

lemons in the large room are probably caused by the much larger ratio of fruit quantity to amount of diphenyl vaporized.

Average residues of diphenyl in fruit from each of the 27 pallet boxes in 4 runs are shown in Figure 5. The general agreement of residue levels in the various boxes and the lack of any pattern in relation to position in the room indicate that the diphenyl vapor circulated uniformly throughout the room and through the

fruit in the boxes. Corresponding results for the split run in the small rooms are shown in Figure 6. The greater variability of these results is because analyses from a single run are shown rather than an average from several runs. Diphenyl residue levels in all boxes were adequate for satisfactory decay control.

The legal tolerance of 110 ppm for diphenyl in lemons (6) was never approached and no evidence of peel injury due to diphenyl was found. At the end of the season, heavy deposits of diphenyl were found on the cooling coils that reduced the cooling efficiency very seriously.

Warning.—If the method is used commercially, personnel working in the diphenylsaturated air would need to wear gas masks. Current studies are aimed at the intermittent night time application to avoid this problem.

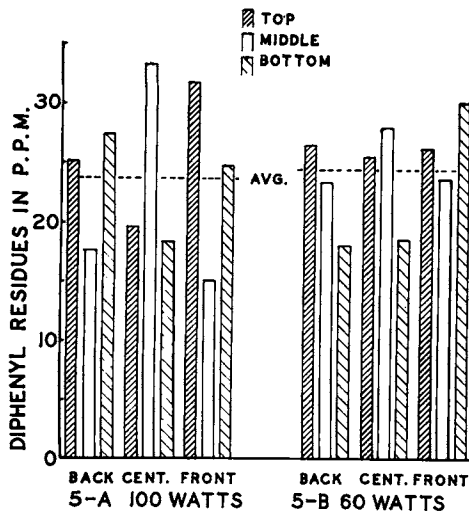


Fig. 6.—Distribution of diphenyl residues in lemons in pallet boxes throughout small cool coloring rooms.

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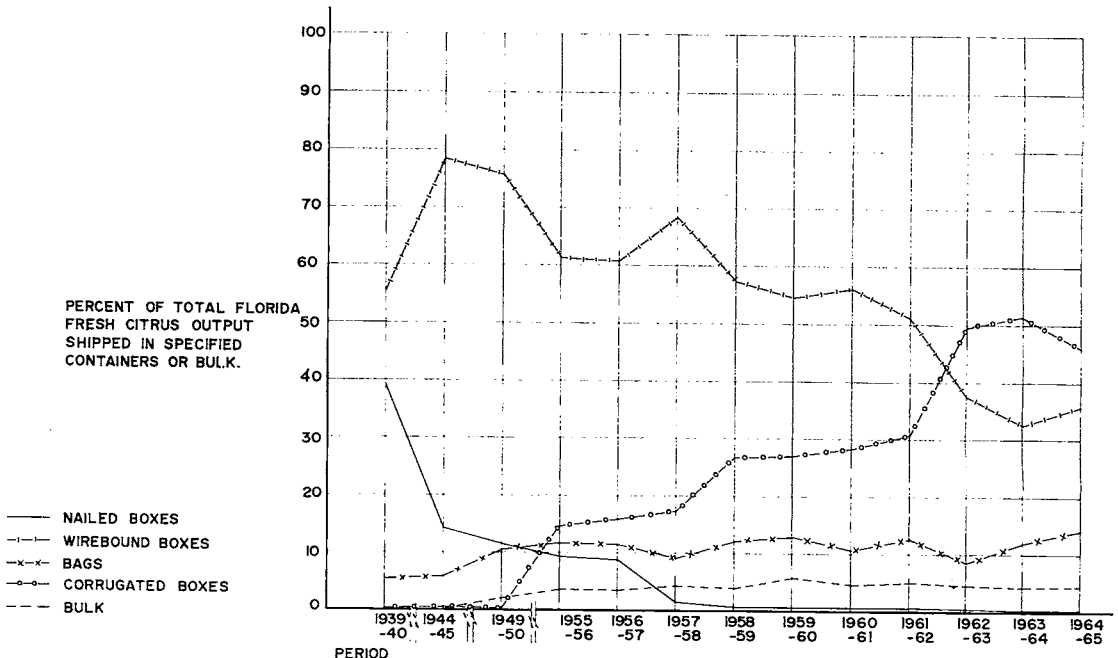
CITRUS PACKING METHODS OF IMPROVEMENT

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Manual place packing of fruit into containers such as the 1-3/5 bushel box has been the packing method used since the beginning of the fresh citrus fruit industry in Florida. Place packing means the placing of fruit in a specified pattern. Studies bearing upon packinghouse costs have regularly shown the labor cost for place packing to be one of the highest in Florida citrus packinghouse operations (1, 2).

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Over a period of many years, improvement in place packing methods has generally been relatively slight—without major advances in technology. Actually, except for the introduction of roll-board packing as a part of a cooperative research program of the Florida Agricultural Experiment Stations and the Agricultural Research Service, changes in packing which have resulted in labor savings in Florida were essentially those caused by changes in containers or the practice of wrapping fruit (3, 4). In the early 30's, the wirebound box was introduced as a desirable alternative to the standard nailed



PROPORTION OF FRESH CITRUS SHIPPED BY TYPE OF CONTAINER.
 SOURCE: REPORTS FROM CITRUS AND VEGETABLE INSPECTION
 DIVISION FLORIDA DEPARTMENT OF AGRICULTURE.
 (TYPE OF CONTAINER NOT SHOWN PRIOR TO 1939-40 SEASON).

Fig. 1.

box, used from the beginning in the commercial shipping of fresh fruit. Individual wrapping of fruit, which had been a firmly established practice, was discontinued for fruit packed in the wirebound box. This change, initiated through Florida industry decision at the time and not necessarily due to features of the container, was notable in respect to the amount of cost reduction it afforded.

The packing labor cost per 1-3/5 bushel box was reduced approximately 40 percent when individual wrapping of fruit was eliminated (1, 2, 3).

In the 1939-40 season, about 40 percent of the fresh citrus shipped from Florida was packed in the nailed box, which still involved individual wrapping of fruit. For the 1957-58 season this percentage had dropped to about 1 percent and since that time has been negligible. More recently, the nailed box has been officially eliminated as a shipping container for the Florida fresh citrus industry. In the 1964-65 season, wire-bound boxes and corrugated cartons toget-

her carried 81 percent of the fresh fruit shipped from Florida, and individual wrapping is not included in packing either of these containers (fig. 1 (5)).

Comparatively recently the roll-board method of manual place packing has been widely accepted in the Florida citrus industry. Possible labor savings of 20 percent were reported from the research on roll-board packing (4). Firms who adopted this method have confirmed savings of this magnitude. Improvements in manual place packing methods have also been developed in California (6, 7).

It has been customary to have piece rate payment for the packing operation in Florida (1, 2). In piece rate structures, factors other than direct reduction in piece rates must be considered in evaluating the savings which result from methods changes. Mentioned briefly, and without elaboration, some of the factors are: prevention or restraining of increase in piece rates while the general trend is toward rising hourly earnings levels for workers, reduction of "makeup"

pay to provide guaranteed minimum hourly earning, and better incentive effect for workers covered by the given piece rates.

Despite the changes which have been mentioned, and the passage of many years, manual place packing of citrus is still firmly entrenched in Florida packinghouse methods and continues to be one of the highest labor cost operations (1, 2). Thus, the proportion of total fresh fruit shipped in wirebound boxes or corrugated cartons—81 percent for the 1964-65 season—takes on special significance.

The work normally involved in manually place packing fruit into containers such as those mentioned may, in methods analysis and time study procedures, be subdivided by activity as shown in Table 1. Time values, based upon time study data, are shown in the same table.

In a typical cycle of place packing fruit into either wirebound boxes or corrugated cartons, about 75 percent of the worker's time is spent

in grasping, moving and placing fruit, all of which is included in "place pack fruit" in Table 1.

Much variation in the effort and effectiveness of packing workers occurs in the activity "place pack fruit." It is comprised of repeated actions by the worker to obtain and place fruit into a container until the proper number is packed in each container. The number of fruits picked up at each action and the degree of utilization of both hands together varies widely between workers, greatly affecting the rate of output. For example, taking two fruits in each hand, the complete sequence of actions in "place pack fruit" must be performed 31 times in filling one carton (125 count) plus movements to place one additional fruit. Frequently the number of fruits per pickup falls below four, causing still more movements in filling the container with fruit. In addition, the pace and overall effort of the packer play an important part.

TABLE 1.--Labor Required for Manually Packing Size 252 Oranges Into
4/5 Bushel Corrugated Cartons by the Roll-Board Method. (3)

Activity	:	Productive Time per Carton
	:	<u>Man-Minutes</u>
Take container from chute	:	.06
Stamp container	:	.06
Open container and position <u>1/</u>	:	.11
Place pack fruit (125 fruit)	:	1.08
Aside packed container to conveyor	:	<u>.11</u>
Total		1.42

1/ Telescoping type carton delivered to packer formed and assembled for glue sealing both top and bottom flaps by machine after packing.

The roll-board method made possible increased productivity mainly by reducing the distance of movement of the packer's hands between pick-up and release points for the large number of movements involved (fig. 2).

Recently, there has been an announcement of developmental work in California on automatic machinery for place packing citrus into cartons (8). Also, semi-automatic machinery for place packing has been under test in Florida and trial installations have been made in some packinghouses. These semi-automatic units deliver fruit into the container, providing for machine count, while the packer manually places the fruit in the proper pattern. Further experience will tell how this ranks as technological improvement in place packing.

Packing labor can be greatly reduced by the use of automatic machinery which will jumble fill boxes. Equipment for filling 4/5 bushel cartons has been commercially available for over five years and has been used in some packing-

houses. In Florida, however, the use of such equipment was discontinued after a relatively short period of time in nearly every case.

This automatic jumble filling of containers offers a practical way to drastic reduction in the labor cost for packing fruit into the shipping containers and the equipment appears to be less complex than that needed for automatic place packing.

Times values derived from studies on a commercially available type of automatic equipment for counting fruit and jumble filling cartons are shown in Table 2.

Although the major effect in reducing labor by the automatic machine-jumble packing method is in the filling of the container with fruit, the labor involved in other parts of the activity in manual place packing is also reduced because the machine moves empty cartons into place and ejects filled cartons onto a conveyor system.

WORK PLACE LAYOUT FOR MANUALLY PACKING FRESH CITRUS FRUIT

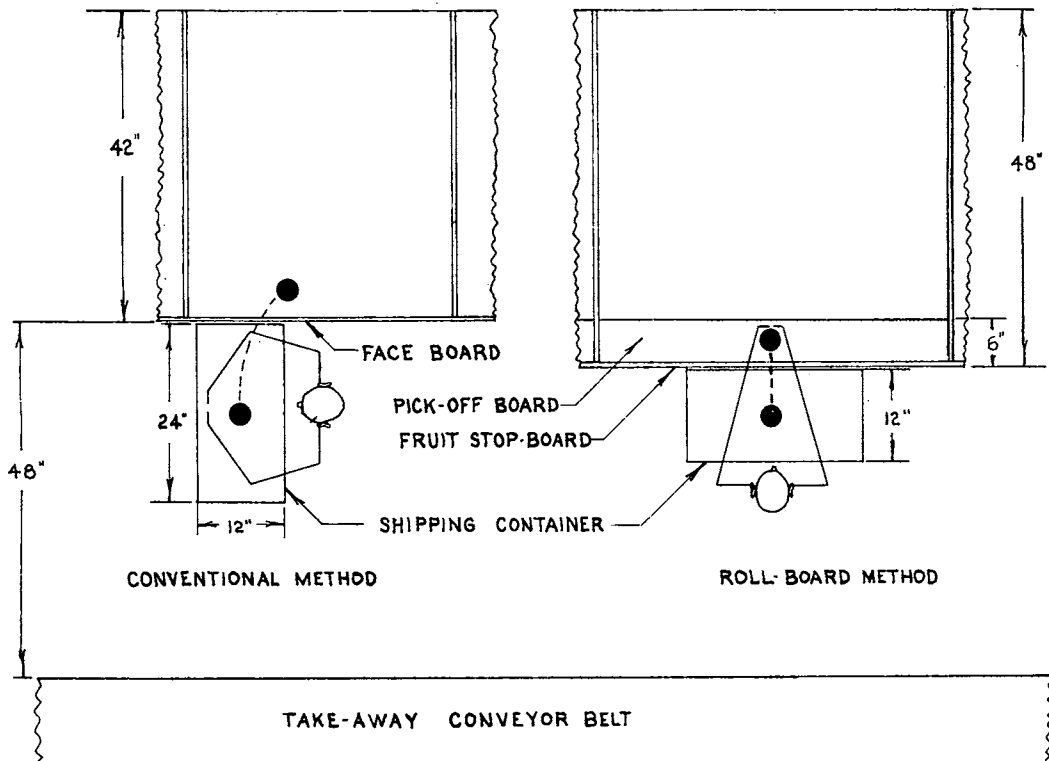


Fig. 2.

TABLE 2.--Labor Required for Machine Packing Size 252 Oranges Into
4/5 Bushel Corrugated Cartons $\frac{1}{2}$

Activity	:	Productive Time per Carton
	:	<u>Man-Minutes</u>
Fill (125 Fruit) $\frac{2}{1}$:	.21
Eject filled carton and advance empty carton	:	<u>.02</u>
Total		.23

$\frac{1}{2}$ One worker per machine assumed for example; may be less in practice.

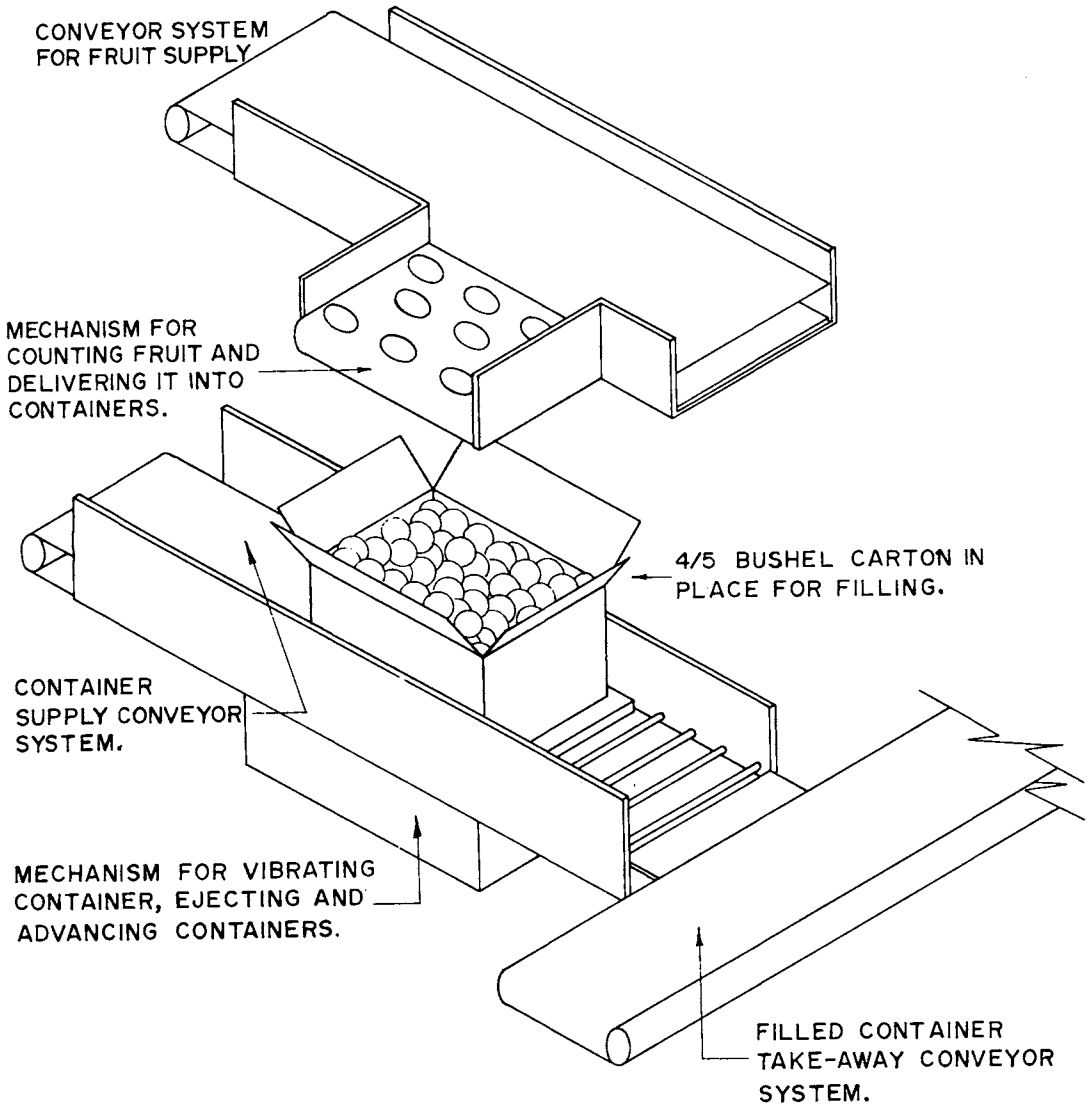
$\frac{2}{1}$ Vibration applied during filling with carton upside down.

Approximately 260 cartons of size 252 oranges can be packed per machine hour by the automatic machine-jumble fill method as compared to 42 cartons per packer hour for manual packing by the roll-board method, assuming an adequate supply of fruit.

The equipment cost per unit of product, as normally weighed in conjunction with reduced labor costs expected from the application of new equipment, is attractively low. Based upon an initial cost of \$7000 per unit, a 10-year service life, interest at six percent, insurance and taxes at four percent and annual volume of 164,000 cartons per machine (90 days per season, machine operating 7 hours per 8 hour day), the total ownership costs amount to slightly over one cent per carton. This plus a labor cost of \$0.007 per carton (\$0.014 per 1-3/5 bushel equivalent) developed on the basis of one worker per machine at \$1.60 per hour is \$0.0172 per carton (\$0.344 per 1-3/5 bushel equivalent) which compares to \$0.0381 per carton (\$0.0762 per 1-3/5 bushel equivalent) for labor only in the manual packing method based upon 42 cartons of 252 size oranges per packer hour and corresponding hourly earnings.

In view of the possibilities for cost reduction through the use of automatic machines for jumble filling containers, it appears that trade customs have, to a considerable degree, prevented general acceptance of jumble-filled boxes instead of place-packed boxes. Also, the relatively large number of different containers offered to the trade by Florida packers has presented difficulties in changing to the use of automatic machinery.

The need for resolution of trade outlook relative to jumble-filled boxes and for reduction in number of container types is urgent. At this juncture, the allocation of resources to the improvement of packing methods through mechanization hangs in the balance. Without needed resolution of trade outlook and action on containers, possibly unwise commitment of resources to the mechanizing of place placing is possible. The alternative, apparently more desirable on a long-term basis, is the refinement and final adaptation of automatic equipment, already commercially usable, for mechanized jumble filling of containers. At the same time, coordination of container types with machine design and capability is vital.



**MACHINERY (ONE STATION) FOR AUTOMATICALLY
COUNTING FRUIT AND JUMBLE FILLING CONTAINERS.**

Fig. 3.

The following factors support emphasis on automatic jumble filling rather than automatic place packing of fruit into boxes in future methods improvement steps:

- (a) Place packed arrangement of fruit no longer has utility. The container as packed at the packinghouse is virtually never seen by the final customer.
- (b) Greater flexibility for accommodating a range of variations in container size and construction.
- (c) Less complexity in equipment design.
- (d) Possible higher output per machine hour.

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CONSUMER PACKAGES FOR FLORIDA CITRUS FRUITS

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ABSTRACT

The rapid increase in the marketing of fresh produce in consumer packages is presenting a new challenge to the fresh citrus trade. Comparatively minor percentages of decayed fruits can mean severe losses in terms of packages rendered unsalable due to 1 or more rots. Simulated shipping and marketing tests were carried out with oranges, grapefruit, tangerines, tangelos, and 'Temples' using perforated polyethylene ("poly") bags, mesh ("Vexar") bags, perforated and nonperforated shrinkfilm packs. Two vapor-phase fungicides were used: diphenyl and 2-aminobutane. Mesh bags and perforated films tended to result in lower decay levels than did perforated "poly" bags and intact shrinkfilms. The new fungicide, 2-aminobutane, was more effective as the carbonated form applied to the fruit cup as a dip than as the free amine used as a vapor-phase fungicide applied to the shrinkfilm trays. Diphenyl and 2-aminobutane were comparable as vapor-phase fungicides, but diphenyl was easier to use.

INTRODUCTION

Current trends in retail marketing of produce move steadily towards more and more consumer packaging (2, 14, 15). This tendency has been so marked that estimates of the proportion of citrus fruits sold at retail in consumer pack-

ages have risen from approximately 20% 5 years ago (15) to a recent estimate that approximately 88% of oranges, grapefruit, and lemons and 68% of tangerines were sold in prepackaged form last year (17). This tendency is encouraged, not only by the shortage of labor in the supermarkets, but also by studies showing that the use of consumer packages increases retail sales volume (1) and net returns (15) in the produce departments. Typical packages such as have been used in this study are shown in Figure 1.

This trend considerably complicates the marketing of decay-prone fruits as Florida citrus. It is no new observation that, because "reworking" of packages is uneconomic and at times impossible, the importance of decay losses is multiplied by the number of fruit in the package (4). It has been estimated that one-fifth of all fresh produce is lost in marketing, (13) and this proportion is apt to increase when intact consumer packages have to be discarded or sold at a loss because of 1 or more decayed fruit in the package.

Shipping point prepackaging of Florida citrus has been almost entirely confined to oranges and grapefruit in mesh and polyethylene bags, and considerable research has been done on the problems involved (3, 6, 7, 8, 9, 10, 11) "Poly" bags have been associated with increased decay ever since they were introduced for use with Florida citrus (3). Originally, these bags had as few as eight ¼-inch holes (11). Increasing the number of holes helps to reduce decay (9), but even after standardization on seventy-two

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