REDUCING COSTS OF PACKING MATURE-GREEN TOMATOES AT FLORIDA SHIPPING POINTS

Marketing Research Report No. 691

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
in cooperation with the
FLORIDA AGRICULTURAL EXPERIMENT STATIONS

PREFACE

The research on which this report is based was conducted under the supervision of Earl K. Bowman and Joseph F. Herrick, Jr., Transportation and Facilities Research Division.

Several Florida tomato packinghouses in Dade, St. Lucie, Collier, Hillsborough, and Manatee Counties made their plant facilities available for this study.

The findings of this study should be useful in other areas where mature-green tomatoes are packed, such as Texas, California, and Mexico.

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SUMMARY

Packinghouses handling mature-green tomatoes at an annual volume of 200,000 60-pound containers (or 300,000 40-pound containers) and operating approximately 500 hours per year can save up to $7,000 annually with minor changes in equipment on the packing line.

The labor and equipment costs for four systems of packing U.S. No. 1, U.S. No. 2, and U.S. No. 3 grades of mature-green tomatoes were compared. The three improved packing systems were designed to reduce the costs of packing tomatoes in 60-pound wirebound and in 40-pound fiberboard containers. The number of workers in the packing crew was reduced from 31 in the standard packing system to 17 or 18 in the best system.

The standard packing system, although not the exact layout of any one packinghouse, is representative of the industry practices in Florida. A few Florida packinghouses use some of the work methods described in the improved packing systems which require fewer workers.

The labor and equipment cost to pack the equivalent of 200,000 60-pound containers of tomatoes was reduced about $2,200 by relocating container checkweighing from each packing station to a single weighing station at the end of the packing line. An additional $3,600 could be saved by using drop-side bins at the slower packing stations, adding backstops at the faster open-spout packing stations, and relocating packing stations for the largest and smallest sizes of fruit to adjacent positions on the line. Two changes would make possible a further saving of $700 to $1,200: Installing chutes from the container makeup area to each packing station and 90-degree skate-wheel conveyors at the packing stations so that the packer could more easily transfer packed containers to the take-away conveyor.

Reducing Costs of Packing Mature-Green Tomatoes at Florida Shipping Points

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BACKGROUND

Most tomatoes packed and shipped from Florida packinghouses are in the mature-green stage.[1] Vine-ripened tomatoes make up only about 15 percent of the tomato shipments during a season.[2]

Five sizes and four grades of mature-green tomatoes are packed in Florida packinghouses. The smallest size is designated as 7 x 8 (minimum diameter 1⅞ inches). The other sizes in order of increasing size are 7 x 7, 6 x 7, 6 x 6, and 5 x 6 (minimum diameter $2\frac{11}{16}$ inches).

Tomato size designations had more meaning when, for many years, the lug box was the most popular package for long-distance shipment of green-wrap tomatoes. At that time the size of the tomatoes packed in Los Angeles-type lug boxes was designated by the number of rows of tomatoes running both ways in the top layer.[3] If the top layer was packed with five rows of tomatoes lengthwise and six rows crosswise, the size was designated as 5 x 6.

Of the four grades of mature-green tomatoes, only three grades will be packed at one time. Normally, these are: U.S. No. 1, U.S. No. 2, and U.S. No. 3. The fourth grade, designated as U.S. Combination, may be packed instead of U.S. No. 1 grade. U.S. Combination grade consists of a combination of U.S. No. 1 and U.S. No. 2 with at least 60 percent of the tomatoes by count meeting the grade requirements of U.S. No. 1 grade.[4]

A tomato packinghouse of average size employs about 90 workers during the tomato harvesting season.

A tomato packing plant has six major activities: Receiving, washing and waxing, grading, sizing, packing, and loading for shipment.

A study was made to determine the labor and equipment requirements and costs of the present system of packing mature-green tomatoes and to develop more efficient systems of packing. These systems were developed around work methods now in use in Florida packinghouses. For purposes of comparison in this report, a packinghouse packing an annual volume of 12 million pounds of mature-green tomatoes (200,000 60-pound boxes or 300,000 40-pound boxes) with a 31-man crew was taken as being representative of the present packing system.

When tomatoes were wrapped and place-packed into lug boxes, 48.3 percent of the total labor required to operate the packinghouse was assigned to packing.[5] In Florida, where mature-green tomatoes are now jumble-packed into wirebound boxes and fiberboard cartons, about 35 percent of the total packinghouse labor force is assigned to packing.

Labor requirements were also determined for other tasks which are related to packing, such as making up empty containers, transporting packed containers from the packing line, and loading containers in a railroad car or semitrailer. However, labor requirements for receiving, washing and waxing, grading, sizing, and loading for shipment were not included in the comparisons of the four packing systems.

[1] A mature-green tomato will not have developed any external color beyond the green stage but may range from greenish-white to dark green. The contents of two or more seed cavities will have developed a jellylike consistency and the seeds will be well developed and slightly hard. When the fruit is sliced with a sharp knife, the seeds will usually be pushed aside rather than cut.

[2] Compiled from annual reports of the Florida Tomato Committee.

[3] A Los Angeles-type lug box contained 34 pounds of place-packed tomatoes. The wooden box had inside dimensions 6⅝ x 13½ x 15⅞ inches.

[4] Agricultural Marketing Service. United States standards for grades of fresh tomatoes. U.S. Department of Agriculture, 12 pp., illus. Oct. 1961.

[5] Sorensen, H. B. Marketing Texas green-wrap tomatoes. Texas Agr. Expt. Sta. Bul. 861, 15 pp., illus. May 1957.

GENERAL LAYOUT OF A TYPICAL TOMATO PACKINGHOUSE

Each of the activities of a tomato packing plant directly follows the other in a continuous sequence and permits a straight-through type of plant layout (fig. 1). A plant with one main processing line is illustrated.

In the receiving area (1), usually located on one end of the packinghouse, field boxes of tomatoes are unloaded from farm trucks. Two-wheel clamp handtrucks transport four to five boxes per trip from the truck to temporary storage on the main floor (2). Other handtrucks transport field boxes to manual or machine dumpers (3). The boxes are emptied, the tomatoes washed (4), and presorted (5). The presorting table is a roller-conveyor which revolves the fruit as the tomatoes pass the sorters. Tomatoes which have started to change from green to pink color (pinks) are removed and sent directly to separate packing facilities (15).

From the presorting table, mature-green tomatoes are conveyed into the waxer (6) and onto another sorting table (7) where all fruit other than U.S. No. 1 grade are removed. U.S. No. 1 grade tomatoes continue to the sizing belts at the end of the sorting table (8). Sorters place the other grades of tomatoes, U.S. No. 2 and 3, on belt conveyors in the center of the sorting table. These tomatoes are conveyed to separate sections of the packing line, (16) and (17), for resorting, sizing, and packing.

Sizer-runout belt conveyors (9) carry sized U.S. No. 1 grade fruit to a distribution belt (10) divided into lanes to maintain size identity. Sized tomatoes are conveyed to the packing stations (11) set up alongside the distribution belt. At the packing stations, shear boards brush the tomatoes from the belt. The tomatoes roll down inclined filling spouts and fall into shipping containers. Workers at the packing stations obtain empty containers from an overhead chute which is attached to the frame of the distribution belt

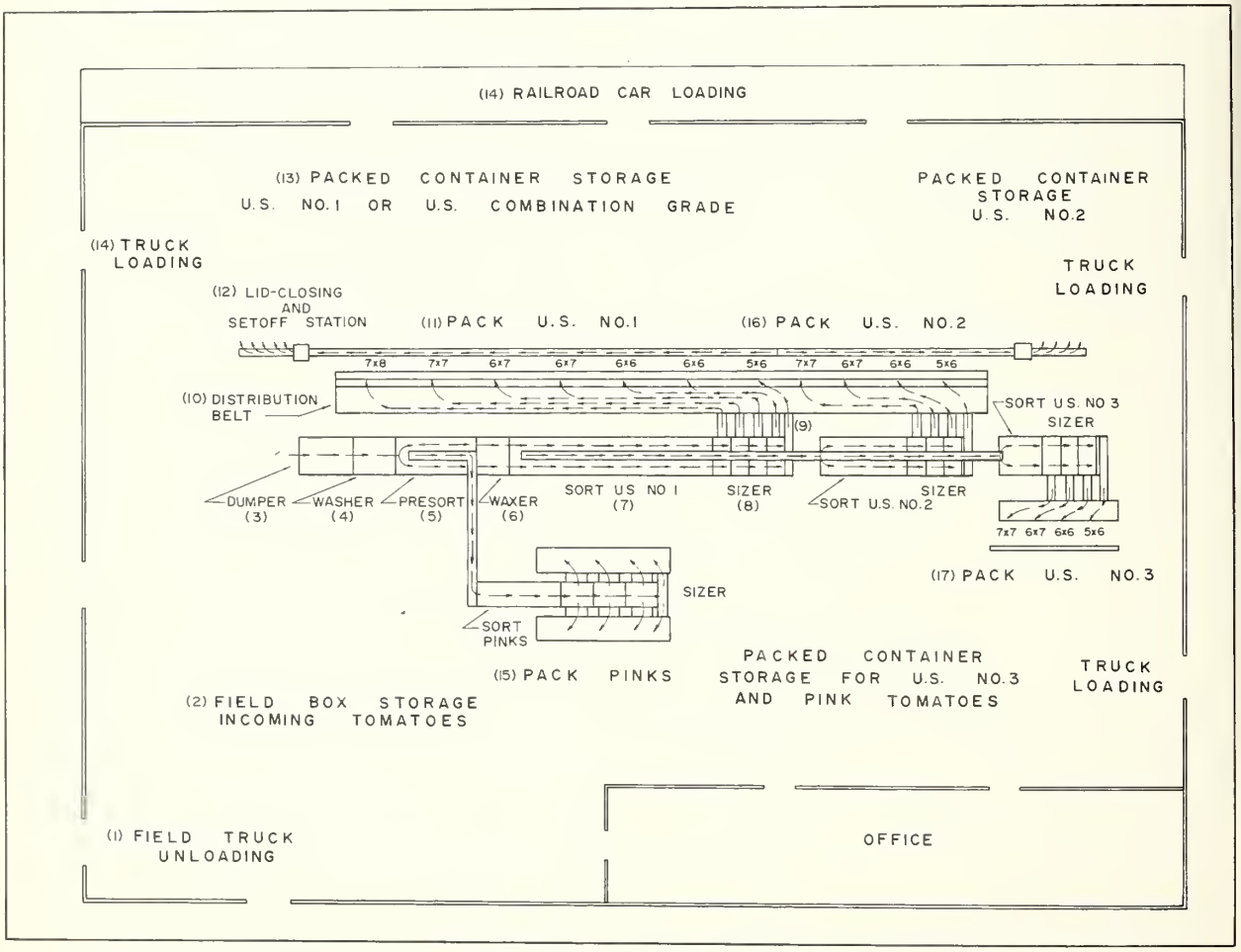

FIGURE 1.—General layout of a typical packinghouse with one processing line for mature-green tomatoes.

and runs parallel to all of the packing stations. These containers are prepared for packing and placed on conveyors leading under the filling spouts. Other workers fill the containers, weigh them, and place them on a belt or chain conveyor for transport to the lid-closing and setoff stations (12). Workers here close the lid on the containers (in some cases, containers are closed by machine), remove them from the conveyor, and stack them on the floor. Handtruck operators pick up the stacks of containers with handtrucks and transport them either to temporary storage on the packinghouse floor (13) or to a railroad car or semitrailer (14). Loaders inside the railroad car or semitrailer restack the containers for shipment.

TOMATO PACKING OPERATIONS

The rate of packing on the line varies with the size of the packed container, fruit maturity, condition of the crop, number of processing lines, number of graders or sorters per line, rate of dumping field boxes, and the handling capacity of machinery. Because only one size and grade of tomato is handled at each packing station and the amount of tomatoes reaching a station depends on the flow rate in that size and grade, the work load varies among stations.

Table 1 lists the average number of 60- and 40-pound containers packed per hour for each size and grade of fruit, based on a dumping rate of 500 field boxes per hour for one processing line. In packinghouses where two processing lines are used or where the dumping rate is more than 500 field boxes per hour, the packing rates given in table 1 should be increased accordingly.

As noted in the table, most Florida packinghouses withhold lower grades of smaller sizes of tomatoes from the market because they are least likely to return a profit. Size 7 x 8 in grades U.S. No. 2 and U.S. No. 3 has therefore been excluded from computations for the packing operation in this report. Crew sizes and labor and equipment requirements in this report are based on hourly packing rates of 481.5 60-pound or 722.4 40-pound containers.

Set Up and Mark Containers for Packing

Workers were assigned to several of the packing stations to assist the worker who filled containers. Their job was to obtain empty containers from an overhead chute, open the lid if one was attached, mark each end with size and grower identification numbers, and position the container on a skatewheel conveyor leading under the filling spout (fig. 2). Of the 31 workers on the standard packing line, 5 set up and marked containers for packing.

A long chute extended over all packing stations on the line. Workers in the container makeup loft inserted containers into the entry end of the chute and shoved them down until the entire length of the chute was full. Workers at the packing stations removed the containers from the chute and prepared them for packing.

The most common containers used, for which productive rates for handling were determined,

TABLE 1.—*Number of 60- and 40-pound containers packed for each grade and size of mature-green tomatoes at dumping rate of 500 field boxes per hour* [1]

Tomato size	60-pound containers packed with—			40-pound containers packed with—		
	U.S. No. 1 and Combination grade	U.S. No. 2 grade	U.S. No. 3 grade	U.S. No. 1 and Combination grade	U.S. No. 2 grade	U.S. No. 3 grade
	Boxes/hour	*Boxes/hour*	*Boxes/hour*	*Boxes/hour*	*Boxes/hour*	*Boxes/hour*
5 x 6	31. 1	4. 3	1. 8	46. 7	6. 4	2. 8
6 x 6	116. 1	40. 6	36. 8	174. 1	61. 0	55. 1
6 x 7	110. 6	38. 6	26. 4	165. 9	58. 0	39. 5
7 x 7	43. 1	13. 5	7. 7	64. 6	20. 3	11. 6
7 x 8	10. 9	[2]	[2]	16. 4	[3]	[3]
Total by grade	311. 8	97. 0	72. 7	467. 7	145. 7	109. 0
Total by container		481. 5			722. 4	

[1] Based on percentage of grade packed in each size of fruit, from annual reports of the Florida Tomato Committee.

[2] 1.1 boxes per hour. Normally not packed by most packinghouses because of low rate of return for profit. Not included in determining equipment and labor requirements for packing tomatoes in this report.

[3] 1.65 boxes per hour. Normally not packed by most packinghouses because of low rate of return for profit. Not included in determining equipment and labor requirements for packing tomatoes in this report.

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FIGURE 2.—Worker obtaining an empty container from the overhead chute. Box at lower right waits to be packed on the skate-wheel conveyor.

were the 60-pound wirebound box and the 40-pound fiberboard carton which had a separating divider and a removable lid. The wirebound box had a lid attached to the body of the box by girth wires; the lid was fastened by wire loops. Most wirebound boxes had prestitched cardboard liners to protect packed fruit from rubbing against the wood veneer; some boxes had separate, unattached liners, which were placed in the box by assembly workers in the container makeup loft. The fiberboard carton was formed by a worker and fastened with interlocking flaps of the container. A divider, inserted into the container by an assembly worker in the loft, separated the carton into two compartments. Lids were assembled separately by workers in the loft and sent directly to the lid closing station.

A worker at the packing line could set up and mark 175.4 60-pound wirebound boxes per hour. This rate of preparing containers to be packed is based on time studies which were made of workers handling wirebound boxes with a prestitched liner and with lids closed but not fastened. Time studies were analyzed to determine the rate at which a worker could work with normal effort if the level of packing activity was sufficient to require all his output.

The rate for a worker to set up and mark wirebound boxes was reduced to 162.2 per hour if workers in the container makeup loft had fastened the lid by one of the wire loops. Workers preparing boxes which had separate liners could set up and mark 163.9 boxes per hour. Wirebound boxes which had separate liners, with the lid fastened by a wire loop, were prepared for packing at the rate of 152.3 boxes per hour.

A worker could set up and mark 312.5 40-pound fiberboard containers per hour.

The empty container chutes were often too high for the worker to reach easily. The chute should be placed over the distribution belt as low as possible as shown in figure 2.

Pack Containers

Open-Spout Packing Station

The most common type of tomato packing station in Florida is equipped with what can be described as an open spout, which is an inclined board with sides. It is about 11 inches wide at the lower end, 17 inches wide at the upper end, and 15 inches long. It is attached to the frame of the distribution belt at the upper end (fig. 3).

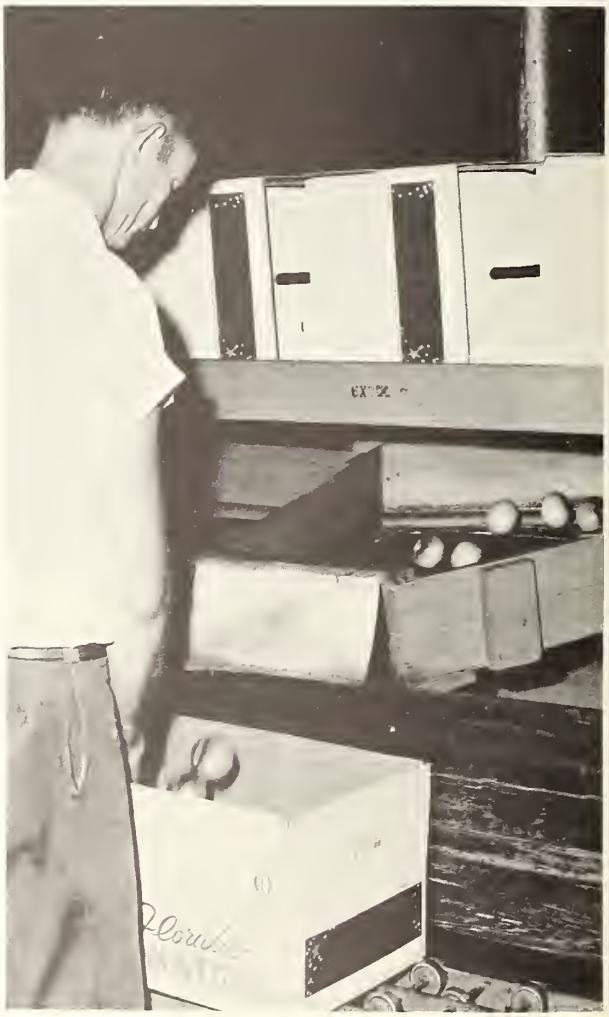

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FIGURE 3.—Worker filling a 40-pound container at an open-spout packing station.

A 48- or 60-inch-wide distribution belt transports sized fruit in lanes from the sizer to the packing station. At the packing station, shear boards placed at an angle to the direction of travel deflect the tomatoes from the distribution belt into the filling spout. The fruit rolls down the inclined spout and falls into the container. Empty containers rest on a skate-wheel conveyor beneath the filling spout.

In the standard packing system, 13 workers were assigned to filling containers: 1 for each packing station.

Workers pull containers under the filling spout and guide tomatoes into the box. Workers shove full containers aside on the skate-wheel conveyor and pull empty containers under the filling spout without interrupting the flow of fruit. Workers do not attempt to place-pack.

Workers assigned to the five faster packing stations (stations receiving the most fruit) focus their full attention on filling containers. Empty containers at these stations are prepared for packing by another worker. Workers assigned to slower packing stations obtain their own empty containers from the overhead chute and mark them on each end with size and grower numbers.

A worker with sufficient tomatoes and containers available at an open-spout packing station, working at a normal pace, could have filled 346.8 60-pound wirebound boxes, or 352.9 40-pound cartons per hour. When necessary, he can pack at a faster rate; containers are sometimes filled at faster rates and often at slower rates.

Drop-Side Bin Packing Station

Although the drop-side bin is not common, it has advantages for some installations where the flow of fruit is slow and the worker can be assigned more than one task, such as preparing containers for filling, filling other containers, weighing packed containers, or setting them on a take-away conveyor for transport to the lidding and setoff stations.

The drop-side bin is a small temporary holding bin and replaces the open spout of the previous packing method. It has high sides, an inclined bottom, and a gate in the front which can be raised or lowered. Tomatoes flow into the top of the bin from the distribution belt, roll down the inclined bottom, and pile up in the bin (fig. 4).

When the bin fills with tomatoes, the worker sets a container on the skate-wheel conveyor in front of the bin, steps on a foot pedal to lower the gate, and guides tomatoes into a jumbled arrangement in the container (fig. 5). When the bin is empty or when the container is full, the worker releases the foot pedal, the gate rises, and tomatoes again collect in the bin.

If a sufficient quantity of tomatoes were available, a worker could fill 93.8 wirebound boxes or 176.5 fiberboard containers per hour at a drop-side bin, if another worker helped by setting up and marking containers for packing. This rate includes time for the worker who fills the container to pick it up, make a 180-degree turn, and set it on a drag chain or belt take-away conveyor for transport to a checkweighing station at the end of the packing line.

A worker setting up, marking, filling, and setting packed containers on a take-away conveyor could handle 62 wirebound boxes or 115.8 fiberboard containers per hour. If he also weighed packed containers, 50.2 60-pound wirebound boxes or 91.7 40-pound fiberboard containers could be handled per hour.

One problem preventing more widespread use of the drop-side bin is the damage to the tomato which can be caused by raising and lowering the gate. The gate rubs against the tomatoes, and bruises the fruit. This could be reduced by a protective device such as a short flap of conveyor belting material attached to the bottom of the bin to separate tomatoes from the gate (fig. 4).

Automatic Machine

Automatic weigh-fill machines are now available and are being adopted by the tomato industry. They are equipped with container feeding mechanisms, a spout or feed belt, and a scale. These machines weigh boxes as the boxes are filling.

The machine positions an empty container under the tomato feed spout, and tomatoes flow into the container until a preset weight is reached. An arm or gate then blocks the path of the incoming tomatoes and the machine simultaneously ejects the full container from the machine, and positions an empty container for filling. Empty containers are delivered to each machine by separate chutes extending down to individual machines from the container makeup loft. Workers in the loft keep each chute full.

Most machines are equipped with a device to vibrate the carton to settle the fruit. At the optimum vibration rate, fruit will rotate upon its own axis and thus settle into layers.

One of the machines in use in Florida feeds cartons from left to right through the machine (fig. 6). Tomatoes are fed to the container via a spout. The cutoff arm, actuated by a solenoid mounted above, swings down into the path of tomatoes when the full container is ejected.

Another machine feeds cartons from the back to the front through the machine (fig. 7). Tomatoes are fed to the container by a feed belt. The cutoff gate, hidden in the photo, swings up to block the flow of tomatoes into the container until the full container is ejected and an empty container is in position for filling.

Automatic weigh-fill machines can handle from 1 to 10 containers per minute. Because of the operation of the machine and the method of feeding fruit, some containers will be overfilled and others will be underfilled. Usually 95 percent of the containers will be within 0.9 to 2.5 pounds of

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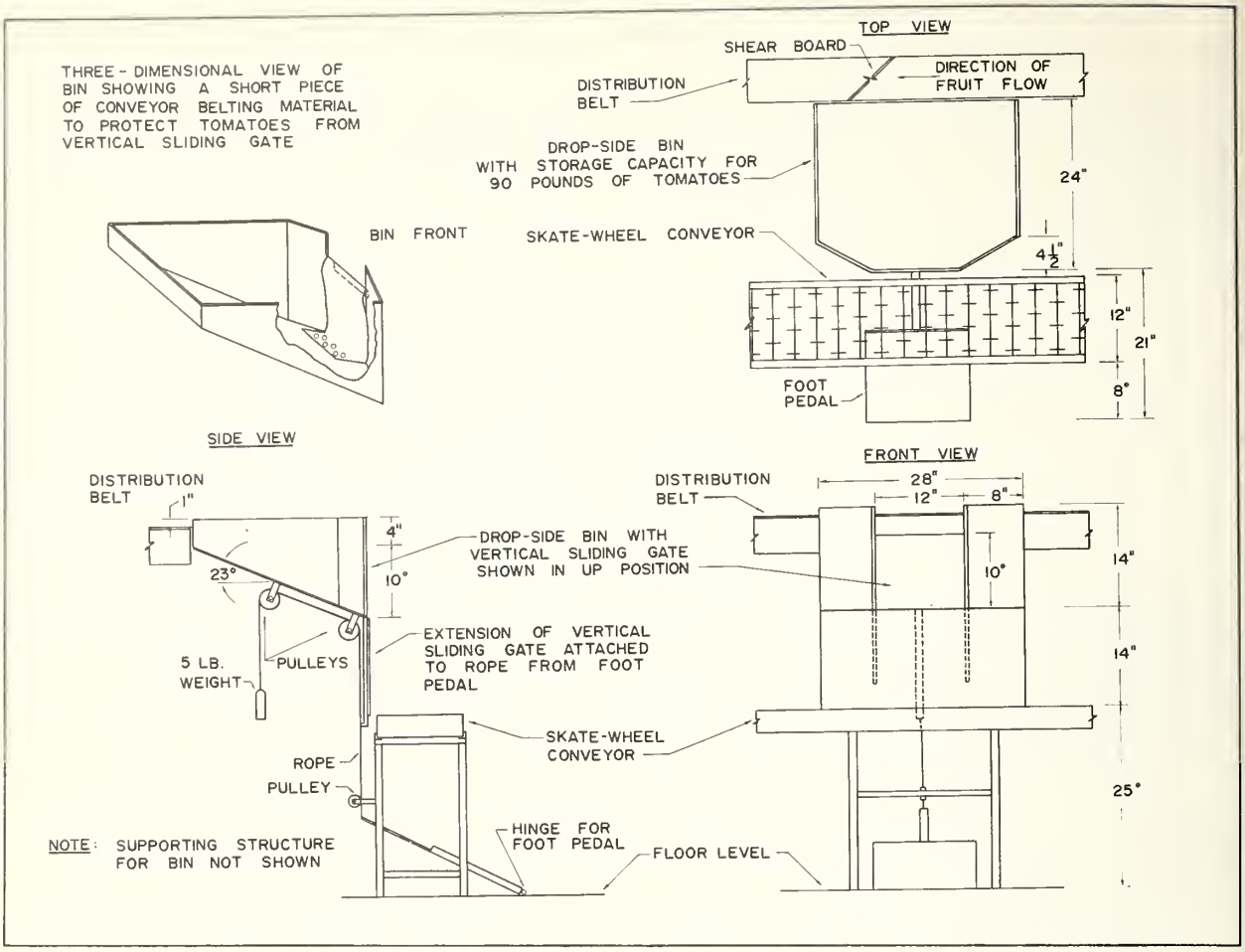

FIGURE 4.—Holding bin for packing tomatoes.

the desired weight, depending on the type of machine used and the rate of filling containers.

Although these machines are automatic, workers are usually assigned to each machine to ensure proper functioning. The worker must take immediate corrective action when an empty container fails to feed into filling position or if the tomato cutoff mechanism does not function properly.

Weigh Containers

After a container has been filled at the packing station, it is weighed and extra tomatoes are added or removed by a worker to adjust the weight of the packed container. The scales have a platform, a single beam, and an over and under weight dial with 1-pound range. Weights are added to the scale beam to indicate correct weight at either 40 or 60 pounds, plus an allowance for container weight and for expected fruit shrinkage in transit.

A short section of skate-wheel conveyor is attached to the top of the scale platform. The conveyor section is on the same level as the other wheel conveyors used on the packing line to transport packed containers.

Checkweigh Beside Packing Station

The most common arrangement in tomato packinghouses is to locate checkweigh stations beside each packing station. With this method, a checkweigher and a scale may be required at each station. Usually 7 workers on a 31-man packing line are assigned to checkweigh at 7 of the 13 packing stations. Workers who fill containers at the six slower packing stations checkweigh containers without additional help.

The scale and the packing station are arranged side by side. Filled containers are easily moved on a skate-wheel conveyor from the packing station to the checkweigh station. The worker pulls the container onto the scale, checks and adjusts the weight, levels the top layer of the fruit, and turns some of the fruit in the top layer blossom end up (fig. 8).

In most Florida packinghouses, the worker then picks up the container, makes a 180-degree turn,

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FIGURE 5.—Worker filling a container at a drop-side bin packing station.

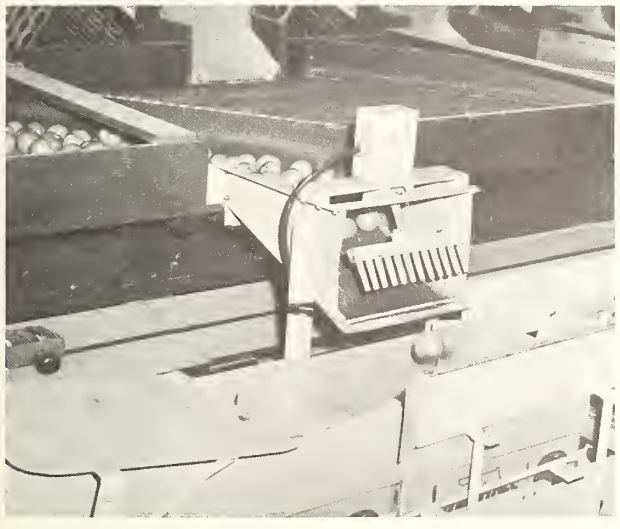

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FIGURE 6.—A machine for filling 40-pound cartons with tomatoes.

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FIGURE 7.—A machine for filling 40-pound cartons and 60-pound wirebound boxes with tomatoes.

and sets the container on a drag chain or belt take-away conveyor for delivery to the lid-closing station.

The rate at which a worker could check and adjust container weights when the weighing station was adjacent to the packing station was 188.1 60-pound wirebound boxes per hour or 326.1 40-pound cartons per hour, if the level of packing activity had been sufficient to utilize the full output of the worker.

Checkweigh at End of Packing Line

Checkweighing at the end of the line for each grade of fruit, instead of weighing at each packing station has advantages, although it is not commonly done. Three workers (1 for each grade of fruit packed) can do the work previously done by 7 workers on a 31-man packing line when checkweigh stations are located beside each packing station.

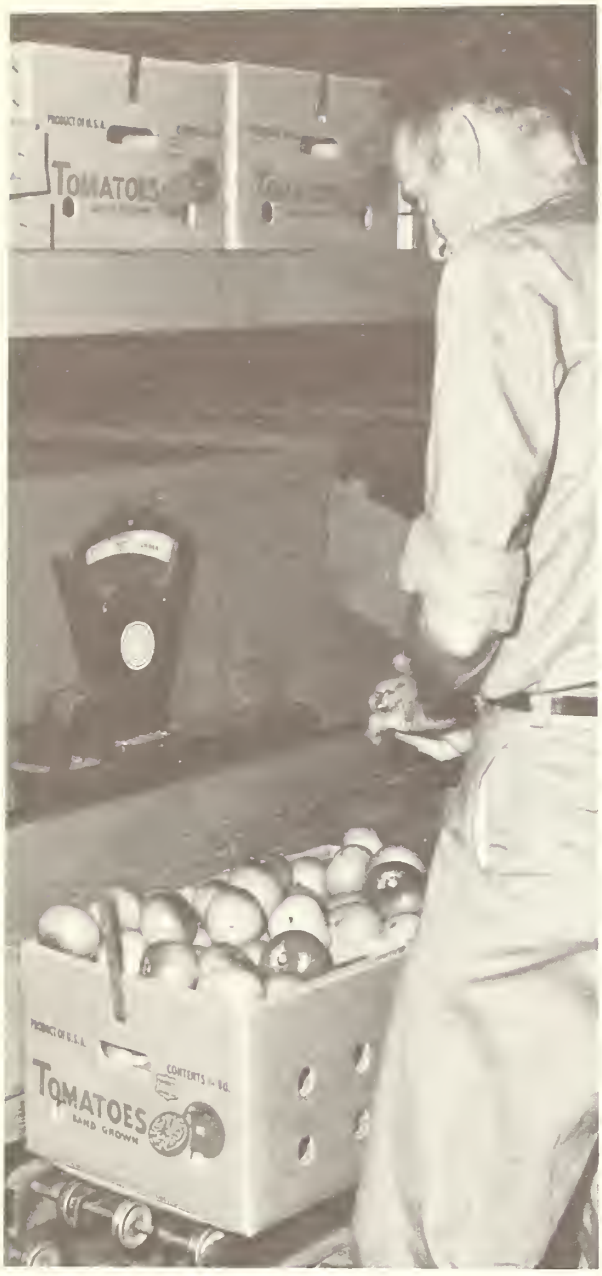

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FIGURE 8.—Worker checking weight of a packed container beside the packing station.

Workers at the packing stations set filled containers on the chain or belt take-away conveyor which transports the container to the checkweigh station. The worker at the checkweigh station pulls a filled container onto the scale, checks the weight, removes or adds tomatoes as required, and pushes the container aside on a wheel conveyor to the lid-closing station.

In order to get maximum production with this arrangement, it is important to place a 2- to 3-foot section of skate-wheel or roller conveyor between the scale platform and the drag chain or belt conveyor which delivers containers from the packing stations to the checkweigh station. This short section of conveyor serves to hold unchecked containers while the worker completes weighing the preceding container; this conveyor should be short to allow the worker to easily reach the next box.

A reserve supply of sized fruit should be arranged on each side of the worker adjacent to the conveyor. Sizes which are packed with the greatest frequency should be placed closer to the scale. If, as is usually done, the reserve supply is kept in partially packed containers, the containers should be placed on inclined stands at a height which will permit the worker to obtain fruit with the least time and effort. The suggested layout and dimensions are shown in figure 9.

A worker checkweighing containers at the end of the packing line could handle 333.3 60-pound boxes or 379.7 40-pound fiberboard containers per hour, a rate of packing activity that utilizes the full output of the worker.

Lid Containers

Filled containers are transported by conveyor from the weighing station to the lidding station at the end of the packing line. Here, workers or machines, depending on the type of box being packed, close the lids on the packed containers. Containers with closed lids are then transported by another conveyor to the setoff station.

The two most commonly packed containers are the 60-pound capacity wirebound veneer crate and the 40-pound capacity fiberboard carton. The carton has interlocking flaps to fasten the container, a divider, and a separate lid. Other containers which are also packed are the 40-pound wirebound box, the 40-pound wirebound box with corrugated end panels and lid, the 40-pound nailed carton (corrugated body nailed onto wooden end frames), and the two-piece full-telescope or the two-piece partial-telescope (5-inch lid) 40-pound carton.

Wirebound Boxes

Lids of wirebound boxes are attached to the body of the box by four girth wires. Loops, formed by the manufacturer on both ends of the girth wires, are engaged to close and fasten the lid. Wirebound boxes can be closed manually with a closing hammer. However, semiautomatic or automatic machines for closing wirebound boxes are in general use in Florida tomato packinghouses.

The most common machine for closing wirebound boxes is the semiautomatic type, which is partly mechanical and partly worker operated. On a standard packing line of 31 workers, 3 workers are generally assigned to 2 of these ma-

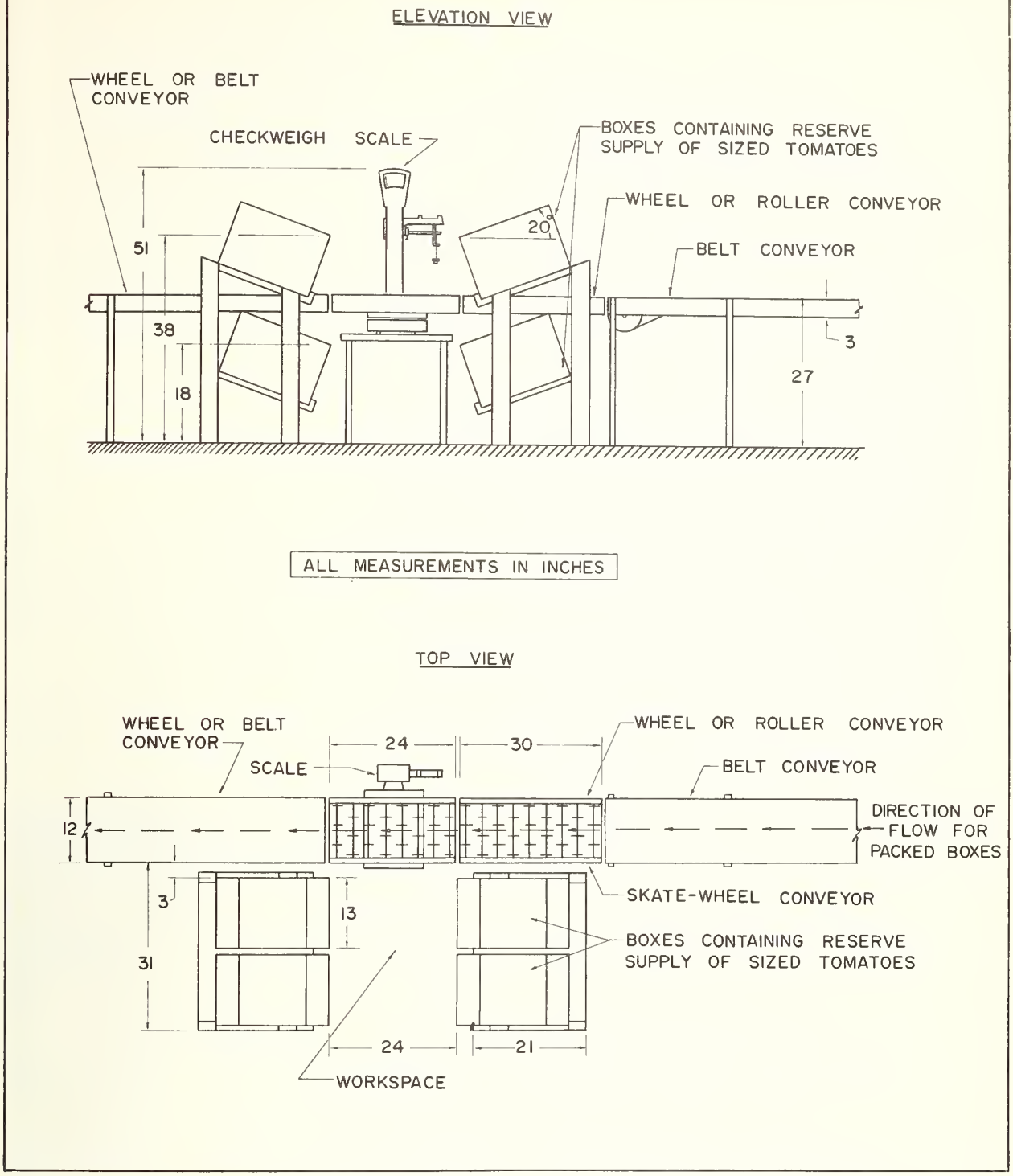

FIGURE 9.—Workplace layout for checking and adjusting weight of tomato containers at end of packing line.

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chines to close lids for the U.S. No. 1 and U.S. No. 2 grades of tomatoes.

The worker pulls a packed box into the machine and partly closes the lid manually. The worker then steps on a foot pedal to operate the machine lid press which completely closes the lid. Wire lid loops are engaged manually, if necessary, then the worker pulls the wire bending device of the machine down to bend the loops of the girth wires on the box to fasten the lid. The machine ejects the box when the worker releases the lid press.

One worker could close up to 303 boxes per hour with a machine of this type. This rate includes time the worker must spend in manually straightening and engaging the wire loops and in positioning the ventilated cardboard liner to protect the tomatoes where the lid and the side of the container are fastened. If a second worker assists by straightening bent wire loops and positioning the cardboard liner, the rate of closing boxes for the crew would be increased to 465.1 per hour.

Machines for automatically closing wirebound boxes are used in some tomato packinghouses. These machines automatically close lids and fasten wire loops. One or two workers are usually assigned to the machine to straighten wire loops and to position the ventilated cardboard liner to protect tomatoes at the junction of the lid and the side of the container.

The automatic machine can close 950 to 1,150 boxes per hour at maximum output. With this potential rate of closing boxes, a single machine could close the output of both the U.S. No. 1 and the U.S. No. 2 grade packing lines.

Separate-Lid Wirebound Boxes

The wirebound box with corrugated end panels is closed by a separate lid. A worker places the lid over the box and attaches it by bending short flaps on the lid to engage a cleat of the wood frame on the end panel of the box.

Separate-Lid Cartons

The most common 40-pound container in Florida, the interlocking parts carton with separating divider, is closed with a separate lid which is placed on the carton by the worker. The worker presses the lid down on each end to lock mating flaps of the fiberboard lid and the body of the carton. The method of engaging the lid on the carton is slightly different than the method of fastening the lid on the wirebound box with corrugated end panels.

On a standard packing line of 31 workers, 4 workers are generally assigned to close lids. However, only three workers are needed: One for each grade packed.

One worker could close 612.2 cartons per hour with a lid which locks to the carton with mating flaps, if the cartons had been packed at that rate on the packing line.

Nailed Cartons

The nailed carton has corrugated body and end panels that are nailed to wood; the lid consists of two flaps and is closed with a pneumatic staple gun. A worker staples the corners of both lid flaps into the wood frame of the end panels. He folds the lid flaps with one hand and operates the staple gun with the other hand.

One worker could close 845.1 cartons per hour with a single-head pneumatic staple gun if the cartons had been available. Two workers, each closing one half of the lid, could close 1,333.3 cartons per hour (fig. 10).

Two-Piece Full-Telescope Cartons

Two-piece full-telescope fiberboard cartons are closed by automatic glue-seal machines (fig. 11). The machine applies glue to the top and bottom flaps of the carton with rollers turning in a pot of glue or with pneumatically operated nozzles which deposit a thin strip of glue on the flaps. Flaps of the carton are closed by the machine, and the container is ejected into a belt-conveyor compression unit until the glue has set. Most models of glue sealers will handle 1,150 to 1,400 cartons per hour.

A worker may be assigned full time or part time to supervise operation of the machine, overcome machine stoppages, and refill the three glue pots.

Set Off Containers

When the containers have been closed, they are transported by skate-wheel conveyor from the lidding station to the adjacent setoff station.

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FIGURE 10.—Two-man crew closing nailed carton with pneumatic staple guns.

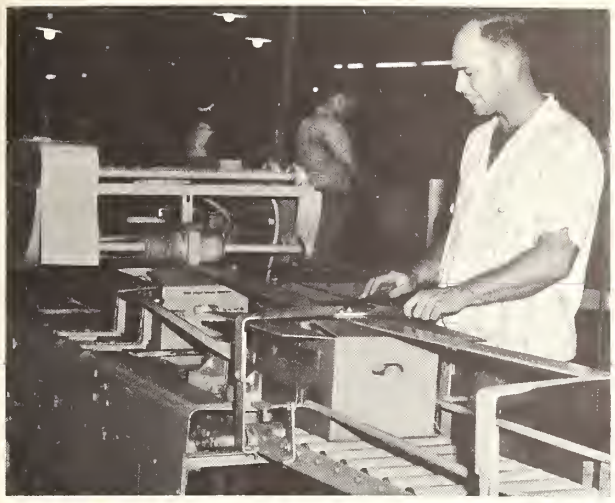

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FIGURE 11.—Glue-seat machine for full-telescope cartons.

Workers assigned to the setoff station pick up the containers and set them on 4- or 5-high stacks on the floor for further handling by handtrucks (fig. 12).

Packed containers must be segregated by the worker at the setoff station according to fruit size, grade, and container type. For example, a carton of 6 x 6 tomatoes is placed in a different stack than a carton of 5 x 6 tomatoes or a wire-bound box of 6 x 6 tomatoes of the same or different grade.

Two workers on a 31-man packing line are assigned to setoff operations. One worker is assigned to the U.S. No. 1 line and one worker to the U.S. No. 2 packing line. The lid closer on the U.S. No. 3 line, in addition to closing lids on the containers, has time to set containers on floor stacks for handtruck pickup.

One worker could set 740.7 60-pound boxes or 845.1 40-pound cartons per hour on 3 stacks for handtruck pickup, if the level of packing activity had been sufficient to utilize the full capability of the worker. One worker assigned to set off and stack the entire output of U.S. No. 1 or Combination grade could make 5 stacks at the rate of 666.7 60-pound or 750 40-pound containers per hour if the containers were available. This rate includes the time required for the worker to walk to the setoff points of the five stacks.

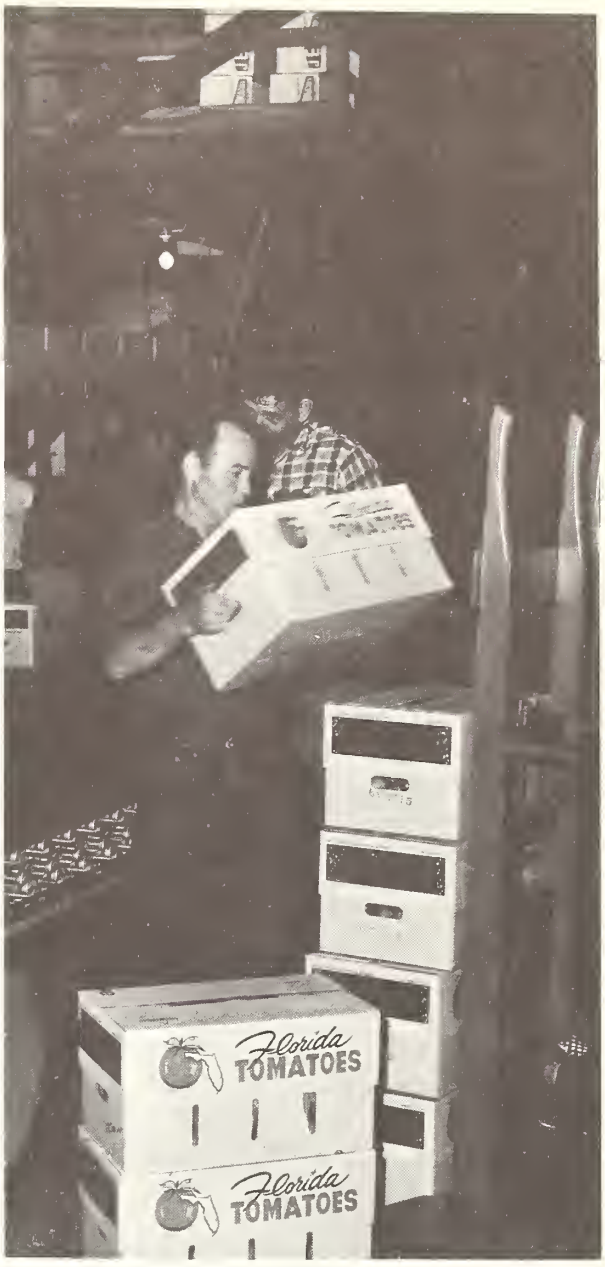

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FIGURE 12.—Worker stacking fiberboard containers. A two-wheel clamp handtruck is shown in position to pick up the stack.

COMBINATIONS OF WORK METHODS AND COSTS FOR PACKING

In this section of the report, combinations of work methods and crew sizes are outlined. The packing crew, for purposes of comparison, includes workers to set up and mark, fill, weigh, lid, and set off containers. Other workers assigned to the packing line to make up containers, transport with 2-wheel handtrucks, and load packed containers in railroad cars are not included.

Other assumptions which have been made to compare combinations of work methods and crew sizes are: A dumping rate on the packing line of 500 field boxes per hour; a total packing rate for the three packing lines (a separate packing line for each grade) of 481.5 60-pound containers per hour, or if packing 40-pound containers, 722.4 per hour; 5 sizes packed in U.S. No. 1 grade and 4

sizes packed in U.S. No. 2 and No. 3 grade (size 7 x 8 omitted).

The 60-pound container used in the comparison is a wirebound veneer crate, and the 40-pound container is the interlocking parts carton with divider and separate lid. The semiautomatic box-closing machine was used for closing the wirebound box. One machine is installed for the U.S. No. 1 grade packing line and one machine for the U.S. No. 2 grade packing line. On the U.S. No. 3 grade line, lids of wirebound boxes are closed manually by a worker with a special closing hammer.[6] No mechanical equipment is needed to close the carton with the separate lid.

Another assumption has been made at the setoff and lid-closing stations on the U.S. No. 2 packing line. At the packing rate used to determine labor requirements and with the workplace layouts used, the work could be combined with one worker doing both jobs. However, the extra worker has been included in the labor tables since this is the worker assignment normally found in tomato packinghouses.

In most packinghouses, there were periods of time during which the packing crew was required to wait for fruit. Since this condition varied in every packinghouse, man-hour requirements are based on an uninterrupted flow of tomatoes to the packing line.

Labor is divided into two classes: Productive and unproductive. Productive labor is the time, plus certain allowances, required by a qualified and properly trained person working at a normal pace to do the task. Unproductive labor is the time during which the worker is unavoidably delayed in his work and may be caused by (1) an unbalanced workload within the packing crew, (2) crew interference when workers get in the way of each other, (3) machine-regulated wait time, when a machine with a full-time attendant does not provide sufficient productive work to keep the attendant fully occupied, or (4) job-regulated wait time resulting from irregular flow of work.

Industrial engineering techniques, including time and motion studies, were used to determine labor requirements. For the time study, the operation was divided into small elements, and each of the elements was timed with a stopwatch. The observed time for a worker to do each element of work was adjusted by a rating factor to a base time which was equal to what a qualified worker, working at a normal pace, could easily do in the specified time. The rating factor, or leveling factor as it is sometimes called, was based on the skill of the operator and the effort or speed of movement used by the operator.

Personal and fatigue allowances were added to the base time to obtain productive time. The allowance for personal time was 5 percent of the base time or 3 minutes for each hour of work. Fatigue allowances used in this report were from 5 to 20 percent of the base time for the different work elements. The higher percentages were used for work which required more physical effort and increased worker fatigue.

[6] The closing hammer is a manually operated tool commonly called a "rocker arm." It is a hinged arm with a handle on one end and a hook on the other end. With this tool a worker can engage two wire loops, pull them tight, and bend them to close the lid on the box.

System No. 1—31-Man Crew

The equipment arrangement and worker assignments as represented in figure 13 are in most common use in Florida for packing U.S. No. 1 or U.S. Combination, U.S. No. 2, and U.S. No. 3 grades of mature-green tomatoes. The complete layout of a packinghouse is described in an earlier section of the report entitled "General Layout of a Typical Tomato Packinghouse." To show more clearly recommended changes in worker assignments and workplaces in the following drawings, the packing line is divided into three sections, one for each grade of fruit packed.

Tomatoes are sized in Florida packinghouses on perforated belt sizers. The sizer conveys unsized fruit over a series of perforated belts, each with increasingly larger holes. Smaller fruit pass through the holes of the first perforated belt and larger fruit are conveyed to the next belt where they in turn have a chance to pass through a larger hole in a perforated belt. A sizer separating tomatoes into five sizes has four perforated belts (the fifth or largest size is composed of the fruit which is too large to pass through the holes of the four perforated belts). Twelve-inch-wide conveyor belts, generally referred to as sizer runout belts, pass under the perforated belt to catch and transport the sized fruit to the distribution belt.

The distribution belt, which may be 48- to 60-inches wide and from 70- to 125-feet in length, is separated into lanes by wood or metal dividers attached to the supporting frame of the conveyor. The belt of the conveyor runs underneath the stationary dividers. The distribution belt transports sized tomatoes to the packing stations along the length of the belt. The largest size (5 x 6) is generally packed closest to the sizing equipment, and the smallest size (7 x 7 or 7 x 8) is packed near the end of the distribution belt.

Different sections of the same distribution belt are generally used to pack grade U.S. No. 1 and U.S. No. 2 fruit. The U.S. No. 3 grade fruit is commonly packed in another section of the packinghouse on a smaller distribution belt.

Empty containers are delivered to the packing stations by a long overhead chute extending over the U.S. No. 1 and the U.S. No. 2 packing line. A separate chute is used over the U.S. No. 3 packing line. The chutes are located over the distribution belt within reach of the workers at the packing stations. They are not shown in the drawings of the packing lines but can be seen in the photos of the packing and checkweighing stations.

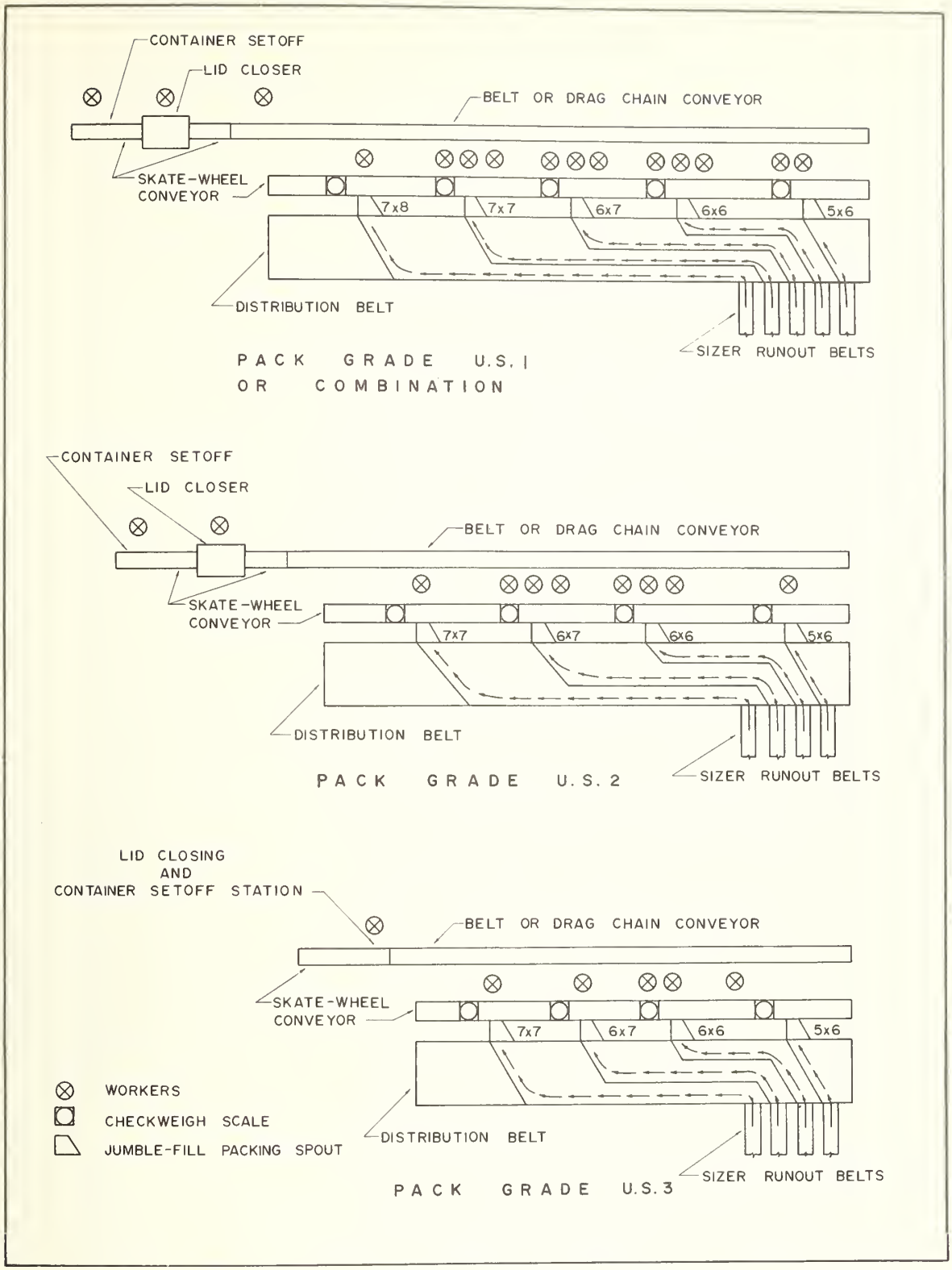

FIGURE 13.—Worker assignments and equipment arrangement for standard packing line for U.S. No. 1 or U.S. Combination, U.S. No. 2, and U.S. No. 3 grades of mature-green tomatoes.

A chain conveyor running the length of the packing line transports containers from the packing stations to the lidding station. At the lidding station, 40-pound fiberboard containers are closed by separate lids, and 60-pound wirebound boxes are closed by semiautomatic box closers.

The packing stations most commonly used are the open-spout type. A worker is assigned to fill containers at each of the 13 packing stations on the standard packing line. Checkweigh scales are located beside each packing station. Seven workers are assigned to weigh containers and set packed containers on the take-away conveyor. At each of the other six packing stations, the worker assigned to fill containers at that packing station checkweighs and sets containers on the take-away conveyor. The stations to which the seven checkweighers are assigned are: 5 x 6, 6 x 6, 6 x 7, and 7 x 7 sizes on the U.S. No. 1 line; 6 x 6 and 6 x 7 sizes on the U.S. No. 2 line; and the 6 x 6 size on the U.S. No. 3 line.

Five workers are assigned to packing stations to assist the worker who fills containers by setting up and marking boxes to be packed on the U.S. No. 1 and No. 2 lines; three are on the U.S. No. 1 line at the 6 x 6, 6 x 7, and 7 x 7 size packing stations, and two are on the U.S. No. 2 line at the 6 x 7 and 7 x 7 size packing stations. On the U.S. No. 3 line, the worker at the 5 x 6 station sets up containers for the 6 x 6 station as well as handling all work for the size 5 x 6 packing station; the checkweigher at the 6 x 6 station checkweighs containers for the 6 x 6 station and sets up containers for packing for the 6 x 7 station. At the remaining six packing stations, the worker who fills containers also sets them up for packing. These packing stations handle a relatively small amount of fruit and the workers have sufficient time to do more than one job.

Two workers are assigned to lid-closing for U.S. No. 1 line and one worker to setting off containers. For the U.S. No. 2 line, one worker closes lids and one sets off containers; and for U.S. No. 3, one worker does both tasks. One of the workers closing lids for the U.S. No. 1 line can be assigned to other duties when the 40-pound containers are packed, but two workers are necessary to keep up with the packing line output when wirebound boxes are packed.

The labor required and the elapsed time for packing 1,000 60-pound and 40-pound containers with this arrangement are shown in table 2. The

TABLE 2.—*Labor required for a 31-man crew to pack 1,000 60-pound wirebound containers or 1,000 40-pound fiberboard containers with three grades of mature-green tomatoes on a standard packing line, as shown in figure 13*

[Dumping rate, 500 field boxes per hour. Elapsed time for packing 1,000 containers: 60-pound containers, 2.077 hours; 40-pound containers, 1.384 hours]

Grade of tomatoes and time item	Workers	60-pound wirebound containers [1]			40-pound fiberboard containers [2]		
		Productive labor	Unproductive labor	Total labor	Productive labor	Unproductive labor	Total labor
U.S. No. 1 or U.S. Combination grade:	*Number*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*
Set up containers	3	3.195	3.036	----------	1.792	2.360	----------
Fill containers	5	2.483	7.902	----------	2.184	4.736	----------
Check and adjust weight	4	3.325	4.983	----------	1.915	3.621	----------
Lid containers	2	2.137	2.017	----------	1.057	1.711	----------
Set off on stacks	1	.971	1.106	----------	.863	.521	----------
Total	15	12.111	19.044	31.155	7.811	12.949	20.760
U.S. No. 2 grade:							
Set up containers	2	0.938	3.216	----------	0.527	2.241	----------
Fill containers	4	.988	7.320	----------	.803	4.733	----------
Check and adjust weight	2	.876	3.278	----------	.505	2.263	----------
Lid containers	1	.665	1.412	----------	.329	1.055	----------
Set off on stacks	1	.302	1.775	----------	.269	1.115	----------
Total	10	3.769	17.001	20.770	2.433	11.407	13.840
U.S. No. 3 grade:							
Set up and fill containers	4	1.380	6.928	----------	0.946	4.590	----------
Check and adjust weight	1	.720	1.357	----------	.409	.975	----------
Lid containers and set off on stacks	1	1.080	.997	----------	.447	.937	----------
Total	6	3.180	9.282	12.462	1.802	6.502	8.304
Total, all grades	31	19.060	45.327	64.387	12.046	30.858	42.904

[1] Based on hourly line output of 481.5 containers: 311.8 for U.S. No. 1 or U.S. Combination, 97.0 for U.S. No. 2, and 72.7 for U.S. No. 3 grade.

[2] Based on hourly line output of 722.4 containers: 467.7 for U.S. No. 1 or U.S. Combination, 145.7 for U.S. No. 2, and 109.0 for U.S. No. 3 grade.

packing rates are based on dumping 500 field boxes per hour on the line for grading, sizing, and packing.

Of the 64.387 or 42.904 man-hours for a crew to pack 1,000 containers of 60- and 40-pound containers, respectively, only about 29 percent of the labor for the crew is productive labor.

System No. 2—27-Man Crew

For this system of packing, container checkweighing is moved from each of the packing stations for U.S. No. 1 and U.S. No. 2 grades to the end of the line as shown in figure 14. The total crew for the three packing lines is reduced by four workers (table 3).

The sizer runout belt, distribution belt, and packing stations remain unchanged from the standard packing line. The only equipment change needed is to locate at the end of the packing line a checkweigh scale and a stand to hold a reserve supply of sized fruit for adjustment of packed container weights (see fig. 9).

At the main checkweighing station, containers are pushed onto a short elevating belt conveyor (fig. 15) which discharges them onto a sloping 180-degree skate-wheel conveyor utilizing gravity flow to deliver the containers to the lid-closing station.

One worker, checkweighing at the end of a packing line, can weigh and adjust 333.3 60-pound or 379.7 40-pound containers per hour. On the U.S. No. 1 line, 2 workers are necessary to checkweigh the output of 467.7 40-pound containers per hour. No additional worker need be assigned to the end of the packing line, however, because one of the two workers who closes lids (fig. 14) can be reassigned to checkweighing when 40-pound containers are packed.

To best utilize the efforts of the second weigher, part of the line output must be diverted from the main checkweighing station. This can be accomplished with a minimum change in equipment by turning the line 180 degrees and situating the second worker between the two sections.

TABLE 3.—*Labor required for a 27-man crew to pack 1,000 60-pound wirebound containers or 1,000 40-pound fiberboard containers with three grades of mature-green tomatoes, when checkweighing was centralized as shown in figure 14*

[Dumping rate, 500 field boxes per hour. Elapsed time for packing 1,000 containers: 60-pound containers, 2.077 hours; 40-pound containers, 1.384 hours]

Grade of tomatoes and time item	60-pound wirebound containers [1]				40-pound fiberboard containers [2]			
	Workers	Productive labor	Unproductive labor	Total labor	Workers	Productive labor	Unproductive labor	Total labor
U.S. No. 1 or U.S. Combination grade:	*Number*	*Man-hours*	*Man-hours*	*Man-hours*	*Number*	*Man-hours*	*Man-hours*	*Man-hours*
Set up containers	3	3. 195	3. 036		3	1. 792	2. 360	
Fill containers	5	4. 046	6. 339		5	3. 148	3. 772	
Check and adjust weight	1	1. 943	. 134		2	1. 774	. 994	
Lid containers	2	2. 137	2. 017		1	1. 057	. 327	
Set off on stacks	1	. 971	1. 106		1	. 863	. 521	
Total	12	12. 292	12. 632	24. 924	12	8. 634	7. 974	16. 608
U.S. No. 2 grade:								
Set up containers	2	0. 938	3. 216		2	0. 527	2. 241	
Fill containers	4	1. 314	6. 994		4	1. 012	4. 524	
Check and adjust weight	1	. 604	1. 473		1	. 531	. 853	
Lid containers	1	. 665	1. 412		1	. 329	1. 055	
Set off on stacks	1	. 302	1. 775		1	. 269	1. 115	
Total	9	3. 823	14. 870	18. 693	9	2. 668	9. 788	12. 456
U.S. No. 3 grade:								
Set up and fill containers	4	1. 400	6. 908		4	0. 971	4. 565	
Check and adjust weight	1	. 699	1. 378		1	. 402	. 982	
Lid containers and set off on stacks	1	1. 080	. 997		1	. 447	. 937	
Total	6	3. 179	9. 283	12. 462	6	1. 820	6. 484	8. 304
Total, all grades	27	19. 294	36. 785	56. 079	27	13. 122	24. 246	37. 368

[1] Based on hourly line output of 481.5 containers: 311.8 for U.S. No. 1 or U.S. Combination; 97.0 for U.S. No. 2; and 72.7 for U.S. No. 3 grade.

[2] Based on hourly line output of 722.4 containers: 467.7 for U.S. No. 1 or U.S. Combination; 145.7 for U.S. No. 2; and 109.0 for U.S. No. 3 grade.

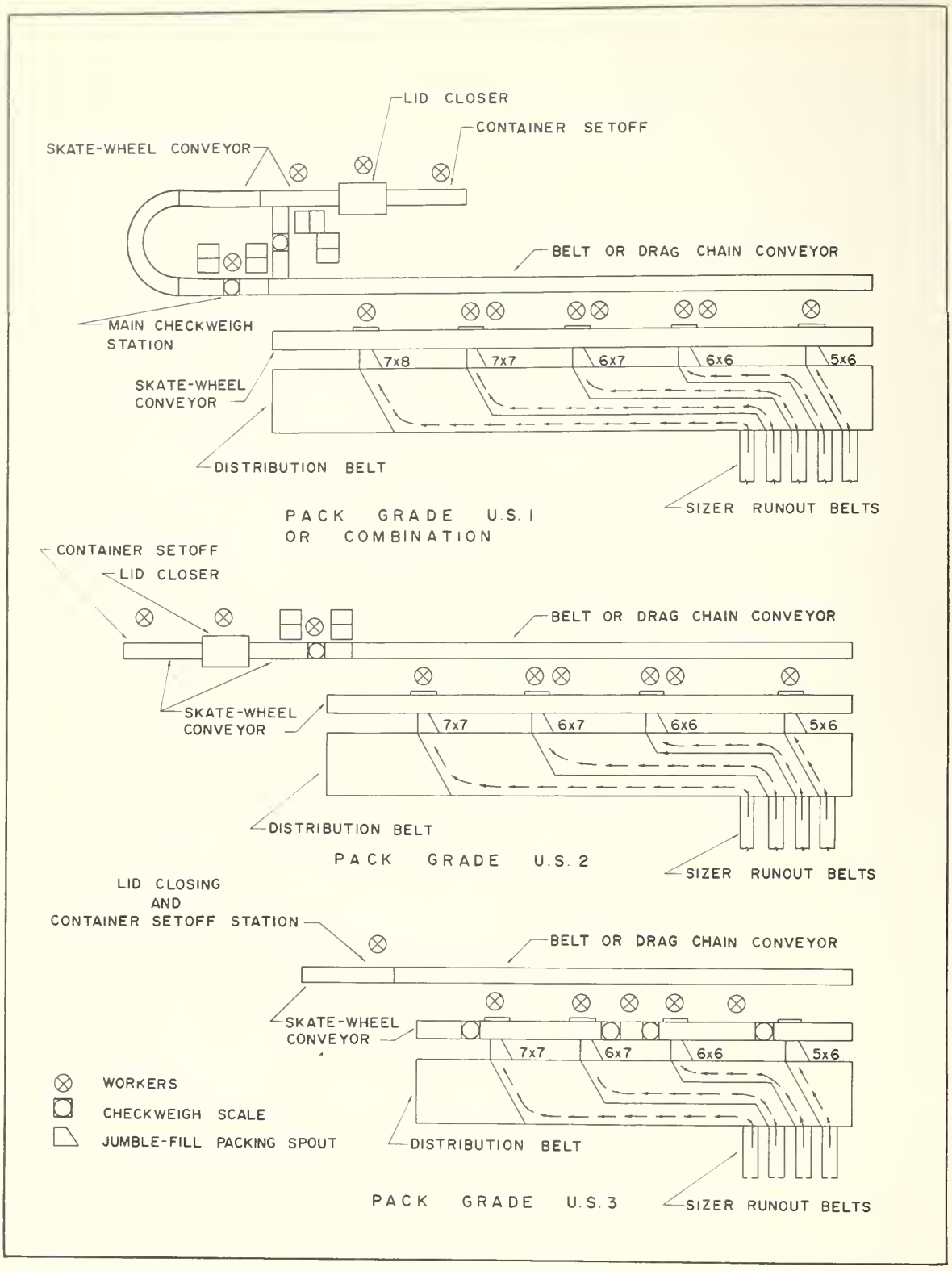

FIGURE 14.—Worker assignments and equipment arrangement to pack three grades of mature-green tomatoes on a standard packing line when checkweighing was centralized.

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FIGURE 15.—Worker checking and adjusting container weights at the end of the packing line. The elevating belt conveyor and the reserve supply of sized tomatoes are in the foreground.

The workplace of the second weigher, in addition to a scale and a reserve supply of sized fruit, includes two short sections of wheel conveyor connecting the belt or drag chain conveyor and the wheel conveyor at the lid-closing station. The worker pulls a container off the main line, checks and adjusts the weight, and pushes the container toward the lid-closing station. Containers which are not pulled off the main line by the second weigher are weighed at the main checkweighing station.

Other systems, which are in use and do not require turning the line 180 degrees, divide the output of the line so each worker weighs half of the line output.

Checkweigh operators, when assigned to the packing stations, were also assigned the task of picking up and setting containers on a drag-chain or belt take-away conveyor for transportation to the lid-closing station. When the weigher is moved away from the packing station, the task of setting packed containers on the take-away conveyor must be assumed by another worker. This job can be done by the worker who fills containers at the slow packing stations with little difficulty. At the faster packing stations, however, some device is required to prevent tomatoes from tumbling down the open spout and bouncing onto the floor while the worker is setting packed containers on the take-away conveyor.

From time study of the work elements, it takes a worker 0.156 minute or 0.096 minute, respectively, to pick up a 60-pound or a 40-pound container and set it on a belt or chain conveyor behind him. Approximately one-fourth of the container will be filled at the 6 x 6 or 6 x 7 U.S. No. 1 grade station while the worker is away from his filling position. A piece of canvas attached to the end of the open spout (fig. 3) or a backstop as shown in figure 16 can be used to help prevent fruit from falling onto the floor.

The backstop should be attached to the outside edge of the wheel conveyor on which containers are packed. It should be directly in line with the spout and close to the container. Fruit which

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FIGURE 16.—Worker filling containers at an open-spout with a backstop (below worker's right hand).

might tumble over the outside edge of the box will be deflected into the container by the backstop.

To more evenly divide the work on the U.S. No. 3 line, the checkweigh operator can be assigned to check the container weights for both the 6 x 6 and 6 x 7 size packing stations. In the standard arrangement, he was assigned to weighing 6 x 6 size and also setting up containers to be packed at the 6 x 7 packing station.

With this change, the work assignments on the U.S. No. 3 line are: One worker at the 5 x 6 station sets up containers for packing at the 6 x 6 station and handles all the work for size 5 x 6; one worker at the 6 x 6 station fills containers; one worker checkweighs containers filled at the 6 x 6 and at the 6 x 7 packing stations; one worker sets up containers for packing and fills them at the 6 x 7 station; and one worker handles all the work at the 7 x 7 station.

System No. 3—20-Man Crew

This system of packing was designed to further improve the previous system in which checkweighers on the U.S. No. 1 and U.S. No. 2 grade lines were moved to the end of the packing line. Eight open-spout packing stations on the three lines are replaced by drop-side bin packing stations and the conveyors delivering fruit from the sizers to the packing stations are changed to locate in adjacent positions the packing stations for the largest and smallest size fruit packed on each line.

The packing crew for the three grades is reduced by 7 workers, compared to the previous system, and by 11 workers, compared to packing system No. 1, the standard packing line. About 49 percent of the labor for the three crews is productive labor (table 4). Packing system No. 1 (31-man crew) had 29 percent productive labor.

Productivity for workers at low-output packing stations was improved by substitution of drop-side bins at eight packing stations on the three lines. The drop-side bins, serving as temporary storage bins for fruit, permit the worker to be assigned more than one job, such as set up containers for filling, fill container, checkweigh, and set packed container on a chain or belt take-away conveyor. The bins were installed at the 5 x 6 and 7 x 8 packing stations on the U.S. No. 1 line, at the 5 x 6 and 7 x 7 packing station on the U.S. No. 2 line, and at all of the packing stations on the U.S. No. 3 line.

Equipment arrangement and worker assignments in figure 17 show the layout changes made in the packing line. The packing stations han-

TABLE 4.—*Labor required for a 20-man crew to pack 1,000 60-pound wirebound containers or 1,000 40-pound fiberboard containers with three grades of mature-green tomatoes when checkweighing was centralized and packing stations were equipped with open spouts and backstops or with drop-side bins as shown in figure 17*

[Dumping rate, 500 field boxes per hour. Elapsed time for packing 1,000 containers: 60-pound containers, 2.077 hours; 40-pound containers, 1.384 hours]

Grade of tomatoes and time item	60-pound wirebound containers [1]				40-pound fiberboard containers [2]			
	Workers	Productive labor	Unproductive labor	Total labor	Workers	Productive labor	Unproductive labor	Total labor
U.S. No. 1 or U.S. Combination grade:	*Number*	*Man-hours*	*Man-hours*	*Man-hours*	*Number*	*Man-hours*	*Man-hours*	*Man-hours*
Set up containers	2	2. 685	1. 469		2	1. 506	1. 262	
Fill containers	4	4. 988	3. 320		4	3. 522	2. 014	
Check and adjust weight	1	1. 943	. 134		2	1. 774	. 994	
Lid containers	2	2. 137	2. 017		1	1. 057	. 327	
Set off on stacks	1	. 971	1. 106		1	. 863	. 521	
Total	10	12. 724	8. 046	20. 770	10	8. 722	5. 118	13. 840
U.S. No. 2 grade:								
Set up and fill containers	3	2. 435	3. 796		3	1. 576	2. 576	
Check and adjust weight	1	. 604	1. 473		1	. 531	. 853	
Lid containers	1	. 665	1. 412		1	. 329	1. 055	
Set off on stacks	1	. 302	1. 775		1	. 269	1. 115	
Total	6	4. 006	8. 456	12. 462	6	2. 705	5. 599	8. 304
U.S. No. 3 grade:								
Set up, fill, check, and adjust weight of containers	3	3. 010	3. 221		3	1. 644	2. 508	
Lid containers and set off on stacks	1	1. 080	. 997		1	. 447	. 937	
Total	4	4. 090	4. 218	8. 308	4	2. 091	3. 445	5. 536
Total, all grades	20	20. 820	20. 720	41. 540	20	13. 518	14. 162	27. 680

[1] Based on hourly line output of 481.5 containers: 311.8 for U.S. No. 1 or U.S. Combination, 97.0 for U.S. No. 2, and 72.7 for U.S. No. 3 grade.

[2] Based on hourly line output of 722.4 containers: 467.7 for U.S. No. 1 or U.S. Combination, 145.7 for U.S. No. 2, and 109.0 for U.S. No. 3 grade.

dling the largest and the smallest size fruit of each grade are moved to adjacent positions on the packing line and are equipped with drop-side packing bins to permit one worker to operate both stations.

The distribution of fruit sizes may average larger or smaller in size when fruit is packed in tomato packinghouses at different times. The concept of the packing system where one worker packs both the largest and the smallest size is based on fruit size varying according to the normal distribution curve. For example, when the box-per-hour output of 5 x 6 size increases, the box-per-hour output of 7 x 8 and 7 x 7 size will normally decrease. Approximately the same amount of work will be required at the packing station handling the largest and smallest sizes of fruit.

Arrangement of the largest and the smallest size fruit packing stations in adjacent positions can be accomplished by extending the sizer runout belt for the smallest size fruit and routing it under the distribution belt so the fruit is delivered directly to the packing station (fig. 17). Other sizes of fruit are delivered to the packing stations in the normal manner.

The above line layout and equipment changes permit a crew reduction of seven workers from that required in packing system No. 2. These workers were previously working at a low level of productivity. Three of these workers were assigned to fill containers at the 7 x 8 size packing station on the U.S. No. 1 line, at the 7 x 7 station on the U.S. No. 2 line, and at the 7 x 7 station on the U.S. No. 3 line. A fourth worker was assigned to checkweigh 6 x 6 and 6 x 7 sizes on the U.S. No. 3 line. The other three workers set up containers for packing at the 7 x 7 size packing station on the U.S. No. 1 line and at the 6 x 6 and 6 x 7 size packing stations on the U.S. No. 2 line. The packers at these stations, with the equipment changes that have been made, have sufficient time to set up containers for packing, fill them, and set the packed containers aside on the take-away belt. The packing stations are equipped with open spouts for filling containers and a backstop is attached to the outside edge of the wheel conveyor on which containers are packed.

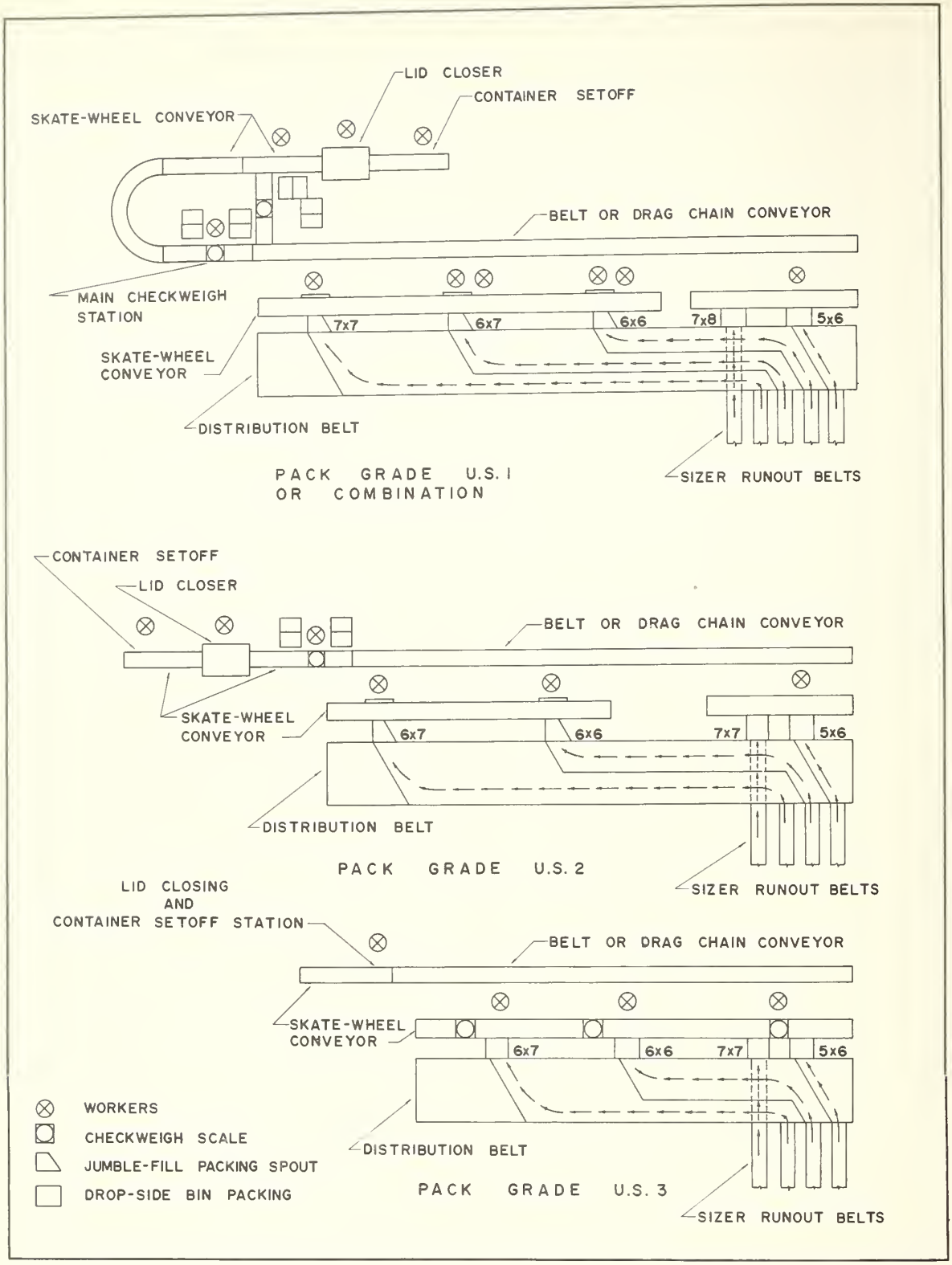

FIGURE 17.—Worker assignments and equipment arrangement for packing three grades of mature-green tomatoes, with centralized checkweighing, and with packing stations for the smallest and largest sizes in adjacent positions on the line.

The work assignments on the U.S. No. 1 line are: One worker sets up containers and fills and sets aside packed containers on the take-away conveyor for 5 x 6 and 7 x 8 size; two workers at the 6 x 6 and two at the 6 x 7 packing station set up, fill, and set aside packed containers; one worker at the 7 x 7 station handles all of the work at that station; one worker checkweighs containers at the end of the packing line; two workers are assigned to close container lids for the U.S. No. 1 grade, and one worker is assigned to set off containers onto floor stacks. One of the workers closing lids for the U.S. No. 1 grade can be assigned to checkweighing when 40-pound containers are packed, and to lid-closing when 60-pound wirebound boxes are packed.

On the U.S. No. 2 grade line, one worker is assigned to set up containers, fill them, and set packed containers aside on the take-away conveyor for the 5 x 6 and 7 x 7 size; one worker at the 6 x 6 and one at the 6 x 7 size station set up, fill, and set aside packed containers on the take-away conveyor; at the end of the packing line, one worker checkweighs containers, one worker closes them, and one worker sets containers on floor stacks for handtruck pickup.

On the U.S. No. 3 grade line, one worker does all of the work for 5 x 6 and 7 x 7 size (sets up containers, fills, weighs, and sets on the take-away conveyor). One worker handles the 6 x 6 size and one worker the 6 x 7 size. A fourth worker closes the lids and stacks packed containers on the floor.

System No. 4—17- or 18-Man Crew

As with packing system No. 3, the filling stations packing the largest and the smallest size fruit of each grade are moved to adjacent positions on the packing line and are equipped with drop-side packing bins to permit one worker to operate both stations, and drop-side packing bins are installed at all packing stations on the U.S. No. 3 grade line.

The following changes were made on the packing line: Individual container chutes were installed at each packing station on the U.S. No. 1 and U.S. No. 2 line to deliver empty containers from the makeup loft to the packing stations on the main floor; 90-degree skate-wheel conveyors were connected between the skate-wheel conveyor at the packing station and the container take-away conveyor (two short sections of straight skate-wheel conveyor with walking space between them were installed at the 5 x 6 stations on the U.S. No. 1 and U.S. No. 2 lines); and the checkweigh station at the end of the packing line on the U.S. No. 2 line was eliminated. With the other changes which have been made, the workers on this line now have sufficient time to checkweigh in addition to setting up, filling, and setting aside packed containers.

The packing crew for system No. 4 was reduced from 20 to 18 workers; 17 workers assigned to the packing line plus one worker assigned to the container makeup loft (table 5). In the other packing systems which were described, two workers in the makeup loft placed empty containers in container chutes. These workers were not included in the size of the packing crew. Because of the increased workload in placing empty containers in the individual container chutes used on the U.S. No. 1 and U.S. No. 2 line in packing system No. 4, an extra worker was assigned to the makeup loft.

The equipment arrangement and worker assignments as represented in figure 18 show the layout changes made in the packing line.

Empty containers are delivered to the packing stations via individual chutes as can be seen in the background of figure 16. In the previously described packing systems, a long overhead gravity chute was used to deliver empty containers to all of the packing stations on the packing line. With this type of chute, a worker at each packing station grasps a container in the chute, lifts it over the edge, marks each end with size and grower identification numbers, and positions the container on a skate-wheel conveyor leading under the filling spout.

Installing individual container chutes at each packing station eliminates part of the work of setting up containers for packing. The chute automatically positions the container with lid open and ready to fill at the packing station. The only work formerly done by the setup man which the packer must still do is to mark size and grower numbers on each end of the container.

Marking can be accomplished with the least labor by marking one end of a full container and one end of an empty container at the same time, rather than marking a complete box at once on both ends.

As a precaution against the chute filler in the loft pushing too hard on the empty containers and shoving several containers past the filling spout, a simple foot pedal and spring-operated stop can be installed at the packing station. The container in filling position under the spout would be prevented from moving out of position by the stop. When the container is full, the operator steps on the foot pedal to lower the stop, and pulls the full container away from the filling spout. A return spring on the foot pedal will reposition the stop when the worker releases the pedal. The end of the next container on the wheel conveyor will then press against the stop and be held in filling position.

To further reduce the labor required at the packing stations, skate-wheel conveyors were connected between the conveyor at the packing stations and the take-away conveyor. A curved 90-degree skate-wheel conveyor was installed at the 6 x 6, 6 x 7, and 7 x 7 packing stations on the U.S. No. 1 line, and at the 6 x 6 and 6 x 7 packing stations on the U.S. No. 2 line. Two short sections of wheel conveyor with a narrow walking space between

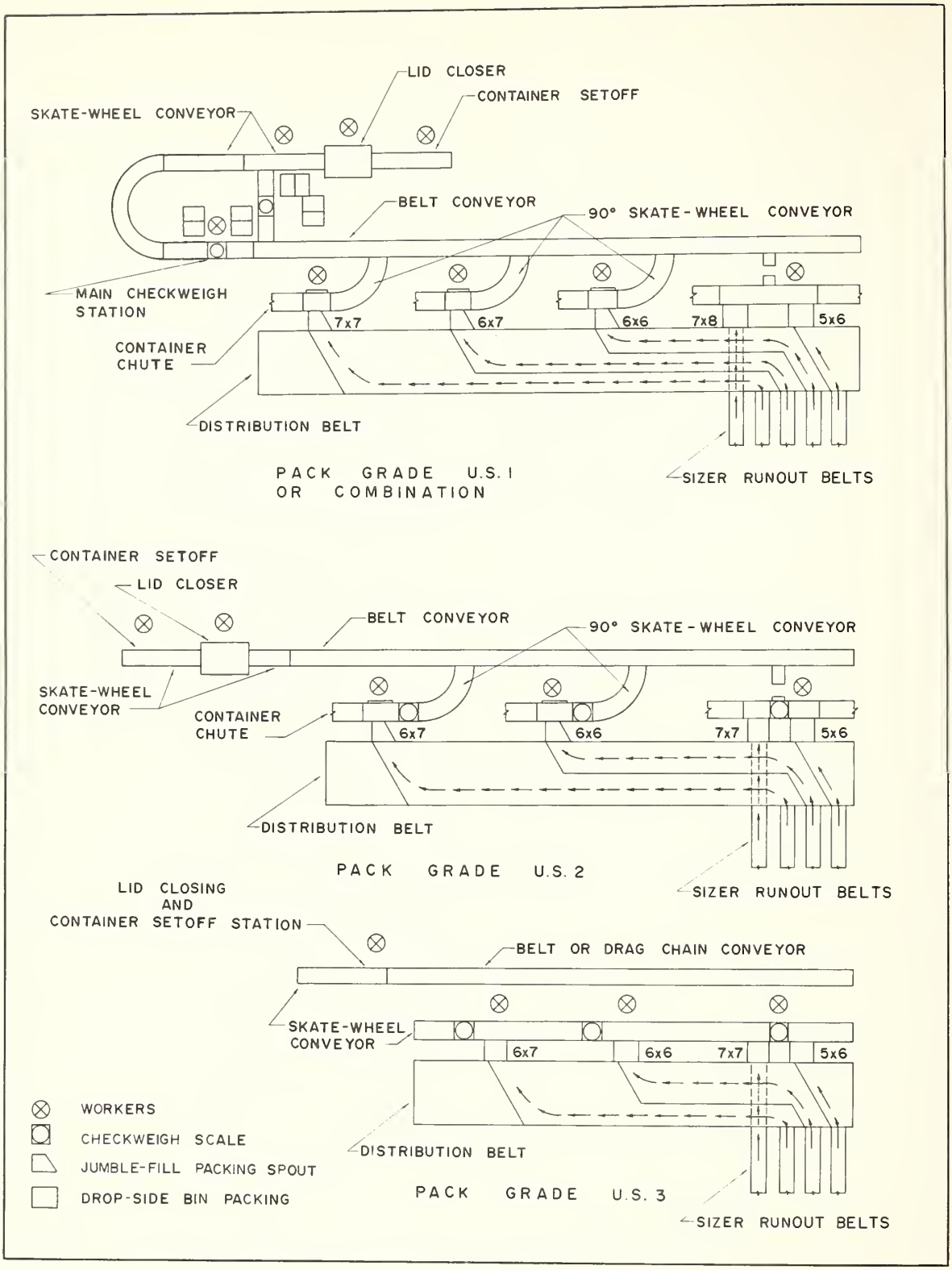

FIGURE 18.—Worker assignments and equipment arrangement for packing three grades of mature-green tomatoes when filling stations were equipped with individual container chutes, open-spout bins with backstops, or drop-side bins, and sections of skate-wheel conveyor to transfer packed containers to the take-away conveyor.

TABLE 5.—*Labor required for an 18-man crew to pack 1,000 60-pound wirebound containers or 1,000 40-pound fiberboard containers with three grades of mature-green tomatoes when packing stations were equipped with individual container chutes, open spouts and backstops or drop-side bins, and sections of skate-wheel conveyor to transfer packed containers to the take-away conveyor as shown in figure 18*

[Dumping rate, 500 field boxes per hour. Elapsed time for packing 1,000 containers: 60-pound containers, 2.077 hours; 40-pound containers, 1.384 hours]

Grade of tomatoes and time item	60-pound wirebound containers [1]				40-pound fiberboard containers [2]			
	Workers	Productive labor	Unproductive labor	Total labor	Workers	Productive labor	Unproductive labor	Total labor
U.S. No. 1 or U.S. Combination grade:	*Number*	*Man-hours*	*Man-hours*	*Man-hours*	*Number*	*Man-hours*	*Man-hours*	*Man-hours*
Set up containers [3]	1	1. 506	0. 571	-------	1	0. 901	0. 483	-------
Fill containers	4	4. 161	4. 147	-------	4	3. 561	1. 975	-------
Check and adjust weight	1	1. 943	. 134	-------	2	1. 774	. 994	-------
Lid containers	2	2. 137	2. 017	-------	1	1. 057	. 327	-------
Set off on stacks	1	. 971	1. 106	-------	1	. 863	. 521	-------
Total	9	10. 718	7. 975	18. 693	9	8. 156	4. 300	12. 456
U.S. No. 2 grade:								
Mark, fill, check and adjust weight of containers	3	2. 015	4. 216	-------	3	1. 540	2. 612	-------
Lid containers	1	. 665	1. 412	-------	1	. 329	1. 055	-------
Set off on stacks	1	. 302	1. 775	-------	1	. 269	1. 115	-------
Total	5	2. 982	7. 403	10. 385	5	2. 138	4. 782	6. 920
U.S. No. 3 grade:								
Mark, fill, check and adjust weight of containers	3	3. 010	3. 221	-------	3	1. 644	2. 508	-------
Lid containers and set off on stacks	1	1. 080	. 997	-------	1	. 447	. 937	-------
Total	4	4. 090	4. 218	8. 308	4	2. 091	3. 445	5. 536
Total, all grades	18	17. 790	19. 596	37. 386	18	12. 385	12. 527	24. 912

[1] Based on hourly line output of 481.5 containers: 311.8 for U.S. No. 1 or U.S. Combination, 97.0 for U.S. No. 2, and 72.7 for U.S. No. 3 grade.

[2] Based on hourly line output of 722.4 containers: 467.7 for U.S. No. 1 or U.S. Combination, 145.7 for U.S. No. 2 and 109.0 for U.S. No. 3 grade.

[3] In this system, no workers are needed on the packing line to set up containers, but an extra worker is needed in the loft to help feed containers to the individual chutes.

them were installed between the two packing stations on the U.S. No. 1 and No. 2 line where the largest and smallest fruit is packed. Filled containers can be easily and quickly transferred by the worker to the container take-away conveyor.

A 40-pound container can be transferred on a skate-wheel conveyor from the packing station to the take-away belt conveyor in 0.029 minutes. If the worker picks up a container, makes a 180-degree turn and sets it on the take-away belt conveyor, the time required is 0.048 minutes. The time reduction amounts to nearly 40 percent. Worker fatigue is also reduced since there is no need to pick up the container.

When installing the 90-degree skate-wheel conveyor, a short vertical rod or roller pivot should be placed at the edge of the frame of the belt conveyor on the side toward the lidding station (fig. 19). The filled container will pivot around the roller pivot onto the belt without the aid of the worker. The worker can merely give the container a shove toward the conveyor belt and turn his attention to filling another container. Without the pivot, the worker must use additional time and effort to manually turn the filled container onto the belt conveyor.

At the 5 x 6 and 7 x 8 packing stations on the U.S. No. 1 line and at the 5 x 6 and 7 x 7 stations on the U.S. No. 2 line, a short section of straight skate-wheel conveyor can be installed. This conveyor section will reduce the labor required to transfer packed containers from the packing stations to the container take-away conveyor. Because one worker is assigned to work the two packing stations on each line, the conveyor section should be broken into two parts with an 8-inch space left between the parts to permit the worker to pass through the "line" for access to both work stations. Packed containers are moved from the packing stations to the take-away conveyor on the wheel conveyor sections. The worker is not required to pick up the container, make a 180-degree

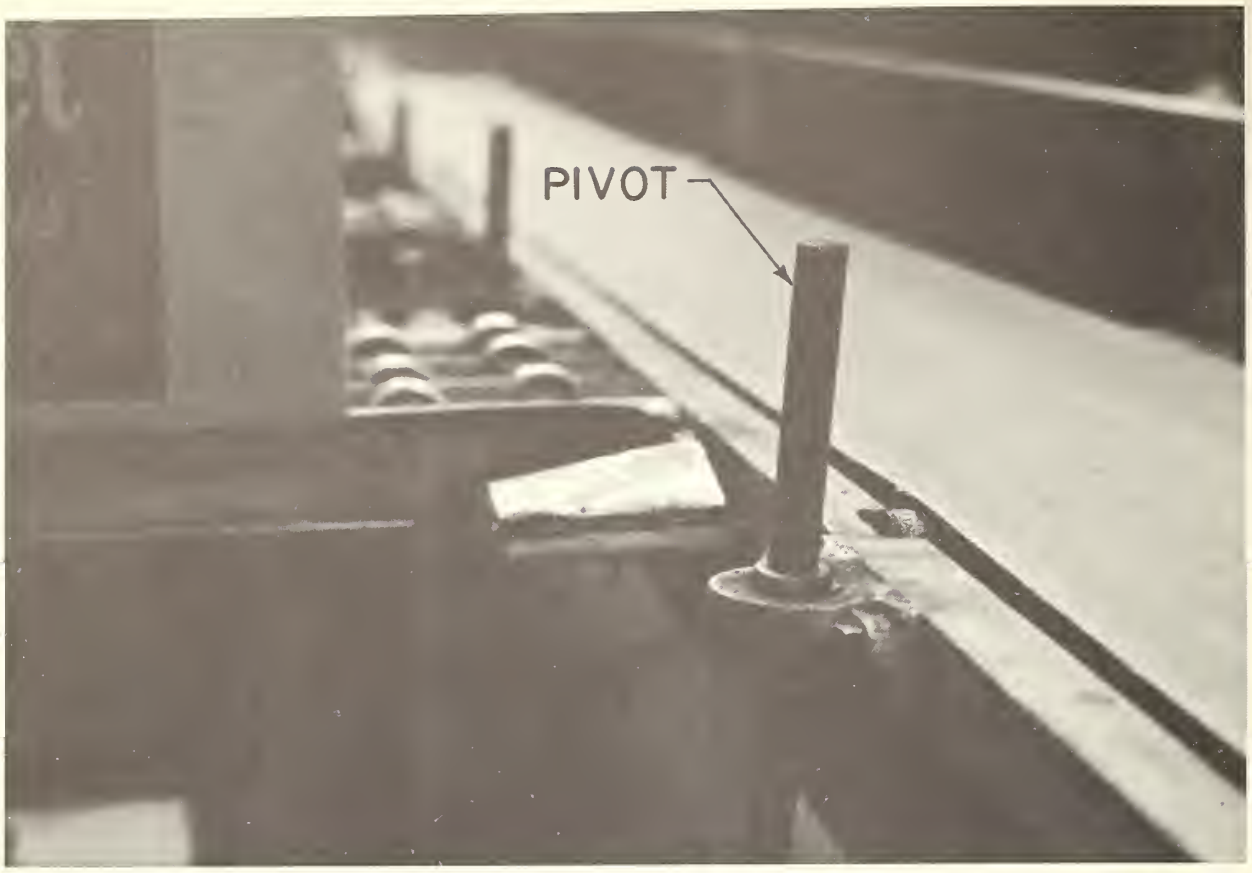

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FIGURE 19.—A roller pivot to turn filled containers onto a take-away belt conveyor without aid from the worker. In this setup the container will be moved from left to right.

turn, and set the container on the take-away conveyor as with previous systems.

At a packing station equipped with individual container chutes, open-spout filling and 90-degree skate-wheel conveyor (as on the U.S. No. 1 line), a worker could fill, mark, and push packed containers aside to the take-away conveyor at the rate of 179.1 60-pound or 191 40-pound containers per hour. A worker also assigned to checkweigh packed containers (as on the U.S. No. 2 line) could fill 113 60-pound or 137.9 40-pound containers per hour.

A worker at a drop-side bin could fill and push aside 84.4 60-pound or 138.6 40-pound containers per hour. Containers are delivered to the filling position via a chute for each bin. Wheel conveyor sections, installed between the conveyor at the filling spout and the container take-away conveyor, reduce the time required to move packed containers onto the take-away conveyor. The worker at a drop-side bin who is also assigned to checkweigh containers could fill 66.2 60-pound or 106.8 40-pound containers per hour.

The work assignments on the U.S. No. 1 line are: One worker marks, fills, and sets aside packed containers on the take-away conveyor for 5 x 6 and 7 x 8 size; one worker at the 6 x 6, one at the 6 x 7, and one at the 7 x 7 station fill, mark, and set aside packed containers on the take-away conveyor; one worker checkweighs containers at the end of the packing line, two workers close container lids, and one worker sets off containers onto floor stacks. One of the workers closing lids for U.S. No. 1 grade can be assigned to checkweighing when 40-pound containers are packed, and to lid closing when 60-pound wirebound boxes are packed.

On the U.S. No. 2 grade line, one worker fills, marks, checkweighs, and sets aside packed containers at the 5 x 6 and 7 x 7 size stations; one worker at the 6 x 6 and one at the 6 x 7 size station fill, mark, checkweigh, and set aside packed containers on the take-away conveyor; at the end of the packing line, one worker closes containers and one worker sets containers on floor stacks for handtruck pickup.

There is no change on the U.S. No. 3 line from the previous system. One worker does all work for the 5 x 6 and 7 x 7 size (sets up containers, fills, weighs, and sets packed containers on the

take-away conveyor); one worker handles the 6 x 6 size and one worker the 6 x 7 size. A fourth worker closes lids and sets packed containers on floor stacks.

The extra worker assigned to the makeup loft to assist the regular crew in placing empty containers in chutes could place 430.1 60-pound boxes or 718.9 40-pound separate-lid cartons per hour in individual chutes leading to 5 packing stations on the U.S. No. 1 grade line. (Only 311.8 60-pound containers or 467.7 40-pound containers at a dumping rate of 500 field boxes per hour are needed on the U.S. No. 1 grade packing line.) The rates are based on a worker picking up two containers at a time, setting them in a chute, walking an average of 8.6 feet to the next container chute and again placing two containers in a chute. Container chutes are located in line 8 feet apart with the exception of 6 x 6 and 6 x 7 size, which are spaced at 16 feet to permit installation of two 6 x 6 and two 6 x 7 packing stations. These provide spare packing stations which can be used when packing at faster line inputs.

An extra item of equipment was added to the makeup loft to make the work of the chute filler easier and to reduce the labor requirements. Belt conveyors were installed on the U.S. No. 1 and U.S. No. 2 lines to transport formed containers from the assembly area to the chutes. The conveyors should be placed adjacent to the chutes at a height of 28 inches above the floor. A switch, installed at the end of each conveyor, will automatically turn off the conveyor drive motors when the conveyor is full and boxes press against the switch.

Advantages of the conveyor are: Positioning of empty containers at a convenient working height for the chute filler; elimination of need for a worker to refold container flaps or orient containers, such as would be needed if the container were tossed onto a pile by the assembly worker; elimination of manual transportation of containers from the assembly area to the chutes; and location of assembly area in a central area instead of scattered along the line formed by the chutes leading to the packing stations.

As previously mentioned, the jobs for the setoff man and the lid closer could be combined on the U.S. No. 2 line.[7] Unproductive labor for both workers exceeds their productive labor and the combined productive labor of both workers is less than the elapsed hours required to pack 1,000 containers on the packing line. For example, the lid closer has 0.665 hour productive labor and the container setoff man has 0.302 hour productive labor. The combined productive labor for both workers is 0.967 hour; 1.110 hours less than 2.077 hours, the time to pack 1,000 60-pound containers with 3 grades of mature-green tomatoes on the three packing lines. With this change, the crew will be reduced to 17 workers; 16 assigned to the packing line, and one extra worker assigned to the container makeup loft to place empty containers in the packing chutes on the U.S. No. 1 line.

In the standard packing line setup, the time of the packing crew was not fully utilized. When the dumping rate was 500 field boxes per hour, very few workers on the packing line had more productive labor than unproductive labor. Workers either worked at a much slower than normal pace or waited for work.

This unused labor permitted a flexibility in the rate at which the packing line could be operated. If the quality of the fruit was good, the dumping rate could be increased above 500, to 600 or 700 field boxes per hour. The increased labor cost of this flexibility was high and it was not always utilized.

The improved packing lines reduce unproductive time for the workers as a part of increasing productive labor and reducing labor costs on the packing line. However, surges of increased output will cause a problem at a few work stations. At a dumping rate higher than 540 and up to 700 field boxes per hour, one or two extra workers will be needed on the packing line. A 17-man crew (one worker in loft) can handle the packing, weighing, and lidding work on the packing line when the rate of dumping field boxes does not exceed approximately 540 field boxes per hour.

One more worker should be assigned to the checkweigh station at the end of the U.S. No. 1 packing line when 60-pound wirebound boxes are packed and field box dumping exceeds 540 per hour. Two extra workers should be assigned to two additional filling stations when packing 40-pound cartons on the U.S. No. 1 line; one worker for the 6 x 6 size, and one worker for the 6 x 7 size. Total crew size for the packing line to permit flexibility to dump field boxes at rates of 540 to 700 per hour will be 18 workers when packing 60-pound wirebound boxes and 19 workers when packing 40-pound cartons. One or two extra workers, assigned as described above, will thus permit the same flexibility in increased rate of dumping to 700 field boxes per hour which formerly required a crew of 31 workers on a standard packing line.

Costs for Packing Three Grades of Mature-Green Tomatoes

The costs for labor and equipment to pack 1,000 containers of mature-green tomatoes by the previously described packing systems are shown in table 6. The cost for labor and equipment for the most economical method of packing tomatoes, packing

[7] See discussion on page 12.

TABLE 6.—*Labor and equipment costs, per 1,000 containers, for a crew to pack 3 grades of mature-green tomatoes*

[Dumping rate, 500 field boxes per hour. Elapsed time for packing 1,000 containers: 60-pound containers, 2.077 hours; 40-pound containers, 1.384 hours]

Packing system	Crew size	60-pound containers				40-pound containers			
		Labor required	Cost			Labor required	Cost		
			Labor [1]	Equipment [2]	Total		Labor [1]	Equipment [2]	Total
	Number	*Man-hours*	*Dollars*	*Dollars*	*Dollars*	*Man-hours*	*Dollars*	*Dollars*	*Dollars*
Packing system No. 1—standard line	31	64. 387	80. 48	5. 16	85. 64	42. 904	53. 63	3. 44	57. 07
Packing system No. 2—centralized checkweighing	27	56. 079	70. 10	4. 75	74. 85	37. 368	46. 71	3. 16	49. 87
Packing system No. 3—centralized checkweighing; filling stations equipped with open spouts and backstops or with drop-side bins	20	41. 540	51. 93	4. 95	56. 88	27. 680	34. 60	3. 30	37. 90
Packing system No. 4—filling stations equipped with individual container chutes, open spouts and backstops or drop-side bins, and sections of skate-wheel conveyor to transfer packed containers to the take-away conveyor	18	37. 386	46. 73	6. 50	53. 23	24. 912	31. 14	4. 33	35. 47
Packing system No. 4—with one man instead of two to close lids and set containers on stacks on the U.S. No. 2 packing line	17	35. 309	44. 14	6. 50	50. 64	23. 528	29. 41	4. 33	33. 74

[1] Based on a labor cost of $1.25 per hour, including fringe benefits.

[2] See tables 7–10 for annual and hourly equipment cost.

system No. 4, with 17 workers, is $50.64 per 1,000 60-pound containers. Labor and equipment cost for the standard 31-man system is $85.64 per 1,000 60-pound containers. The same cost differential exists when packing 40-pound fiberboard containers for an equivalent volume of 60,000 pounds of tomatoes. With an annual volume of 200,000 60-pound equivalent containers, the savings will be $7,000.

Potential savings and the cost of investment in new equipment required to change from the present packing system to a recommended system will vary with each packinghouse, depending on the present equipment, crew size, and plant layout. A packinghouse with a standard packing line and a 31-man crew must invest about $3,400 in new equipment to change to the improved packing line and a 17-man crew (system No. 4). For a capital investment of $3,400, the annual savings will amount to $7,000; a rate of return on investment of 200 percent when allowance is made for a 5-percent interest charge on borrowed capital. Some presently owned equipment, such as the 100-foot overhead box chute, seven 10-foot skate-wheel conveyor sections, and five checkweighing scales could be sold to reduce capital required for investment in the new equipment.

The packing system change which provided the highest rate of return on new capital investment as compared to the standard packing line was system No. 3 with the 20-man crew (centralized checkweighing and packing stations equipped with open spouts and backstops or with drop-side bins). New capital investment of $1,211 in equipment was required to change from the 31-man crew, standard packing-line system. Annual savings were $5,732; a rate of return of approximately 450 percent (with allowance for 5-percent interest charges on the additional investment in new equipment).

The equipment costs, derived in tables 7–10 for each packing system, do not include all items of equipment normally found on a packing line. Only those items of equipment which would differ among the systems have been included. Other items of equipment common to all four systems, which would not change the total cost relationships among the packing systems, have been omitted.

Some of the items of equipment which have not been included are: Empty container chute on the U.S. No. 3 grade packing line, fruit distribution belt, container take-away conveyor, lid-closing equipment, and container marking devices on all three packing lines.

TABLE 7.—*Annual equipment cost to pack three grades of mature-green tomatoes with packing system No. 1* [1]

Equipment item	Initial cost per unit	Expected life	Annual ownership costs				Annual operating costs			Total annual cost	Number items needed	Total cost for packing line
			Depreciation	Interest at 5% [2]	Insurance and taxes [2]	Total	Power [3]	Maintenance [4]	Total			
	Dollars	*Years*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Number*	*Dollars*
5-belt runout conveyor	1, 250	12	104. 17	33. 85	50. 00	188. 02	22. 50	12. 50	35. 00	223. 02	1	223. 02
4-belt runout conveyor	1, 000	12	83. 33	27. 08	40. 00	150. 41	15. 00	10. 00	25. 00	175. 41	2	350. 82
100-foot overhead box chute	320	15	21. 33	8. 53	12. 80	42. 66		1. 60	1. 60	44. 26	1	44. 26
Jumble filling spout	2	15	. 13	. 05	. 08	. 26				. 26	13	3. 38
Skate-wheel conveyor (10-foot sections)	42	10	4. 20	1. 16	1. 68	7. 04		. 20	. 20	7. 24	17	123. 08
Weigh scales	198	10	19. 80	5. 45	7. 92	33. 17		5. 00	5. 00	38. 17	13	496. 21
Total cost												1, 240. 77
Cost per hour												2. 48

[1] Based on 500 hours of annual use.
[2] Interest based on average investment over the life of the equipment; insurance and taxes based on initial investment.
[3] Based on 3 cents per kilowatt hour for electricity.
[4] Estimated annual costs.

TABLE 8.—*Annual equipment cost to pack three grades of mature-green tomatoes with packing system No. 2* [1]

Equipment item	Initial cost per unit	Expected life	Annual ownership costs				Annual operating costs			Total annual cost	Number items needed	Total cost for packing line
			Depreciation	Interest at 5% [2]	Insurance and taxes [2]	Total	Power [3]	Maintenance [4]	Total			
	Dollars	*Years*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Number*	*Dollars*
5-belt runout conveyor	1, 250	12	104. 17	33. 85	50. 00	188. 02	22. 50	12. 50	35. 00	223. 02	1	223. 02
4-belt runout conveyor	1, 000	12	83. 33	27. 08	40. 00	150. 41	15. 00	10. 00	25. 00	175. 41	2	350. 82
100-foot overhead box chute	320	15	21. 33	8. 53	12. 80	42. 66		1. 60	1. 60	44. 26	1	44. 26
Jumble filling spout with backstop	3	15	. 20	. 08	. 12	. 40				. 40	13.	5. 20
Skate-wheel conveyor (10-foot sections)	42	10	4. 20	1. 16	1. 68	7. 04		. 20	. 20	7. 24	19	137. 56
Weigh scales	198	10	19. 80	5. 45	7. 92	33. 17		5. 00	5. 00	38. 17	7	267. 19
Reserve fruit supply stand	5	10	. 50	. 14	. 20	. 84				. 84	6	5. 04
Skate wheel conveyor (3-foot section)	18	10	1. 80	. 50	. 72	3. 02				3. 02	4	12. 08
6-foot elevating conveyor belt	415	10	41. 50	11. 41	16. 60	69. 51	7. 50	8. 00	15. 50	85. 01	1	85. 01
180° skate wheel conveyor	72	10	7. 20	1. 98	2. 88	12. 06		. 30	. 30	12. 36	1	12. 36
Total cost												1, 142. 54
Cost per hour												2. 28

[1] Based on 500 hours of annual use.

[2] Interest based on average investment over the life of the equipment; insurance and taxes based on initial investment.

[3] Based on 3 cents per kilowatt hour for electricity.

[4] Estimated annual costs.

TABLE 9.—*Annual equipment cost to pack three grades of mature-green tomatoes with packing system No. 3* [1]

Equipment item	Initial cost per unit	Expected life	Annual ownership costs				Annual operating costs			Total annual cost	Number items needed	Total cost for packing line
			Depreciation	Interest at 5% [2]	Insurance and taxes [2]	Total	Power [3]	Maintenance [4]	Total			
	Dollars	*Years*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Number*	*Dollars*
5-belt runout conveyor; 1 belt extended to packing station	1,350	12	112.50	36.56	54.00	203.06	22.50	12.50	35.00	238.06	1	238.06
4-belt runout conveyor; 1 belt extended to packing station	1,100	12	91.67	29.79	44.00	165.46	15.00	10.00	25.00	190.46	2	380.92
100-foot overhead box chute	320	15	21.33	8.53	12.80	42.66		1.60	1.60	44.26	1	44.26
Filling spout with backstop	3	15	.20	.08	.12	.40				.40	5	2.00
Drop-side bin	45	15	3.00	1.20	1.80	6.00		.50	.50	6.50	8	52.00
10-foot skate-wheel conveyor	42	10	4.20	1.16	1.68	7.04		.20	.20	7.24	18	130.32
3-foot skate-wheel conveyor	18	10	1.80	.50	.72	3.02				3.02	4	12.08
Weigh scales	198	10	19.80	5.45	7.92	33.17		5.00	5.00	38.17	6	229.02
Reserve fruit supply stand	5	10	.50	.14	.20	.84				.84	6	5.04
6-foot elevating conveyor	415	10	41.50	11.41	16.60	69.51	7.50	8.00	15.50	85.01	1	85.01
180° skate-wheel conveyor	72	10	7.20	1.98	2.88	12.06		.30	.30	12.36	1	12.36
Total cost												1,191.07
Cost per hour												2.38

[1] Based on 500 hours of annual use.

[2] Interest based on average investment over the life of the equipment; insurance and taxes based on initial investment.

[3] Based on 3 cents per kilowatt hour for electricity.

[4] Estimated annual costs.

TABLE 10.—*Annual equipment cost to pack three grades of mature-green tomatoes with packing system No. 4* [1]

Equipment item	Initial cost per unit	Expected life	Annual ownership costs				Annual operating costs			Total annual cost	Number items needed	Total cost for packing line
			Depreciation	Interest at 5% [2]	Insurance and taxes [2]	Total	Power [3]	Maintenance [4]	Total			
	Dollars	*Years*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Number*	*Dollars*
5-belt runout conveyor; 1 belt extended to packing station	1,350	12	112.50	36.56	54.00	203.06	22.50	12.50	35.00	238.06	1	238.06
4-belt runout conveyor; 1 belt extended to packing station	1,100	12	91.67	29.79	44.00	165.46	15.00	10.00	25.00	190.46	2	380.92
Container chute	60	15	4.00	1.60	2.40	8.00		.30	.30	8.30	9	74.70
Filling spout with backstop	3	15	.20	.08	.12	.40				.40	5	2.00
Drop-side bin	45	15	3.00	1.20	1.80	6.00		.50	.50	6.50	8	52.00
10-foot skate-wheel conveyor	42	10	4.20	1.16	1.68	7.04		.20	.20	7.24	10	72.40
90° skate-wheel conveyor	36	10	3.60	.99	1.44	6.03		.15	.15	6.18	5	30.90
3-foot skate-wheel conveyor	18	10	1.80	.50	.72	3.02				3.02	12	36.24
Weigh scales	198	10	19.80	5.45	7.92	33.17		5.00	5.00	38.17	8	305.36
Reserve fruit supply stand	5	10	.50	.14	.20	.84				.84	4	3.36
6-foot elevating conveyor	415	10	41.50	11.41	16.60	69.51	7.50	8.00	15.50	85.01	1	85.01
180° skate-wheel conveyor	72	10	7.20	1.98	2.88	12.06		.30	.30	12.36	1	12.36
60-foot conveyor belt in box assembly loft	710	10	71.00	19.53	28.40	118.93	7.50	20.00	27.50	146.43	1	146.43
40-foot conveyor belt in box assembly loft	580	10	58.00	15.95	23.20	97.15	7.50	20.00	27.50	124.65	1	124.65
Total cost												1,564.39
Cost per hour												3.13

[1] Based on 500 hours of annual use.

[2] Interest based on average investment over the life of the equipment; insurance and taxes based on initial investment.

[3] Based on 3 cents per kilowatt hour for electricity.

[4] Estimated annual costs.

OTHER PACKINGHOUSE OPERATIONS

Make Up Containers

In Florida tomato packinghouses, bundles of container materials are commonly stored and assembled on the box balcony above the main floor. Assembled containers are delivered to the packing line on the main floor by chutes.

Workers carry bundles of unformed containers from storage to a work area near the chutes. Each bundle contains 10 wirebound boxes or 20 to 25 fiberboard blanks. The lids of full-telescope fiberboard cartons are stored in the loft and must be carried to the work area to be assembled with the bottom of the containers. Lids of partial-telescope fiberboard cartons are stored in the loft and assembled with the bottom of the container, or are stored on the main floor and formed in a separate work area near the packed container lidding station.

Wirebound Boxes

Tomato Wirebound Veneer Crate.—A worker makes up wirebound crates (either 40- or 60-pound capacity) by folding the end and side panels to an erect position and inserting wire loops from the ends of the crate through corresponding slots in the sides of the box. The loops are then hooked and bent with a small handtool. Ventilated cardboard liners are placed into the container to protect the fruit from the inner surfaces of the box. Then the worker bends the lid of the crate to a closed position and places the completed crate in a chute which delivers the container to the packing line. In some packinghouses, the worker fastens the lid in a closed position by engaging and bending wire loops attached to the lid and the side of the crate.

Manufacturers can also supply boxes with prestitched liners, already in place, that reduce the work of the makeup crew. The rate of making boxes can be increased 40.8 percent by using such boxes.

In other packinghouses, where workers close and fasten the lid by engaging a wire loop, the rate of making boxes can be increased 11.6 percent if the worker closes the box lid but does not fasten it. Since lids must be opened before the box is packed, lids fastened during assembly cause additional labor for the packing crew on the main floor.

One worker can make up 257.5 boxes per hour when ventilated liners are prestitched in the box by the manufacturer. A worker making boxes with a separate liner can form 182.9 per hour. If the worker closes and temporarily fastens the lid by one of the four wire loops attached to it, the rate will be 230.8 per hour. If the lid is fastened and a separate liner must also be inserted, the assembly rate will decrease to 169 per hour.

Wirebound Box With Corrugated End Panels and Lid.—This box, made only in a 40-pound capacity, is a modification of the regular wirebound box. Fiberboard end panels are stapled to a 5/8- by 7/8-inch cleat at the top of the wooden box frame.

Workers make up the box by folding the box body into shape, bending the end panels into erect position, and fastening them to the side panels with a wire loop attached to the wood cleat on the end panels. The tool used to fasten the wires on the box is commonly called a rocker-arm closing hammer, which is described earlier in the section "Combinations of Work Methods and Costs for Packing."

A separate 2-inch partial fiberboard lid used with this type of wirebound box has flaps with interlocking parts that require no stapling or glue-sealing. Workers form these lids by folding and fastening the flaps.

Fiberboard Containers

The flaps of fiberboard containers are fastened by a variety of methods. Flaps can be stapled, fastened by special interlocking parts of the container, or be left loose and fastened by a glue-sealing machine after the carton is packed.

Interlocking Parts Carton With Separating Divider.—The body of the most common corrugated container is assembled with interlocking flaps of the container. The worker opens the carton blank and with a series of motions folds the special additional bottom and end flaps in such a manner as to interlock and to form a completed container which does not require stapling or glue-sealing. This procedure results in double walls on the end panels and on the bottom of the carton. A second worker inserts a divider piece which strengthens the sides of the carton and divides it into two compartments (fig. 20).

A 2-man crew can form 461.5 boxes per hour. One worker forms cartons and the second worker inserts the divider piece and places the carton in a chute which delivers the carton to the packing line.

A third worker, located on the main floor adjacent to the end of the packing line, forms the

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FIGURE 20.—Workers forming an interlocking-parts container and inserting a divider piece into a formed carton.

3- or 5-inch deep partial lids to be used with the interlocking parts carton (fig. 21).

The worker makes the lid by folding the flaps and interlocking the parts to form a completed lid which requires no stapling or glue-sealing. Completed lids are tossed on a pile on the floor or placed on a stack of formed lids adjacent to the work station. Lids which are tossed on the floor are later picked up by the worker and made into a stack of lids which are stored at the lidding station and used to close packed containers.

One worker can fold and stack 365.9 lids per hour. If the lids are formed, tossed on a pile on the floor, and later picked up and stacked, the rate is 346.8 per hour.

Stitched Carton With Separating Divider.—A crew of three workers makes up cartons on stitching machines. One worker operates the stitching machine, the second worker inserts a fiberboard divider into the carton, and the third worker straightens the divider and stacks the carton in storage for later use or places it on a chute to be delivered to the packing line.

The worker operating the machine shapes the carton by pushing the ends of the carton together. He then folds the bottom flaps of the carton, places them under the head of the stapler machine and steps on a foot pedal. As the machine continuously places staples through the flaps, the worker moves the carton with a rhythmical swinging motion to space seven to eight staples across the bottom of the carton.

A crew of 3 workers can form and stitch 555.5 boxes per hour.

As with the interlocking parts carton, a lid is formed separately by a worker on the main packing floor near the lidding station. Lids are also formed and stacked in groups of four or five in the loft. These groups of lids are sent down to the main floor via the gravity chute with the formed boxes. This method requires extra labor on the main floor to remove lids from the chute and to carry them to the lidding station at the end of the packing line.

Two-Piece Full-Telescoping Carton.—The carton is composed of a bottom piece (inner piece) and a full-telescoping lid (outer piece). The two parts of the container are assembled on worktables or on wooden forming jigs.

A worker picks up the inner piece of the carton from a stack of parts, and opens and slips it over the top of the jig with the flaps up. The outer

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Figure 21.—Forming a carton lid. Note the notch (below the fingers of the right hand) that will lock into a slot.

piece is picked up and slipped over the inner piece with the flaps down. End and side flaps of the inner piece are folded and the assembled carton is removed from the jig and tossed aside to a pile on the floor or set on a chute leading to the packing area. A worker can form and assemble 251 two-piece telescoping cartons per hour on a jig and place the cartons in several nearby chutes.

The wooden table in another method commonly used to form cartons is 22 to 26 inches high, with top dimensions 25 x 48 inches. Unformed bundles of parts are set on the table by the worker and cartons are formed on top of them.

A worker assembling a carton on a table, picks up the outer piece, forms it with the flaps down, and shoves it to one side against a 12- x 13-inch block about 4½ inches high. This motion folds the left side flap of the carton. The operator releases the outer piece of the carton and reaches for the inner piece. He picks up the inner piece, open with the flaps up, and inserts it into the outer piece. The worker folds the flaps of the inner piece, picks up the assembled carton, turns it over, and sets it in the container chute.

When a crew of two workers assemble cartons, one worker forms and holds the outer piece while the other worker forms and slips the inner piece into the outer piece of the carton. The first of the two workers sets the assembled carton in a container chute.

A crew of three workers can work together if one worker forms the inner piece, the second worker forms the outer piece, and the third worker assembles the two pieces. Formed cartons are tossed onto a pile on the floor and two extra workers are needed to remove cartons from the pile, refold the bottom flaps, and set them in container chutes.

The rate of forming cartons with the larger crew is faster, but the labor requirement per 1,000 cartons formed is greater than when operators work individually. For example, 1 worker assembling cartons on a table can form 333.3 cartons per hour; a crew of 2 workers can form 375 cartons per hour[8]; and a crew of 3 workers can form 759.5 cartons per hour.

The labor required in man-hours per 1,000 containers formed is 3 for the 1-man crew, 5.34 for the 2-man crew, and 6.58 for the 5-man crew.

Nailed Carton.—Another type of 40-pound carton which has come into use is a nailed carton. This carton has two corrugated end panels reinforced with ¾- x 1-inch wooden strips. The fiberboard main body of the carton is fastened with 38 ⅝-inch nails to these end panels. The lid is different from those of other tomato boxes; it is composed of two 5½-inch flaps, which when closed leave a 2-inch gap in the center of the carton. A ¼- x 1½-inch wood strip is stapled by the manufacturer to each lid flap for added strength and to serve as stacking strips between containers when the cartons are shipped.

The box manufacturer delivers the parts of the box to the tomato packer in unitized loads (a load contains 1,000 end panels or 250 body panels) for forklift-truck handling (fig. 22). The driver unloads unitized box parts from the supplier's truck, places them in storage, and transports them to a nailing machine when needed.

One worker at the nailing machine places box parts in the feed magazines of the machine. A second worker supervises the operation of the machine, eliminates machine stoppages, and loads nails into the supply hopper (fig. 23). A third worker inspects nails in the end panels of the boxes

[8] GRIZZELL, W. G. A DEVICE FOR FORMING TWO-PIECE TELESCOPING CARTONS. U.S. Dept. Agr. AMS–490, 23 pp., illus. December 1962.

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FIGURE 22.—Worker transporting body panels with a fork-lift truck.

and applies a staple with a pneumatic staple gun where nails may have been missed by the machine.

Transport, Store, and Load for Shipment

Workers use 2-wheel, clamp handtrucks in Florida packinghouses to transport 4- or 5-high stacks of packed tomato containers from the packing line. The stacks of containers are set in temporary storage on the packinghouse floor to await shipping orders or are taken directly to the railroad car or semitrailer for loading.

The handtruck is equipped with movable clamps to grip the stack of containers. Flanges are attached to the bottom of the clamps to slide under the bottom box. The transporter opens the clamps with a foot pedal, pushes the truck against the load, compresses the clamps with a foot pedal, and tilts the load back against the handtruck.

One worker transporting 5-high stacks of 40-pound cartons 100 feet, setting the stack on the floor, and returning with the truck empty, can handle 284.6 containers per hour.

Containers of mature-green tomatoes are hand-stacked in railroad cars and semitrailers for shipment from Florida (fig. 24). The work is performed in essentially the same manner for trailers and railroad cars. Handtruck operators set the stacks of containers near the work face. Then the loader picks up containers individually and sets them in the proper loading pattern designed to permit air circulation and safe shipment of the fruit.

The labor required for a crew of 3 workers to load 1,000 containers in a railroad car is shown in table 11.

TABLE 11.—*Labor required for a 3-man crew to load 1,000 40-pound containers when packages are transported 75 feet with 2-wheel clamp trucks and are hand-stacked in a railroad car* [1]

Time item	Workers	Labor required
Productive labor:	*Number*	*Man-hours*
Set up and clean up	3	0.006
Pick up 5-high stack with handtruck	2	.346
Transport 75 feet [2]	2	2.190
Set down stack	2	.254
Stack containers in loading pattern	1	1.383
Total productive labor		4.179
Unproductive labor:		
Loader waits for transporters	1	.012
Total unproductive labor		.012
Total labor	3	4.191
		Hours
Elapsed time		1.397

[1] Five 40-pound containers loaded on each clamp truck. Crew organization: 2 men transport loads from storage or setoff station to railroad car; 1 stacks containers in railroad car.

[2] The productive time for a worker to transport a stack of containers and return empty can be determined for other distances by using the equation $t=0.000146d$. This equation is based on the standard walking speed of a worker at 3 miles per hour when t=productive time per round trip in man-hours and d=one-way distance in feet.

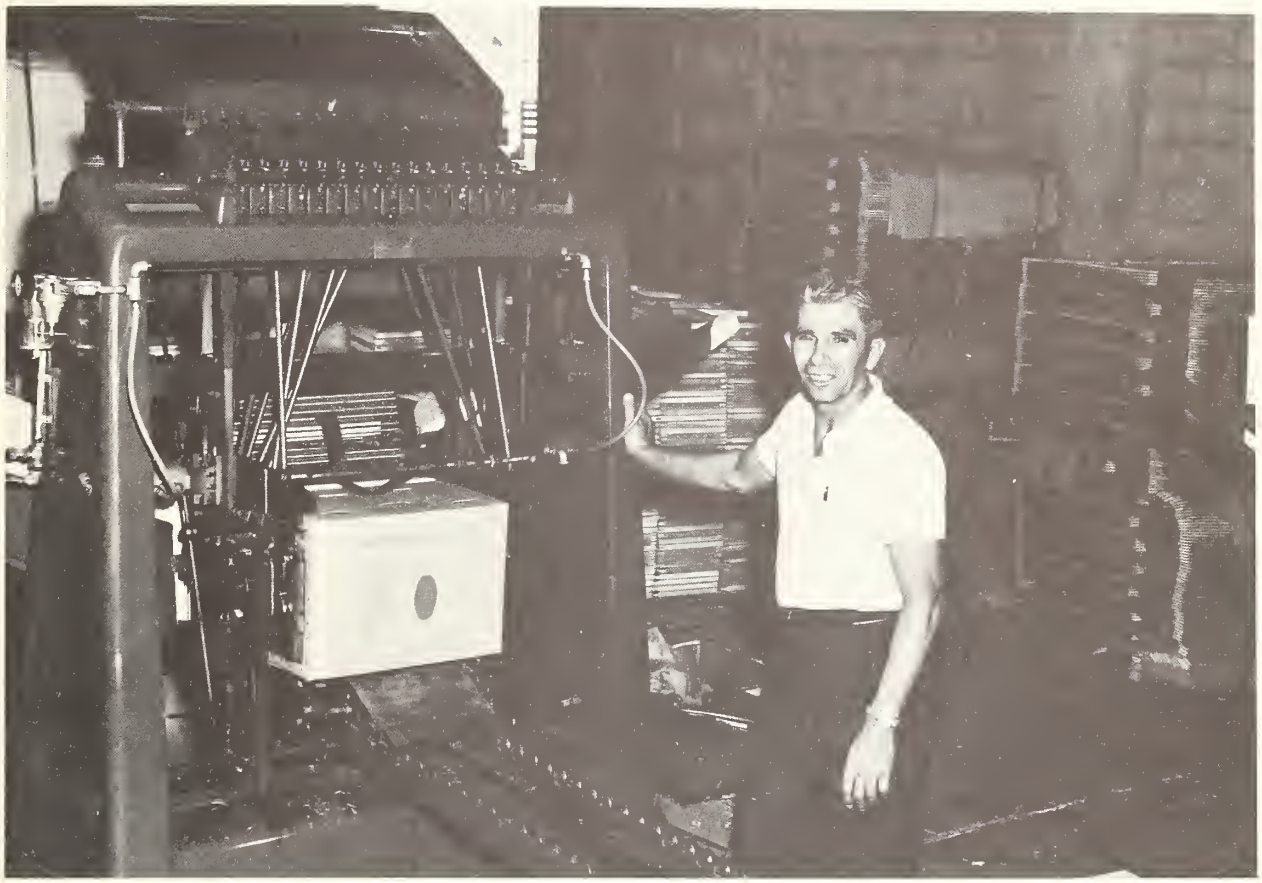

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FIGURE 23.—Nailing machine making up a carton. Note the feed magazine and box parts behind the machine.

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FIGURE 24.—Worker stacking 40-pound tomato cartons in a semitrailer.

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