternatives	1 day?	Thu 11/19/09	Thu 11/19/09		
42		Select Project based on Inp	2 days?	Thu 12/3/09	Fri 12/4/09		
43		**Project Planning**	**57 days?**	**Fri 10/30/09**	**Fri 1/15/10**		
44		Work Breakdown Structure	6 days?	Fri 10/30/09	Fri 11/6/09		
45		Task List	1 day?	Fri 11/13/09	Fri 11/13/09	44	
46		**Gantt Chart**	**40 days?**	**Mon 11/23/09**	**Fri 1/15/10**	**45**	
47		First Draft	1 day?	Mon 11/23/09	Mon 11/23/09		
48		Final Draft	1 day?	Fri 1/15/10	Fri 1/15/10	47	
49		**Build Prototype(s)**	**11 days?**	**Fri 1/22/10**	**Fri 2/5/10**		
50		Draw SolidWorks Model	1 day?	Fri 1/22/10	Fri 1/22/10		
51		Send Designs to BAE Lab t	1 day?	Fri 1/29/10	Fri 1/29/10	50	
52		Acquire any needed Electro	1 day?	Fri 1/29/10	Fri 1/29/10		
53		Assemble	1 day?	Fri 2/5/10	Fri 2/5/10	52,51	
54		**Testing**	**15 days?**	**Mon 2/8/10**	**Fri 2/26/10**		
55		Run Initial Tests	4 days?	Mon 2/8/10	Thu 2/11/10		
56		Transport to J-M Farms an	1 day?	Thu 2/18/10	Thu 2/18/10	55	
57		Bring Prototype Back and N	1 day?	Thu 2/25/10	Thu 2/25/10	56	
58		Iterate until Acceptable Pro	1 day?	Fri 2/26/10	Fri 2/26/10	57	
59		Draw up Final Plans for Product	1 day?	Thu 4/1/10	Thu 4/1/10		
60		**Economics**	**77 days?**	**Fri 10/30/09**	**Fri 2/12/10**		
61		**Market Research**	**1 day?**	**Fri 10/30/09**	**Fri 10/30/09**		
62		Industry Analysis	1 day?	Fri 10/30/09	Fri 10/30/09		
63		Consumer Research	1 day?	Fri 10/30/09	Fri 10/30/09		
64		**J-M's Capabilities**	**18 days?**	**Fri 10/30/09**	**Mon 11/23/09**		
65		Management	1 day?	Fri 10/30/09	Fri 10/30/09		
66		Products	1 day?	Mon 11/23/09	Mon 11/23/09		
67		**Competitive Analysis**	**18 days?**	**Fri 10/30/09**	**Mon 11/23/09**		
68		**Internal Competition**	**1 day?**	**Mon 11/23/09**	**Mon 11/23/09**		
69		Picking Competition	1 day?	Mon 11/23/09	Mon 11/23/09		
70		Packing Line Competit	1 day?	Mon 11/23/09	Mon 11/23/09		
71		**External Competition**	**1 day?**	**Fri 10/30/09**	**Fri 10/30/09**		
72		Regional Competition	1 day?	Fri 10/30/09	Fri 10/30/09		

Page 2

Figure 11

ID		Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		**Communications**	**87 days?**	**Fri 11/6/09**	**Fri 3/5/10**		
2		**Web Site**	**22 days?**	**Fri 11/6/09**	**Sat 12/5/09**		
3		Pictures of Team	1 day	Fri 11/6/09	Fri 11/6/09		
4		Conceptual Drawing	1 day?	Mon 11/23/09	Mon 11/23/09		
5		**Execution**	**3 days?**	**Wed 12/2/09**	**Sat 12/5/09**		
6		Build Index Page	1 day?	Wed 12/2/09	Wed 12/2/09		
7		Build Team Page	1 day?	Fri 12/4/09	Fri 12/4/09		
8		Build J-M Page	1 day?	Fri 12/4/09	Sat 12/5/09		
9		**Reports**	**14 days?**	**Wed 11/18/09**	**Fri 12/4/09**		
10		**Drafts**	**11 days?**	**Wed 11/18/09**	**Tue 12/1/09**		
11		Receive Materials	1 day?	Wed 11/18/09	Wed 11/18/09		
12		Receive Updated/Corr	10 days?	Thu 11/19/09	Tue 12/1/09	11	
13		**Editing**	**11 days?**	**Sun 11/22/09**	**Fri 12/4/09**		
14		First Draft	1 day?	Sun 11/22/09	Sun 11/22/09		
15		Final Draft	10 days?	Mon 11/23/09	Fri 12/4/09	14	
16		**Materials**	**36 days?**	**Fri 1/15/10**	**Fri 3/5/10**		
17		**Recipe Cards**	**21 days?**	**Fri 1/15/10**	**Fri 2/12/10**		
18		Cost	1 day?	Fri 1/15/10	Fri 1/15/10		
19		Recipes	1 day?	Fri 2/12/10	Fri 2/12/10		
20		Method of Delivery	1 day?	Fri 2/12/10	Fri 2/12/10		
21		**Informational Cards**	**21 days?**	**Fri 1/15/10**	**Fri 2/12/10**		
22		Cost	1 day?	Fri 1/15/10	Fri 1/15/10		
23		Information/Facts	1 day?	Fri 2/12/10	Fri 2/12/10		
24		Method of Delivery	1 day?	Fri 2/12/10	Fri 2/12/10		
25		**Buyer Web Page**	**16 days?**	**Fri 2/12/10**	**Fri 3/5/10**		
26		Design	1 day?	Fri 2/12/10	Fri 2/12/10		
27		Completed	1 day?	Fri 3/5/10	Fri 3/5/10	26	
28		**Package Recipe/Informati**	**36 days?**	**Fri 1/15/10**	**Fri 3/5/10**		
29		Cost	1 day?	Fri 1/15/10	Fri 1/15/10		
30		Recipes and Informati	1 day?	Fri 2/12/10	Fri 2/12/10		
31		Design	1 day?	Fri 3/5/10	Fri 3/5/10		
32		**Engineering**	**111 days?**	**Fri 10/30/09**	**Thu 4/1/10**		
33		**Design Concepts**	**18 days?**	**Fri 10/30/09**	**Mon 11/23/09**		
34		**Existing Documents**	**1 day?**	**Fri 10/30/09**	**Fri 10/30/09**		
35		Journal Article Search	1 day?	Fri 10/30/09	Fri 10/30/09		
36		Patent Search	1 day?	Fri 10/30/09	Fri 10/30/09		

Page 1

Figure 12

ID		Task Name	Duration	Start	Finish	Predecessors	Resource Names
73		National Competition	1 day?	Fri 10/30/09	Fri 10/30/09		
74		**Cost Breakdown**	**57 days?**	**Fri 10/30/09**	**Fri 1/15/10**		
75		Activity Based Costing for E	1 day?	Mon 11/23/09	Mon 11/23/09		
76		Overall Flow of System/Pro	1 day?	Fri 10/30/09	Fri 10/30/09		
77		Identify Costly Processes th	1 day?	Fri 12/4/09	Fri 12/4/09		
78		Cost Saving from Proposed	1 day?	Fri 1/15/10	Fri 1/15/10		
79		Proposed Budget for Prototype c	1 day?	Fri 1/15/10	Fri 1/15/10		
80		Business Plan	1 day?	Fri 2/12/10	Fri 2/12/10		

Page 3

Figure 13

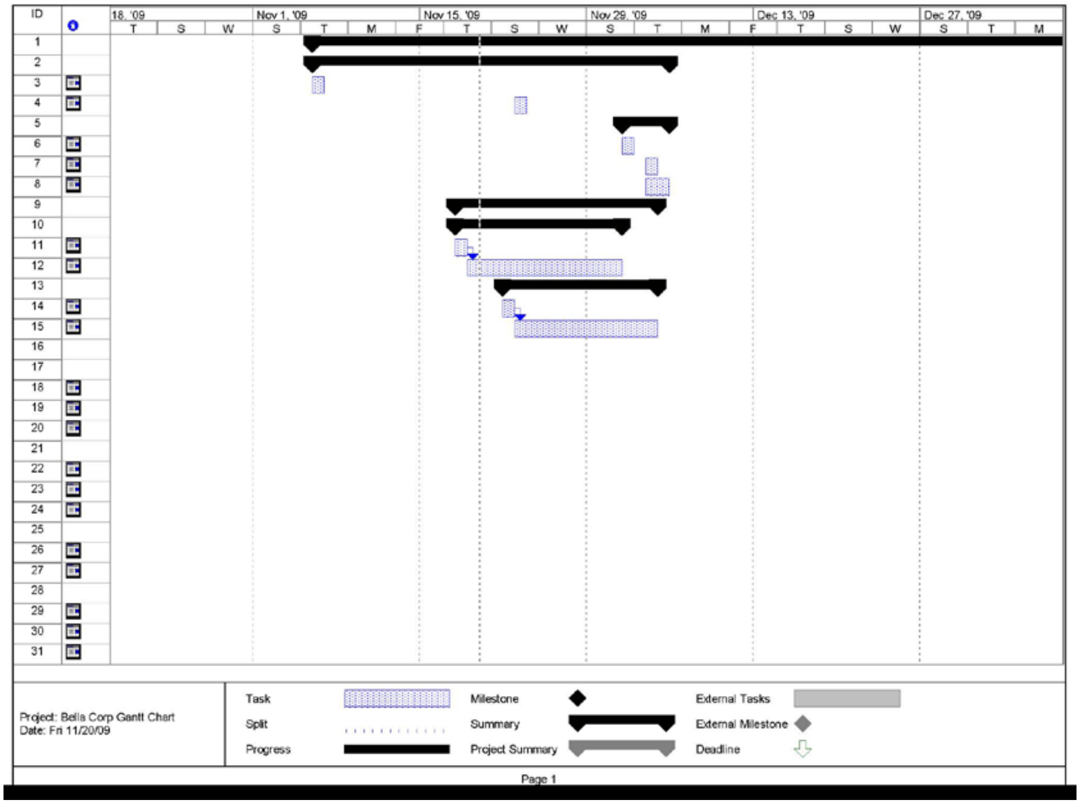


Figure 14

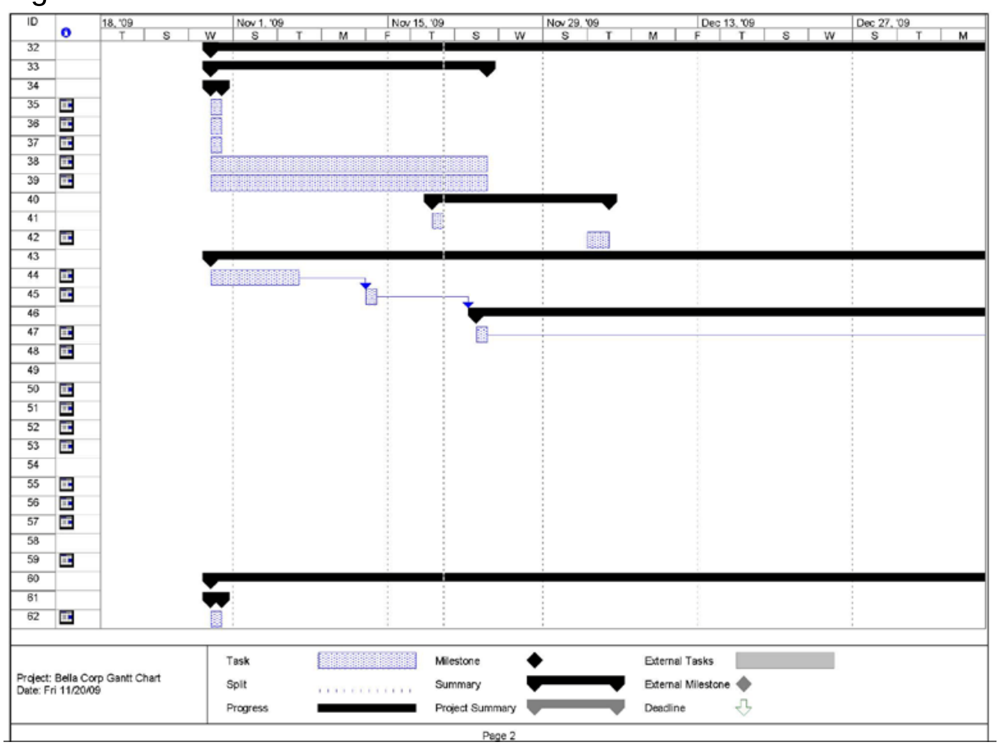


Figure 15

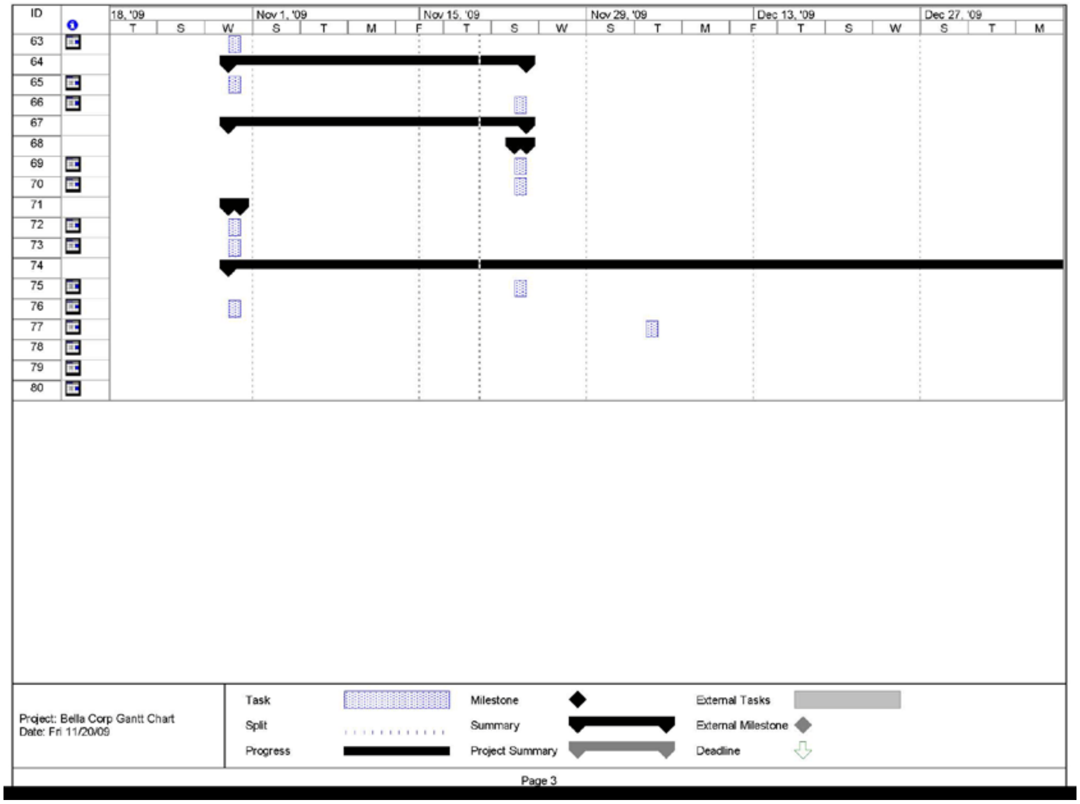


Figure 16

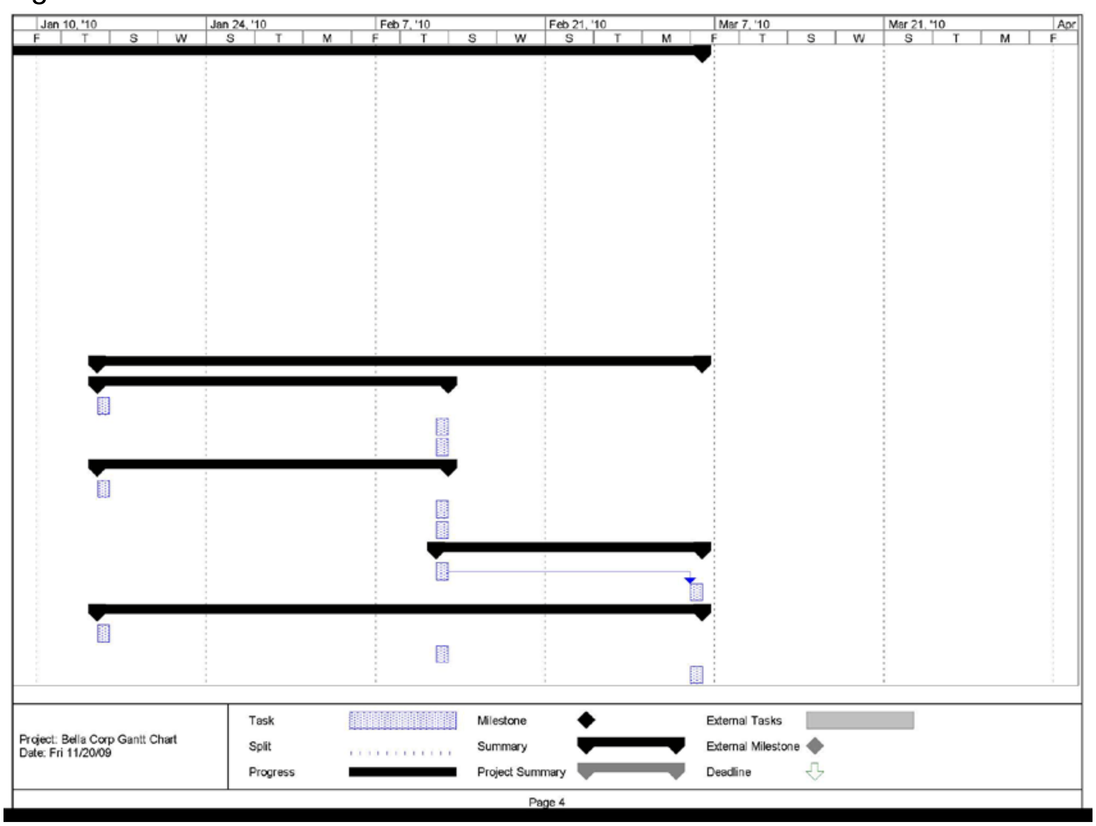


Figure 17

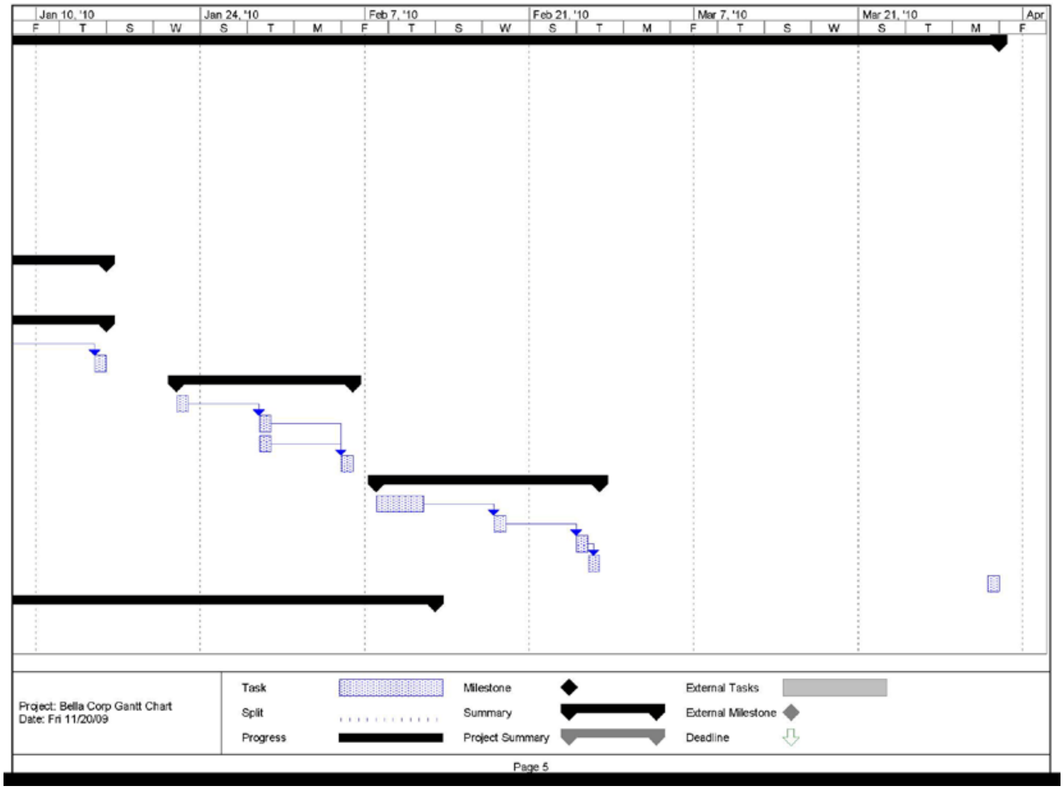


Figure 18

Figure 19

Proposed Budget for Prototype

Bella Corp will not have a proposed budget for a prototype until we meet with J-M Farms and determine which direction they want to pursue. As soon as a design is determined as budget will be formulated for the project.

Works Cited

Amycel/spawnmate. <http://www.amycel.com/spawnmate.htm>

C P Yeatman & sons. <http://www.organicmushrooms.com/about.html>

Citrus and vegetable. 2009. 15 October 2009. <http://www.citrusandvegetable.com>

Citrus and vegetable. 2009. 20 October 2009. <http://thepacker.com/>

Company profile. <http://www.allbusiness.com/companyprofile/J-M_Farms_Inc/F2AEFBE73033412DBB40834BBF346057-1.html>

Computing scale system. United States Patent # 4,091,449. <http://www.google.com/patents?id=_9QvAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Creekside mushrooms. <http://www.creeksidemushrooms.com/productlist.htm>

Digital electronic scale. United States Patent # 4,153,125. <http://www.google.com/patents?id=UxcvAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Electronic scale printer. United States Patent # 4,700,791. <http://www.google.com/patents?id=8cg5AAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Method and container for the improved packing and cooling of produce. United States

Mushroom and tomato production in the U.S. 2009. 15 October 2009. <www.ibisworld.com>

Network address management for a wired network supporting wireless communication to a plurality of mobile users. United States Patent # 5,159,592. <http://www.google.com/patents?id=MiAhAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Package closing label. United States Patent # 5,866,183. <http://www.google.com/patents?id=cQ8XAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Patent # 5,738,890. <http://www.google.com/patents?id=VwMdAAAAEBAJ&zoom=4&pg=PA1#v=onepage&q=&f=false>

Phillips mushroom farms. <http://www.phillipsmushroomfarms.com/>

Portable electronic scale of minimal thickness and weight. United States Patent # 4,800,973.
<http://www.google.com/patents?id=qK42AAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Tray for the improved packing and cooling of produce. United States Patent # 6,007,85.
<http://www.google.com/patents?id=UC0YAAAAEBAJ&pg=PA1#v=onepage&q=&f=false>

Wireless local area network communications system. United States Patent # 5,276,703.
<http://www.google.com/patents?id=-qQgAAAAEBAJ&zoom=4&pg=PA1#v=onepage&q=&f=false>

Appendix

Consumer Research
Consumer Analysis
Scientific Articles

rose research

FRESH MUSHROOM ATTITUDE & USAGE TRACKING STUDY FINDINGS

May, 2008

fresh Mushrooms
Nature's Hidden Treasure

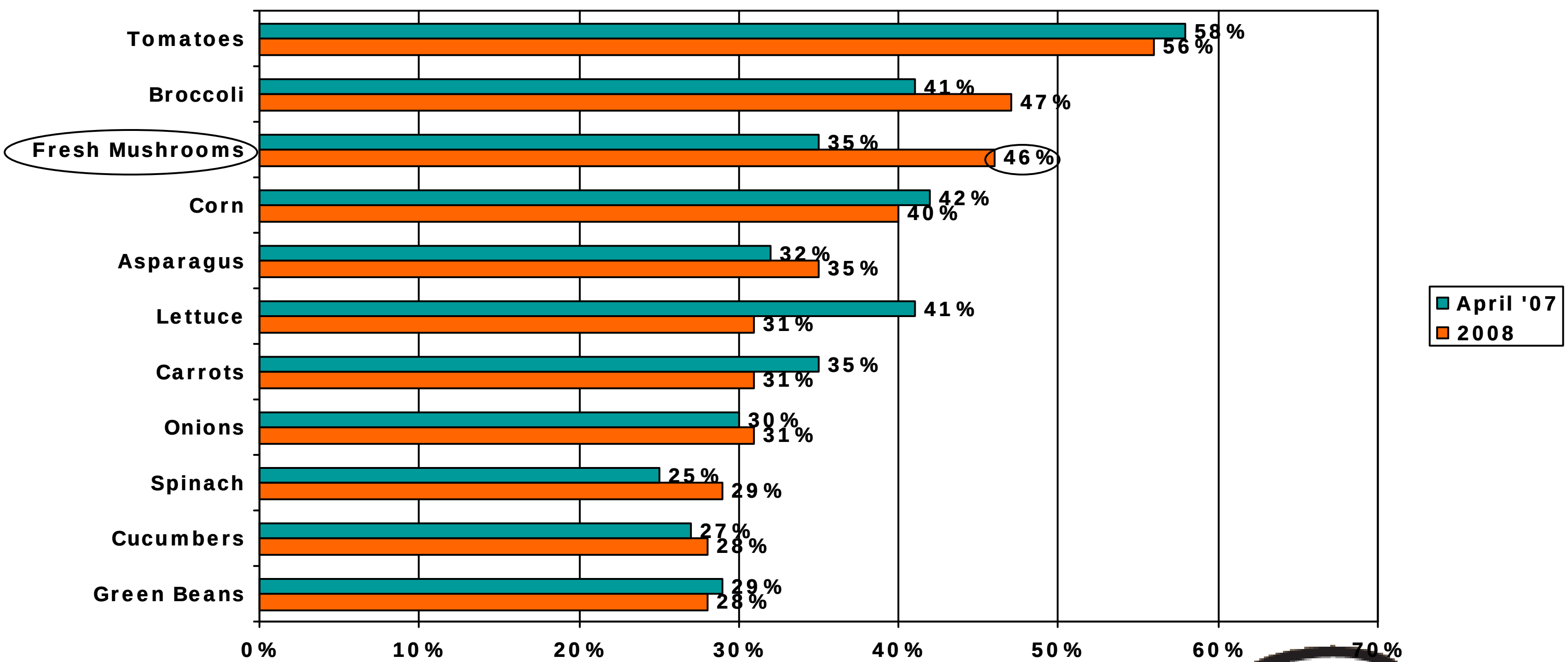
METHODOLOGY

- A total of 500 interviews were completed via the internet among primary household grocery shoppers (female & male).
  - Respondents were screened to ensure that they have purchased fresh mushrooms within the past year.
  - Results will be compared to previous studies (where applicable) and tracked going forward.

rose research

TOP-5 FAVORITE FRESH VEGETABLES

- Fresh mushrooms are third in overall popularity…

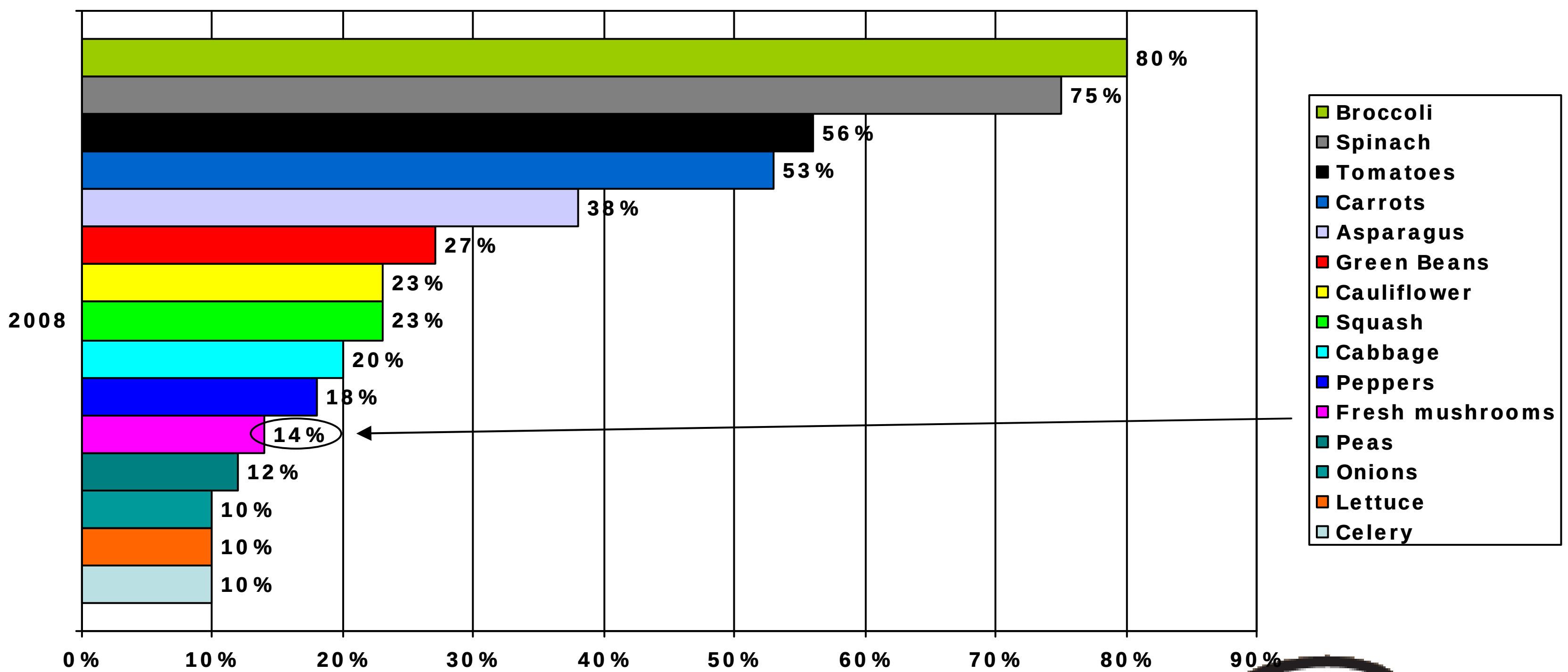


fresh Mushrooms Nature's Hidden Treasure

r² rose research

TOP-5 MOST HEALTHY FRESH VEGETABLES

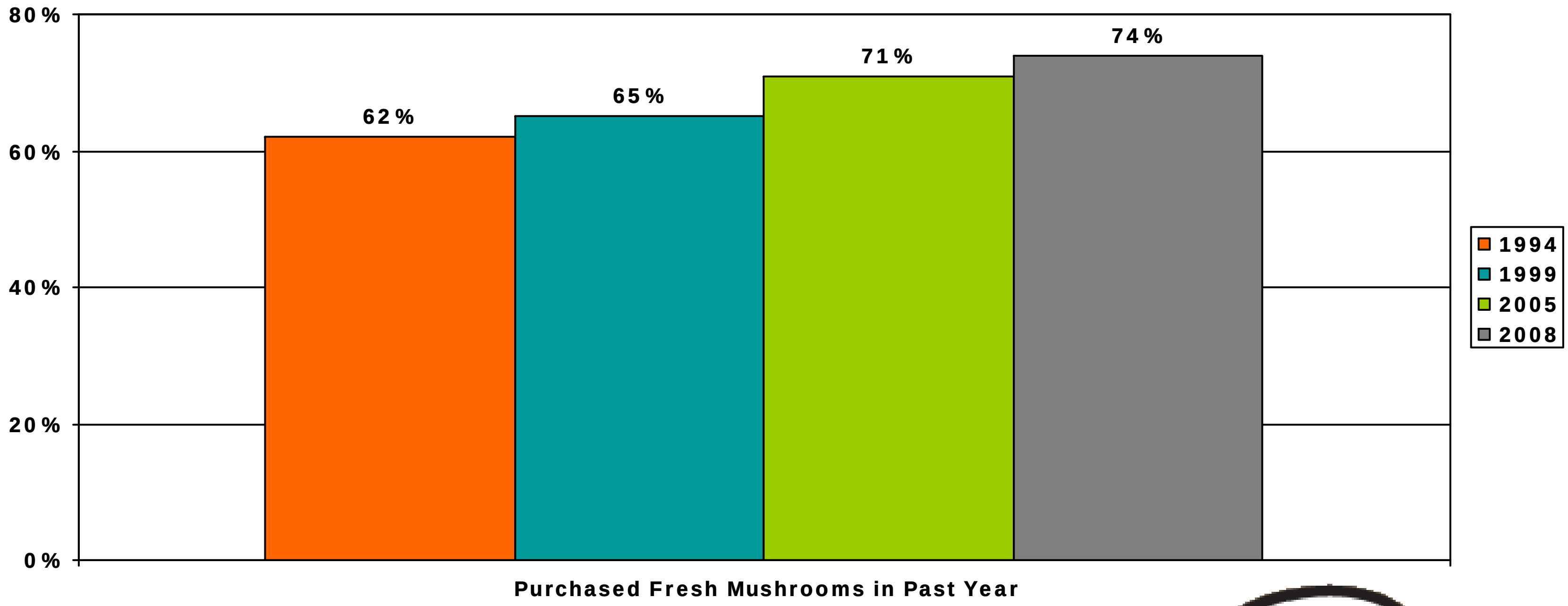
- However, further consumer education is warranted...



fresh Mushrooms Nature's Hidden Treasure

OVERALL INCIDENCE OF PURCHASING FRESH MUSHROOMS

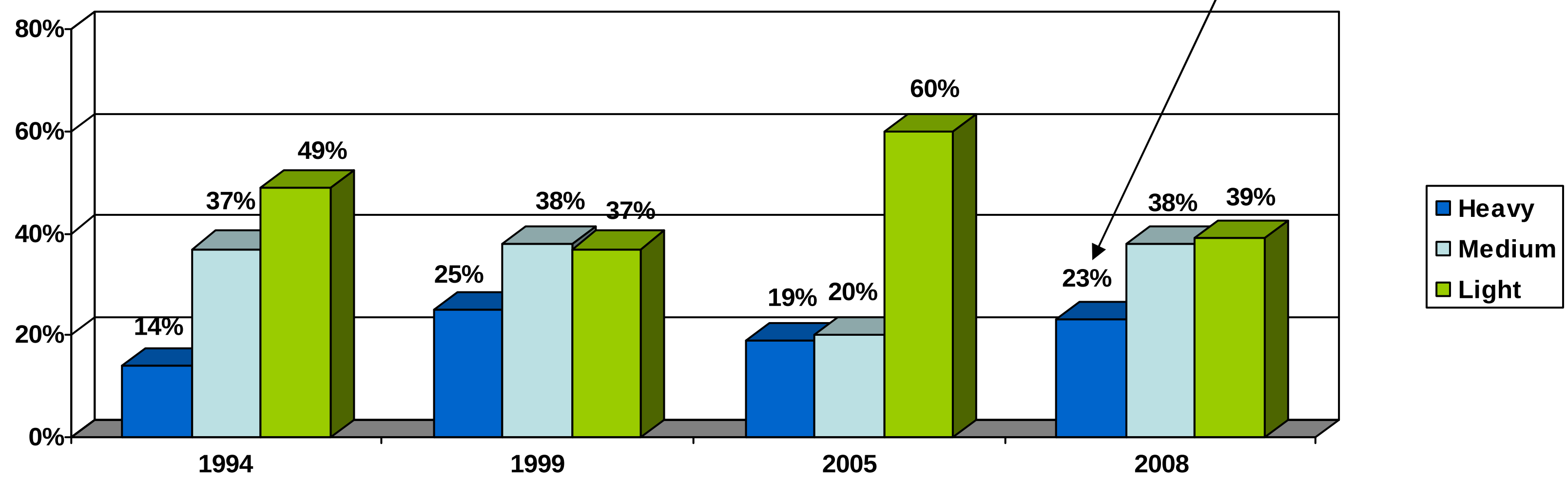
- The percentage of households who have purchased fresh mushrooms in the past year continues to climb…



HEAVY VS. MEDIUM VS. LIGHT USERS

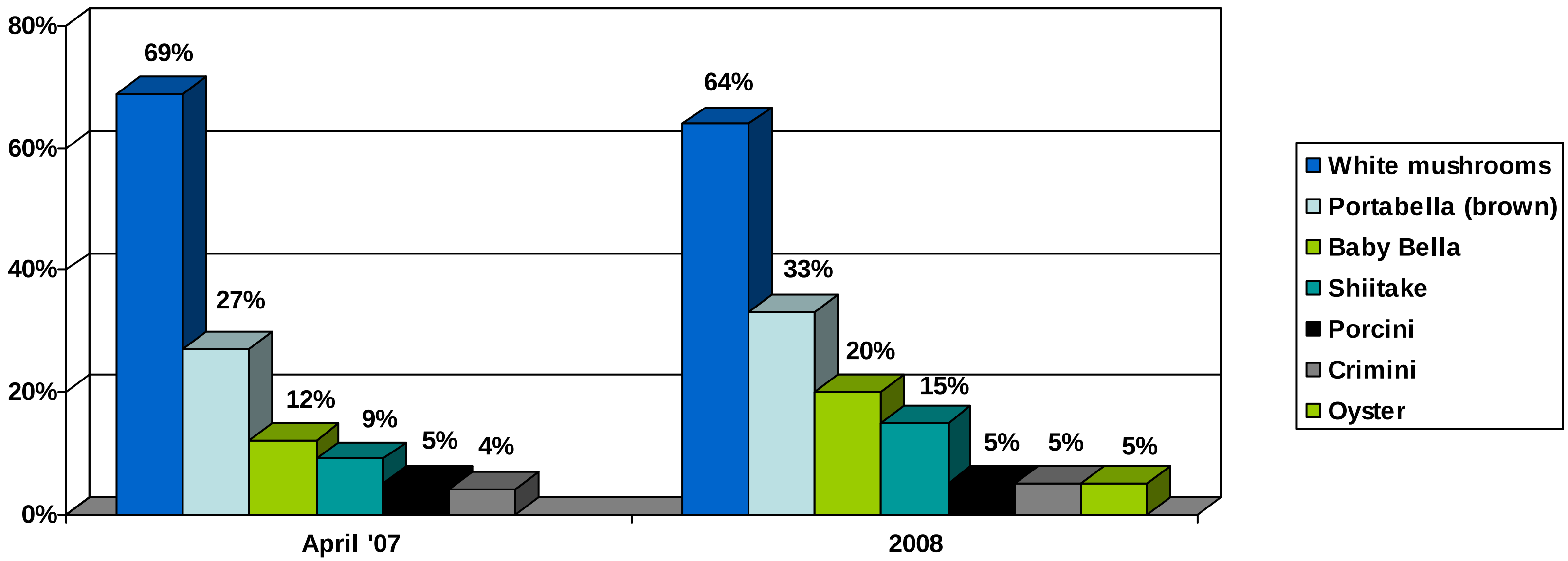
- Most consumers are defined as either medium or light purchasers…

How do we convert them to heavy users?



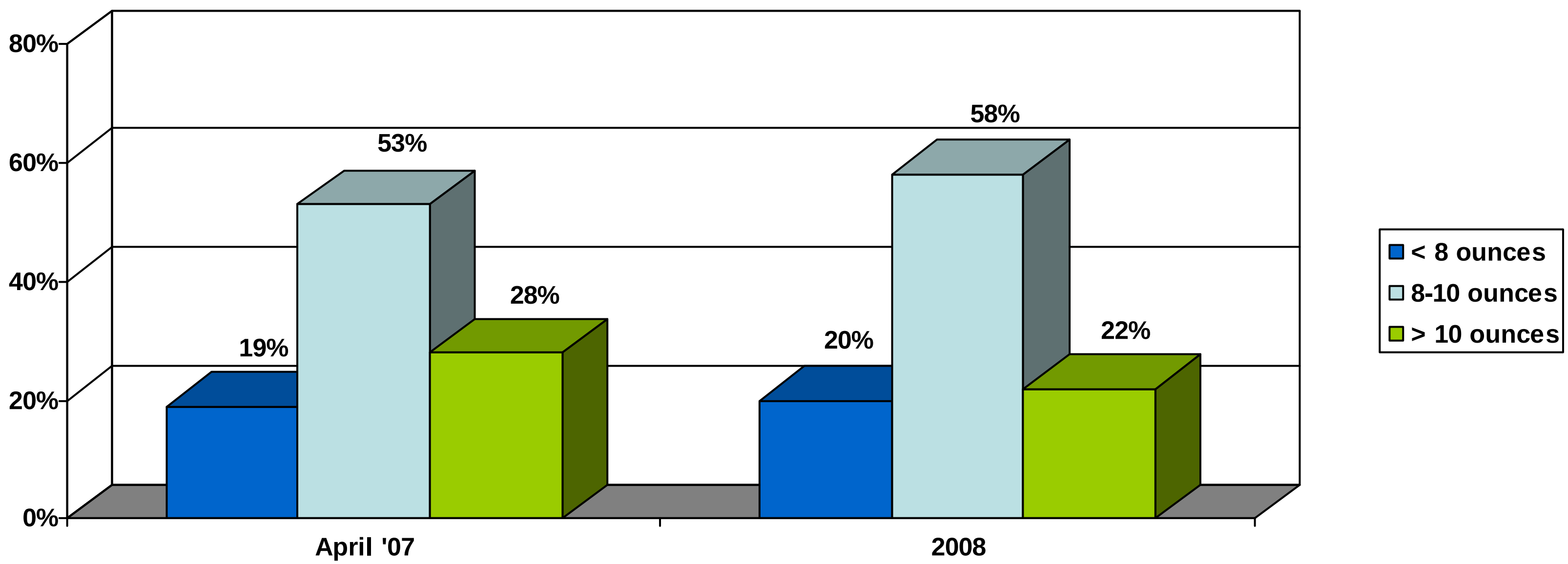
TYPE OF MUSHROOM PURCHASED MOST RECENTLY

- Findings are more or less in line with last year, as White mushrooms are by far the most popular variety…



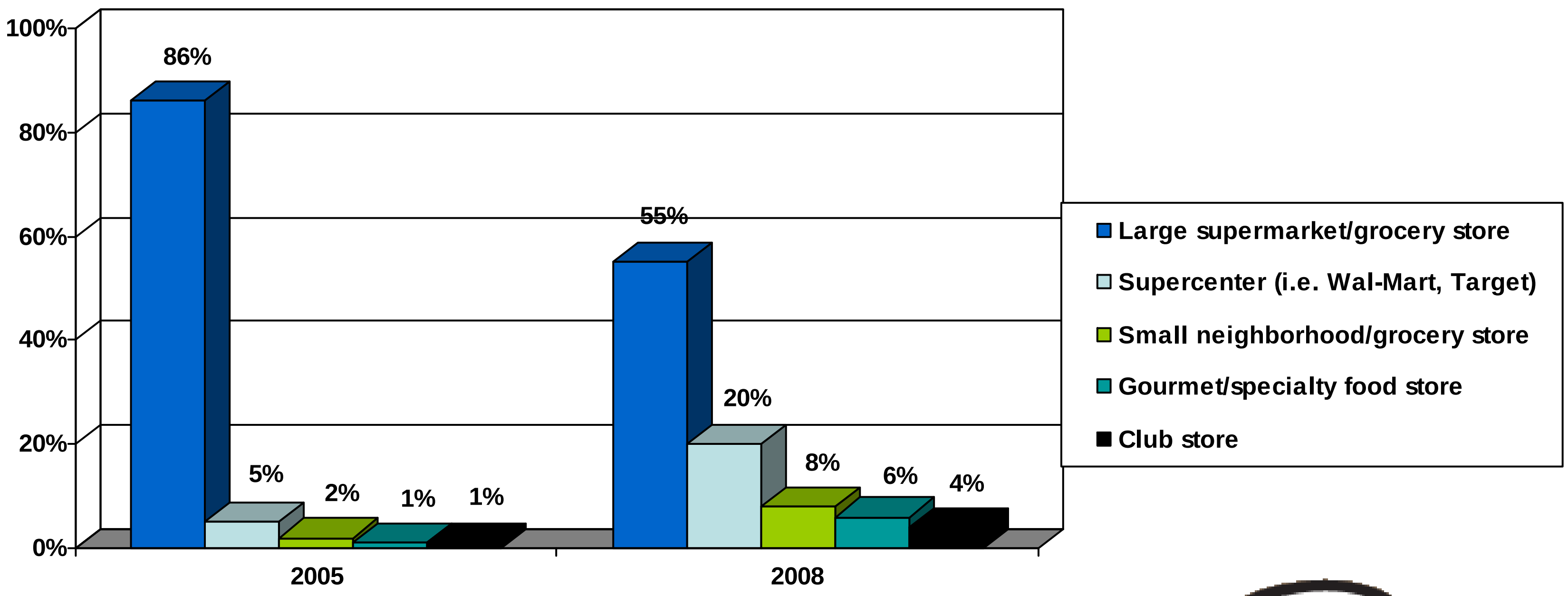
QUANTITY OF LAST MUSHROOM PURCHASE

- Also in line with last year, most of the shoppers purchased between 8 and 10 ounces of mushrooms…



WHERE MUSHROOMS ARE PURCHASED MOST OFTEN

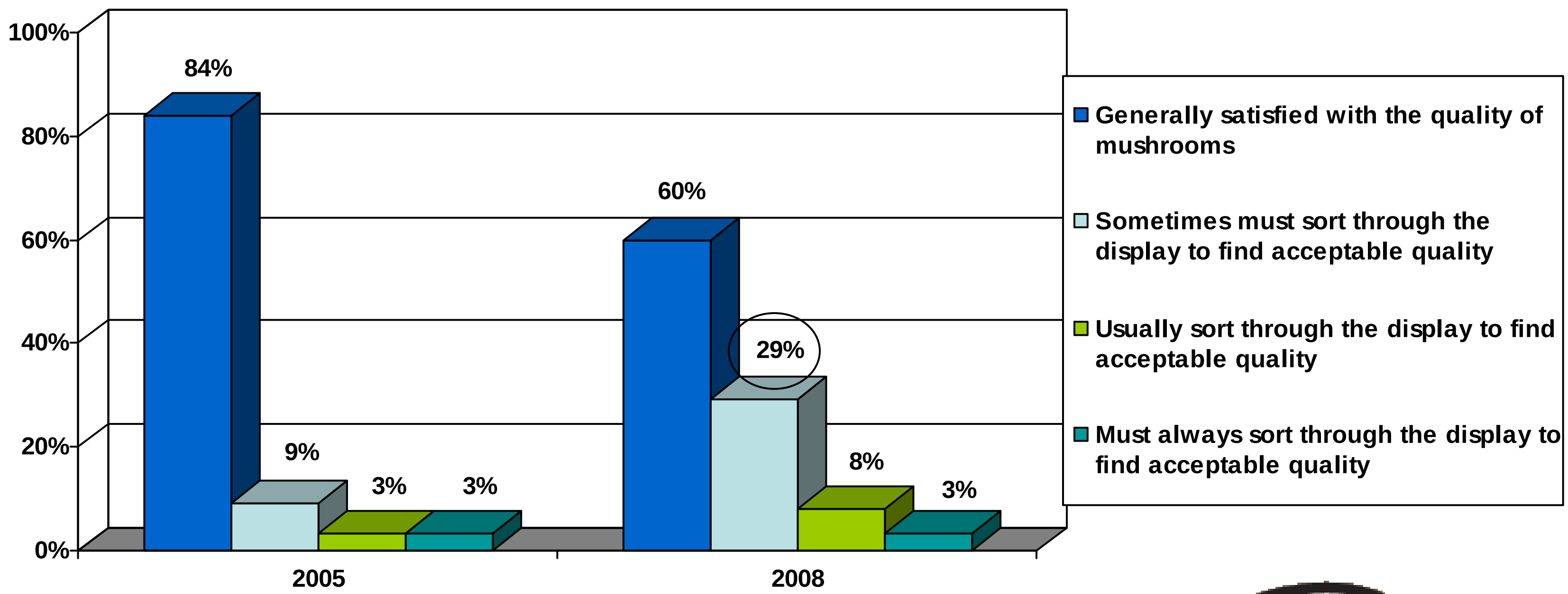
- While supermarkets have lost share of wallet, incidence of purchasing mushrooms at other outlets increased significantly…



rose research

OVERALL SATISFACTION WITH QUALITY OF MUSHROOMS AVAILABLE

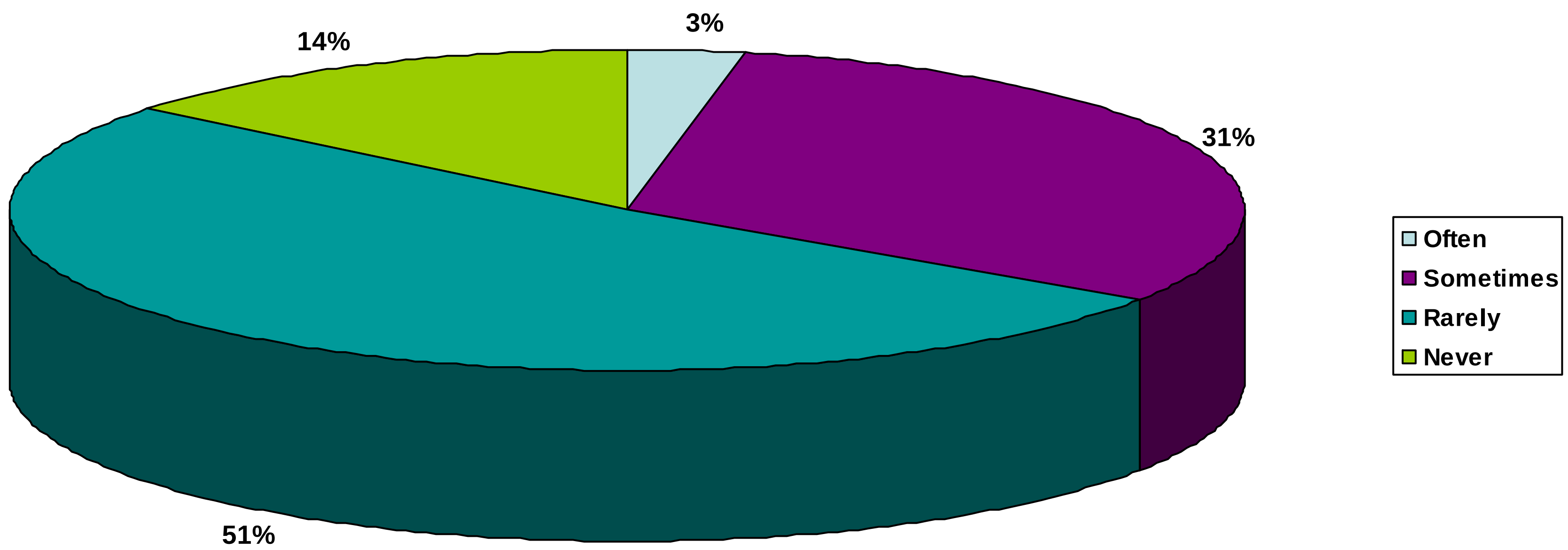
- Shoppers have become more savvy – with many indicating that they sort through the display to find good mushrooms versus 2005…



fresh Mushrooms
Nature's Hidden Treasure

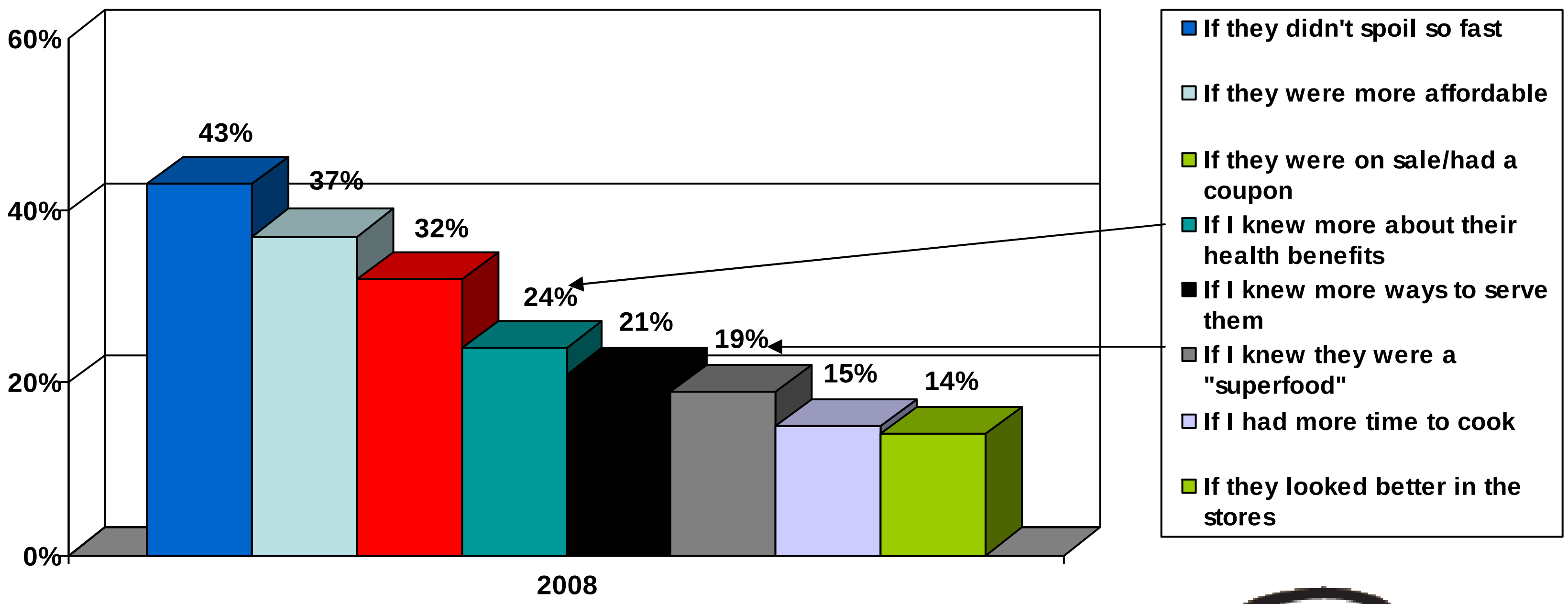
FREQUENCY OF NOT PURCHASING MUSHROOMS DUE TO QUALITY

- Despite having to look through the display, most indicate that they either "rarely" or "never" not purchase mushrooms for quality reasons…



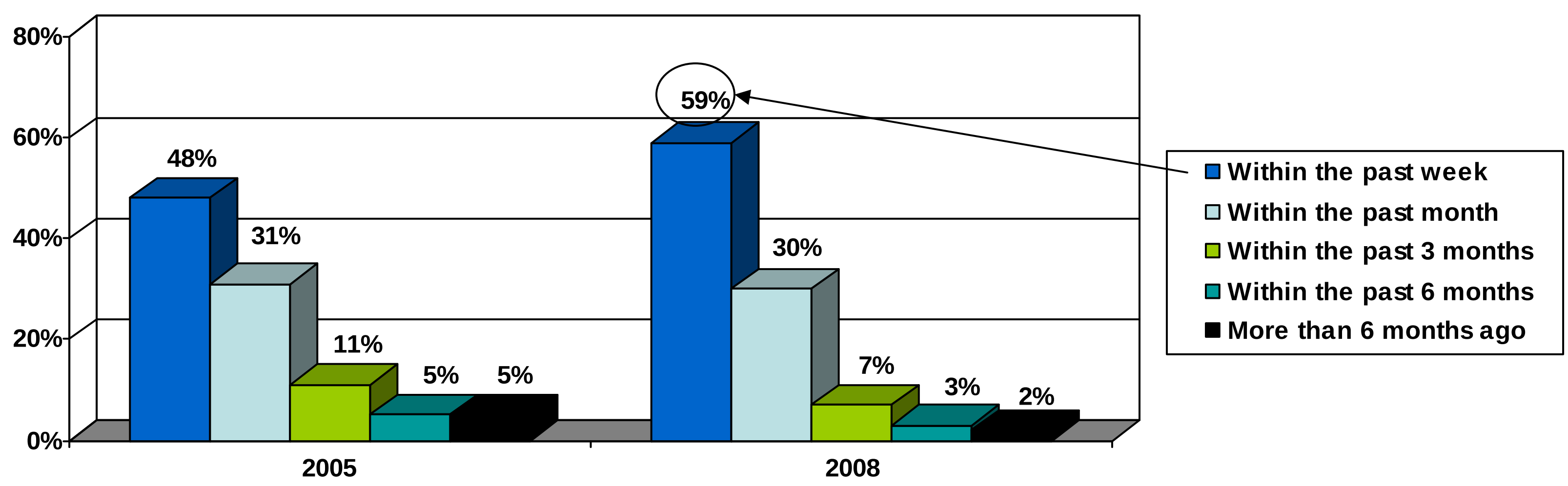
ENTICEMENTS TO PURCHASE MORE MUSHROOMS – TOP-3 CHOICES

- In addition to quality and price, health is also a motivating factor…



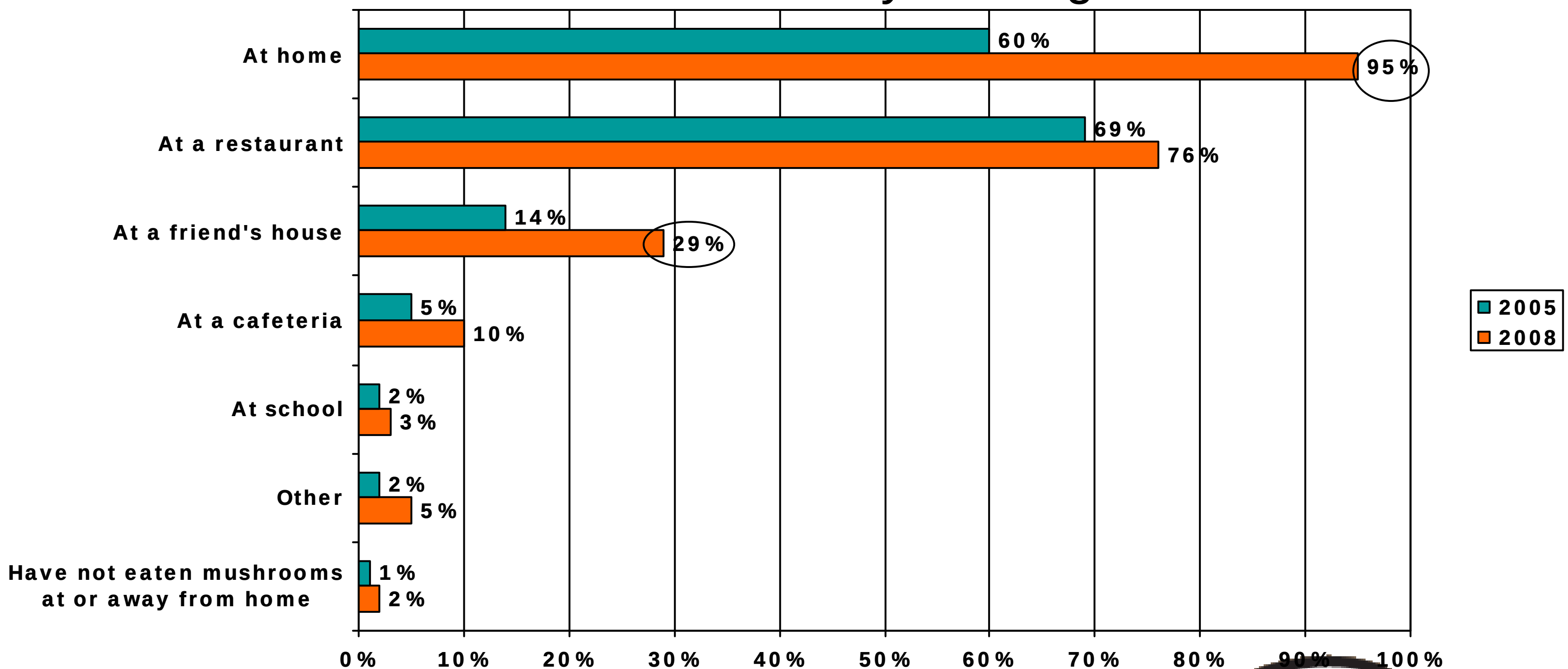
LAST TIME MUSHROOMS WERE CONSUMED

- Mushroom consumption has also increased vis-à-vis 2005, with nearly 6 in 10 having eaten them within the past week…



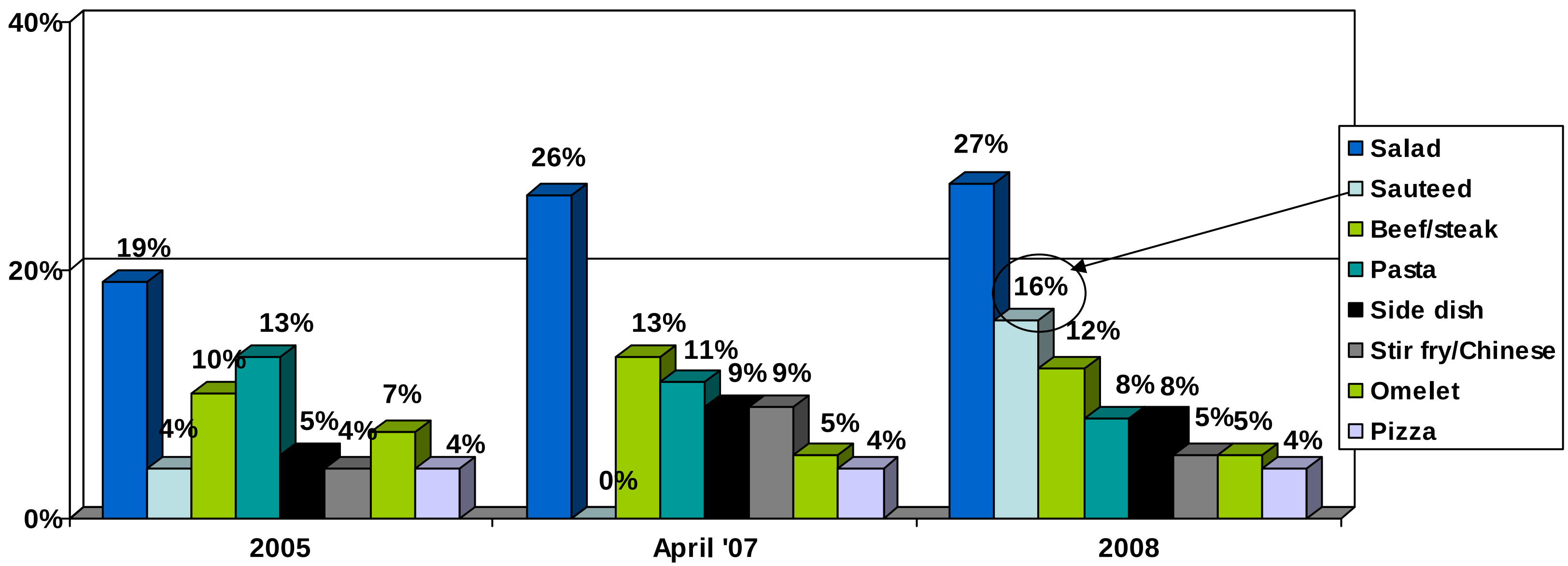
WHERE FRESH MUSHROOMS HAVE BEEN CONSUMED (PAST YEAR)

- Fresh mushrooms are significantly more likely to be consumed in the home versus 3 years ago…



DISH EATEN MOST OFTEN W/MUSHROOMS

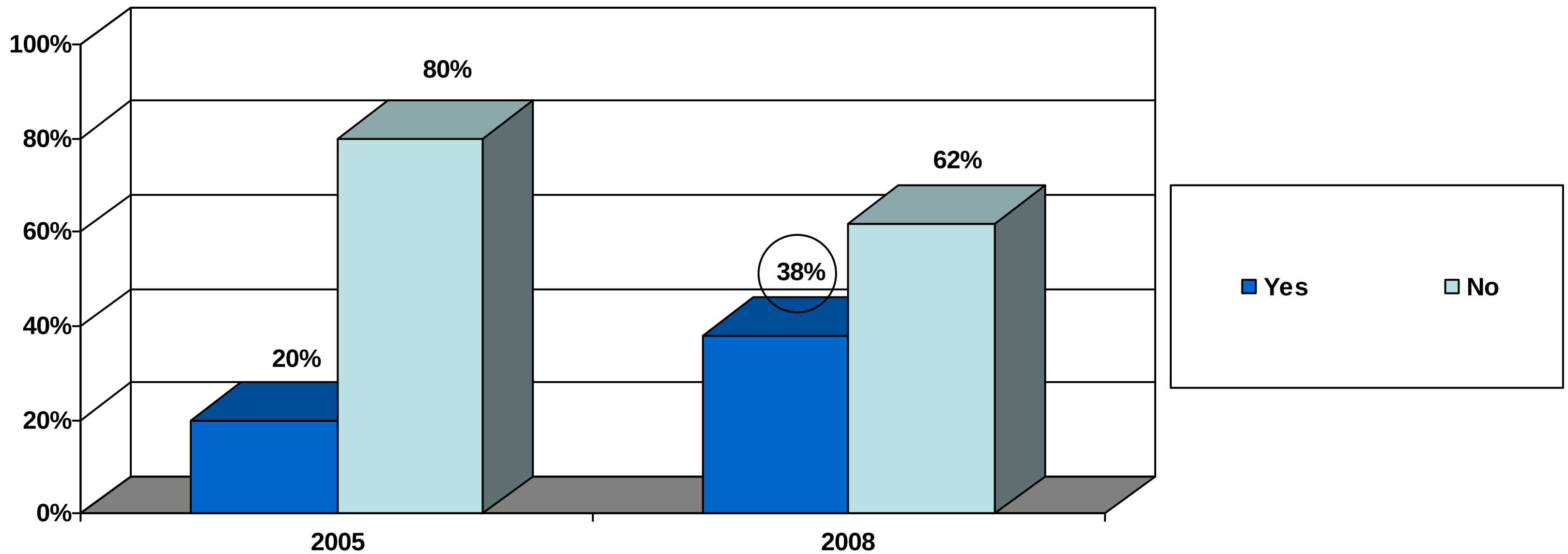
- While overall findings are similar to previous years, more consumers are sauteeing mushrooms in 2008 than in previous years…



rose research

INCIDENCE OF USING NEW RECIPES (PAST 6 MOS.)

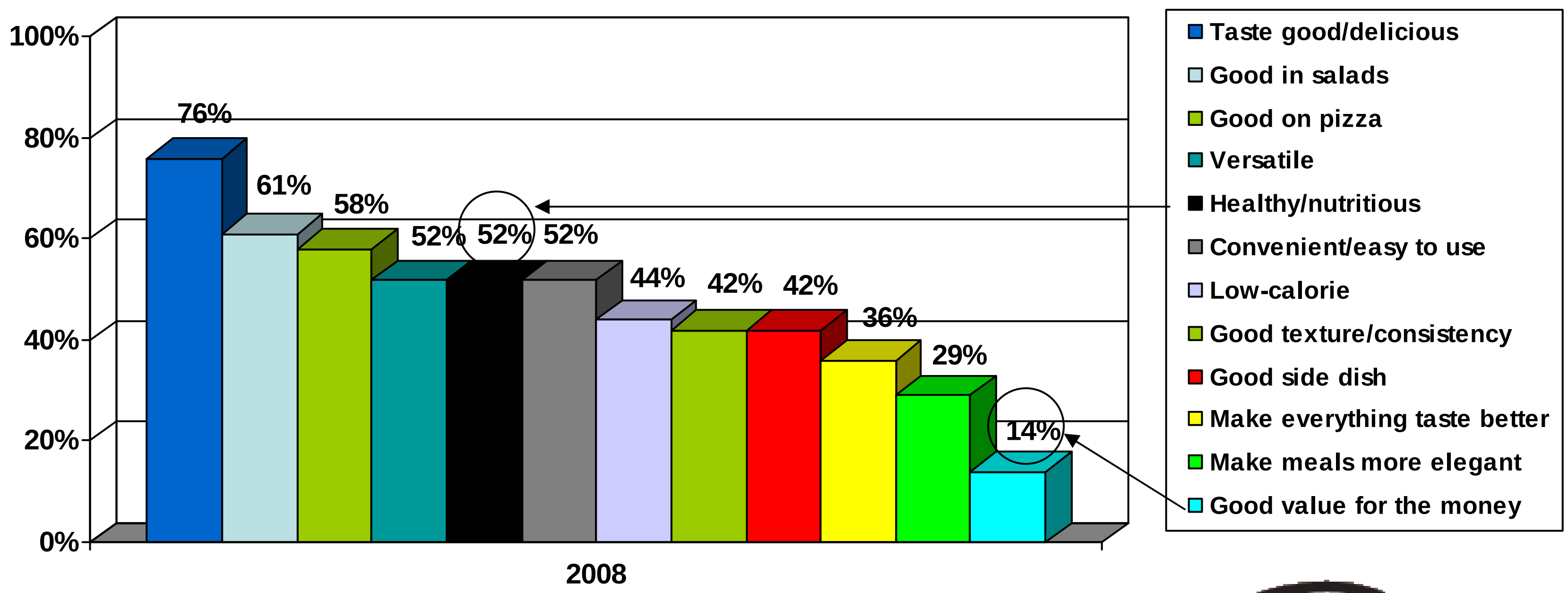
- Along these lines, more respondents are trying out new recipes including mushrooms…



fresh Mushrooms
Nature's Hidden Treasure

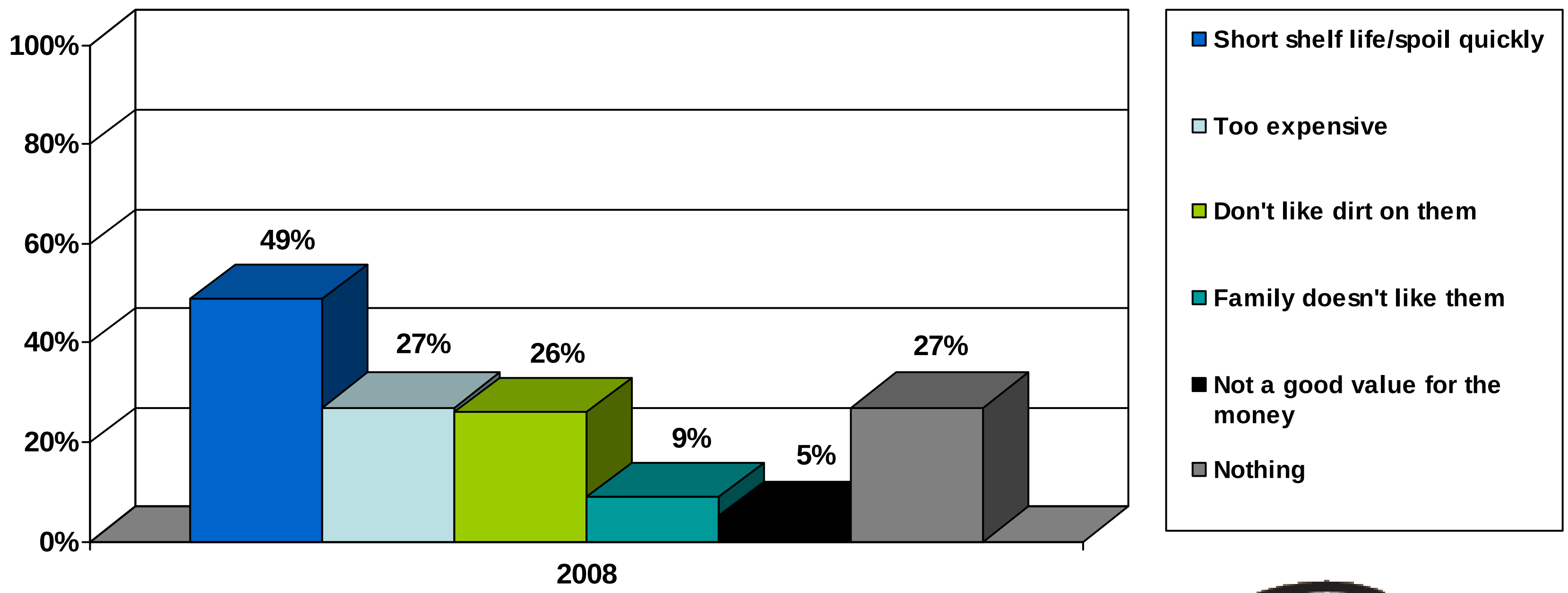
FRESH MUSHROOM LIKES

- Mushrooms are credited for their taste and versatility, however, health and value are not inherent strengths…



FRESH MUSHROOM DISLIKES

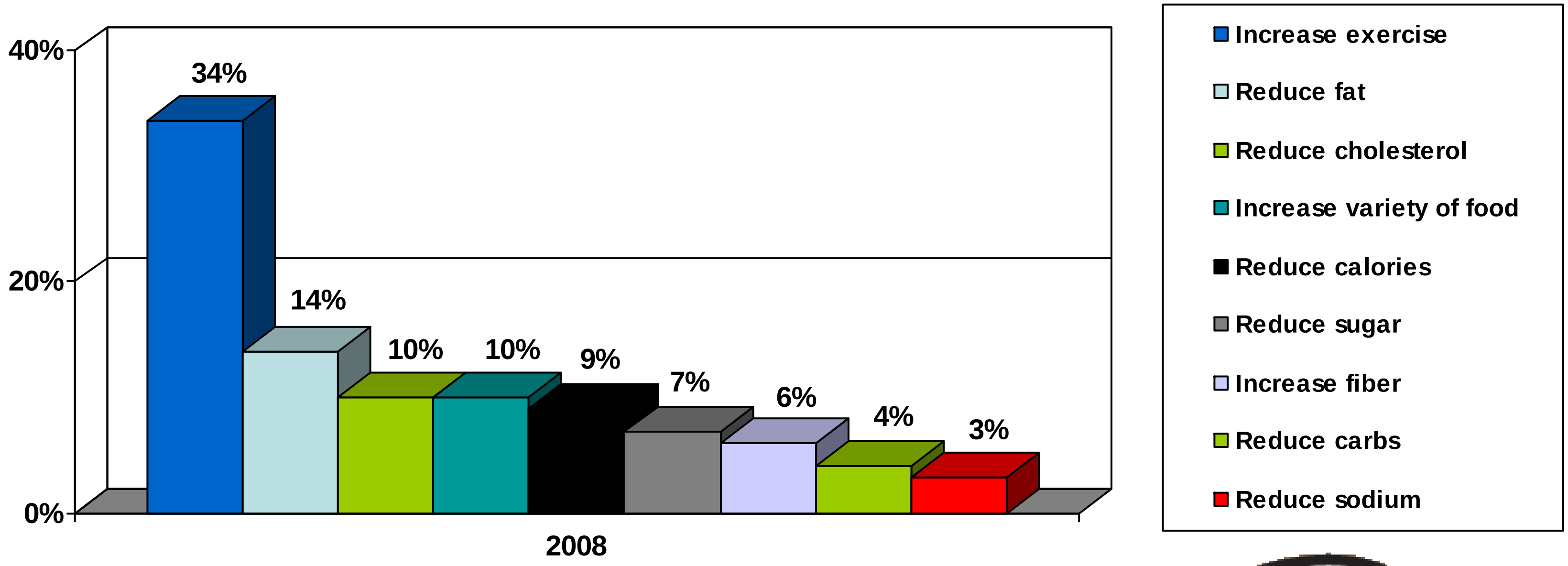
- In line with previous findings, spoilage concerns and price are some of the major complaints consumers have with fresh mushrooms…



rose research

MOST IMPORTANT ACTION TO EAT/LIVE HEALTHIER

- While most consumers indicate that they're eating healthier compared to a couple of years ago, increasing exercise is perceived to be the most important thing they can do for themselves...

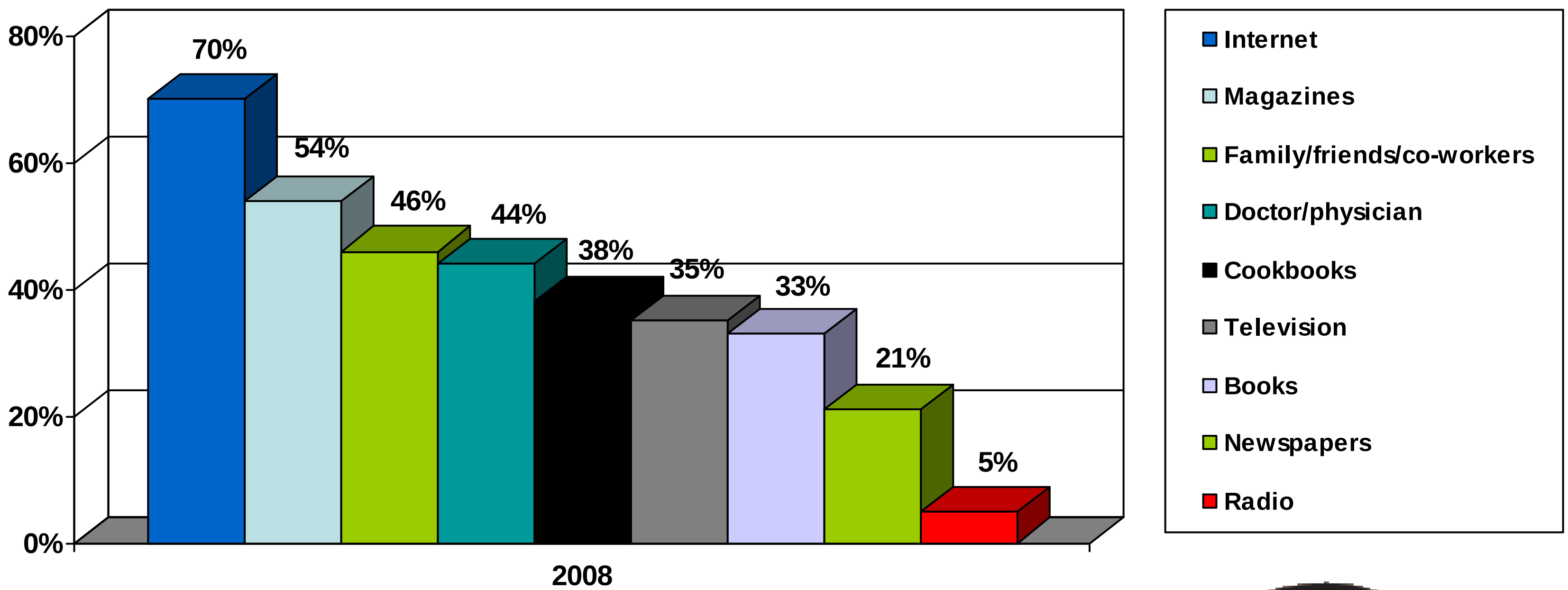


fresh Mushrooms
Nature's Hidden Treasure

rose research

SOURCES FOR HEALTHY EATING INFORMATION

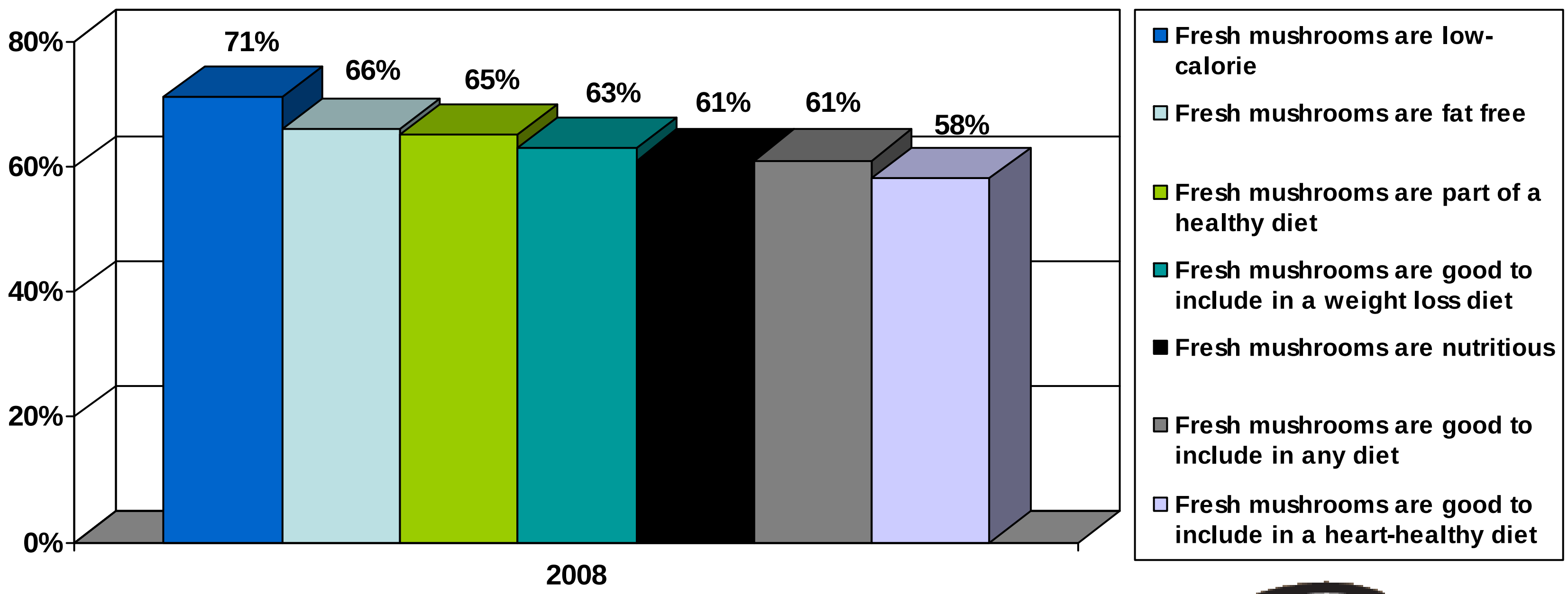
- Most consumers look to the Internet for information regarding healthy eating...



fresh Mushrooms Nature's Hidden Treasure

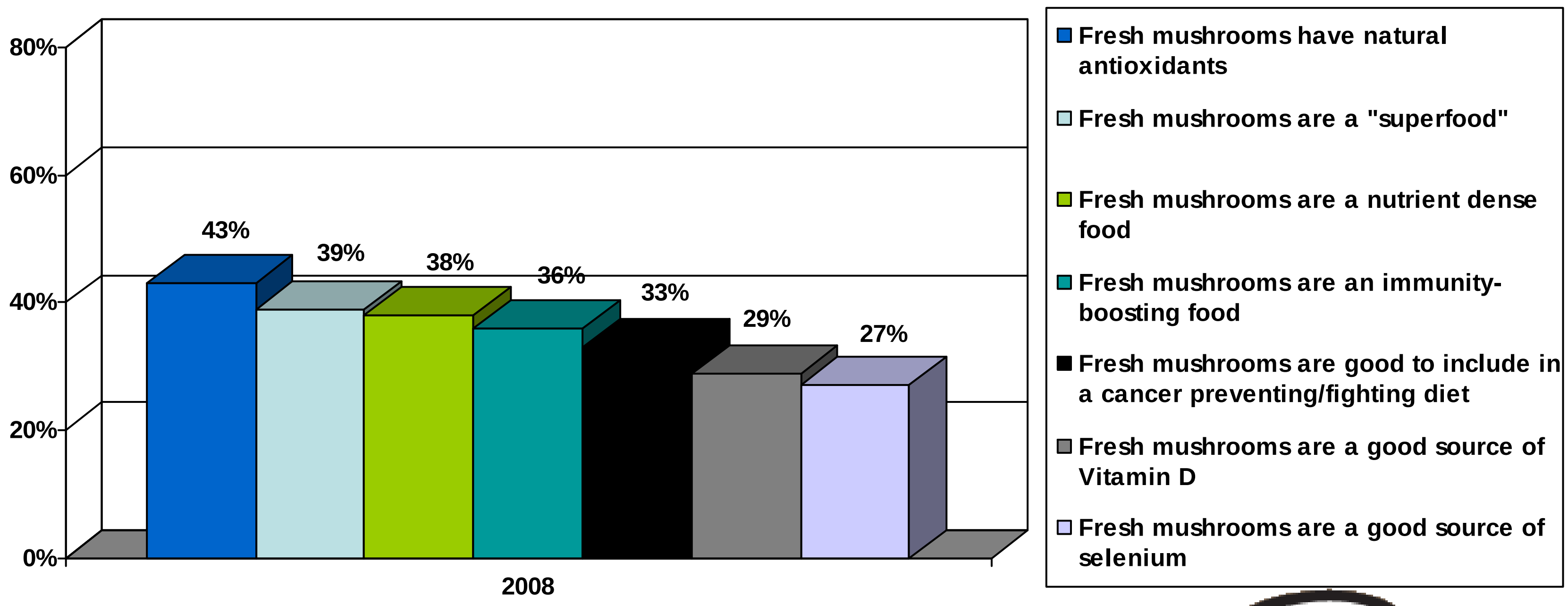
FRESH MUSHROOM HEALTH PERCEPTIONS

- In general, consumers perceive fresh mushrooms to be healthy/good for the diet…



FRESH MUSHROOM HEALTH PERCEPTIONS

- However, most are not aware of the specific health benefits provided by fresh mushrooms...



CONCLUSIONS

- While incidence of fresh mushroom purchasing continues to be strong and is becoming more of a mainstream product, there is room for additional growth.

  – About three-quarters have bought them in the past year – up from 62% in 1994

  – 95% of households have consumed fresh mushrooms at home in 2008 – versus 60% in 2005

rose research

CONCLUSIONS

- The key challenge continues to be converting medium and light purchasers to heavy ones.
  - Consumer education should continue to stress:
    - Storage/spoilage information
    - Specific health benefits

$$$BETTER VALUE FOR THE MONEY$$$

fresh Mushrooms Nature's Hidden Treasure

rose research

CONCLUSIONS

- In addition, the wide variety of fresh mushroom choices should be communicated – offering consumers more choice.
- Along these lines, fresh mushroom versatility should also be integrated into the marketing strategy via new recipes, as shoppers are very receptive to new uses.
- The Internet should be utilized as much as possible, as it is the medium where consumers get most of their information about healthy eating/foods.

fresh Mushrooms
Nature's Hidden Treasure

Consumers are Changing

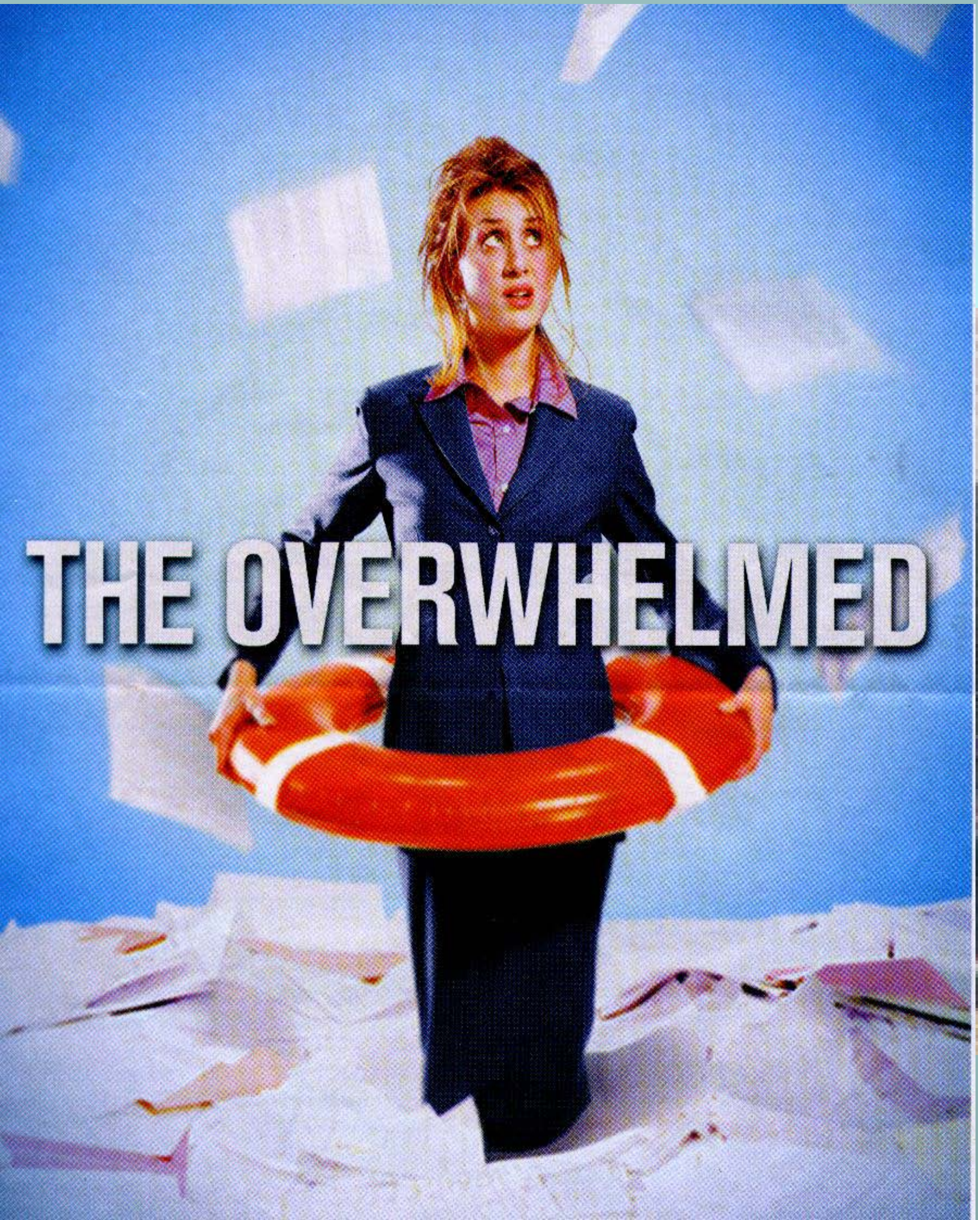
By Dr. John L. Stanton
Department of Food Marketing
Saint Joseph's University
www.johnlstanton.com
jstanton@sju.edu

Another way to say it is:

"Shift happens"

The single biggest change in consumer buying habits has been the quest for convenience

Women are in the midst of a Time Famine



Time Starved Consumers

- Almost 80% of adult women work outside the home
- Average work week getting longer (163 more hours/year than the 1960s)
- Perception of time poverty increases

According to Tyson research today’s cooks want to cook *15 minutes or less*

versus 30 minutes in the ‘80s; versus 2.5 hours in the ‘50s

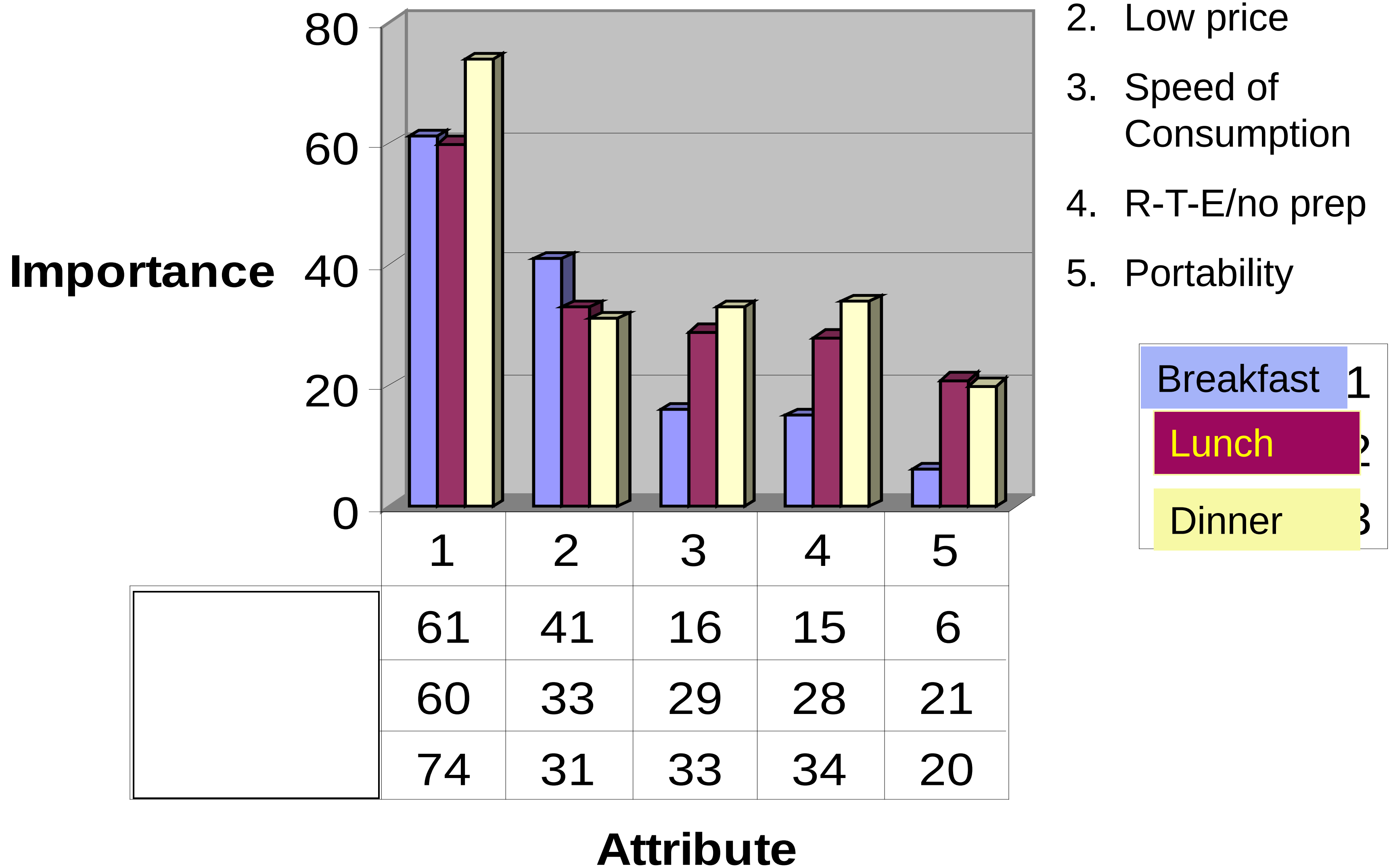
Some involvement is still important in meal preparation

- According to Stouffer’s, women ages 25-50 have time concerns but they also want to feel like they have done something to make the meal.
- 80% of women believe “stove top” preparation is closer to homemade.


Norman
Rockwell

Food Attributes

1. Ease of Preparation
2. Low price
3. Speed of Consumption
4. R-T-E/no prep
5. Portability

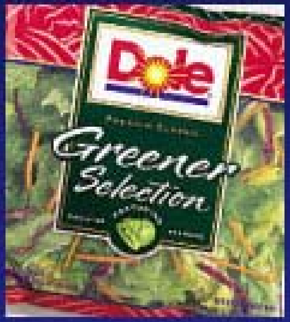


"Consumers are seeking simplification in their lives. Any product or service that responds to that need will receive acceptance."

— Donald Sokolnicki
Vice President
National Accounts
Nestlé USA

It has affected almost every section of the grocery store as well as the stores themselves

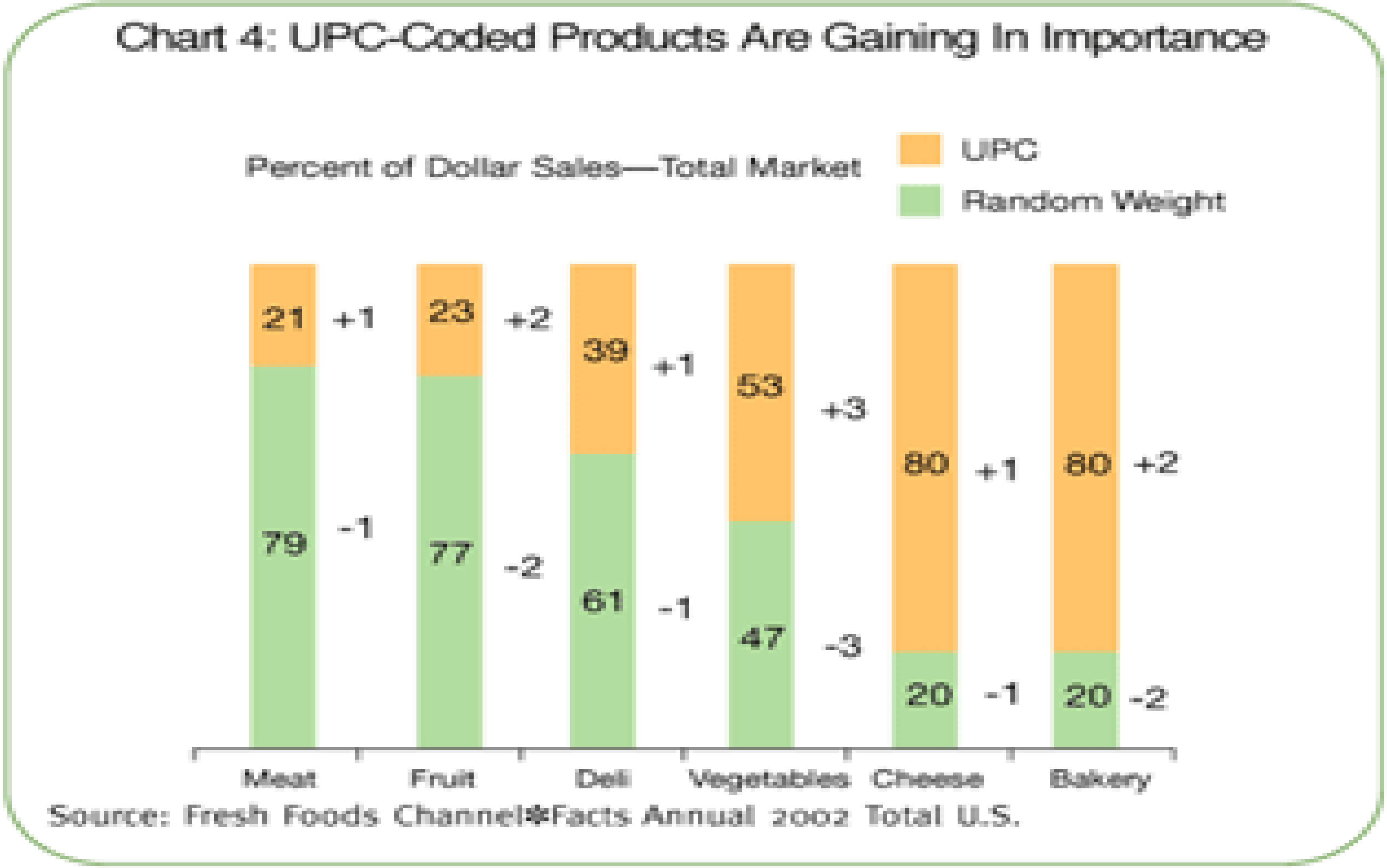
Convenient Solutions Skyrocketing



	$ Sales (Millions)	% Growth
Precut Fresh Salad Mix	2,083	12
Refrigerated Entrees	1,061	21
Breakfast Bars	414	28
Polishing/Cleaning Cloths	248	8
Frozen Biscuits/Rolls/Muffins	213	43
Shelf-Stable Entrees	211	50
Pre-Moistened Cleaning Towels	151	48
Refrigerated Meal Starters	18	304

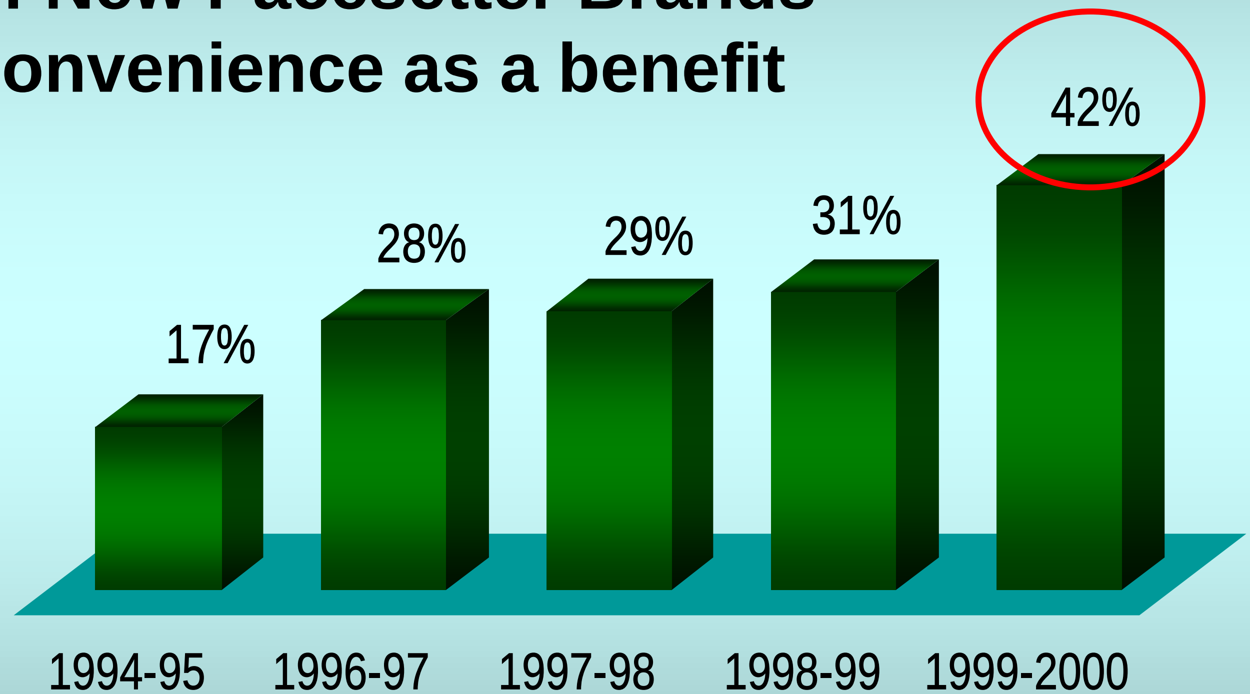
Source: ACNielsen Strategic Planner F/D/M (Ex WM) - 2002.

UPC coded vegetables are up!



Increasing trend toward convenience

Percent of New Pacesetter Brands offering convenience as a benefit



Number of Pacesetters	**102**	**87**	**91**	**95**	**120**

Pacesetters: top 200 or so new brands with year-one sales +7.5 mm

Ready-to-heat and ingredients are where the action is!

The supermarket’s new role will be as the “family’s sous chef.”

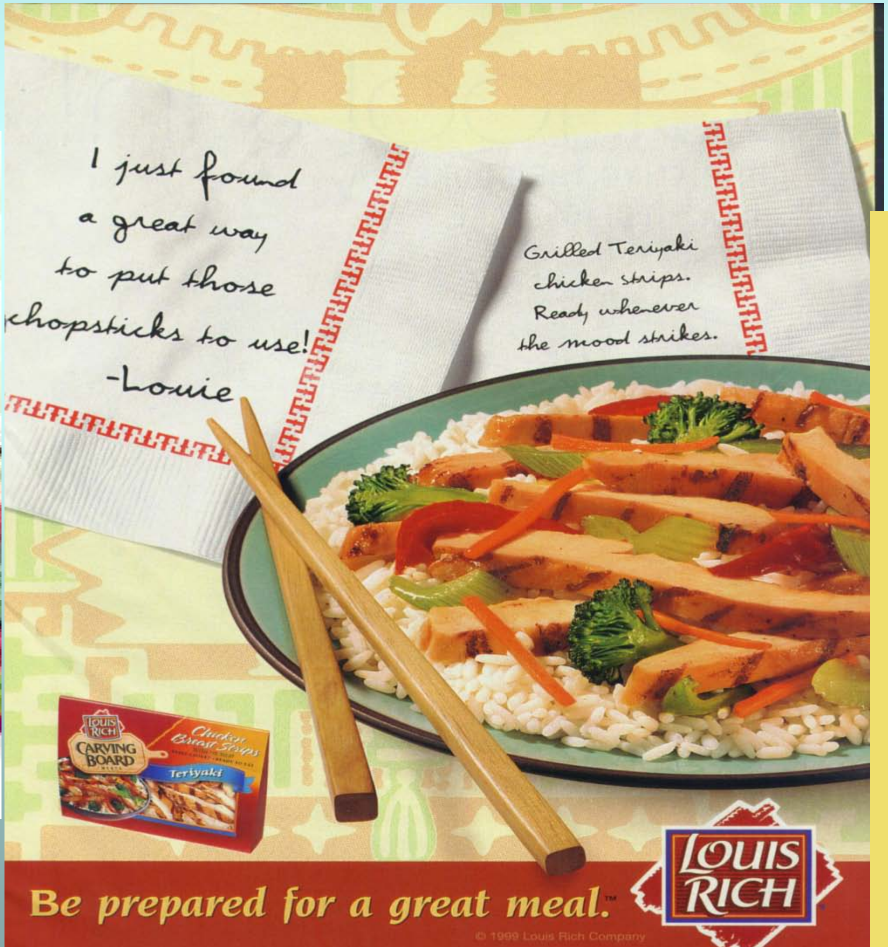
Here's another example

This is merchandised in the MEAT Aisle

What else is in the meat aisle?

- Produce such as
  - Stir fry vegetables near the steak
  - Refrigerated mashed potatoes
  - Vegetable soup mixes near the chuck and beef bones
- To name but a few
- What is missing?

Some companies are providing food that can be easily made into a meal such as a chicken Caesar



How About Bacon, Lettuce and Tomato Merchandised Together!

Fresh Cut Fruit is more convenient and more profitable!

This is not news; A.C. Nielsen* wrote this about the produce section:

Make these categories more accessible and leverage them as impulse purchases in other store sections to enhance meal occasion trips.

*A.C. Nielsen insight magazine 12/15/03

How does the future fare for mushrooms?

- They are very easy to cook
- They are very very fast to cook
- They are low carb
- They are low fat
- They go with most every thing from pizza to beef stroganoff
- They are available all year
- They come in many varieties

My God man, They are perfect

But what must be done to get consumers to buy more

- Follow the advice of Robert Sokolnicki:
- Make it easier and more convenient to use mushrooms.
- Find out what are the obstacles to using mushrooms and remove them.

The obstacles are simple to understand

- I don’t like or have time to get them ready
- I forget to buy them
- I don’t know how to use them
- I don’t know how to store them

My presentation tomorrow will talk about the products and labels that can overcome these obstacles

As Phil Mickelson said about Golf:

- It’s simple it just isn't easy. Nor will overcoming the consumer obstacles about mushrooms be easy.

- It will require a change of grower attitude about how you go to market.

- Some of you just won’t be able to do it.

In one case a wholesaler provided a retailer with 10 hanging racks for Parmesan cheese. They were put in all the sections where cheese could be used.

When the wholesaler returned to the store all the racks were in the storeroom (empty). ***"We took the damn things out, we couldn't keep them filled,"*** the retailer said.

- In a fast changing world, what worked yesterday probably doesn’t work today.
    - »Peter Drucker, 1998

“Complacency is something confectionery manufacturers, retailers and wholesalers cannot indulge in.”

Joe Viviano

Vice Chairman

Hershey Foods Corp.

Words of Darwin

- In the struggle for survival, the fittest win out at the expense of their rivals *because they succeed in adapting themselves best to their environment.*

- *Survival is about adaptation!*

  - **Charles Darwin (1809 - 1882), The Origin of Species 1859**

Mushroom growers can heed the words of Darwin

- Adapt or die away!
- Adapt and flourish

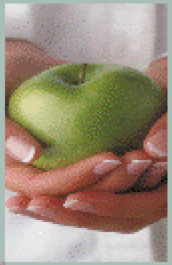
- But unlike the animals you have a choice.

Choose today!

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com



Mushroom Consumer Panel Research

Prepared for:

MUSHROOM COUNCIL

August 2005

ACNielsen

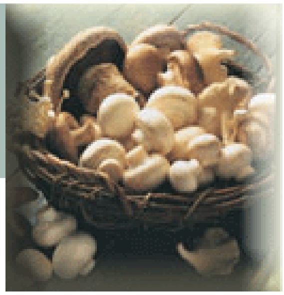
homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

PERISHABLES GROUP™

Keeping Your Business Fresh®
www.perishablesgroup.com

Contents



FRESH MUSHROOMS what a good idea

Background

ACNielsen Homescan Fresh Foods consumer panel provides the data to document consumer purchasing behavior across fresh food categories and retail channels.

- **The consumer panel consists of roughly 10,000 households. The purchasing behavior of these panelists, in aggregate, accurately reflects (projects to) all households in their region and the rest of the country.**
  - ***Channel*Facts allows comparisons of basic shopping measures across category buyers within key channels and accounts.***
  - ***Consumer*Facts provides household purchasing behavior and demographic profiles.***

Source: ACNielsen Homescan Panel Data, 2004

Perishables Group™

Keeping Your Business Fresh®

www.perishablesgroup.com

Background

UPC Purchases

FF / RW Purchases

Consumer Panel

Fresh Foods Consumer*Facts

How do consumers shop fresh foods and my category? Who are the consumers of this category?

Fresh Foods Channel*Facts

How do consumers shop and buy the category in a particular channel?

Fresh Mushrooms what a good idea

Source: ACNielsen Homescan Panel Data, 2004

Research Project Objectives

Gain insight into the mushroom consumer across regions and markets.

HOW are consumers purchasing the mushroom category:

- **Category Purchase Components – evaluate dollar worth and size of category buyers, buy rate, purchase frequency, purchase size, dealing activity, basket size, and buyer conversion.**
- **Opportunity Assessment – mushroom sales opportunities across regions and markets.**

WHO are the mushroom consumers:

- **Demographic Profile – identify who mushroom buyers are (by income, HH size, heads of households, presence of kids, etc.). Demonstrate the value of buyers according to their demographic profile.**
- **Regional Comparisons – assess how consumers vary by geographic region.**

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Key Findings & Implications

ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

Key Findings

- **Penetration of mushrooms is relatively low, but the spend rate on the category is among the highest, trailing only potatoes and tomatoes.**
  - ***Mushrooms are a large portion of the vegetable consumer's annual spend, and is a higher ring category.***
  - ***The mushroom consumer makes an average of 5 trips per year on mushrooms, and the average transaction size is among the highest of all vegetables.***
- **Majority of mushroom sales are in packages (UPC). The spend rate of UPC mushrooms is nearly double that of RW mushrooms.**
- **Mushroom buyers are evenly distributed nationally. There are distinct differences in mushroom type preferences across the country.**
  - ***The Central region is slightly more developed than other regions. RW mushrooms have a strong presence in West, where the region captures 44% of buyers.***

Source: ACNielsen Homescan Panel Data, 2004

Key Findings

- **Penetration is highest in major markets – San Francisco, Los Angeles and Chicago.**
  - ***Particularly in San Francisco, 50% of all households are buying the category. Interestingly, deal activity is among the lowest in San Francisco. Purchase behavior in SF is independent of any deal incentive.***
- **Buy rate is second highest in Atlanta.**
  - ***There is a group of core buyers in Atlanta that are either buying mushrooms at a high price point, buying a significant amount or making frequent trips.***
- **San Francisco is a top performing market, with significantly higher penetration and buy rate than other markets.**
- **Atlanta is a market of opportunity, where spend rate is high but penetration is the lowest.**
  - ***Further research is recommended to examine usage patterns of these core mushroom buyers in Atlanta.***

Key Findings

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

- **The South region dominates in total sales, but the East region has heavier category buyers that are spending more and make the most category trips per year.**
- **Deal activity varies widely across regions, and is lowest in the West, where only 20% of total dollars were associated with promotion/discounting.**
- **Consumers are shopping mushrooms primarily through traditional grocery stores.**
  - ***Compared to produce and vegetables, mushroom buyers shopping alternative formats (Mass, Club) is minimal with the exception of Super Centers, where 16% of mushroom buyers are shopping the category.***
  - ***A portion of RW mushrooms buyers are shopping fruit stands.***
- **Repeat purchase level of the category is generally high (70% nationally), and is highest in the Central and East regions where deal activity is also more prominent.**

FRESH MUSHROOMS what a good idea

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Key Findings

- **Households that purchase mushrooms tend to be more affluent 2 person households.**
  - ***The category also exhibits strong skews towards Asian households.***
  - ***Households in the West tend to be affluent, smaller households that are Empty Nesters or Childless Younger Couples.***
  - ***In the East and South, however, households tend to be larger with children.***
- **The main differences between the average vegetable and average mushroom consumer is that mushroom households tend to be slightly more affluent, educated and have strong skews towards Asian households.**
  - ***The category also attracts more childless younger couples, and fewer older singles. This younger, highly educated demographic that may be open to targeted programs on usage and preparation. In store demos and POS material with usage (recipes) are recommended to boost penetration.***

FRESH MUSHROOMS *what a good idea*

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Key Findings

- **Mushroom shoppers are valuable to retailers. The average shopping basket with mushrooms is more than double the value of a shopping basket without mushrooms.**
- **Dairy products and specific produce items are most likely to be purchased along with mushrooms:**
  - ***Fresh carrots, packaged salads, lettuce and fresh potatoes are the produce items most likely to be purchased along with mushrooms.***
  - ***Sour cream, shredded cheese, yogurt and fresh eggs are the dairy items most likely to be purchased along with mushrooms.***
  - ***Spaghetti/marinara sauce, canned soup and margarine/spreads are the grocery items most likely to be purchased with fresh mushrooms.***

FRESH MUSHROOMS *what a good idea*

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Research Implications

- **The low levels of repeat purchases, trips per year (in South) and especially penetration indicate that consumers are shopping the category for specific purchase occasions.**
  - ***When consumers are purchasing the category they spend significant dollars relative to the rest of the produce department. However, a general lack of mushroom usage/preparation knowledge may be hurting category performance.***
- **Current mushroom consumers may need to be presented with additional eating occasions and usage options.**
  - ***Summer grilling recipes/themes and holiday tie-ins are two examples.***
- **The low penetration, across all regions, strongly suggests that new consumers will need information and education on usage and preparation.**
  - ***In store demos and POS material with usage (recipes) and handling/storage suggestions are critical to increasing penetration in underdeveloped markets. If this can be accomplished the data indicates that once consumers begin to use mushrooms they may spend more on the category than most other significant produce categories.***

FRESH MUSHROOMS *what a good idea*

Source: ACNielsen Homescan Panel Data, 2004

Research Implications

- **POS materials (including recipes) should be produced and distributed with Hispanic and Asian consumers in mind.**
  - ***Regardless of region, particular attention should be given to Asian markets/chains as they are heavy buyers.***
  - ***In the Central and South regions the Hispanic consumer exhibits a propensity to purchase mushrooms.***
- **The household panel data indicates that marketing resources may be more efficiently applied to the traditional retail channel as this is where a disproportionate percentage of purchases occur.**
  - ***However, the lack of successive years of data eliminates trending to reveal if mushroom purchases in Supercenters are consistent with the growth of this overall channel.***
- **The data indicates that promotions are important for driving repeat purchases and increasing trip occasions for the category.**
  - ***Promotions should be used to drive eating/purchase occasions but discount depths should be limited as it appears consumers are willing to spend more on this category relative to the rest of produce.***
  - ***In addition the mushroom consumer is very affluent. This again reinforces the notion that the industry should make every effort to trade up consumers from white to browns and etc.***

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Research Implications

- **Practices impacting penetration in the Central region should be identified and utilized across other regions.**
  - ***Penetration in the Central region is relatively high. More consumers, per capita, shop the category in this region than any other region. This does not appear to be the result of dealing. The Central region is on par with respect to the percent of category sold on deal vs. the other regions and Total US.***
- **The data indicates that, by region, the following mix/positioning of mushrooms relative to the primary consumer demographics is recommended:**
  - ***West – Bulk items or smaller package sizes. Position as high end, perhaps part of a gourmet meal solution. Asian recipes for POS materials.***
  - ***Central – Maintain bulk offering while displaying a strong proportion of packaged items . Position as high end, perhaps part of a gourmet meal solution. Hispanic recipes for POS materials.***
  - ***South – Offer larger package sizes. Position as high end, perhaps part of a gourmet meal solution.***
  - ***East – Some bulk with moderate package sizes. Position as high end, perhaps part of a gourmet meal solution. Asian and Hispanic recipes for POS materials.***

FRESH MUSHROOMS what a good idea

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Research Implications

- **Mushrooms are not only valuable to supermarkets in driving overall transaction size, but specific items, especially in produce, appear to be highly complimentary. As a result, retailers should be encouraged to utilize primary displays and/or secondary displays designed leverage the likelihood of these complimentary purchases.**
  - ***Fresh Carrots and packaged salads are eight times more likely to be purchased in conjunction with mushrooms.***
  - ***Bulk lettuce is 6 times more likely to be purchased in conjunction with mushrooms. Fresh potatoes are purchased with mushrooms by a factor of 5.***
- **Fresh mushrooms appear to be utilized as a primary ingredient in cooking by consumers. Secondary retail displays to support the tendancy by consumers to purchase mushrooms as part of meal planning are likely to be successful in driving incremental sales.**
  - ***Shredded cheese and sour cream purchases are more than 5 times more likely to be purchased in conjunction with fresh mushrooms.***
  - ***Spaghetti sauce/marinara buyers are nearly five times more likely to buy fresh mushrooms.***
  - ***Egg buyers and canned soup buyers are nearly four times more likely to make a fresh mushroom purchase.***

FRESH MUSHROOMS *what a good idea*

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Consumer Panel Data

Shopping Behavior

ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

Consumer Shopping Behavior

Shopper Components

Total Mushroom Dollar Sales =

Buyer Base
(HH Penetration)

Buying/Spend Rate
(Dollars per Buyer)

Purchase Rate
(Dollars per Trip)

How much per trip?

Purchase Frequency
(Trips per Buyer)

How many trips?

FRESH MUSHROOMS what a good idea

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

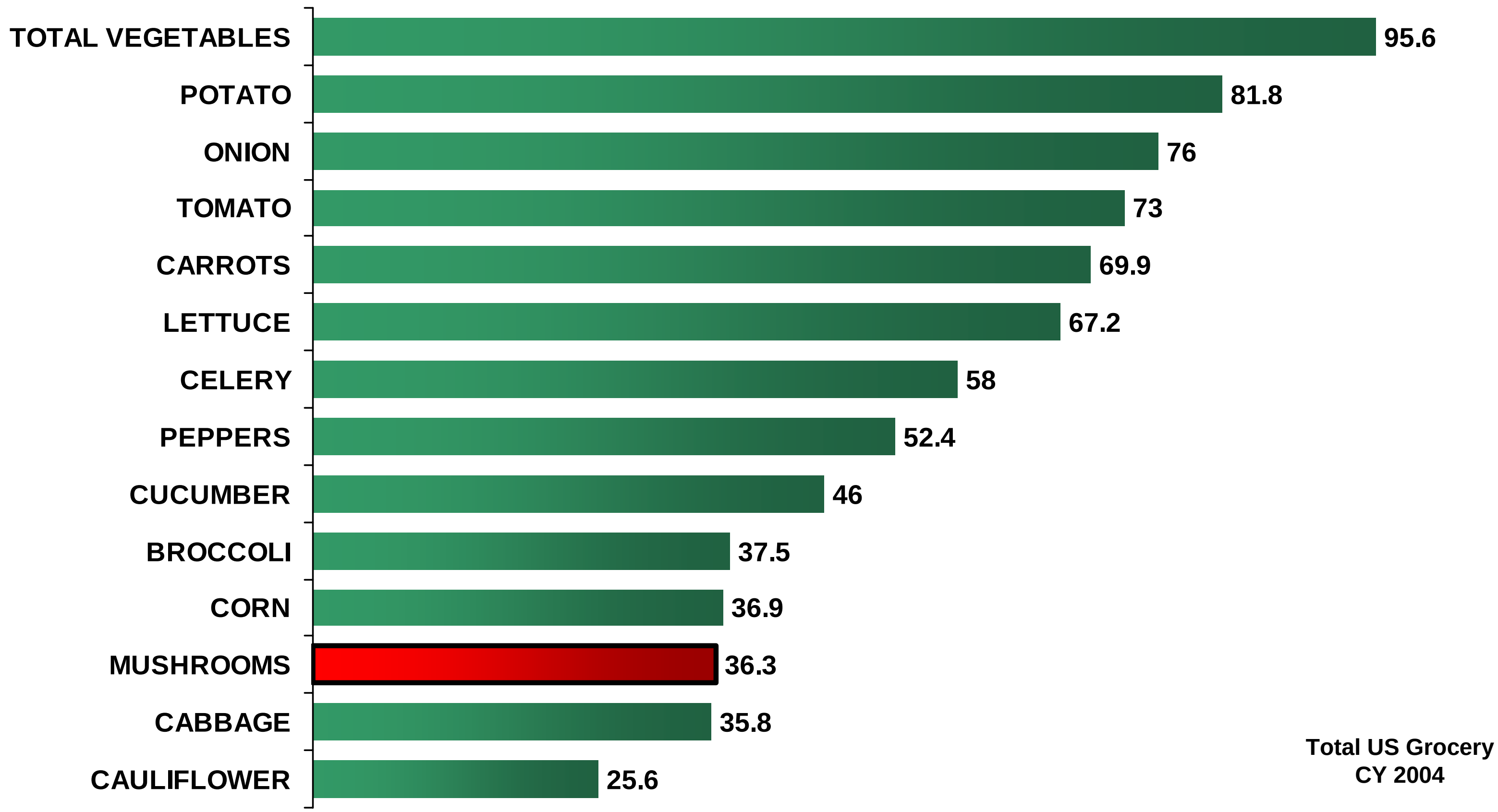
Keeping Your Business Fresh®

www.perishablesgroup.com

Consumer Shopping Behavior

- **Benchmarking penetration across vegetable categories**
  - ***Penetration of mushrooms is relatively low compared to other vegetables, at 36%. One out of 3 households are purchasing the mushroom category.***

VEGETABLE PENETRATION



Penetration = % of HHs that purchases the product atleast once.

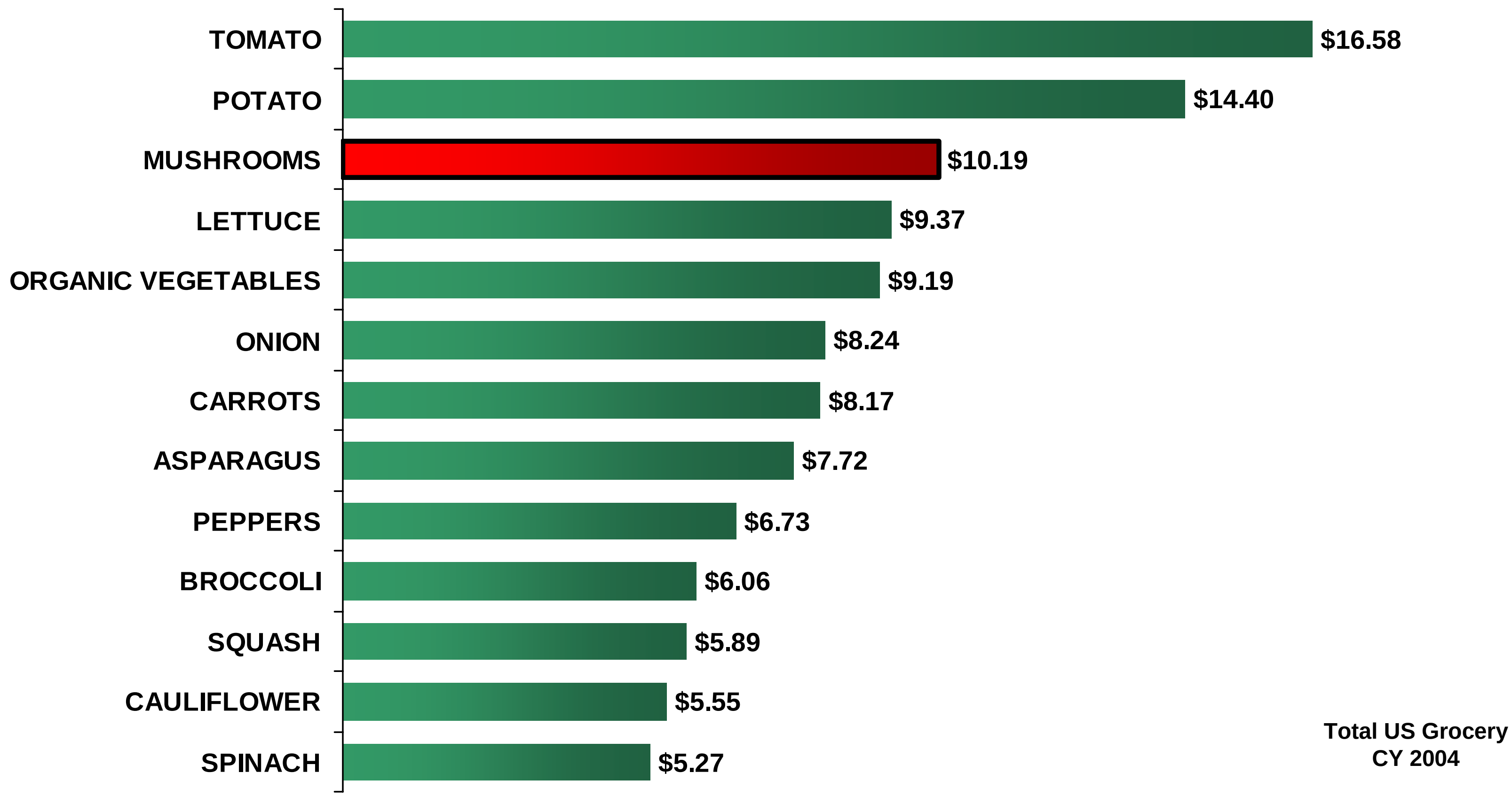
Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

- **Benchmarking buy rate across produce categories**
  - ***The buying rate of mushrooms is one of the highest of all vegetables. The annual spend per buyer on the category is $10.***

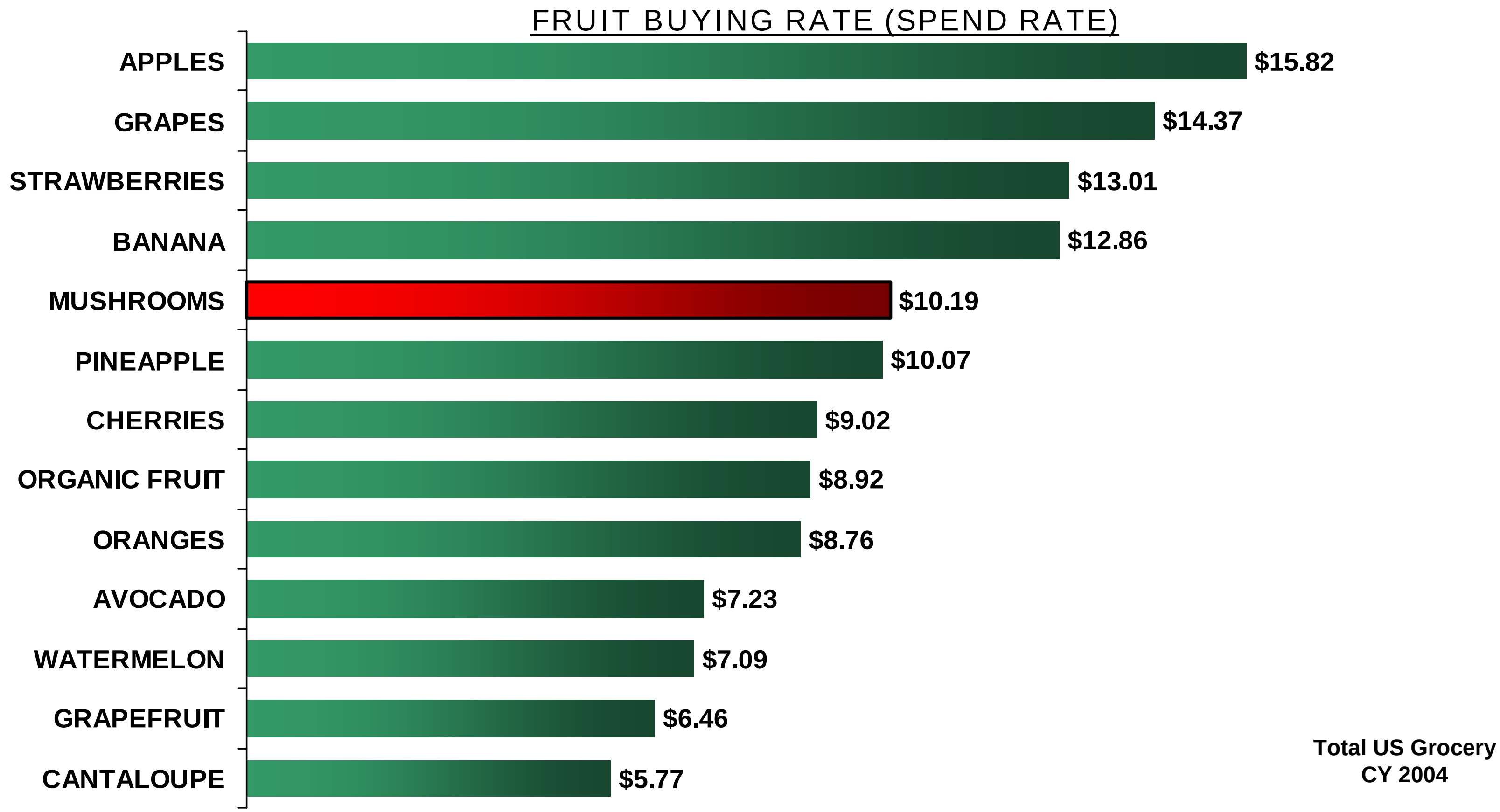
VEGETABLE BUYING RATE (SPEND RATE)



Buy Rate = The average dollars spent per buyer.

Consumer Shopping Behavior

- **Benchmarking buy rate across fruit categories**
  - ***The buying rate of mushrooms exceeds several fruit categories. Consumers are spending nearly the same amount on mushrooms as several traditional mainstream fruits, such as cherries, oranges and pineapple.***



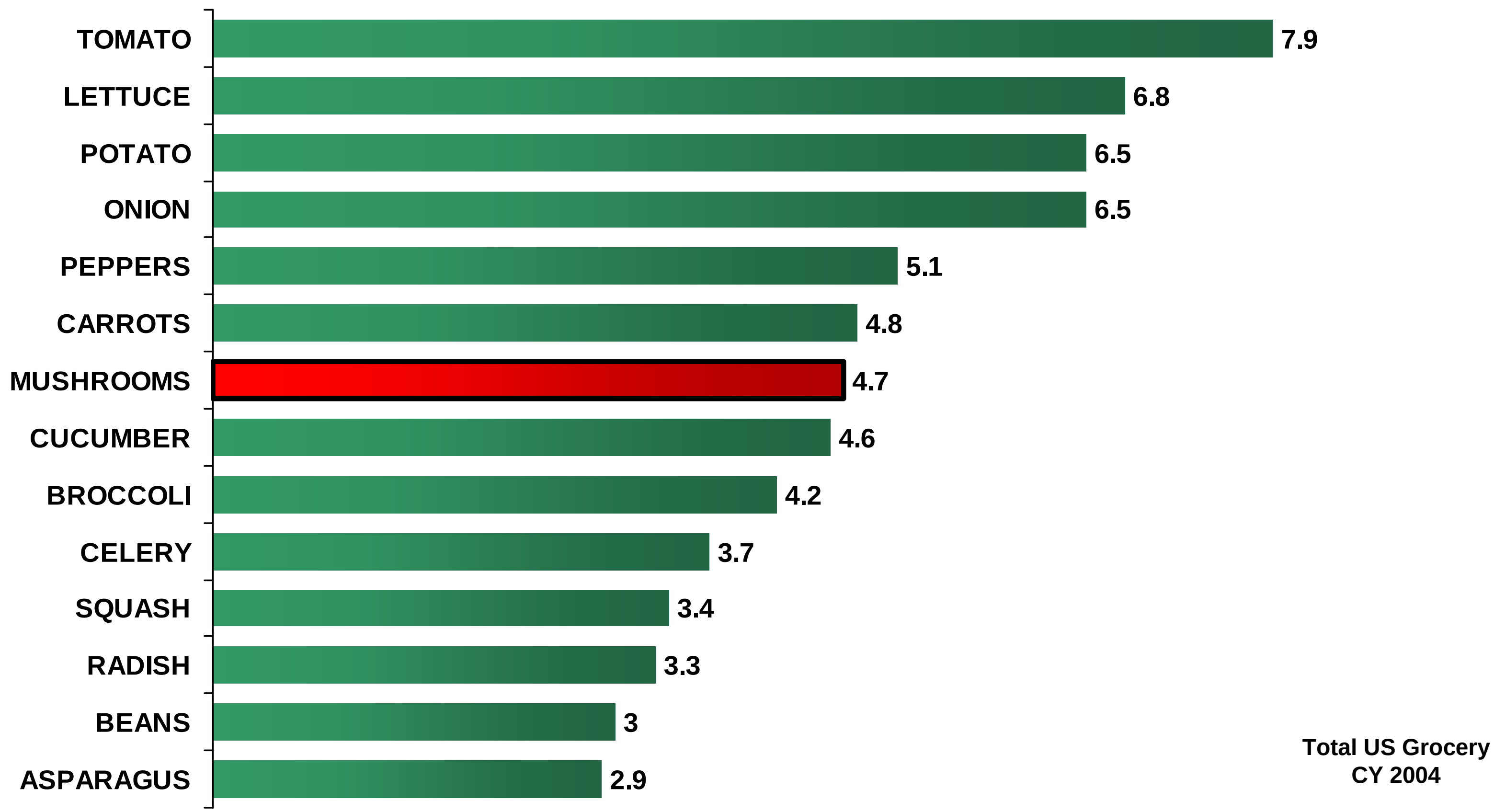
Buy Rate = The average dollars spent per buyer.

Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

- **Benchmarking frequency across produce categories**
  - ***Mushroom buyers are making roughly 4-5 trips per year.***

VEGETABLES FREQUENCY



Frequency = The average annual number of product purchase occasions.

PERISHABLES GROUP™

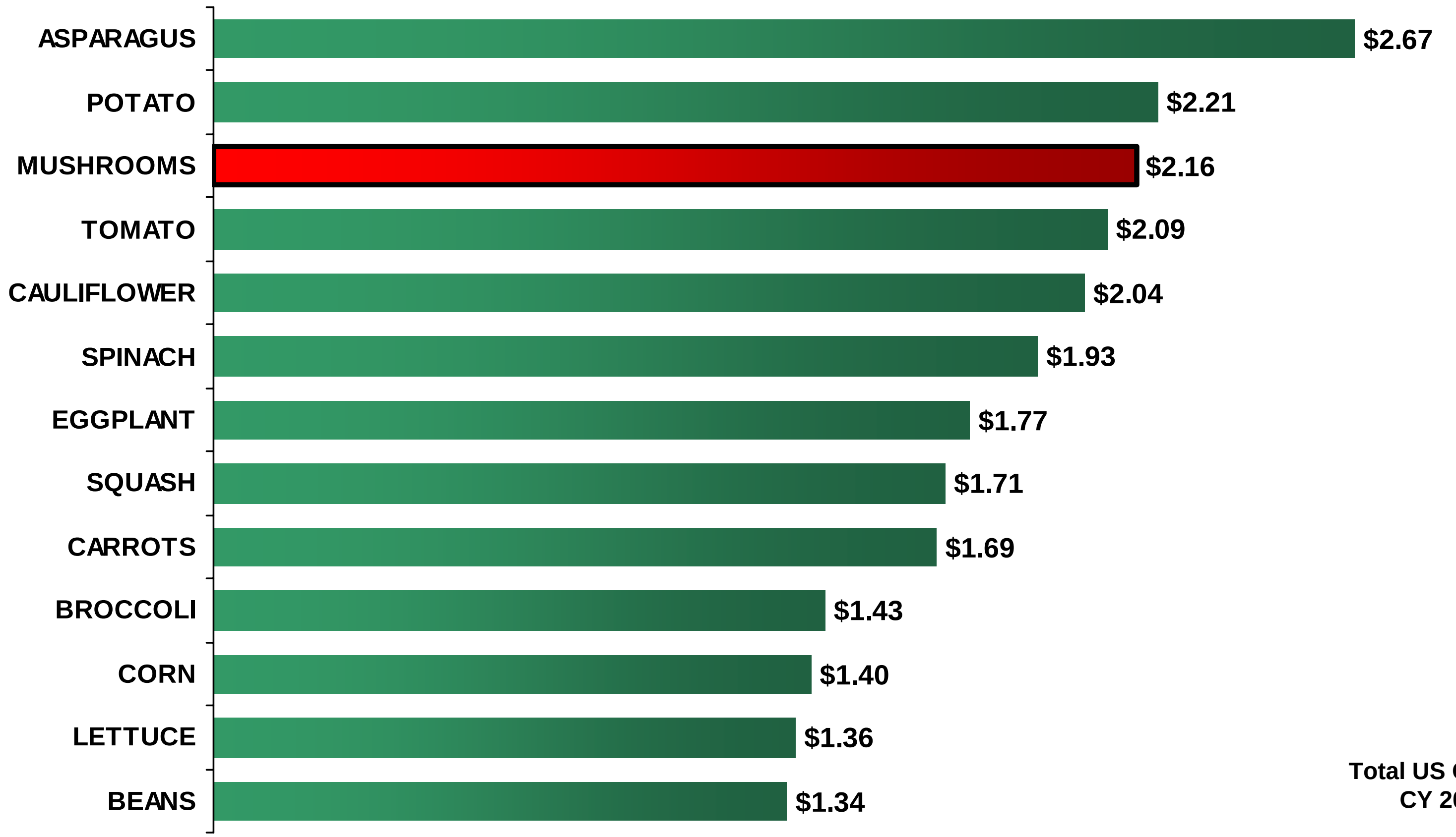
Keeping Your Business Fresh®

www.perishablesgroup.com

Consumer Shopping Behavior

- **Benchmarking transaction size across produce categories**
  - ***The average mushroom consumer spends $2.16 per trip, among the highest of all vegetables.***

VEGETABLES TRANSACTION SIZE

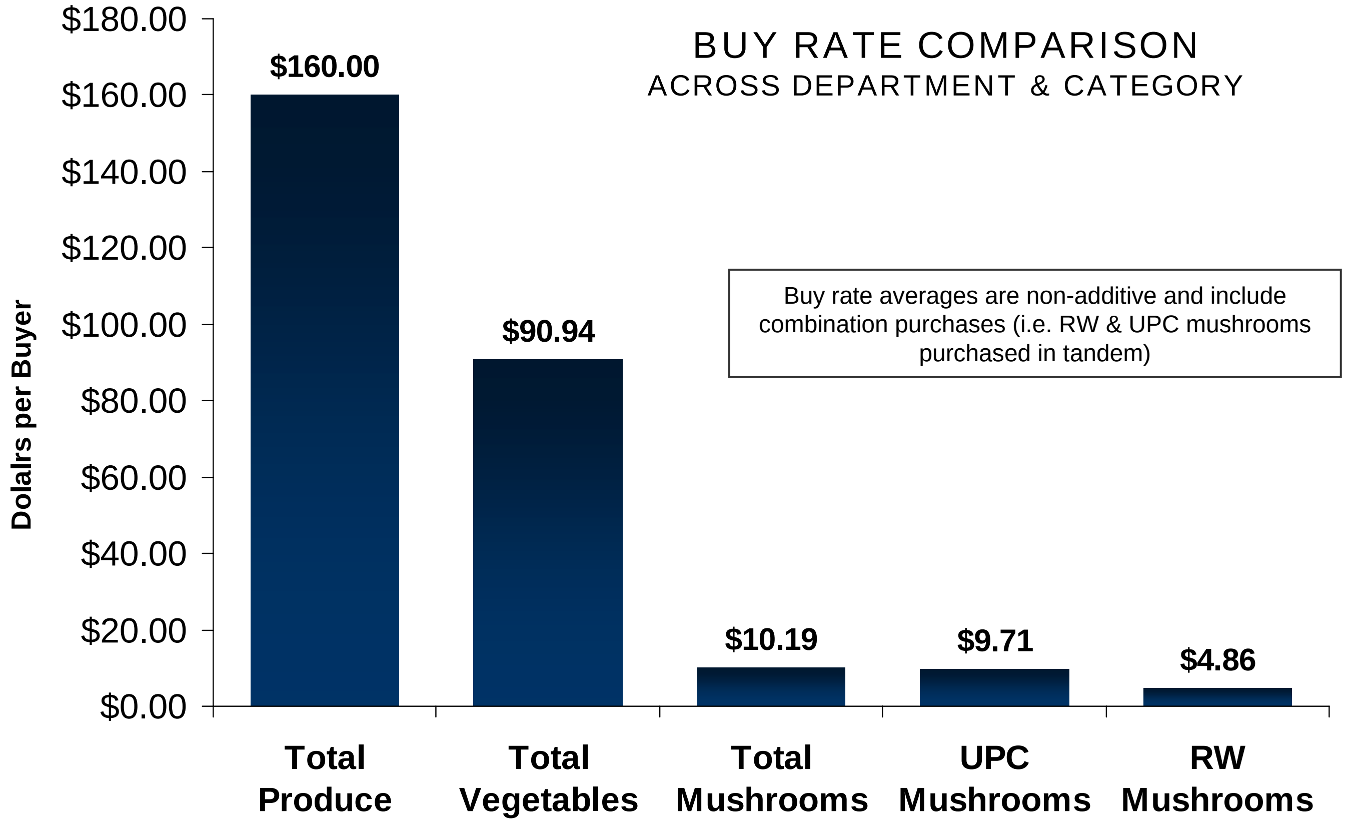


Total US Grocery
CY 2004

Dollars per Trip = The average dollars spent per product purchase occasion.

Consumer Shopping Behavior

- **Buy Rate Comparison**
  - ***The average consumer spends $160 per year on produce. $90 of those dollars are towards vegetable purchases, and $10 are spent on mushrooms. The spend rate of UPC (packaged) mushrooms is nearly double that of RW (bulk) mushrooms.***



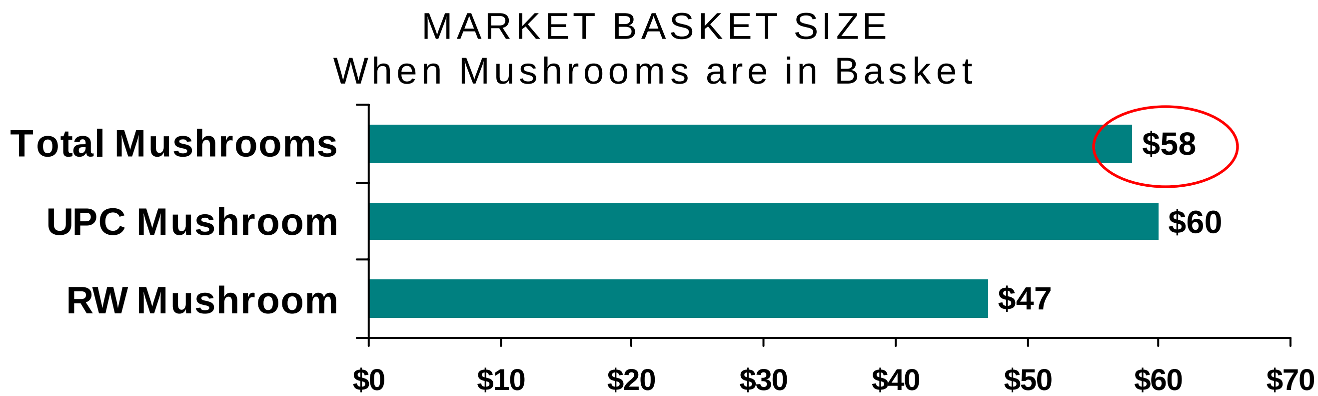
Source: ACNielsen Homescan Panel Data, 2004

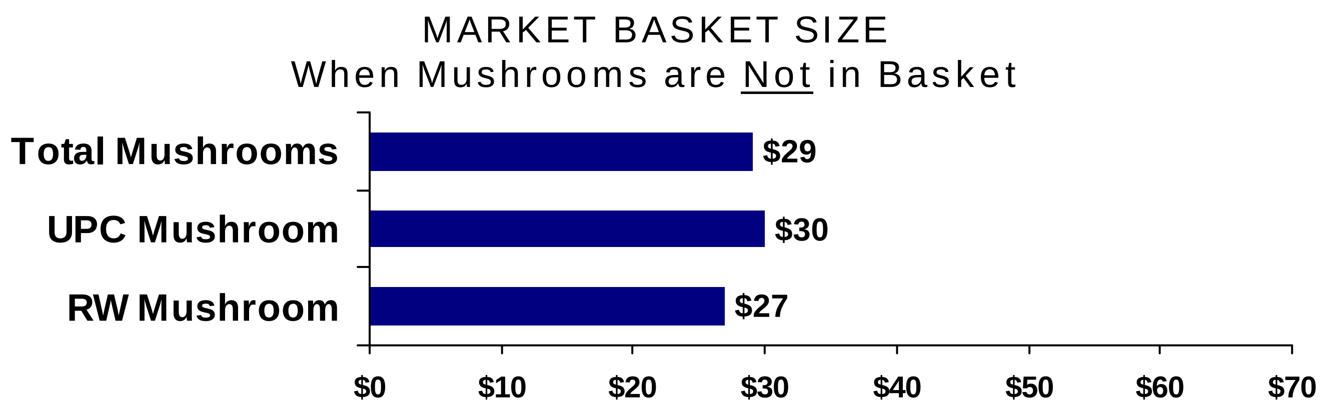
Consumer Shopping Behavior

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

Market Basket Size

- ***The average dollar value of the shopping basket is $58 when mushrooms were included. This is double the basket when when mushrooms were absent. Mushrooms add significant additional shopping basket spending dollars to the retailer.***





FRESH MUSHROOMS *what a good idea*

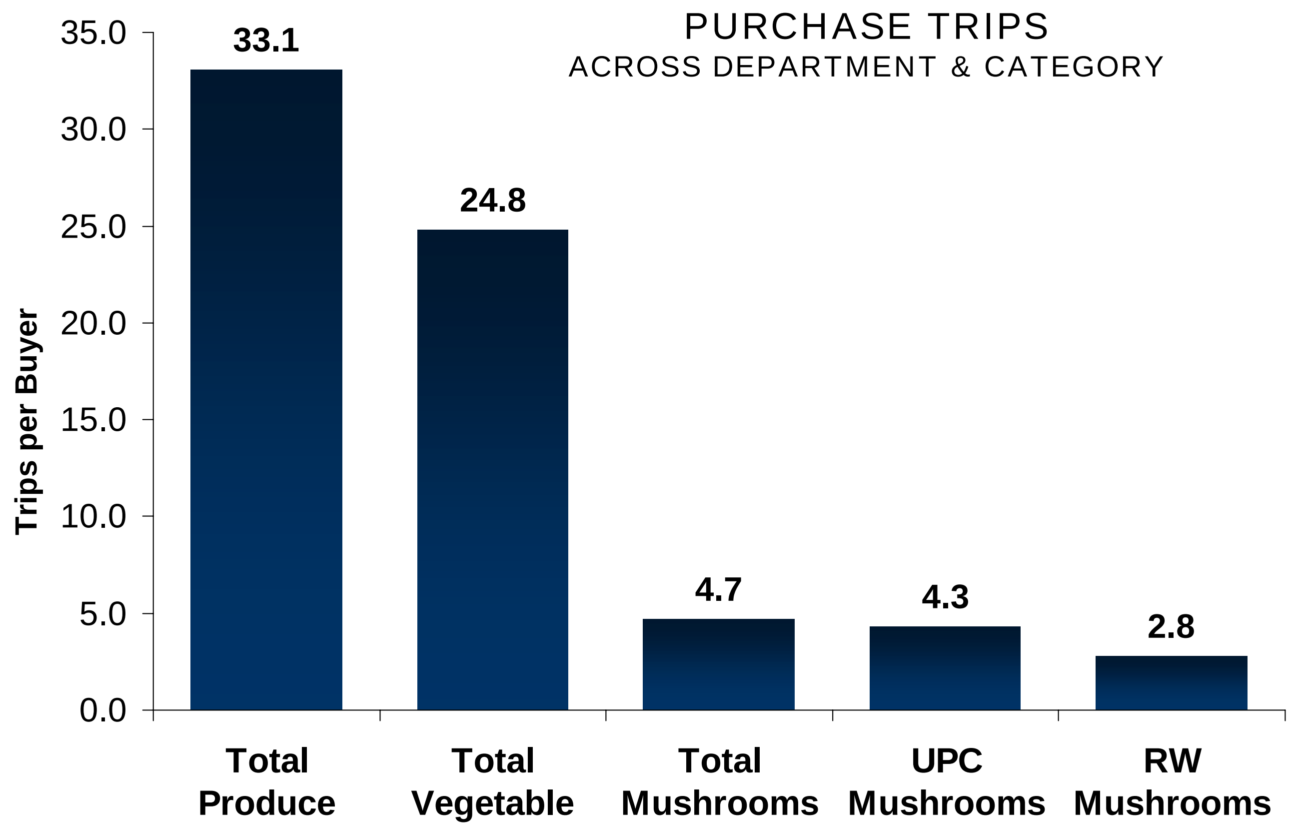
Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

Purchase Frequency Comparison

- ***The average consumer makes 33 trips per year for produce. 22 of those trips are for vegetable, and 4 trips are for mushroom purchases.***

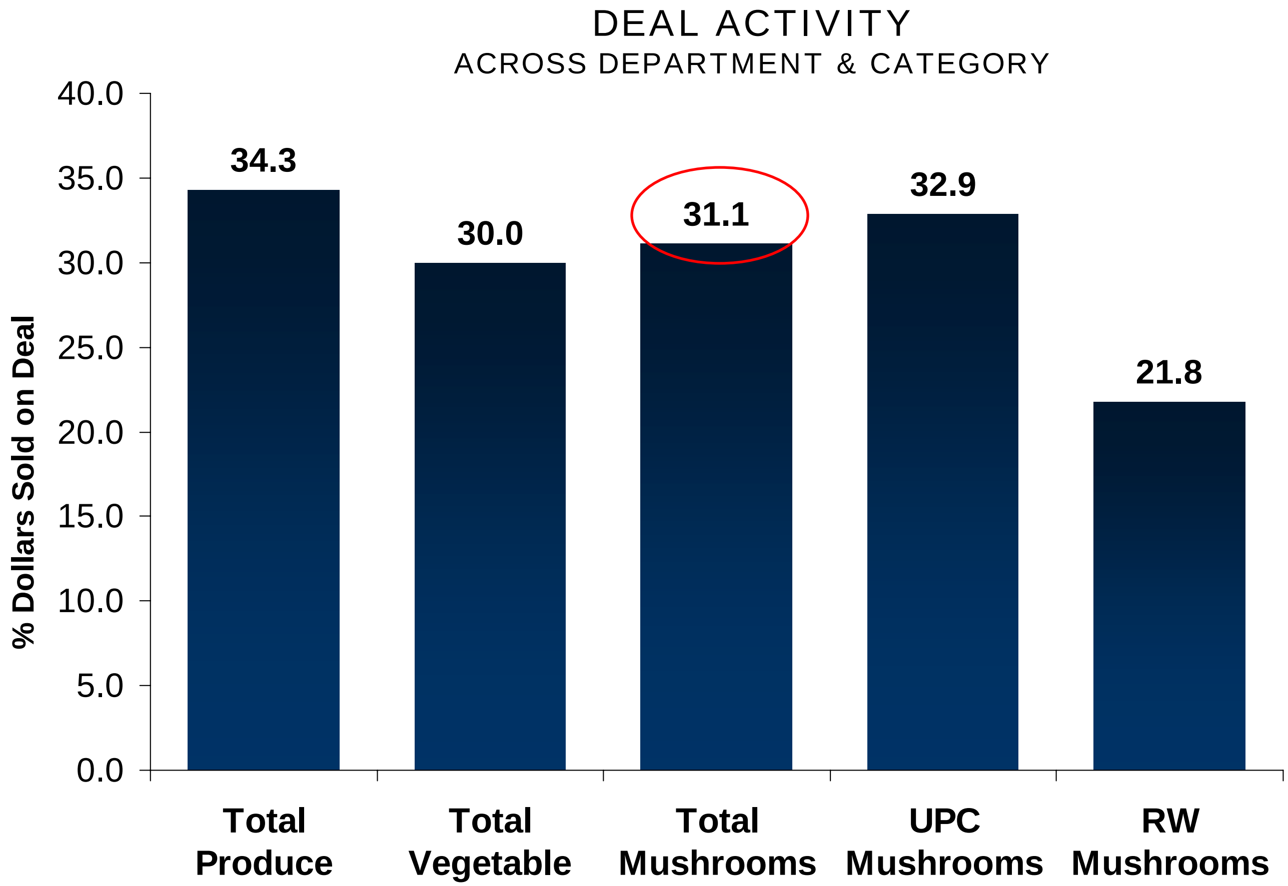


Consumer Shopping Behavior

Deal Activity Comparison

- ***A greater percentage of mushroom dollars is sold on deal than vegetables. Furthermore, nearly a third of all UPC mushroom sales is associated with deal.***

Deals are defined as features, displays, store coupons, manufacturer coupons, and other deals such as price packs or bonus packs.



Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

PERISHABLES GROUP™

Keeping Your Business Fresh®

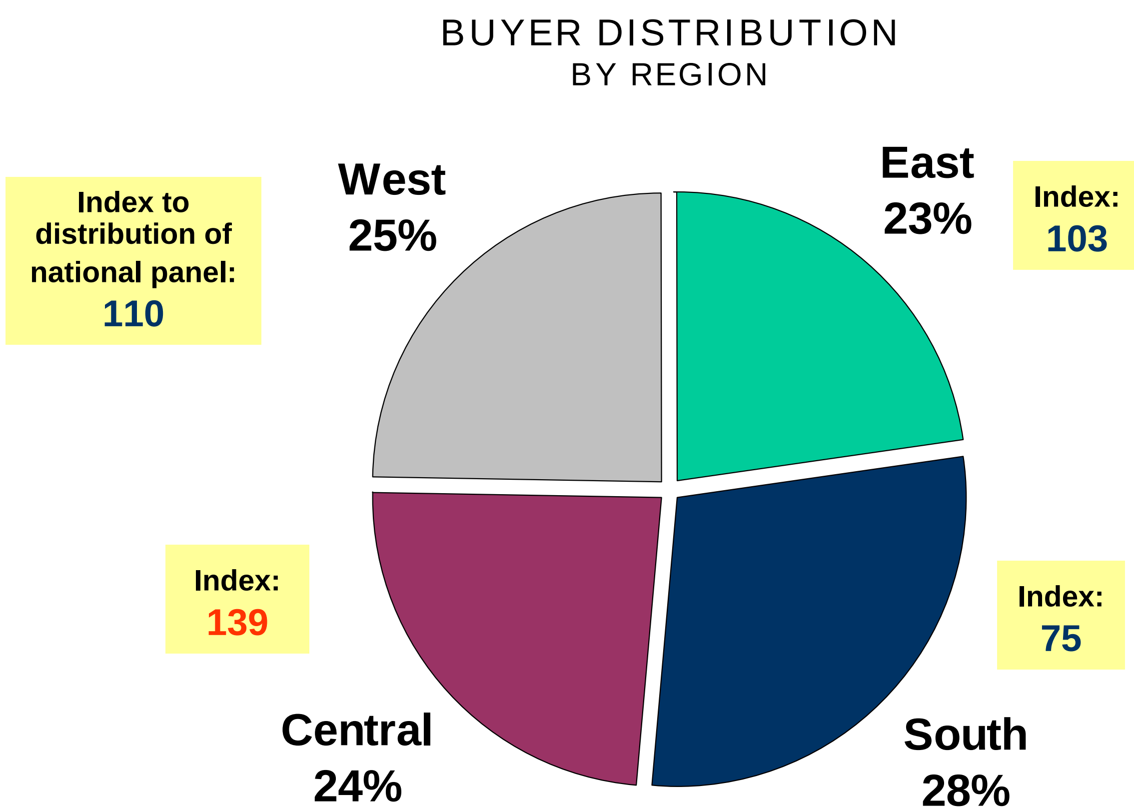
www.perishablesgroup.com

SAMPLE SIZE:
Total US HHs buying mushroom category: 3,532

East: 832 HHs
South: 1,198 HHs
Central: 592 HHs
West: 910 HHs

Buyer Distribution

- ***Mushroom buyers are evenly distributed across geographic regions. The South is under-developed, while there are more buyers than expected in the Central region.***



Consumer Shopping Behavior

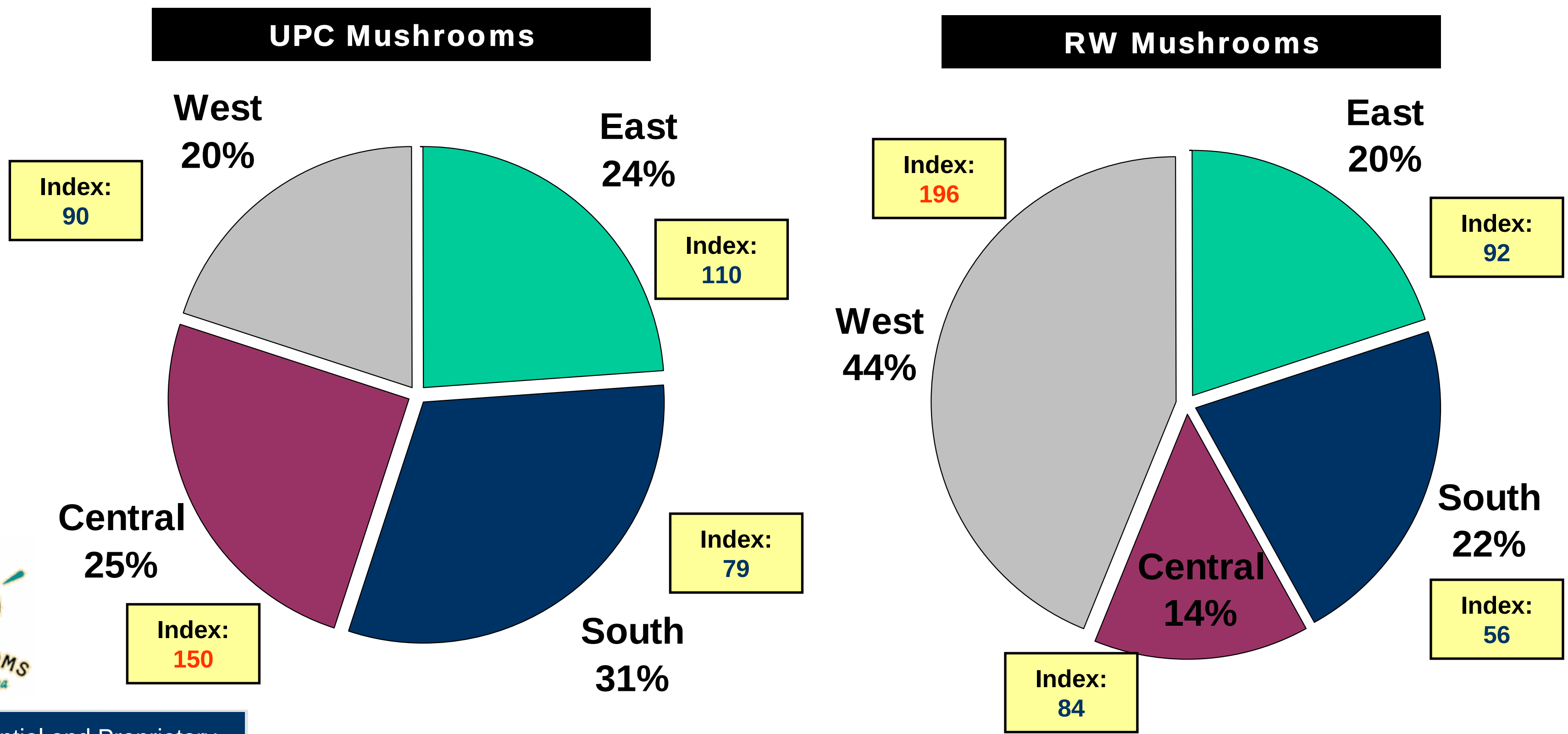
PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

- **Buyer Distribution (cont.)**
  - ***There are clear differences in mushroom type preferences across geographic regions. RW mushrooms have a strong presence in the West, and is somewhat under developed in other regions.***

BUYER DISTRIBUTION
BY MUSHROOM TYPE



Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

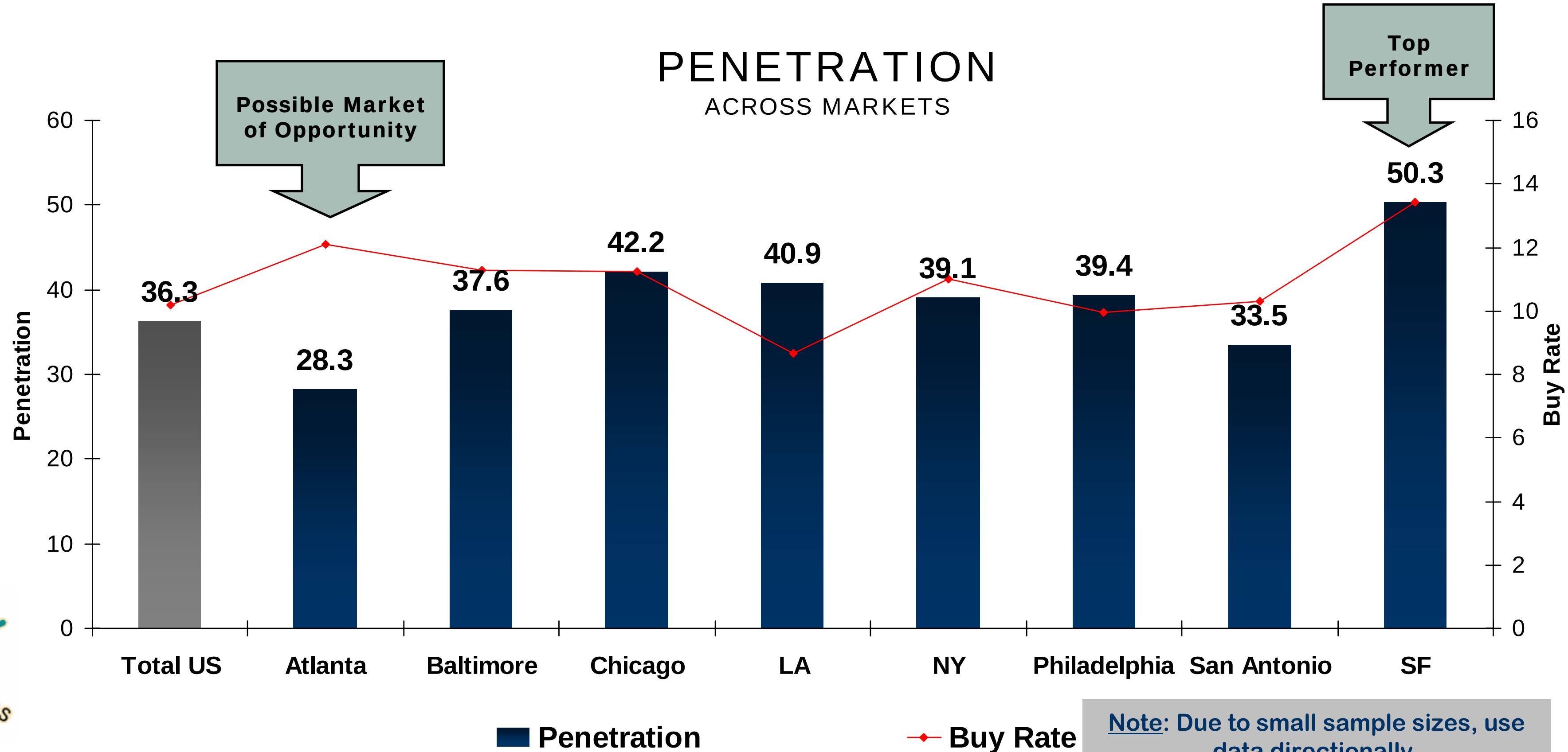
PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Penetration & Buy Rate by Market

- ***Penetration is highest among the SF, LA and Chicago markets. Spend rate, however, is second highest in Atlanta, where the average mushroom buyer spends $12 per year on the category.***



Note: Due to small sample sizes, use data directionally.

Source: ACNielsen Homescan Panel Data, 2004

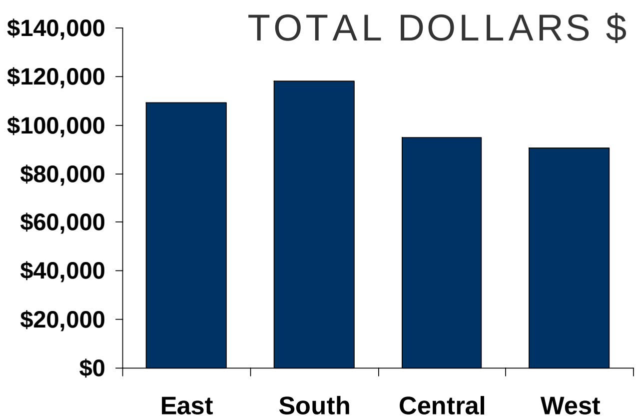
Consumer Shopping Behavior

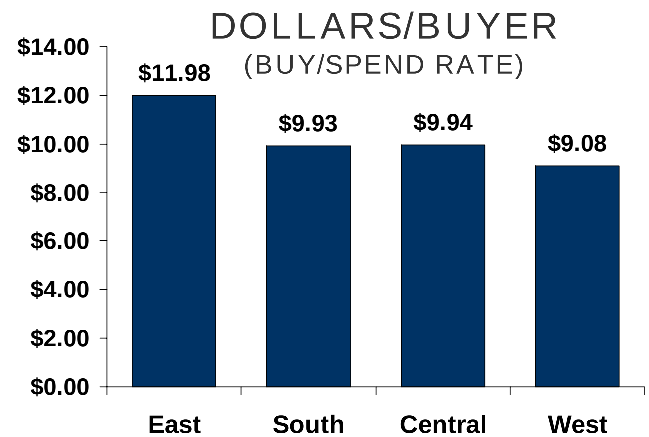
PERISHABLES GROUP™

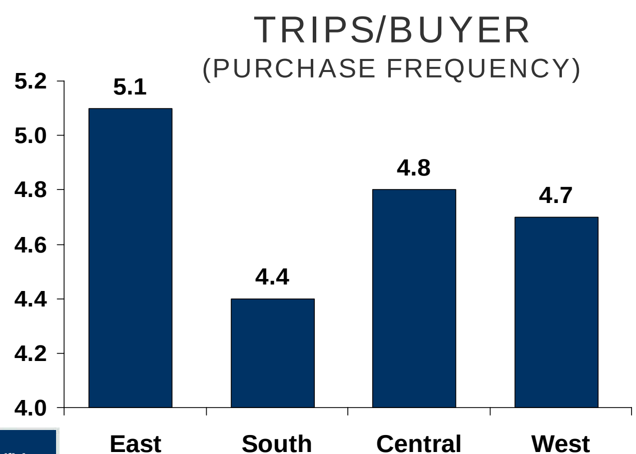
Keeping Your Business Fresh®

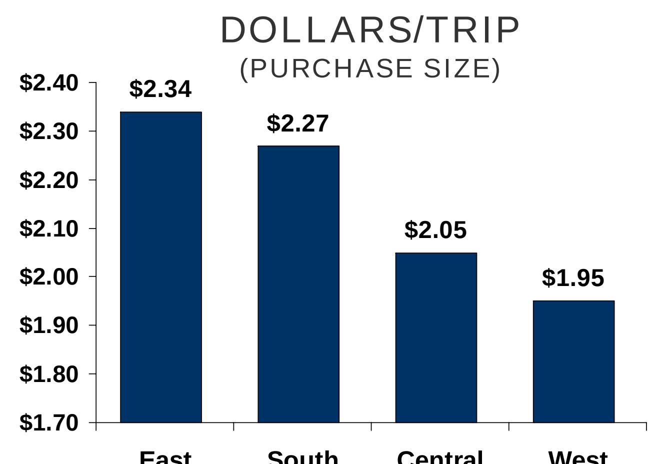
www.perishablesgroup.com

- **Total Mushrooms Regional Comparison**
  - ***Although the South Region dominates in total sales, the East Region has heavier category buyers that have high spend rate and make the most trips per year.***







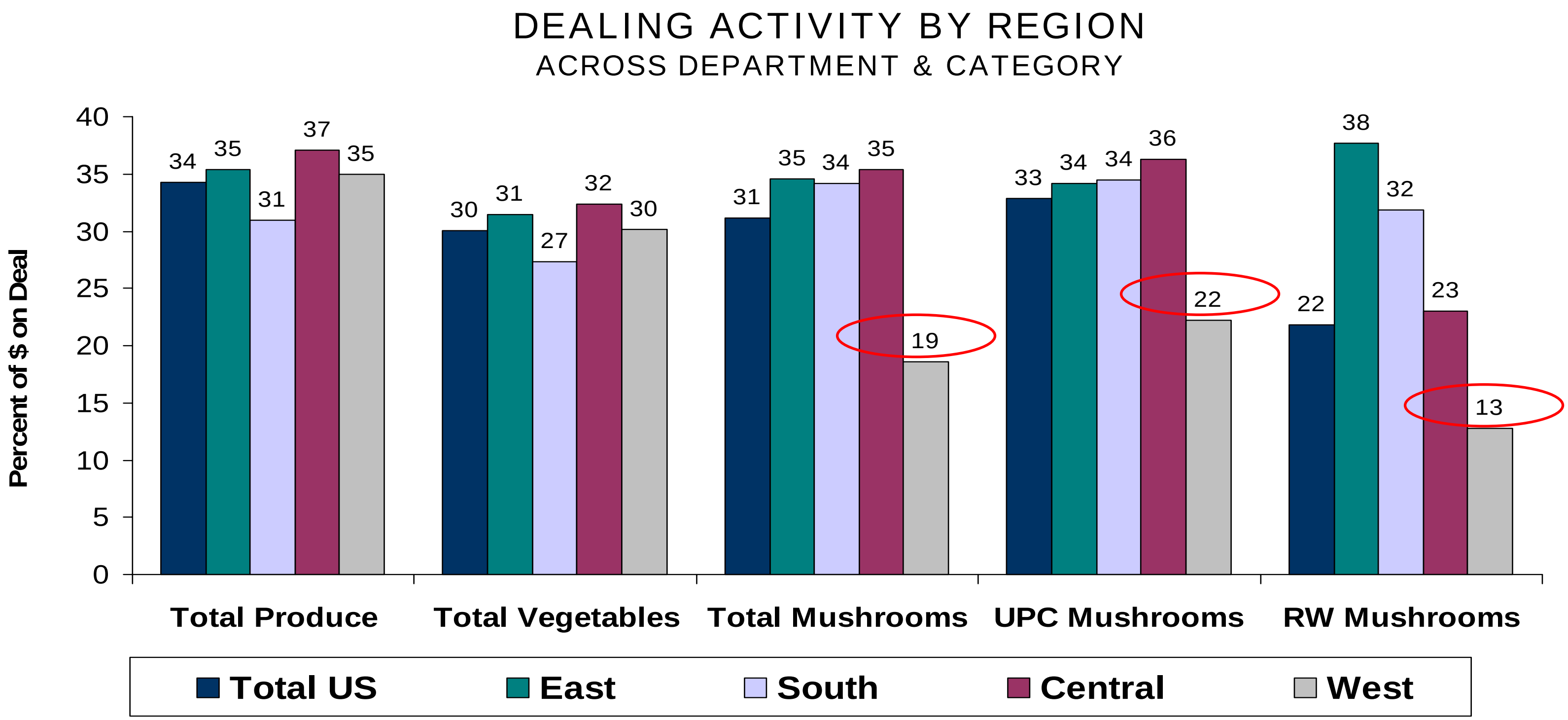


Consumer Shopping Behavior

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

Dealing Activity by Region

- ***Approximately one-third of produce and vegetable purchases are associated with retail promotion/discounting. Deal activity for mushrooms varies widely across geographic regions. Deal activity is at the lowest level in the West.***



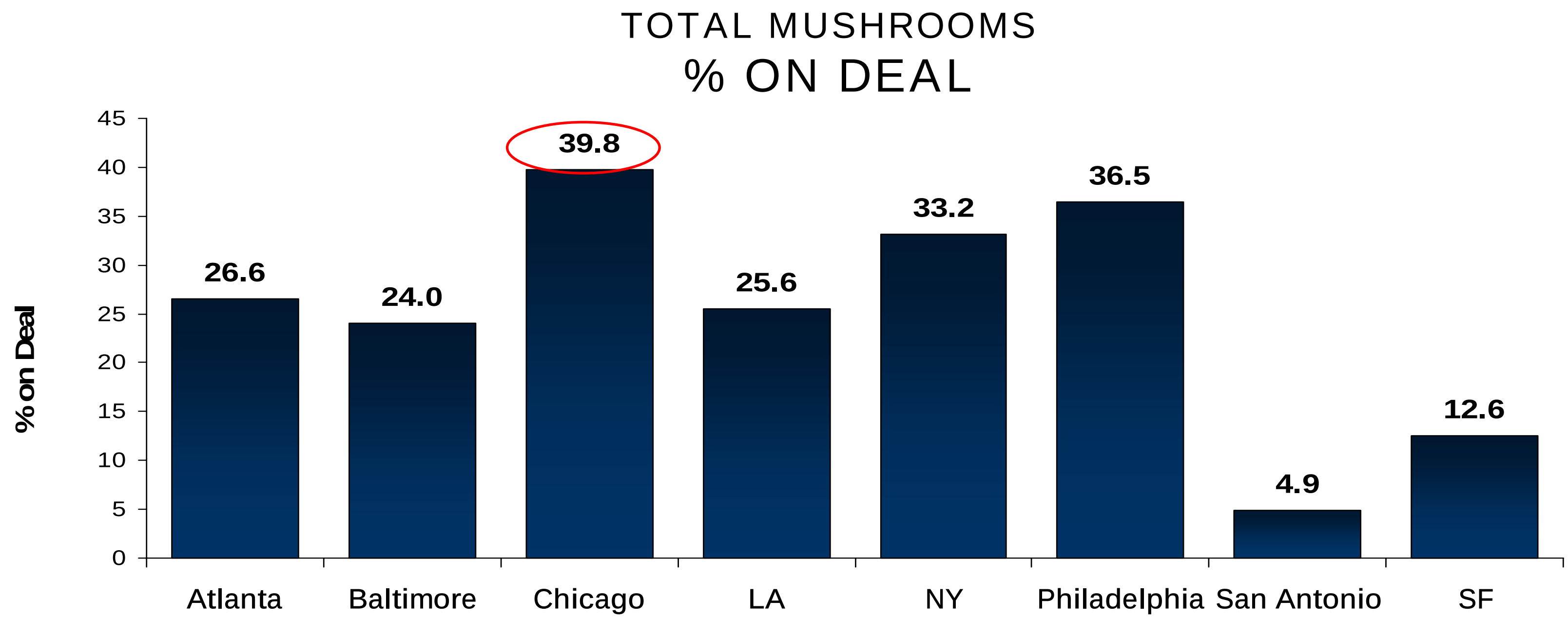
Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

PERISHABLES GROUP™
Keeping Your Business Fresh®
www.perishablesgroup.com

Dealing Activity by Market

- ***Deal percentages vary significantly by market. Chicago and Philadelphia have the highest level of promotion/discounting.***



Note: Due to small sample sizes, use data directionally.

Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

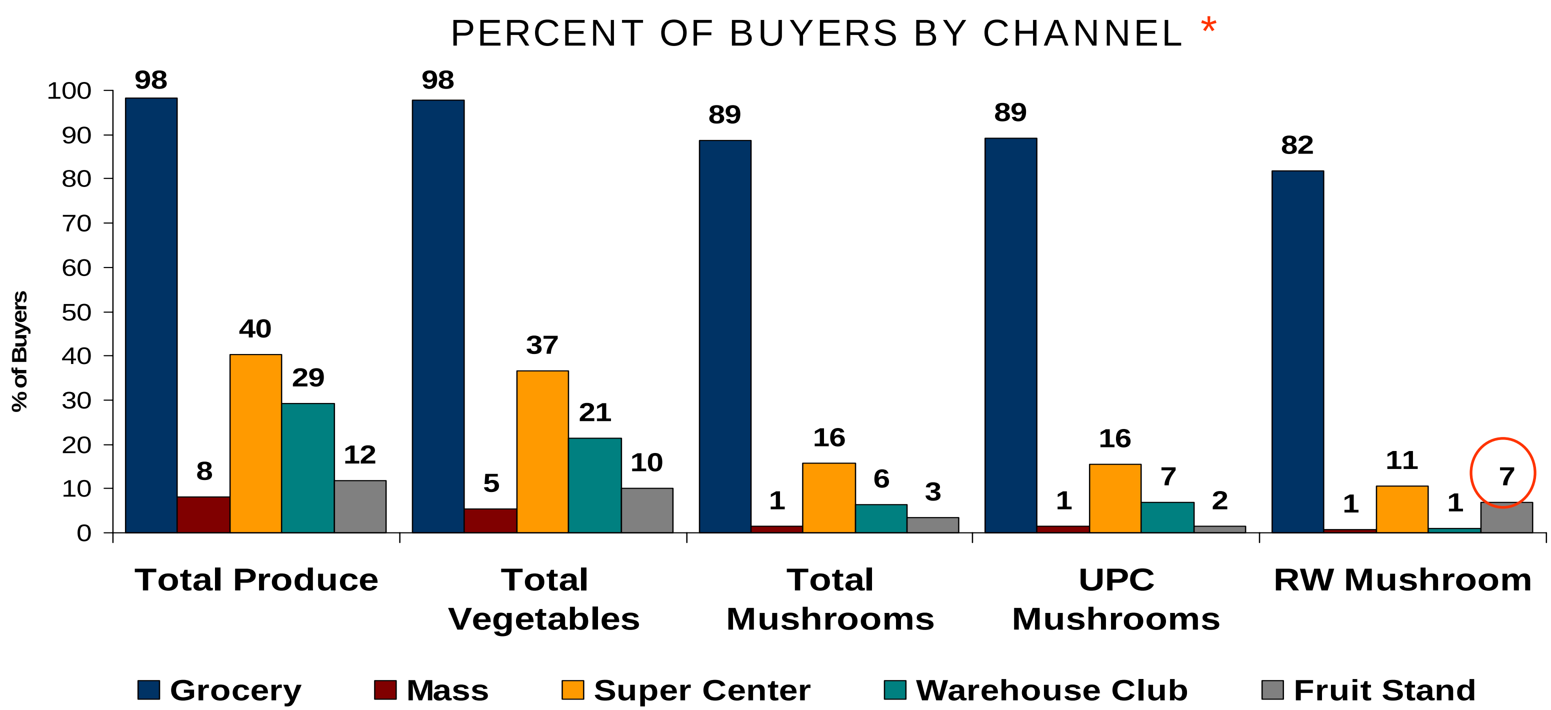
PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Percent of Buyers by Channel

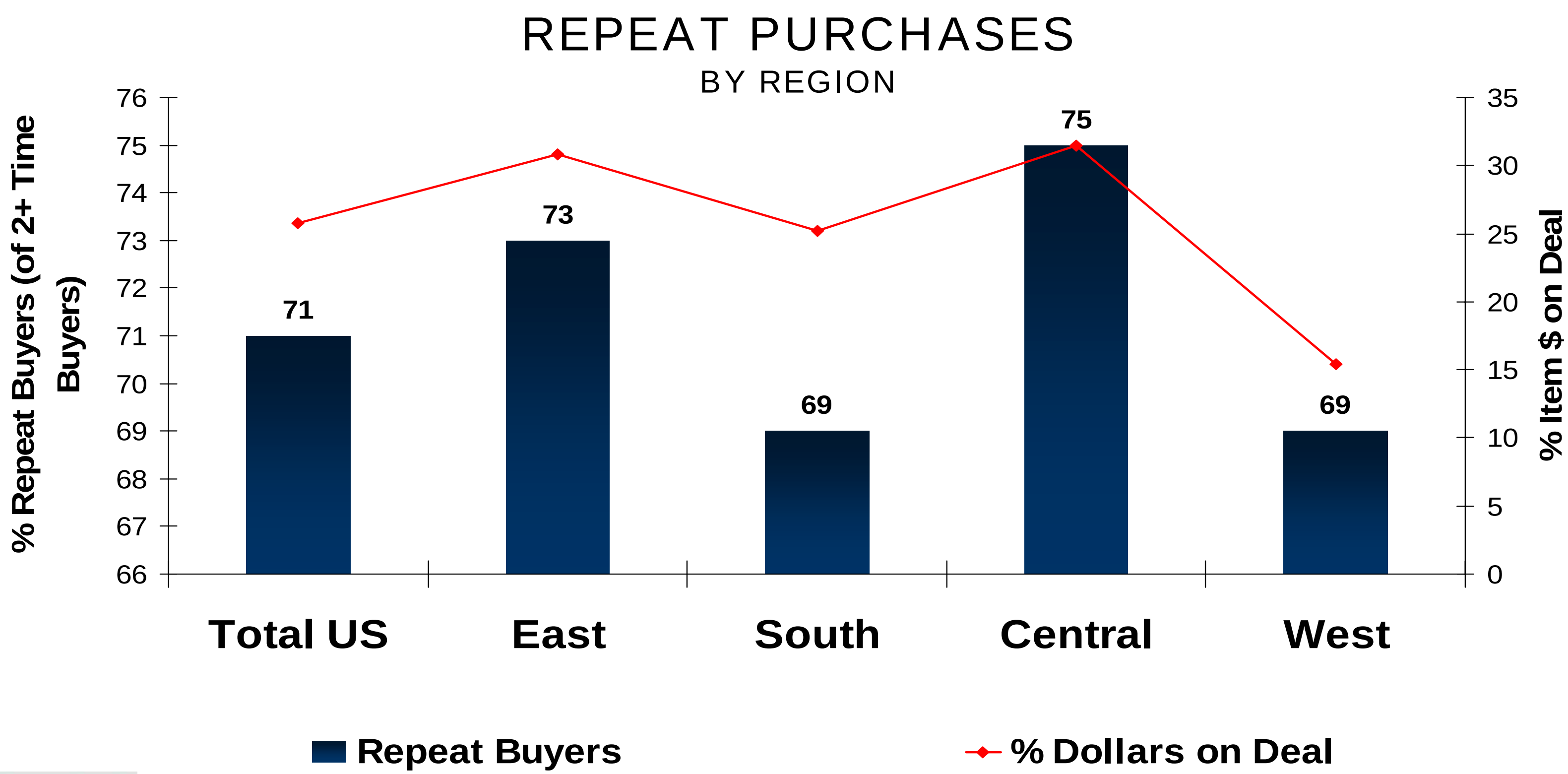
- *Mushroom buyers are shopping primarily in traditional grocery stores. Fewer mushroom buyers are shopping in Mass, SC and club than consumers of vegetables & produce. A portion of RW mushroom consumers are buying through vegetable stands (7%).*



* Percentages also reflect buyers shopping multiple channels (percentages are not additive).

Consumer Shopping Behavior

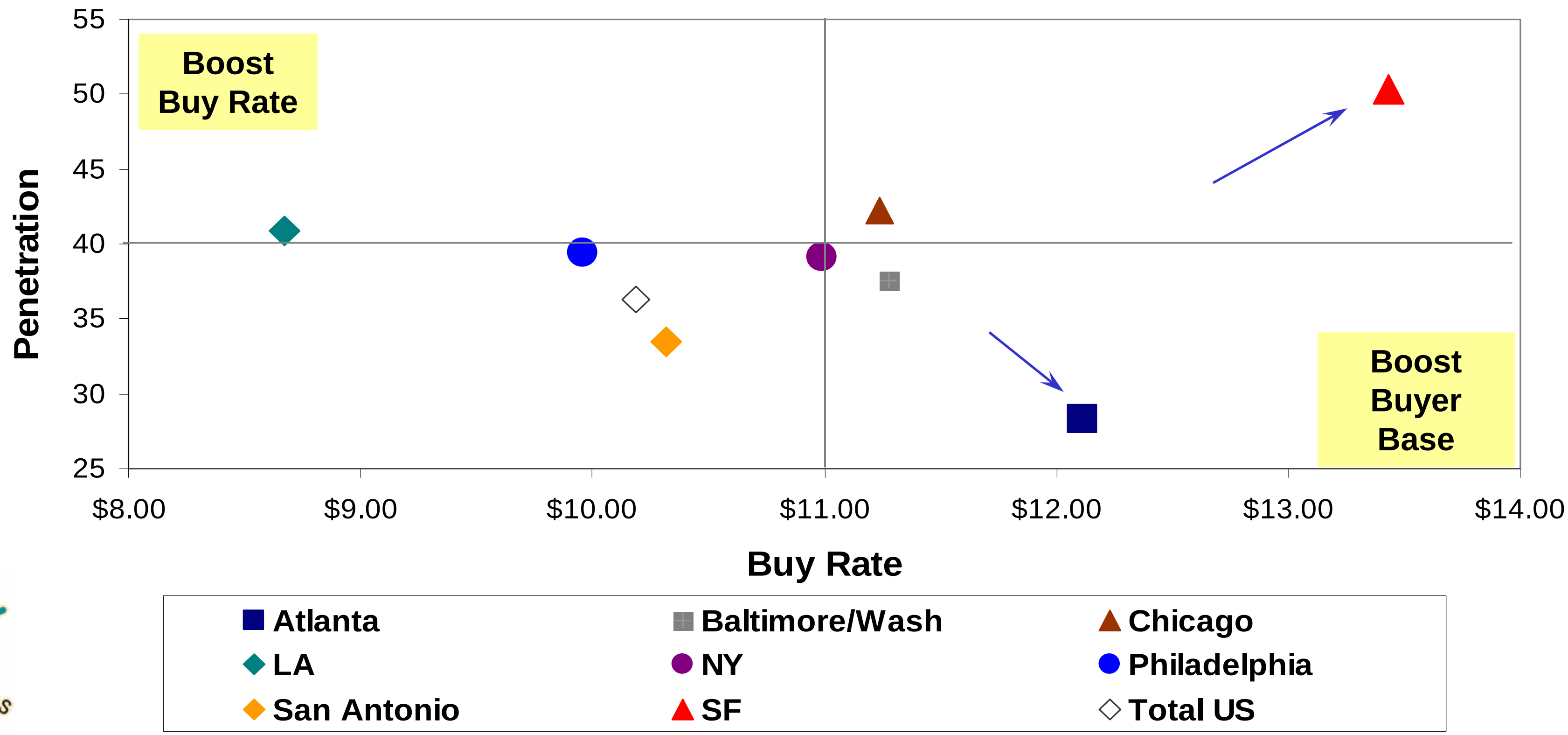
- **Repeat Levels by Region**
  - ***Repeat level is highest in the Central region, where 75% of 2+ time buyers bought again.***



Source: ACNielsen Homescan Panel Data, 2004

Consumer Shopping Behavior

- **Market Opportunity Growth**
  - ***SF is a top performing market, with high penetration and significantly higher buy rate. Atlanta is a high potential market with high buy rate, but remains one of the lowest in penetration.***



PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Consumer Demographic Profile

ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

Demographic Profile

Mushroom Consumer Profile Summary

GROUPS REPRESENTING
MAJORITY OF MUSHROOM DOLLARS

HH Income Level
Higher Income $70k+ (30% of dollars)

HH Size
2 Members (39%)

Presence of Children
No Children less than 18 years old (48%)

Lifestage
Empty Nesters (19%)

Race
Caucasian (68%)

Source: ACNielsen Homescan Panel Data, 2004

Demographic Profile

Mushroom Consumer Profile Summary

- **High indices towards more affluent, 2 member households; strong index towards Asian households**

HIGH INDEXING GROUPS *

HH Income Level
Higher income $70k+ (157 index)

HH Size
2 Members (119)

Presence of Children
(No skew)

Lifestage
Childless Younger Couples (128), Empty Nesters Living Comfortably (130), New Families (124)

Race
Asian (186)

* Groups exhibiting strongest skews, i.e. representing more than their "fair share" of category dollars.

Source: ACNielsen Homescan Panel Data, 2004

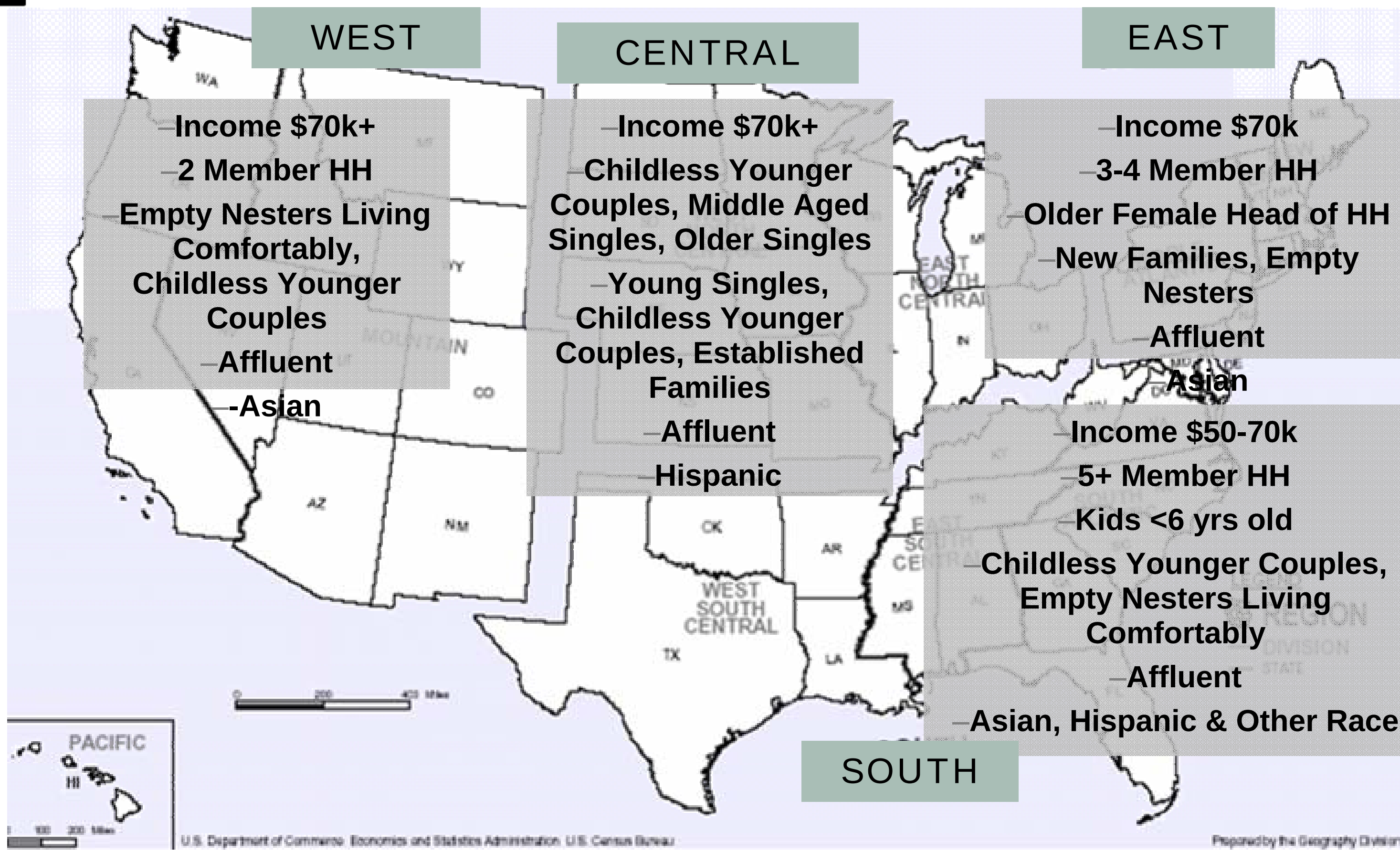
Demographic Profile

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Who are your mushroom consumers? *



WEST

- Income $70k+
- 2 Member HH
- Empty Nesters Living Comfortably, Childless Younger Couples
- Affluent
- Asian

CENTRAL

- Income $70k+
- Childless Younger Couples, Middle Aged Singles, Older Singles
- Young Singles, Childless Younger Couples, Established Families
- Affluent
- Hispanic

EAST

- Income $70k
- 3-4 Member HH
- Older Female Head of HH
- New Families, Empty Nesters
- Affluent
- Asian

SOUTH

- Income $50-70k
- 5+ Member HH
- Kids <6 yrs old
- Childless Younger Couples, Empty Nesters Living Comfortably
- Affluent
- Asian, Hispanic & Other Race

FRESH MUSHROOMS *what a good idea*

* Groups exhibiting strongest skews, i.e. representing more than their "fair share" of category dollars.

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Consumer Demographic Profile

Total Vegetable vs. Mushroom

ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

PERISHABLES GROUP™

Keeping Your Business Fresh®

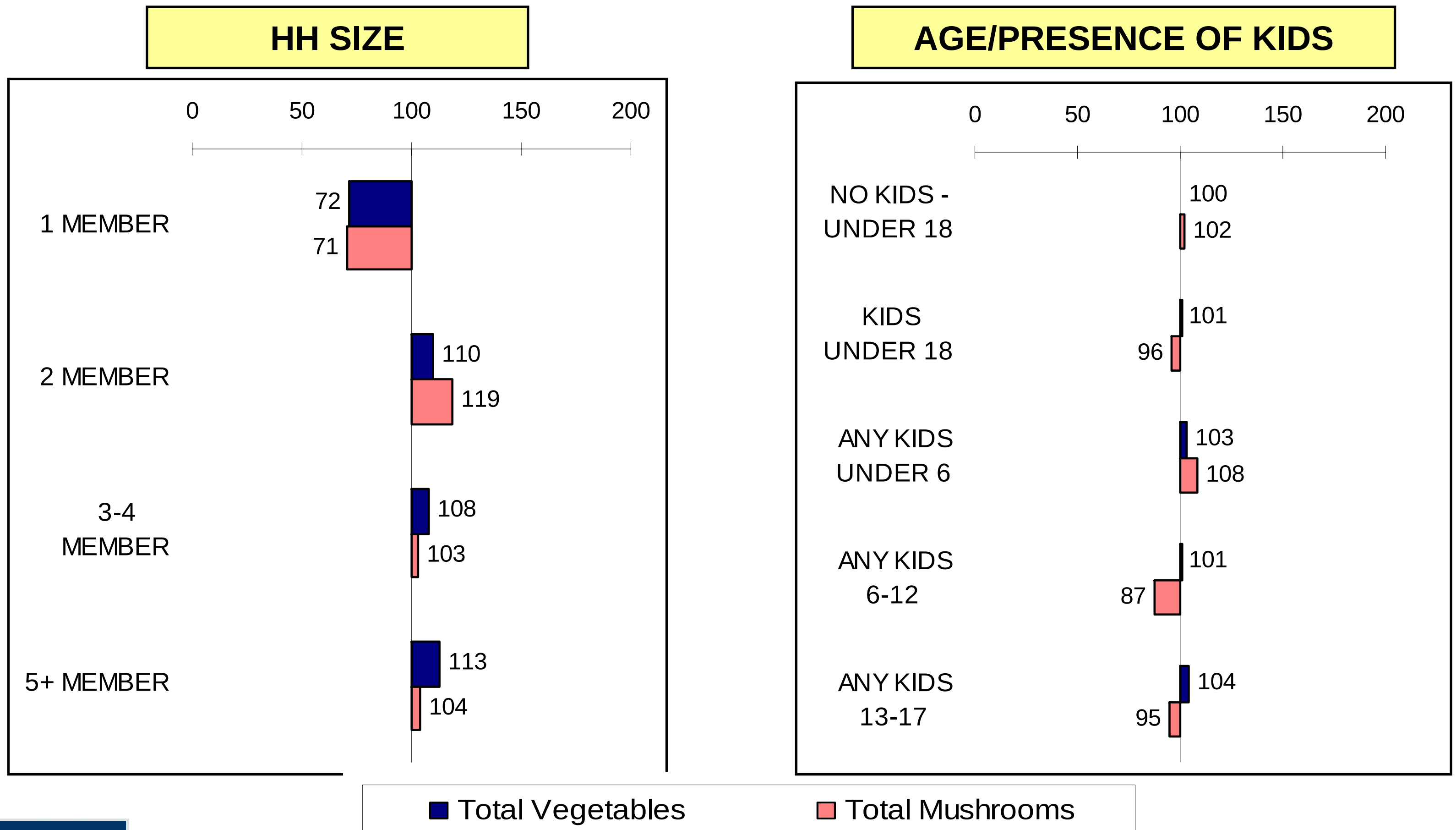
www.perishablesgroup.com

Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

Vegetable Consumers vs. Mushroom Consumers

- ***Mushroom households tend to be larger (5+ members) and have young kids.***



Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

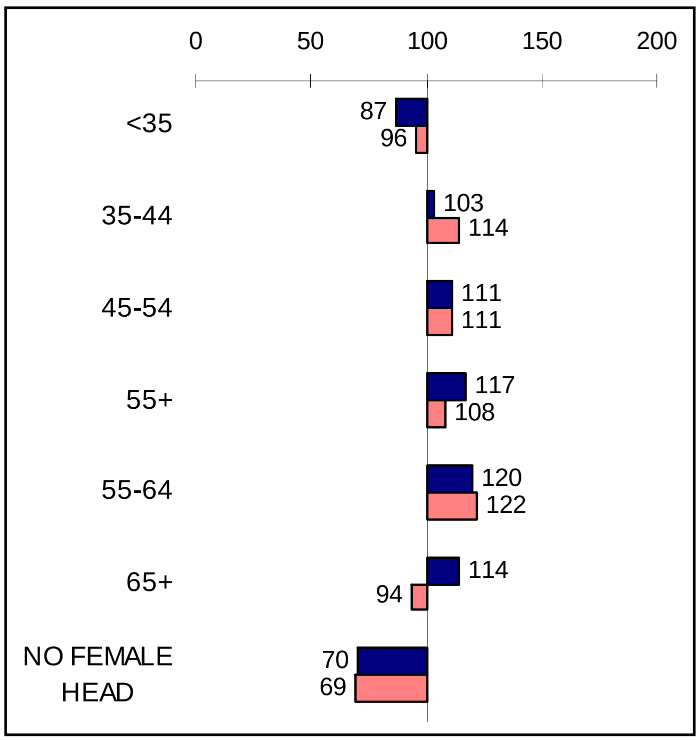
www.perishablesgroup.com

Demographic Profile

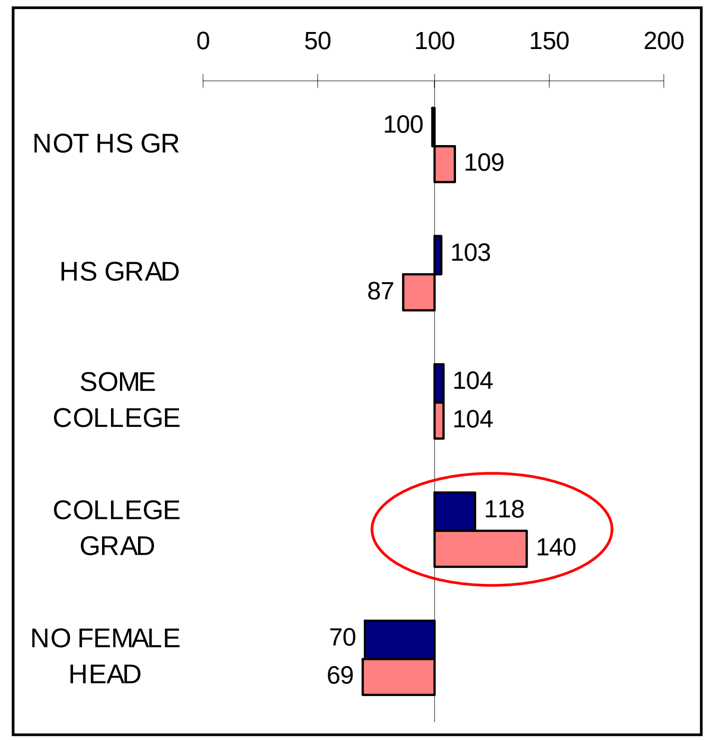
Index of 120 or greater indicates the group purchases more than expected.

- **Vegetable Consumers vs. Mushroom Consumers**
  - ***The female head age tends to be slightly older (65+) for mushroom households (65+), with skews in both the educated and uneducated groups, while the general vegetable category attracts female head ages of 55-65.***

FEMALE HEAD AGE



FEMALE HEAD EDUCATION



■ Total Vegetables ■ Total Mushrooms

FRESH MUSHROOMS *what a good idea*

Source: ACNielsen Homescan Panel Data, 2004

Perishables Group™

Keeping Your Business Fresh®

www.perishablesgroup.com

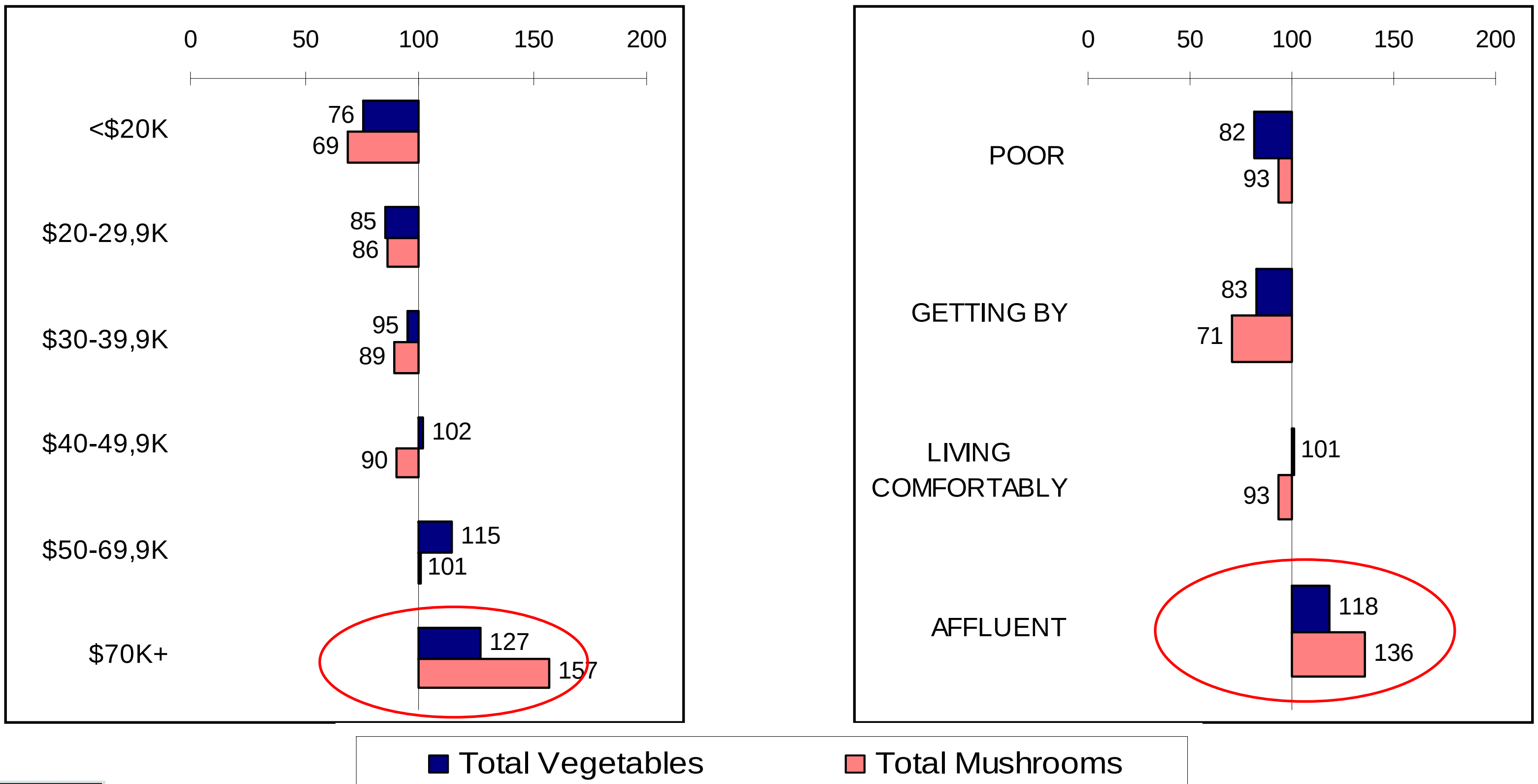
Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

Vegetable Consumers vs. Mushroom Consumers

- ***Mushroom consumers tend to be just as affluent as the average vegetable buyer.***

HH INCOME | **HH AFFLUENCY**



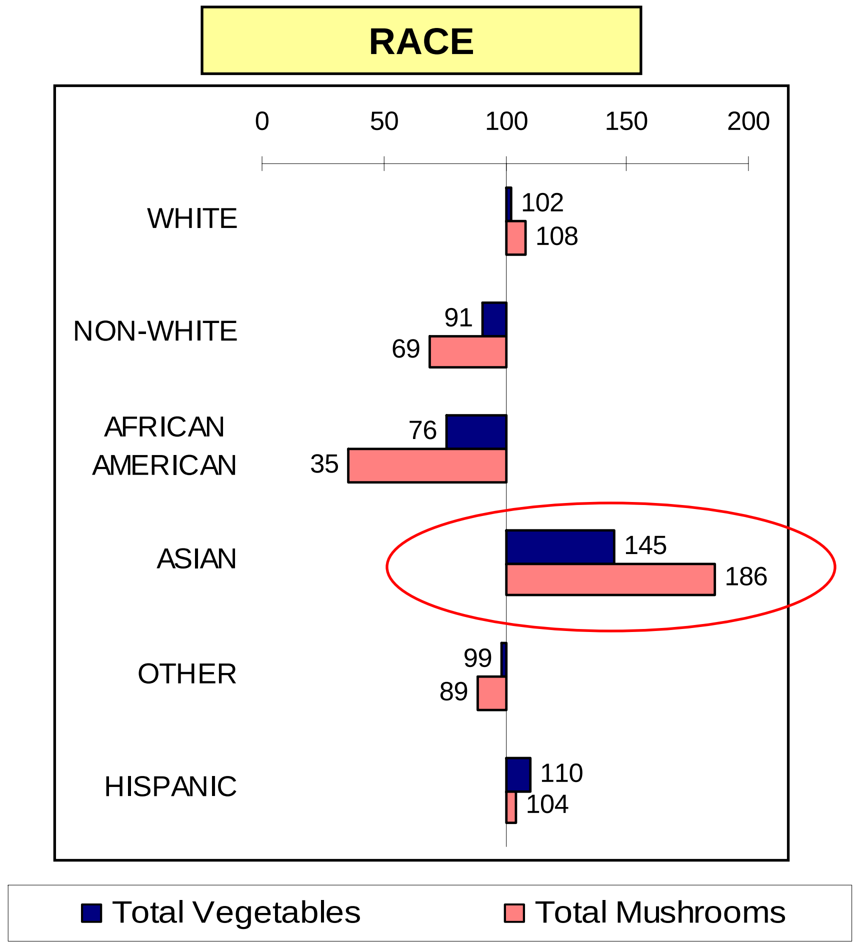
www.perishablesgroup.com

Source: ACNielsen Homescan Panel Data, 2004

Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

- **Vegetable Consumers vs. Mushroom Consumers**
  - ***Total vegetable and mushrooms both over-index in Asian households***



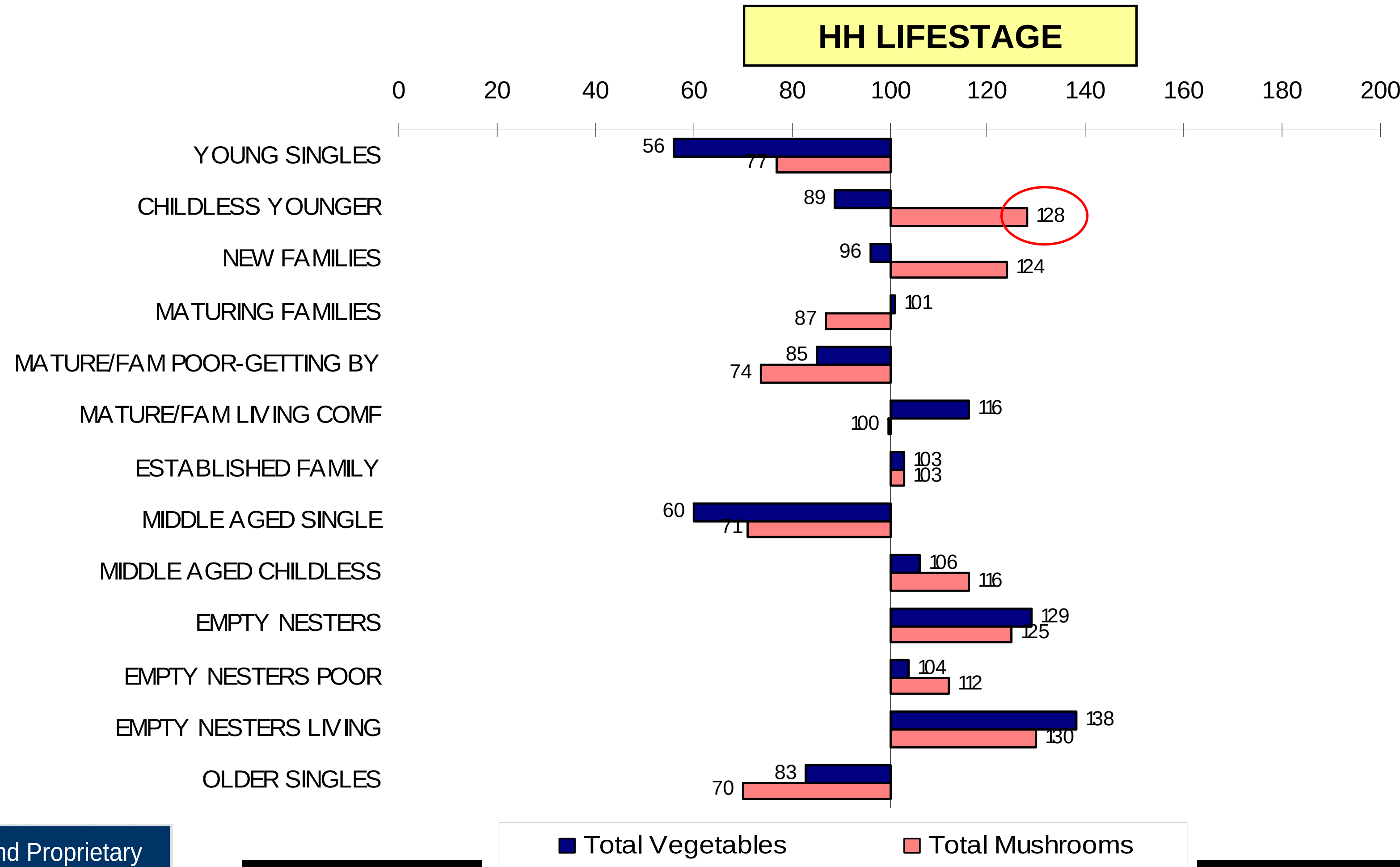
Source: ACNielsen Homescan Panel Data, 2004

Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

Vegetable Consumers vs. Mushroom Consumers

- ***Mushroom consumers exhibit high indices towards Childless Younger and New Families, while average vegetable consumers are Empty Nesters.***

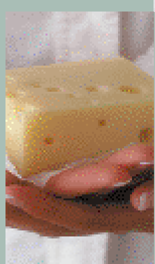


Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com



Consumer Demographic Profile

UPC vs RW Mushroom

ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

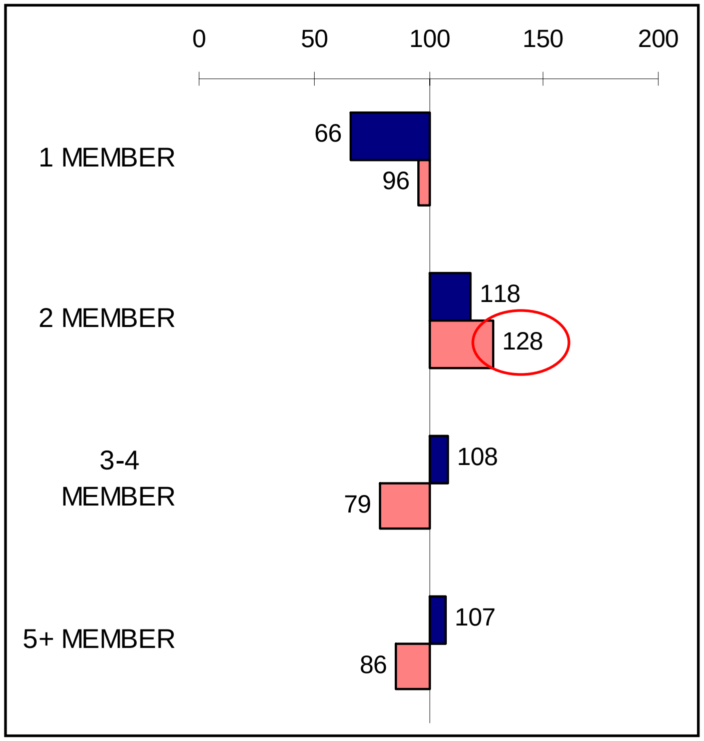
Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

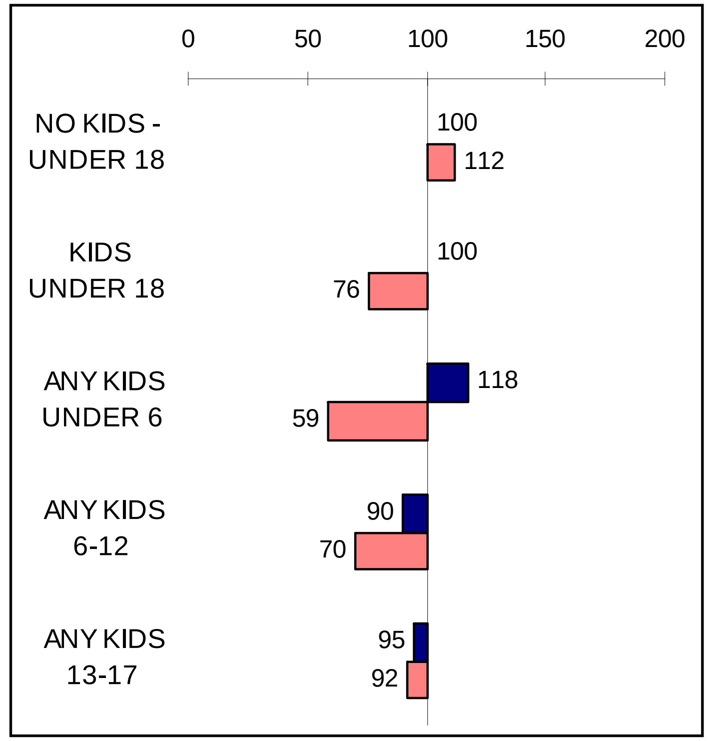
UPC vs. RW Mushroom

- ***RW Mushroom consumers tend to fall in 2 member households.***

HH SIZE



AGE/PRESENCE OF KIDS



UPC Mushrooms   RW Mushrooms

FRESH MUSHROOMS *what a good idea*

Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

PERISHABLES GROUP™

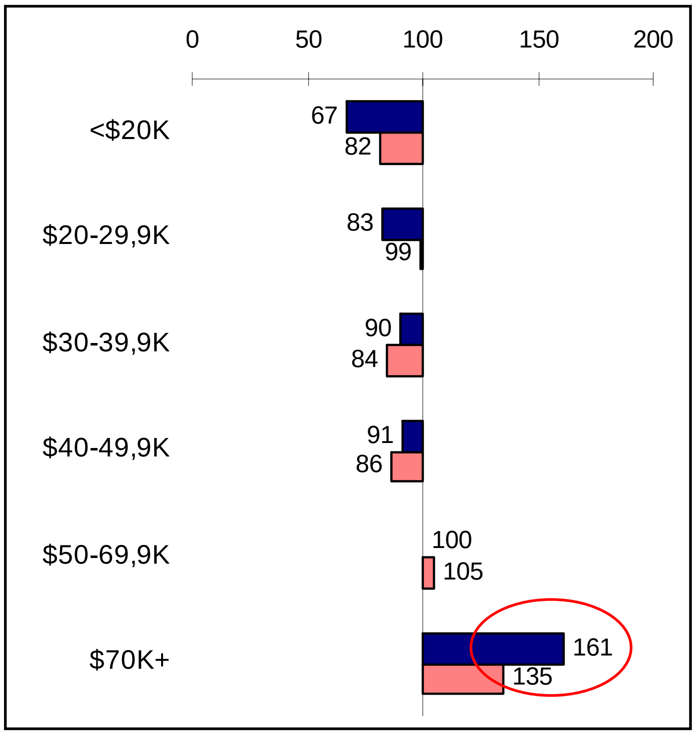
Keeping Your Business Fresh®

www.perishablesgroup.com

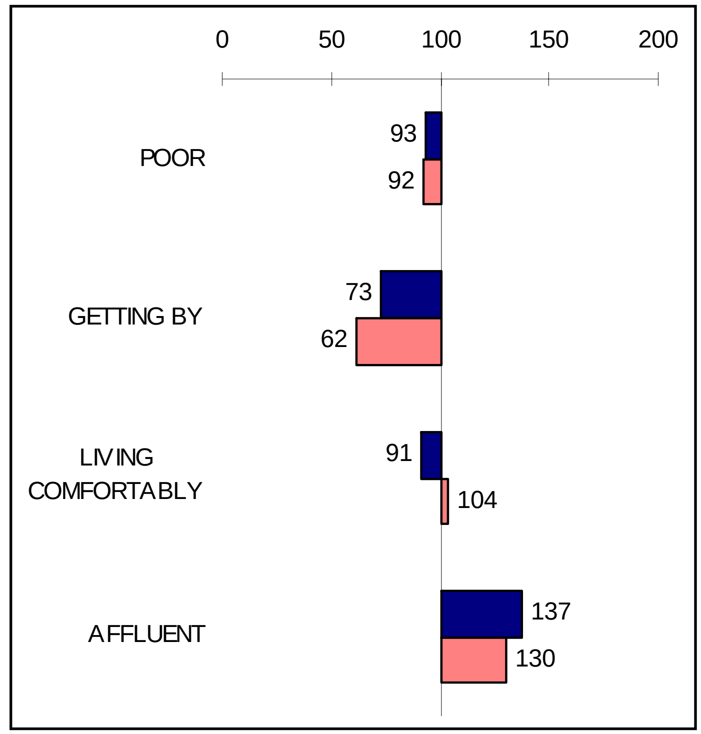
UPC vs. RW Mushroom

- ***UPC Mushroom households tend to be slightly more affluent.***

HH INCOME



AFFLUENCY



UPC Mushrooms RW Mushrooms

Source: ACNielsen Homescan Panel Data, 2004

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

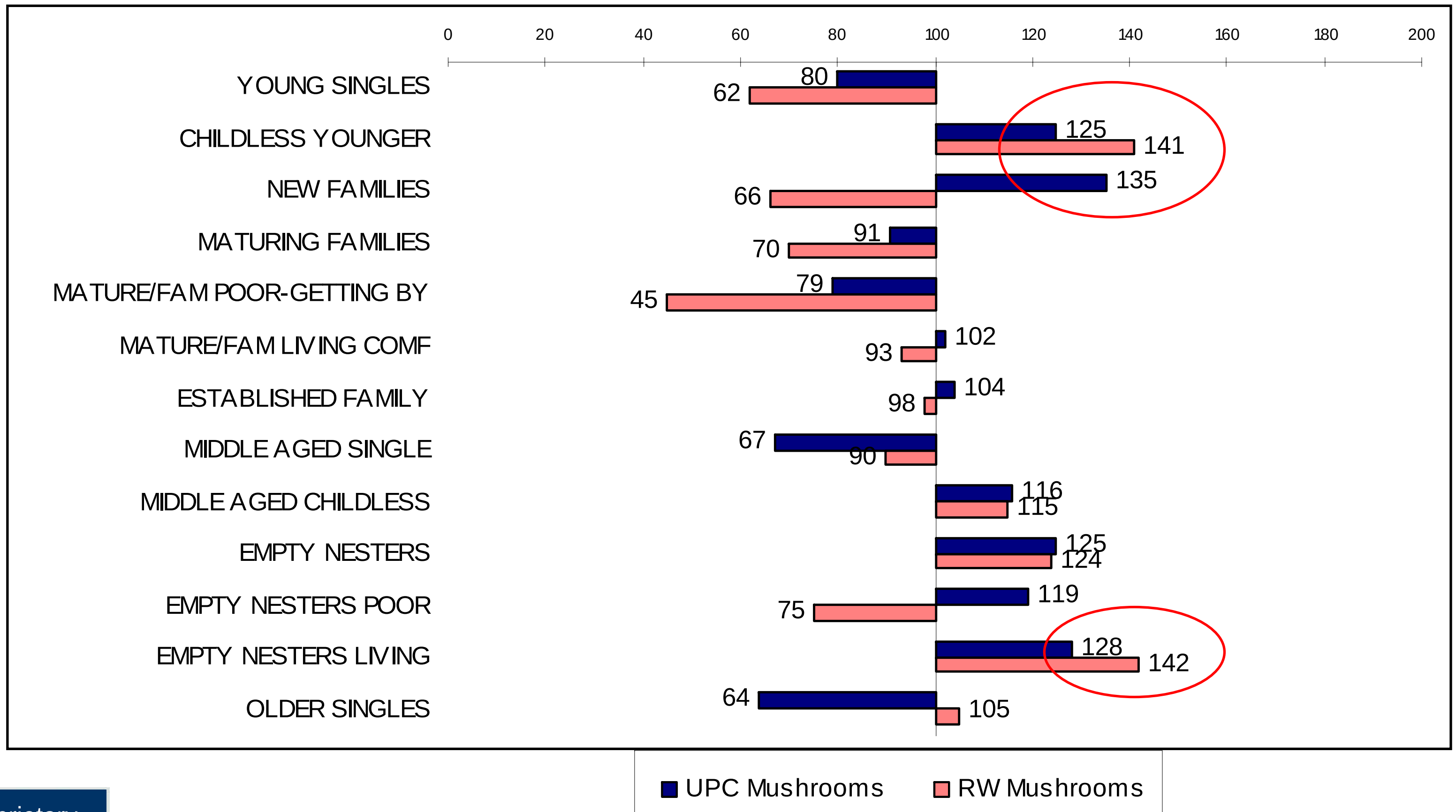
Demographic Profile

Index of 120 or greater indicates the group purchases more than expected.

UPC vs. RW Mushroom

- ***More childless younger couples and older singles purchase RW mushrooms than UPC mushrooms.***

LIFESTAGE



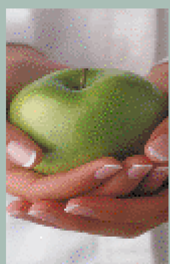
FRESH MUSHROOMS what a good idea

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Market Basket Data



ACNielsen

homescan

THE AUTHORITY ON CONSUMER BEHAVIOR

PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Market Basket

Trips Per Shopper

Items purchased with mushrooms in more than 2 shopping trips per year:

Dairy Department:

Butter & Margarine (2)

Cheese (3)

Cottage Cheese/Sour Cream (2)

Shredded Cheese (2)

Eggs (2)

Milk (3)

Yogurt (3)

Shelf Stable Department:

Canned Shrimp (3)

Toppings (Liquid & Dry) (3)

Refrigerated/Produce:

Precut/Fresh Salad Mix (3)

Fresh Lettuce (3)

Meat Department:

Fresh Meat (2)

Packaged Meat/Deli (3)

FRESH MUSHROOMS what a good idea

Source: ACNielsen Homescan Panel Data, 2004

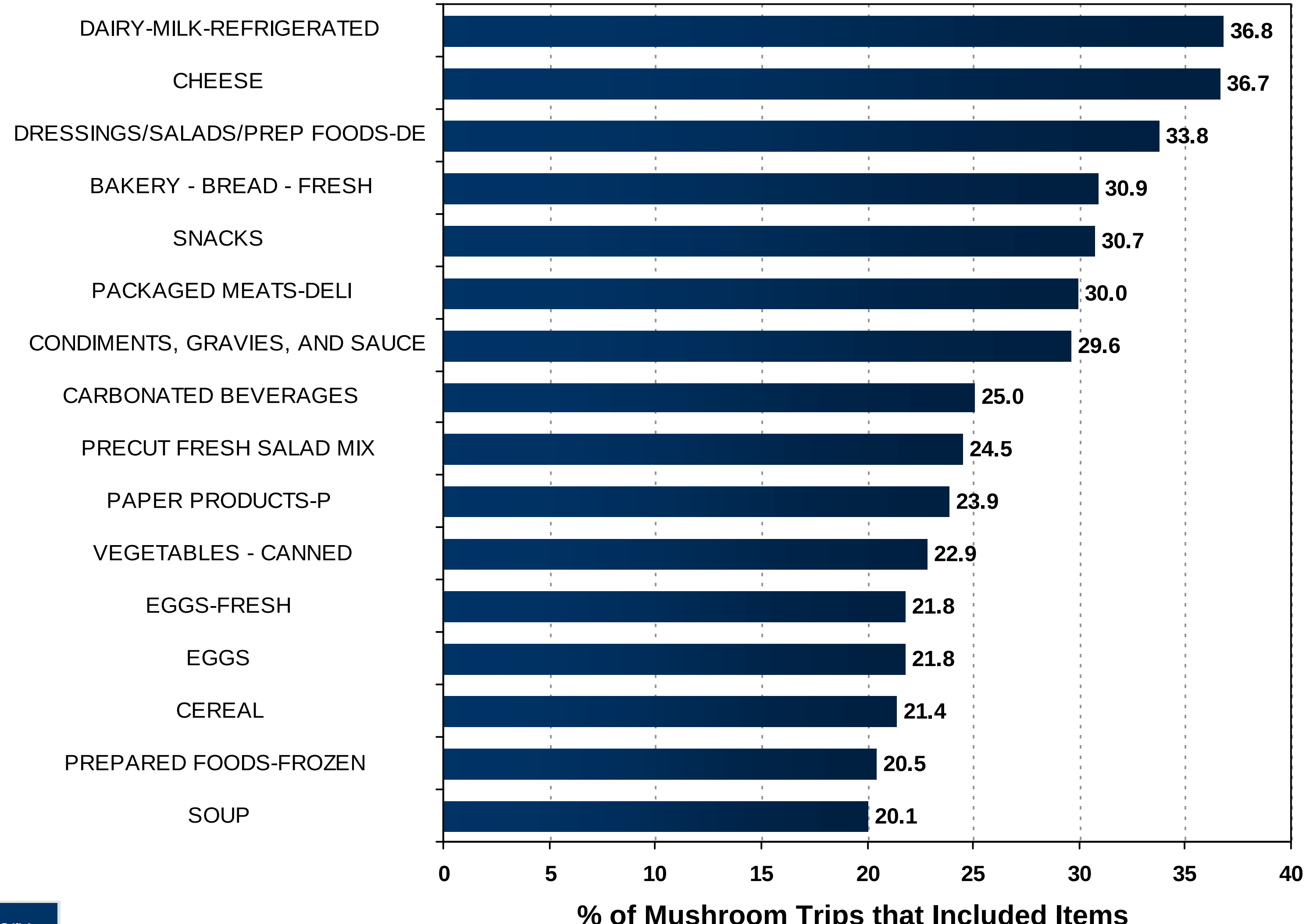
PERISHABLES GROUP™

Keeping Your Business Fresh®

www.perishablesgroup.com

Market Basket

% of Trips With Mushrooms

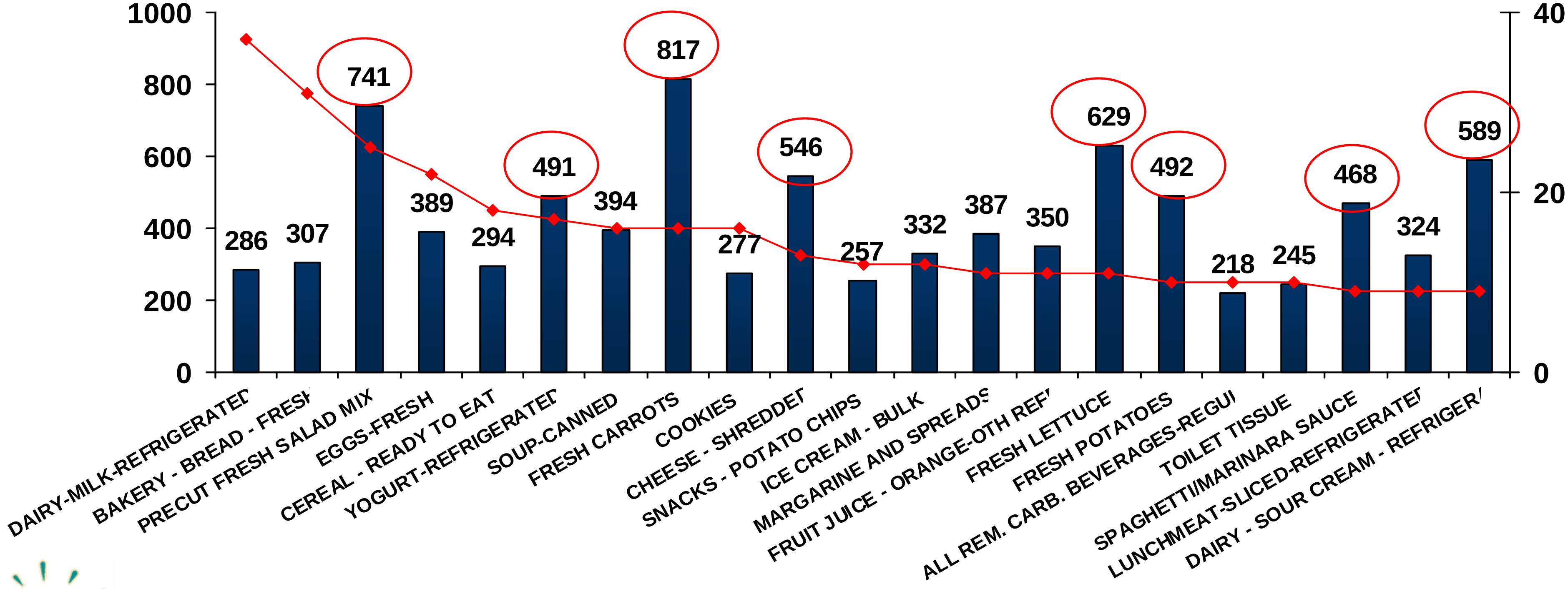


Source: ACNielsen Homescan Panel Data, 2004

Market Basket

% of Trips with Mushrooms vs. Trip Index

Higher index indicates higher likelihood of being in basket when mushrooms are purchased



Source: ACNielsen Homescan Panel Data, 2004

Scientific Literature Review Appendix

List of Scientific Articles

- “Analysis of Automatic Weight-Fill Bagging Machinery for Fresh Citrus”
- “Analysis of the Factors Implied in the Fruit to Fruit Impacts on Packing Lines”
- “Analysis of the Mechanical Aggressiveness of Three Orange Packing Systems: Packing Table, Box Filler and Net Filler”
- “Apple Impact Damage Thresholds”
- “Apple Packing Line Damage Reduction”
- “Assessment of Apple Damage on Packing Lines”
- “Design of a Shitake Mushroom Packing Line”
- “Fruit Damage Assessment in Peach Packing Lines”
- “Fruit and Vegetable Bruise Threshold Prediction Using Theory of Elasticity and Failure Tissue Properties”
- “Grading of Mushrooms using Machine Vision System”
- “Impact Bruise Estimates for Onion Packing Lines”
- “Impacts Recorded on Avacado, Papaya, and Pineapple Packing Lines”
- “Instrumented Sphere Impact Analysis of Tomato and Bell Pepper Packing Line”
- “Mechanical Harvesting System for Burley Tobacco”
- “Multi Purpose, Vegetable Production Machine Investigation”
- “Packing Line Bruise Evaluation for ‘Walla Walla’ Summer Sweet Onions”
- “Peach Physical Characteristics for Orientation”
- “A Procedure for Testing Padding Materials In Fruit Packing Lines Using Multiple Logistic Regression”
- “Reduction of Mechanical Damage to Apples in Packing Lines Using Mechanical Devices”
- “Sorting Table Illumination on Stonefruit Packing Lines in California”
- “Suspended Tray Package for Shipping Soft Fruit”

“Analysis of Automatic Weight-Fill Bagging Machinery for Fresh Citrus”
Citation: Applied Engineering in Agriculture. 2(2): 252-256. @1986
Authors: W. M. Miller, R. P. Muraro, W. F. Wardowski
Keywords: Automation, Citrus packing, Fruit production
Abstract – “AUTOMATIC bagging machines which minimize weight overfill have been introduced to pack fresh citrus in Florida. At a commercial packinghouse, a machine was analyzed in bagging K-early tangelos (large fruit, low count/bag) and Robinson tangerines (small fruit, large count/bag). A non-parametric statistical computer program was developed to analyze automatic bagging machinery performance. Iterations in the weight-fill mode of operation were analyzed as an inferential indicator of potential product damage through recycling. Mixing of dimensional sizes was investigated to reduce search iterations.”
Available at - http://asae.frymulti.com/abstract.asp?aid=26751&t=1

“Analysis of the Factors Implied in the Fruit to Fruit Impacts on Packing Lines”

Citation: Applied Engineering in Agriculture. Vol. 20(5): 671-675. @2004
Authors: F. J. García-Ramos, J. Ortiz-Cañavate, M. Ruiz-Altisent
Keywords: Fruit-to-fruit impact, Bruise, Instrumented sphere, Powered decelerator
Abstract – "The problem of fruit-to-fruit impacts on packing lines was analyzed in an experimental fruit packing line. Different factors were considered including fruit susceptibility to damage, fruit flow in the line, and characteristics of the transfer points between elements on the line. Tests were performed using "Golden" apples and IS 100 instrumented spheres. Most of the fruit-to-fruit impacts occurred at angled transfer points. A powered decelerator was developed and installed in the packing line that significantly minimized the number and intensity of fruit-to-fruit impacts at transfer points with a 90 degree angle between two transporting belts."
Available at - http://asae.frymulti.com/abstract.asp?aid=17447&t=1

"Analysis of the Mechanical Aggressiveness of Three Orange Packing Systems: Packing Table, Box Filler and Net Filler"
Citation: Applied Engineering in Agriculture. Vol. 20(6): 827-832. @2004
Authors: F. J. García-Ramos, C. Valero, M. Ruiz-Altisent, J. Ortiz-Cañavate
Keywords: Packing systems, Orange, Impact detection, Damage
Abstract – "Three different types of orange packing systems (packing table, box filler, and net filler) were analyzed using an instrumented sphere IS 100 (7 cm.) in four orange packing lines in the region of Levante (Spain). Four packing tables, three box fillers, and three net fillers were tested by analyzing impacts inflicted to fruit at the entrance and outlet transfer points of the machine. In general, entrance transfer points were more aggressive than outlet transfer points. Box filler was the least aggressive machine."
Available at - http://asae.frymulti.com/abstract.asp?aid=17716&t=1

"Apple Impact Damage Thresholds"
Citation: Applied Engineering in Agriculture. 8(1): 55-60. @1992
Authors: N. L. Schulte, G. K. Brown, E. J. Timm
Keywords: Bruising, Fruit, Quality, Packing lines
Abstract – "Drop tests were conducted using an Instrumented Sphere (IS) and four varieties of apples to determine the impact conditions which initiate bruising. 'McIntosh' apples were found to be the most sensitive of the apple varieties. Bruising was initiated at an estimated 2.0 mm (0.08 in.) drop onto steel for large 'McIntosh' apples, the day after harvest. The IS recorded a 20 peak G impact for this drop condition. Bruise threshold response lines for 'McIntosh' were developed and combined with IS impact response lines for typical surfaces used on apple packing lines. This information was incorporated into the IS software, allowing the analysis of impact data based on the probability of occurrence of apple bruises. These estimates can be used to develop conservative design estimates for apple packing line changes, as well as the practical application and choice of cushioning for hard surfaces."
Available at - http://asae.frymulti.com/abstract.asp?aid=26033&t=1

"Apple Packing Line Damage Reduction"

Citation: Applied Engineering in Agriculture. 6(6): 759-764. @1990
Authors: G. K. Brown, N. L. Schulte Pason, E. J. Timm, C. L. Burton, D. E. Marshall
Keywords: Acceleration, Fruit damage, Fruit handling, Fruit quality, Instrumented sphere
Abstract – "Mechanical equipment and operations used on apple packing lines often bruise the apples. These bruises are caused by impacts with hard surfaces or other apples. An Instrumented Sphere (IS) was used to evaluate commercial packing lines and identify areas where damaging impacts occur. Damage free apples were also used on some lines to provide a direct indication of damage. A few lines were changed to reduce impacts and damage, and then were re-evaluated. Impacts exceeding 20 g* (summation of all peak g) and total bruise damage were directly related, and both were significantly reduced using relatively inexpensive line changes. When installing new lines, traditional use of large elevation changes and hard instead of cushioned surfaces between line components must be avoided. Manufacturers, installers and owners can work together to make low handling damage a reality."
Available at - http://asae.frymulti.com/abstract.asp?aid=26460&t=1

"Assessment of Apple Damage on Packing Lines"
Citation: Applied Engineering in Agriculture. 5(4): 475-484. @1989
Authors: G. K. Brown, C. L. Burton, S. A. Sargent, N. L. Schulte Pason, E. J. Timm, D. E. Marshall
Keywords: Fruit damage, Fruit handling, Fruit marketing, Orchard management
Abstract – "Apples for fresh market can incur physical damage during packinghouse operations. During the 1986 packing season, eight different packing lines were studied by placing essentially bruise-free 'Golden Delicious' apples in the lines to quantify the amount of damage (bruises, cuts, punctures), to identify the cause of damage and to suggest ways of reducing damage. The results are summarized in terms of cumulative damage magnitude and bruises/fruit for each operation. Laboratory tests were conducted to define conditions that should help minimize bruising and to estimate the effect of bruising on subsequent decay development. Improvements in methods and equipment to reduce such damage are both needed and feasible."
Available at - http://asae.frymulti.com/abstract.asp?aid=26547&t=1

"Design of a Shitake Mushroom Packing Line"
Citation: Applied Engineering in Agriculture. 5(3): 405-411. @1989
Authors: W. F. Wilcke, C. G. Haugh, K. C. Diehl, C.W. Coale
Keywords: Packing material, Produce handling, Produce marketing

Abstract – "This paper describes design and testing of a packing line for shiitake mushrooms. Because the mushroom marketing cooperative that used the packing line had limited resources, the design minimized equipment costs. In the final design, seven workers could pack three hundred 99-g (3.5-oz) containers per hour, with variable costs for packing materials and labor of $0.42 per container."

Available at - http://asae.frymulti.com/abstract.asp?aid=26535&t=1

“Fruit Damage Assessment in Peach Packing Lines”
Citation: Applied Engineering in Agriculture. Vol. 17(1): 57-62. @2001
Authors: A. Berardinelli, A. Guarnieri, J. Phuntsho, L. Ragni
Keywords: Peach, Mechanical damage, Fruit packing line, Instrumented sphere
Abstract – “In order to assess the effects of mechanical handling on peaches, the impacts measured in Italian packing lines using an instrumented sphere were emulated in the laboratory by means of a simple drop-test device. Samples of Big Top, Caldesi 2000, Centry, and Rich Lady peaches were subjected to impacts representative of the conditions observed at the critical points in packing lines: the drop onto the conveyor belt from the dry bin dumper, the entrance into the counter-basket filler, and at the beginning of the filling of the mini-bin. A test was also carried out to assess the effects on the damages of repeated drops onto the same point of the surface of the fruits. At the highest impact level (180 g, 2.20 m/s), at the beginning of the filling of the mini-bin, damaged fruit did not exceed 18% and the average dimension of the flesh damages did not exceed 10 mm in diameter (Big Top) and 6 mm (Centry) in depth. In general, repeated drops did not seem to cause substantial additional damage. However, they did cause an increase in percentage of damaged fruits for Centry and for the dimension of the alterations for Rich Lady. Considering the severity of the test, the low number of fruits subjected to high impacts by the mini-bin filler and the kind of the damages, the packing lines studied in the present research should not produce an appreciable commercial damage to the ready-to-eat fresh peaches.”
Available at - http://asae.frymulti.com/abstract.asp?aid=1922&t=1

“Fruit and Vegetable Bruise Threshold Prediction Using Theory of Elasticity and Failure Tissue Properties “
Citation: Paper number 016139, 2001 ASAE Annual Meeting. @2001
Authors: J. Varith, G. M. Hyde, A. L. Baritelle, T. Sattabongkot
Keywords: Bruise threshold, fruit and vegetable bruising, tissue failure, tissue properties, dynamic axial compression, paired-increasing height multiple impacting

Abstract – “Determining bruise threshold (drop height at which bruising just begins) from tissue failure properties and whole specimen mass and shape has the advantages of speed and the ability to predict threshold change from failure property changes. Conditioning in turn can influence failure properties; with the result that bruise threshold can be controlled to some degree by commodity conditioning. This work compared bruise threshold prediction using theory of elasticity, tissue failure stress and strain determined by dynamic axial compression (DAC), Poisson’s ratio, and specimen mass and radius of curvature, with results of paired increasing-height multiple-impacting (PIHMI), a whole specimen technique that has proven reliable for determining bruise threshold in apples. The results show that DAC prediction agreed with PIHMI results with a standard error of 1.7 mm for bruise thresholds up to 16 mm grouped by hydration level, DAC and PIHMI bruise thresholds were not significantly different (p>0.05) using a paired t-test.”
Available at - http://asae.frymulti.com/abstract.asp?aid=7517&t=1

“Grading of Mushrooms using Machine Vision System”

Citation: Transactions of the ASAE. 37(5): 1671-1677. @1994
Authors: P. H. Heinemann, R. Hughes, C. T. Morrow, H. J. Sommer, III, R. B. Beelman, P. J. Wuest
Keywords: Mushrooms, Machine Vision System, Grading
Abstract – "The quality features of the common white Agaricus bisporus mushroom were quantified using image analysis in order to inspect and grade the mushrooms by an automated system. The features considered were color, shape, stem cut, and cap veil opening. Two human inspectors evaluated samples which were divided into training and test sets. The vision system was trained to classify mushrooms into two quality grades using thresholding. The human inspection results were compared with each other as well as the computer vision system results. Misclassification by the vision system ranged from 8 to 56% depending upon the quality feature evaluated, but averaged about 20%. The disagreement between inspectors ranged from 14 to 36%."
Available at - http://asae.frymulti.com/abstract.asp?aid=28255&t=1

"Impact Bruise Estimates for Onion Packing Lines"
Citation: Applied Engineering in Agriculture. 7(5): 571-576. @1991
Authors: E. J. Timm, G. K. Brown, R. C. Brook, N. L. Schulte, C. L. Burton
Keywords: Impact, Bruising, Onion, Packing line, Instrumented sphere
Abstract – "The common dry onion (Allium cepa) is grown throughout the United States. Most of these are cured (dried) and held in long term storage before being mechanically cleaned, trimmed, sorted, sized, and bagged for marketing. The mechanical operations can cause bruise, cut and puncture damage, due mainly to impacts against hard surfaces. The Instrumented Sphere (IS), an impact recorder, was handled along with onions in packing line operations to record the impacts caused by the lines. In the laboratory, impact tests using the IS and both freshly harvested and cured 'Spartan Banner 80' onions were conducted to estimate the impact conditions which initiate bruising. Bruising initiated at a 10 mm (0.39 in.) drop onto steel for the freshly harvested onions compared to 6 mm (0.24 in.) for the cured onions. The IS recorded 85 and 56 peak G for these respective drops. Many impacts on hard surfaces exceeding these G levels were recorded on the packing lines. It is yet unknown what amount of bruising will result in discoloration, decay, or a reduction in shelf life after storage. But, improvements of packing line handling operations would reduce the impact levels and related bruising determined from this research."
Available at - http://asae.frymulti.com/abstract.asp?aid=26271&t=1

"Impacts Recorded on Avacado, Papaya, and Pineapple Packing Lines"
Citation: Applied Engineering in Agriculture. 7(4): 418-422. @1991
Authors: E. J. Timm, G. K. Brown
Keywords: Impact, Bruising, Instrumented sphere, Avocado, Papaya, Pineapple
Abstract – "Mechanical equipment and operations used in avocado, papaya, and pineapple packing lines can cause bruise damage resulting in post-harvest losses. An Instrumented Sphere (IS) was used to record impacts occurring in commercial packing lines for these fruit. The IS was able to identify transfers that caused high impacts in each line. Impacts from each packing line were also classified relative to impacts on known surfaces. Improvements in all of these lines can be made by adding cushioning

to bare steel surfaces, replacing worn cushioning, reducing elevation changes between components, and controlling fruit flow at each transfer. Impact tests to establish bruise damage thresholds with each fruit are needed to determine impact and fruit conditions which result in bruise damage. Improved handling conditions can then be identified to maintain fruit quality."
Available at - http://asae.frymulti.com/abstract.asp?aid=26259&t=1

"Instrumented Sphere Impact Analysis of Tomato and Bell Pepper Packing Lines"
Citation: Applied Engineering in Agriculture. 8(1): 76-83. @1992
Authors: S. A. Sargent, J. K. Brecht, J. J. Zoellner
Keywords: Lycopersicon esculentum, Capsicum annuum, Postharvest handling, Quality control, Mechanical injury, Mechanical damage, Bruising, Vegetable packinghouses
Abstract – "Transfer points with potential to cause mechanical injury were identified in 11 tomato packing lines (5 packing green tomatoes, 5 packing tomatoes showing red color, 1 repacker); 3 bell pepper packing lines; and 2 mobile field pack units for peppers. Average maximum impact levels for the lines packing tomatoes with red color were higher than those packing green tomatoes. Field pack units for peppers had significantly fewer numbers of impacts than the pepper packing lines. Modifications to some transfer points resulted in over 50% reduction in impact levels."
Available at - http://asae.frymulti.com/abstract.asp?aid=26036&t=1

"Mechanical Harvesting System for Burley Tobacco"
Citation: Applied Engineering in Agriculture. 3(1): 95-98. @1987
Authors: J. H. Casada, M. J. Bader, L. R. Walton, L. D. Swetnam, M. E. Fiedeldey
Keywords: Mechanical harvester, Tobacco harvesting, Tobacco production
Abstract – "A harvesting-handling system for burley tobacco was modified and field tested to evaluate its performance. The system utilizes a semi-mounted harvester to cut the plants, notch their stalks and convey them to a trailing wagon where workers hang the notched plants on wire-strung portable frames. A grasping chain conveyor was added at the front of the harvest to positively control the plants in the cutting and notching zone. An adjustable frame holder was added to the wagon which allowed the frame to be repositioned to provide working space for completely filling the frame. A quickly adjustable wagon tongue was provided which facilitated turning the machine at end of row. Test results showed that 94.7% of plants were successfully harvested and hung while 2.2% were lost from the conveyors and 3.1% were not properly notched for hanging. Leaves lost amounted to 18.7% and harvest rate was 40.5 plants/min."
Available at - http://asae.frymulti.com/abstract.asp?aid=26653&t=1

"Multi Purpose, Vegetable Production Machine Investigation"

Citation: Applied Engineering in Agriculture. 6(6): 691-696. @1990
Authors: C. E. Hood, Y. Alper, R. E. Williamson
Keywords: Controlled-traffic production, Field packing, Harvesting, Materials handling, Mechanization

Abstract – "Two multi-purpose, vegetable production vehicles with 3-m (10-ft) spans have been developed by retrofitting commercial high-clearance power units. Bi-directional and movable operator stations were designed to allow the operator to view critical field operations. Dual three-point hitch systems were incorporated into the design to allow multiple field operations in a single pass. The prototype vehicles have successfully performed tillage, bed shaping, planting, cultivating, spraying, and harvesting operations."
Available at - http://asae.frymulti.com/abstract.asp?aid=26449&t=1

"Packing Line Bruise Evaluation for 'Walla Walla' Summer Sweet Onions"
Citation: Transactions of the ASAE. 38(4): 1167-1171. @1995
Authors: R. W. Bajema, G. M. Hyde
Keywords: Onion, Bruise resistance, instrumented sphere, packing lines
Abstract – "An instrumented sphere (IS) was used to analyze the handling impact characteristics of five eastern Washington State summer sweet onion packing lines. Bruise probability curves were developed for the onions by dropping them from known heights, using a pendulum, onto three reference surfaces. The IS was then used to characterize the surfaces and onion bruise thresholds were determined. Recommendations, based on the impact characteristics of the packing lines and the bruise threshold results, were made to the packing line management on how to reduce bruise damage. A dramatic reduction in impact levels was verified in the packing lines that used the evaluation to improve their equipment's handling characteristics. The bruise threshold results should be useful throughout the sweet onion industry."
Available at - http://asae.frymulti.com/abstract.asp?aid=27936&t=1

"Peach Physical Characteristics for Orientation"
Citation: Transactions of the ASAE. 39(4): 1493-1497. @1996
Authors: M. P. Rigney, G. H. Brusewitz, M. L. Stone
Keywords: Fruit, Packing lines, Property, Shape
Abstract – "Packing line sorting equipment utilizing an electronic quality sensor usually requires oriented fruit for reliable measurements. The performance of mechanisms using the rolling behavior of peaches to achieve orientation is dependent on the fruit's physical characteristics. The focus of this study was to determine the effect of peach physical characteristics (shape and mass) on orientation potential. Starting completely out of orientation, peaches became oriented within 43 cm of travel, on the average, and always within 105 cm. Starting with the peaches properly oriented (the stem-to-blossom axis horizontal), 75% remained so oriented while being rolled 1.4 m. Thinner peaches (cheek diameter, D, less than stem-blossom height, H) like Harmony stayed oriented 88% of the time while only 57% of spherical-shaped fruit like 'Red Haven' stayed oriented for 1.4 m. Peaches with diameter/height ratio (D/H) greater than 1.0 had the greatest variability in orienting behavior. Knowing a peach's shape enables a prediction of orientation probability for a given travel distance."
Available at - http://asae.frymulti.com/abstract.asp?aid=27643&t=1

"A Procedure for Testing Padding Materials in Fruit Packing Lines Using Multiple Logistic Regression"

Citation: Transactions of the ASAE. Vol. 45(3): 751–757. @2002
Authors: F. J. García–Ramos, P. Barreiro, M. Ruiz–Altisent, J. Ortiz–Cañavate, J. Gil–Sierra, I. Homer
Keywords: Padding material, Packing line, Impact tester, Instrumented sphere, Bruises, Logistic regression, Fruit
Abstract – "Padding materials are commonly used in fruit packing lines with the objective of diminishing impact damage in post–harvest handling. Two sensors (IS 100 instrumented sphere and UC–LPF impact tester) were compared to analyze the performance of six different padding materials used in Spanish fruit packing lines. Padding materials tested were classified according to their capability to decrease impact intensities inflicted on fruit in packing lines. A statistical procedure to test padding materials was tested for Golden Delicious apples. Its basis is a multiple logistic regression to predict bruise probability in fruit. The model combines two groups of parameters: padding material parameters measured with the IS, and fruit properties."
Available at – http://asae.frymulti.com/abstract.asp?aid=8846&t=1

"Reduction of Mechanical Damage to Apples in Packing Lines Using Mechanical Devices"
Citation: Applied Engineering in Agriculture. Vol. 19(6): 703-707. @2003
Authors: F. J. García-Ramos, J. Ortiz-Cañavate, M. Ruiz-Altisent
Keywords: Instrumented sphere, Bruise, Transfer points, Fruit quality, packing lines
Abstract – "Fresh fruits and vegetables experience impacts as they are mechanically handled in commercial packing lines. Impacts commonly occur when the product is transferred between successive unit operations (transfer point) along the line. Mechanical devices can be used at transfer points to decrease the mechanical damage to fruit.

Bruise onset is induced when the failure stress or the maximum deformation for the product tissue are exceeded (depending upon the damage mechanism). Bruise onset and its magnitude depend on different factors: height of the transfer points, working velocity, hardness of the surfaces, curvature of the surfaces, and fruit characteristics (mass, curvature, temperature, humidity, and firmness).

To analyze the effectiveness of mechanical devices (cushioned rollers, powered brush, and padding materials) to reduce mechanical damage to "Golden" apples, three standard transfer points (transporting belt – rollers transporter; rollers transporter – singularize; and transporting belt – transporting belt) of a experimental packing line were studied using instrumented spheres (IS 100). The efficiency of the solutions was analyzed using "Golden" apples and measuring the presence of external bruises during the handling.

Solutions tested reduced the acceleration values under 50 g, which is commonly a safe level to avoid the mechanical damage in apples. Once the transfer points were improved, apples were handled, and values around 100% of fruit were EC Grade I.

Tests carried out showed that mechanical devices are useful to reduce mechanical

damage in “Golden” apples, but must be correctly regulated to obtain optimum results (fruit without bruises). This regulation can be carried out using instrumented spheres (IS 100) and fresh fruit.”
Available at - http://asae.frymulti.com/abstract.asp?aid=15653&t=1

“Sorting Table Illumination on Stonefruit Packing Lines in California”
Citation: Applied Engineering in Agriculture. 9(6): 539-543. @1993
Authors: M. J. Delwiche, J. F. Thompson, R. S. Johnson
Keywords: Lighting, Grading, Inspection
Abstract – “Sorting table illumination was evaluated in nine stonefruit packing houses, including table configuration, light intensity, uniformity, and spectral quality. Typical sorting tables had two sorting lanes with a cull lane running between, and the fruit were moved by roller conveyor made from white PVC pipe. Luminaires with two fluorescent lamps were usually centered above and along each sorting lane section. Correlated color temperatures of the lamps varied from 3600 to 5000° K, and color rendering indices varied from 62 to 90. Illuminance at the center of each sorting lane ranged from 920 to 4080 lx (85 to 379 fc), with a mean value of 2170 lx (202 fc). Light intensity was relatively uniform over the entire surface of the sorting lane. Luminance ratios between the white roller conveyors and darker fruits exceeded the 3:1 industry recommendation and could be improved by using darker rollers. The majority of packing lines used “cool-white” fluorescent lamps. Color rendering might be improved with lamps having higher correlated color temperatures and color rendering indices, thereby more closely approximating daylight. Defect recognition might be enhanced with lamps having more energy in the red region of the spectrum.”
Available at - http://asae.frymulti.com/abstract.asp?aid=26019&t=1

“Suspended Tray Package for Shipping Soft Fruit”
Citation: Paper number 066188, 2006 ASAE Annual Meeting. @2006
Authors: J.F. Thompson, D.C. Slaughter, M.L. Arpaia
Keywords: packaging, vibration damage, quality, transportation, pear, avocado
Abstract – “A new suspended fruit packaging system for damage-free transport of soft fruit was developed and tested. Transit vibration tests simulating a continental USA cross-country trip of approximately 4,500 km (2,800 mi) showed that this suspended fruit system prevents nearly all transport vibration damage to pears when used with a plastic clamshell package and to avocados when used with a plastic clamshell or corrugated fiberboard master container. Comparative damage data are reported for simulated shipment (American Standards Testing Materials D4169-94 assurance level I) of Hass avocados and Bartlett pears ripened to varying firmness levels.”
Available at - http://asae.frymulti.com/abstract.asp?aid=21535&t=1

Bella Corp

Design Proposal

Brady Brewer   Stephen Eller
Michelle Jones   David Haury

Outline

- Introduction
- Business
- Communications
- Engineering
- Radical Ideas
- Recommendations
- Questions

Bella Corp

J-M Farms

- Main Facility – Miami, OK
- Established 1973
- 5 Satellite Farms
- White & Portabella Mushrooms
- Cover OK, TX, AK, MS, NM, KS, MO, IA.

Photo Available at :
http://www.jmfarms.com/index.html

Bella Corp

Problem

- Problem Statement

"Our project is to improve the harvesting and packaging efficiency at J-M satellite farms. The most important factors affecting design are: ergonomics, cost effectiveness, maintenance, and simplicity."

- Mission Statement

"To provide a quality solution to improve J-M Farm's packing efficiency."

Bella Corp

Project Description

- Improve efficiency and quality of mushroom packaging process
- New cart was suggested
- We examined the entire packaging process
- Process Flow
- Machine Design

Bella Corp

Current Process

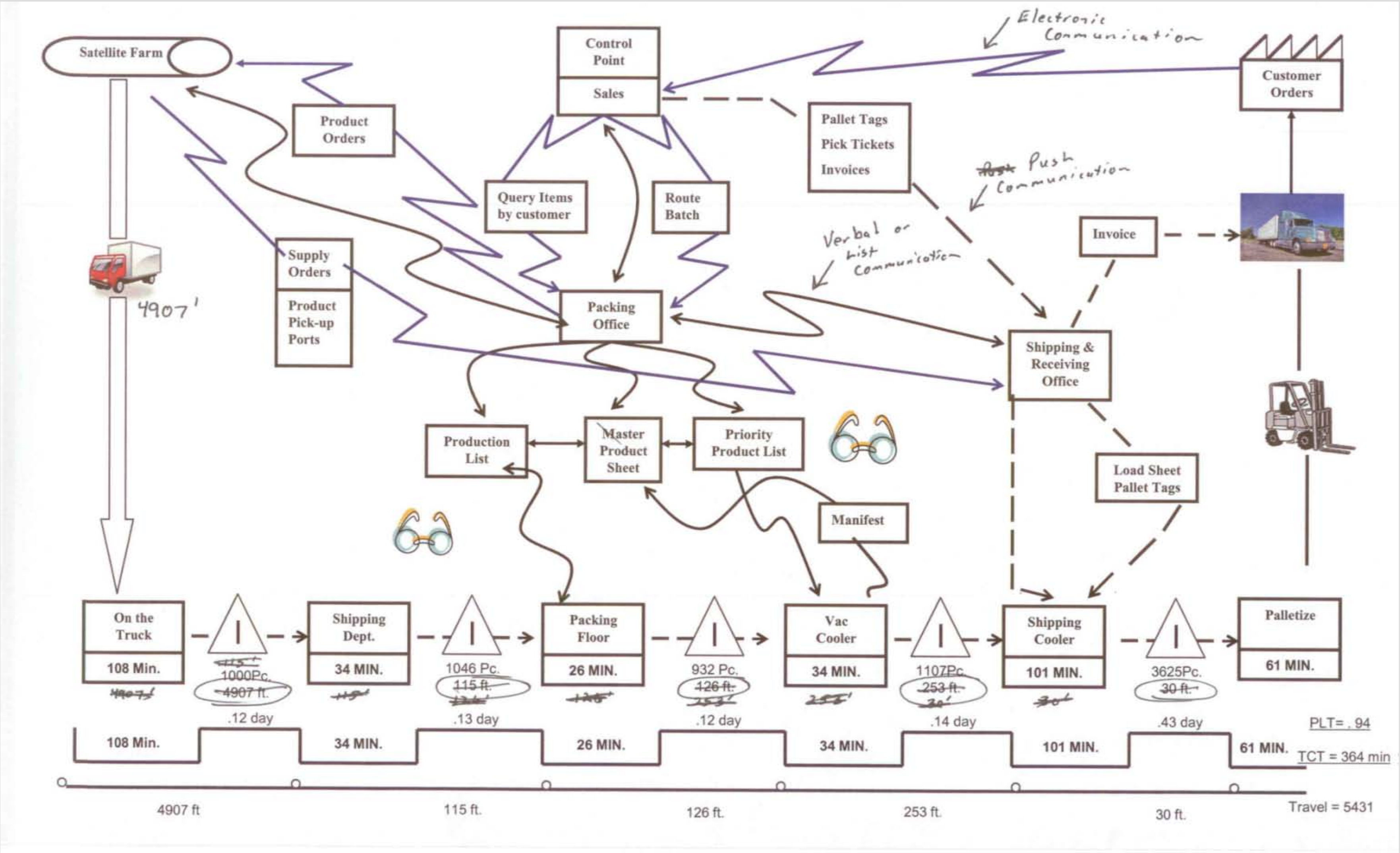
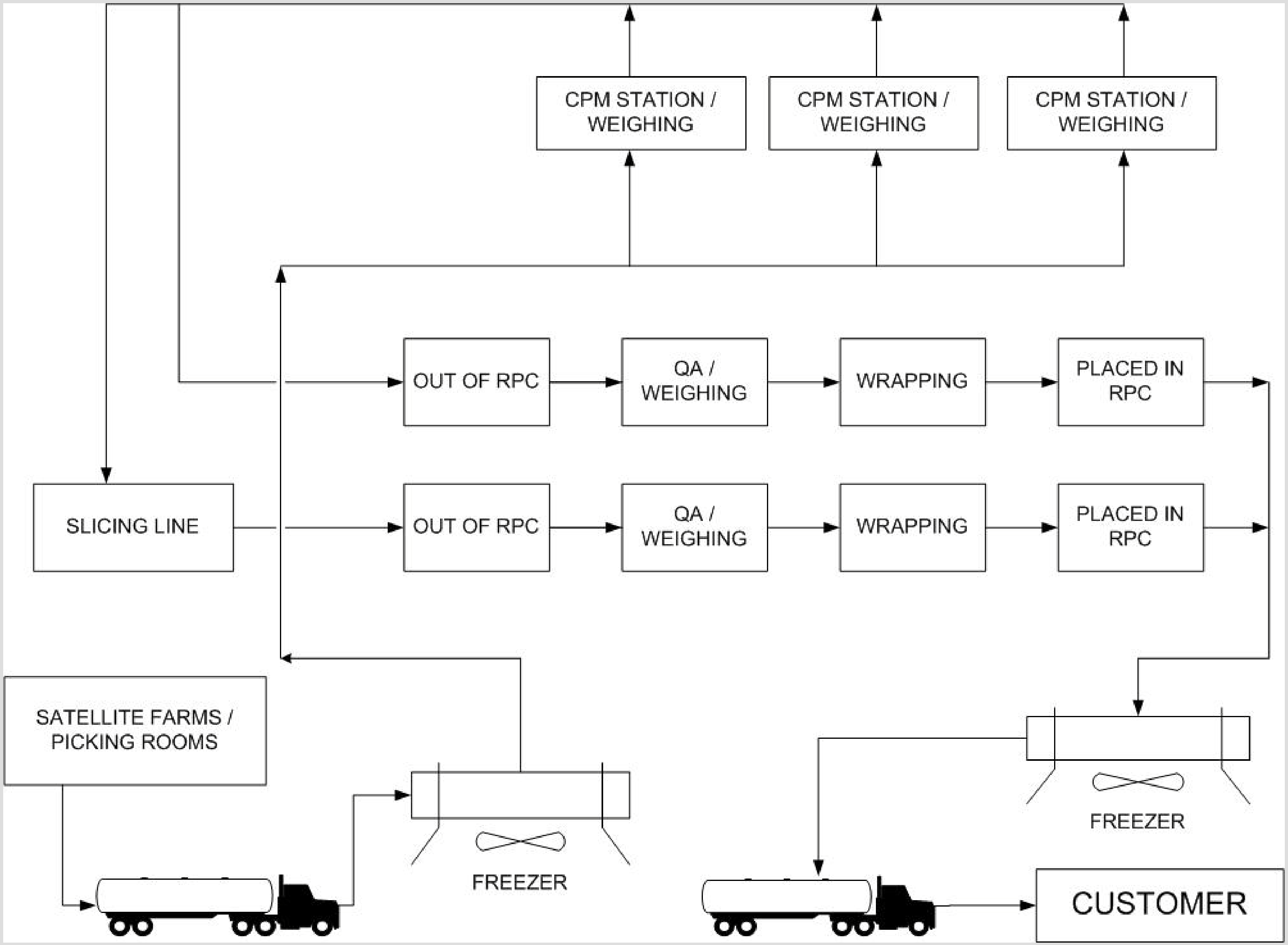


Diagram courtesy of J-M Farms.

Current Process



Industry Analysis

- Premium goods dominate the industry
  - Emphasis on quality
  - Consumer behavior
- Industry similar to Tomatoes
  - Growth in the recent past

Bella Corp

Competitive Analysis

- Internal Competition
  - Among pickers and processes
- External Competition
  - Regional
  - National
    - Specialization seen amongst the industry

Bella Corp

Competitive Analysis

- Monterey Mushrooms

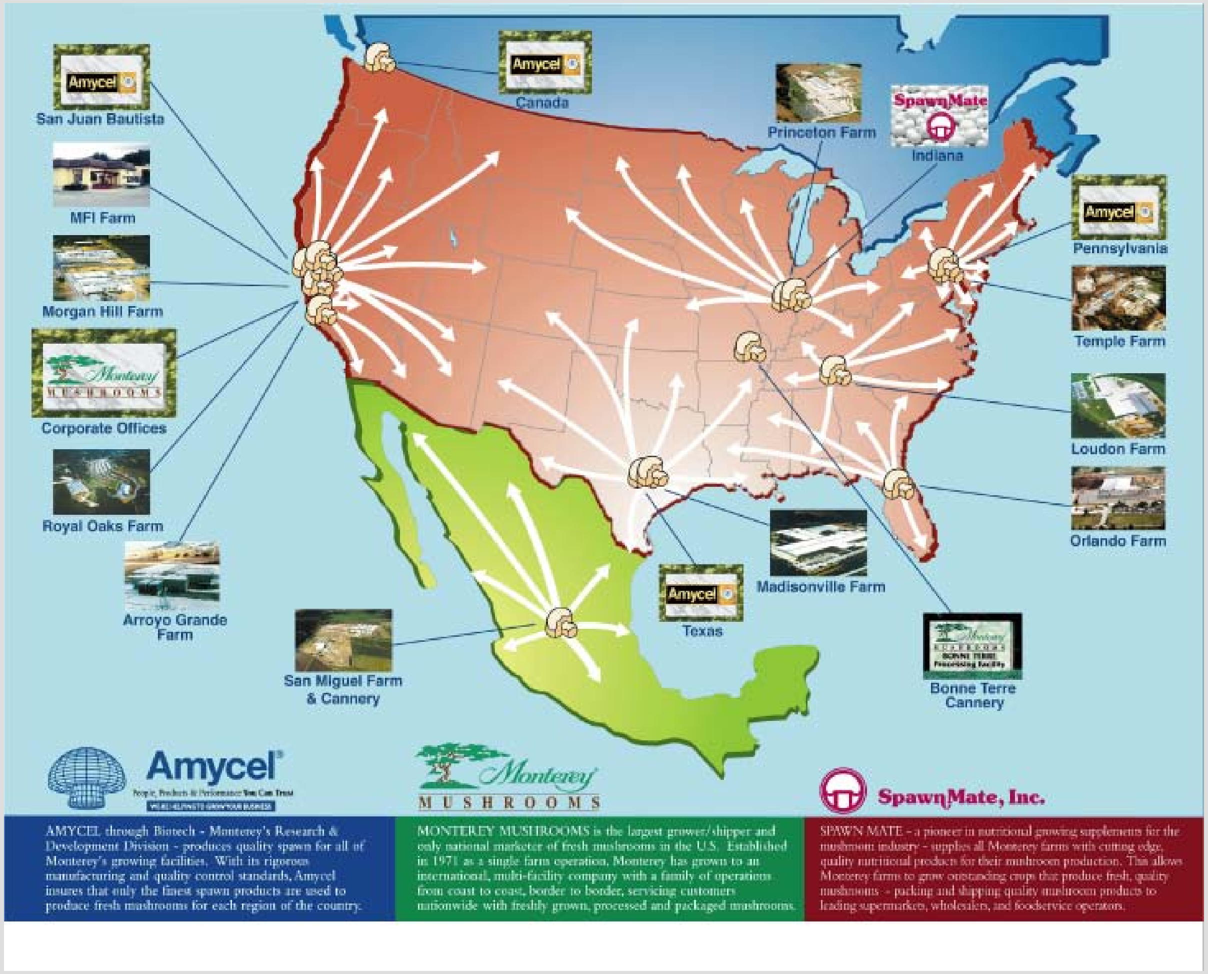


Photo Available at:
http://www.montereymushrooms.com/overview.htm

Bella Corp

Proposed Business Plan

- Executive Summary
  - Overview of business
  - Roadmap to follow
- Industry Analysis
- Competitive Analysis
  - Emphasis on Internal Competition for picking process

Bella Corp

Proposed Business Plan

- S.W.O.T. Analysis
- Marketing Strategy
  – Will includes Communications plan
  – Market saturation versus Market Penetration
- Conclusion

Bella Corp

Business Plan Impact

Walmart

Save money. Live better.

Bella Corp

Photo Available at :
http://www.flashbackinfo.org/images/Walmart_New_Logo.png

Proposed Financial Analysis

- Activity Based Costing
  - What is it?
  - Why would you use it over other methods?
- Keep costing for picking process the same
- Identify key processes
- Cost savings from engineering solution

Bella Corp

Communications Plan

- Business-to-Business
  - Mushroom shoppers are valuable to retailers. The average shopping basket with mushrooms is double the value of shopping baskets without mushrooms.
- Business-to-Customers
  - Customers tend to be highly educated and wealthy
  - Hispanic and Asian purchases increasing
  - Response to point of source materials

Bella Corp

Business-to-Business

- Web page
  - Quality control
  - Traceability Statistics
  - Recycling Efforts
- Flier or Brochure
  - Quality control
  - Traceability Statistics
  - Recycling Efforts
  - Next Day Service

Bella Corp

Business-to-Customers

- Web page
  - Recipes
  - Storage and handling procedures
  - Quality control
  - Traceability Statistics
  - Recycling Efforts
- Recipe/Fact Booklet Label
  - Recipes
  - Storage and handling tips
  - Quality control
  - Traceability Statistics
  - Recycling Efforts

Photos Available at:
http://www.jhbertrand.com/cs_promotionalnut.html

Bella Corp

Business-to-Customers

- Recipe Cards
  - Recipes
  - Storage and handling procedures
- Fact Cards
  - Nutritional facts
  - Storage and handling tips

Photos Available at:

http://www.stonewallkitchen.com/Content/images/whl_merch_carousel.jpg

http://www.ccicards.com/product-group.aspx?groupID=6

Bella Corp

Engineering

- Interdisciplinary Problem
  - Food Handling
  - Industrial Engineering / Ergonomics
  - Mechanical Design

Bella Corp

Engineering Concepts

- Industrial/Ergonomic Ideas
  - 1. CPM Weighing Station at Satellites
  - 2. Packing Line at Satellites
  - 3. Redesign Packaging Process at Main Farm
  - 4. Redesign/Alter Slicing Line at Main Farm
  - 5. Temperature/Time/Handling Study

Bella Corp

Ergonomic/Industrial Ideas

Packaging Line at Satellites

PROS:

- Mushrooms are ready for shipment at satellites
- Decreased work load at main facility
- Increased space at main facility (focus on slicing)
- Test feasibility of a streamlined process

CONS:

- Heavy initial cost for satellite
- Substantial space requirements

Ergonomic/Industrial Ideas

Redesign Packaging Process at Main Farm

PROS:

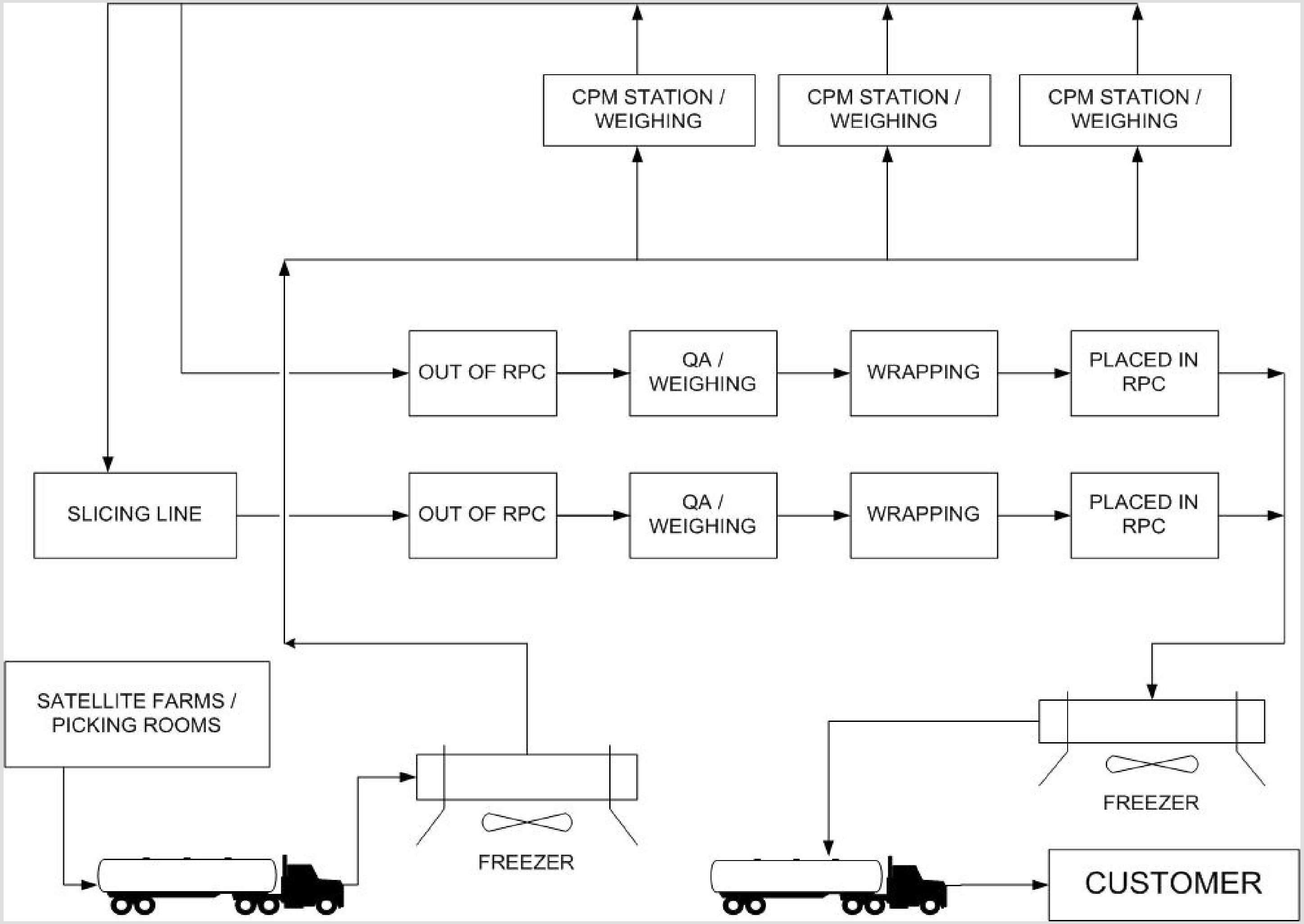
- Increase Efficiency
- Eliminate redundant processes
- Mitigate loss

CONS:

- Adjustment required of employees
- Potential production shut down

Ergonomic/Industrial Ideas

Temperature/Time/Handling Study



Ergonomic/Industrial Ideas

Bella Corp

Engineering Concepts

- Mechanical Design Ideas
  - 1. Picker Cart with Scales
  - 2. Packaging Cart (using snap-on lids)

Mechanical Design Ideas

Picker Cart with Scales

PROS:

- Pick by weight, not volume
- Better quality, reduced handling
- Shorter time to package

CONS:

- Less Flexibility with increased size
- Large capital investment
- Increase picker work load

Bella Corp

Mechanical Design Ideas

Weighing/Packaging Cart (Snap-on lids)

PROS:

- Ready for shipment at satellites
- Increased shelf life
- ‘One Touch’ produce
- Less work load at main facility

CONS:

- Size of cart will likely double
- Heavy capital investment
- Increase picker work load substantially
- May require alternate RPC

Bella Corp

Radical Ideas

- Team Pay
- Value-Added Products
- Sell Mushrooms by Count, not by Weight

Bella Corp

Team Pay

- Current system pays picker by the pound and packing line workers at an hourly rate
- “You do your job, I do mine”
- Mushrooms get dropped

Bella Corp

Team Pay

- Team would get paid based on what goes onto the truck
- Increase motivation to decrease waste
- Foster teamwork among the members across the different steps in the harvesting process

Bella Corp

Value Added Products

- Sautéed
- Fried
- Battered

Photo Available at:
http://www.poboyexpress.com/menu/foodimg_lg/fried_mushrooms.jpg

Bella Corp

Sell Mushrooms By Count

- Mushrooms sold in stores today must meet a certain minimum weight
- Leads to wasted effort in weighing the package multiple times
- Pack by number of mushrooms inside, not by a goal weight
- Print a sticker to display the weight of package so product could still be sold by weight, if mandated

Bella Corp

Sell Mushrooms By Count

- Process of packing is simplified because the picker can do it with minimal equipment
- Scale could even be dropped if mushrooms are sold purely by count
- Package directly after picking
- Highest quality and freshness

Bella Corp

Sell Mushrooms By Count

- Some fresh tomatoes are already being sold by count
- Customers can easily see the quality product

Photo available at:
http://www.linpac.com/PageFiles/312/About---tomato-tray.jpg

Bella Corp

Sell Mushrooms By Count

Photo available at:
http://www.linpac.com/PageFiles/179/Library/Tomato-tray-collage.jpg

Bella Corp

Project Recommendation

1. Redesign Packaging Floor
2. Temperature/Time/Handling Study
3. Weighing / Packaging Cart (Snap on Lids)
4. Combination

Bella Corp

Questions?

Bella Corp

Thank You!

Bella Corp