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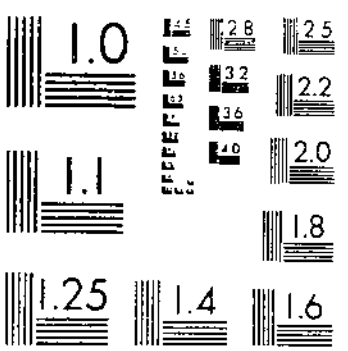
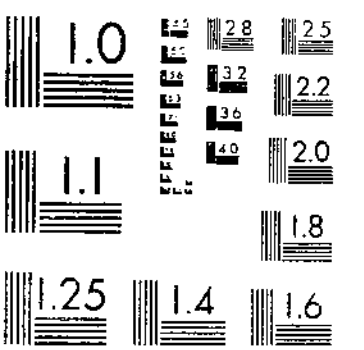


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A



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NATIONAL BUREAU OF STANDARDS-1963-A

TECHNICAL BULLETIN No. 153 DECEMBER, 1929

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

EFFECT OF MILK-PLANT ARRANGEMENT AND METHODS OF OPERATION ON LABOR REQUIREMENTS

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INTRODUCTION

Increased costs of labor, supplies, and equipment have made it necessary for the managers of milk plants to study the methods employed with a view to increasing the efficiency and decreasing the cost of operation.

In order to determine the most efficient systems used, the Bureau of Dairy Industry has made labor studies of the operations in milk plants in various sections of the country from the time the milk reaches the plant until it is placed on the wagons ready for delivery. The amount of labor and the time required for each operation were determined.

No attempt has been made to compare the costs of different methods of operation. Labor and other costs vary greatly in different sections and at different times. The fact that a certain system is operated with the least amount of labor does not necessarily show,

[1] Mr. Le Fevre, who did a large part of the field work, resigned before the work was completed.

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therefore, that it is the least expensive. Furthermore, two plants may have the same labor costs, but one may have greater overhead expenses than the other.

RECEIVING THE MILK

The process of receiving the milk at the plant consists of transferring the cans from the receiving platform to the dump tank, removing the lids, emptying, and placing the cans on the washer or on a conveyor leading to it. The men who receive the milk inspect it before it is dumped from the cans. When the milk is weighed at the city plant they note and record the weight also. Samples are taken at regular intervals for butterfat test. Usually the men who operate the trucks place the cans of milk on the platform, but these men are not included in the labor of receiving the milk except where they help in transferring the cans to the dump tank. In some cases the men on the platform help unload the truck, but as a rule the truckmen do this work alone, placing the cans of milk on the platform or on a conveyor.

It is desirable to have the plant so arranged that the milk can be received with as small a labor cost as possible. A rapid system is also desirable so that the milk may be handled as fast as it arrives.

In many plants the cans of milk are transported by automobile or by horse-drawn trucks from the country or from the railroad station in the city to the receiving platform. From a study carried on at 63 milk plants, the following systems for receiving milk thus transported have been found:

(1) Cans are transferred from receiving-room door to weigh or dump tank by means of platform trucks. After being emptied and washed, they are returned by the same trucks to the loading-out door.

(2) Cans are taken to the second or third floor by means of the ordinary freight elevator, which accommodates about 16 cans to the load. The empty cans, after being washed, are returned by the same elevator.

(3) Cans are rolled from receiving-room door to the dump or weigh tank. This distance varies from 10 to 30 feet, but at the majority of the plants the distance is approximately 15 feet. In most cases the cans are fed directly into the washer by the man who empties the milk from the cans, although at a few of the plants another man is required to transfer the cans to the washer. At some of the plants the washer delivers the cans at a point near the door, whereas at others extra handling of cans is required at this point because of considerable distance from the delivery end of the washer to the point where they are loaded on the truck.

(4) Dump or weigh tank is located close to the receiving-room door, so that the cans are emptied with practically no handling. The washer is so located that the cans are transferred to it and out to the truck with little handling, but usually some handling is required either before or after the cans are washed. Some of the plants are so arranged that the man who empties the cans places them in the washer; whereas other plants have a space of 10 to 25 feet between the dump tank and the washer, in which case the washer usually leads directly to the loading-out door.

(5) Cans are rolled approximately 12 feet from the receiving-room door to the dump tank, and after being emptied they are placed in an automatic washer from which they are transferred to the trucks by a gravity or power conveyor.

(6) Cans are transferred from the receiving-room door to the dump or weigh tank by means of gravity or power conveyors. The cans are placed in the washer directly after being dumped, usually by the same man who empties them, there being no extra handling at this point. The washer leads to the loading-out door either directly or by means of conveyors so that there is no extra handling at this point.

(7) Same system as 6 is used, except that the cans are elevated from the street floor to a higher level by means of power conveyors or lifts and the washed cans

are returned to the street floor by a similar conveyor or lift. When the cans of milk reach the higher floor they are conveyed to the dump tank as in system 6. The cans are placed directly in the washer, from which they pass on another conveyor to the lift or to a gravity conveyor which takes them to the street floor to be loaded on the trucks.

COMPARISON OF DIFFERENT SYSTEMS AS TO TIME AND LABOR REQUIRED

Table 1 shows a comparison of the results obtained from the use of these systems at 63 milk plants. At the 23 plants using system 6 (fig. 1) the number of gallons received per hour varied from 650 to 5,685, and the number of gallons received per man-hour varied from

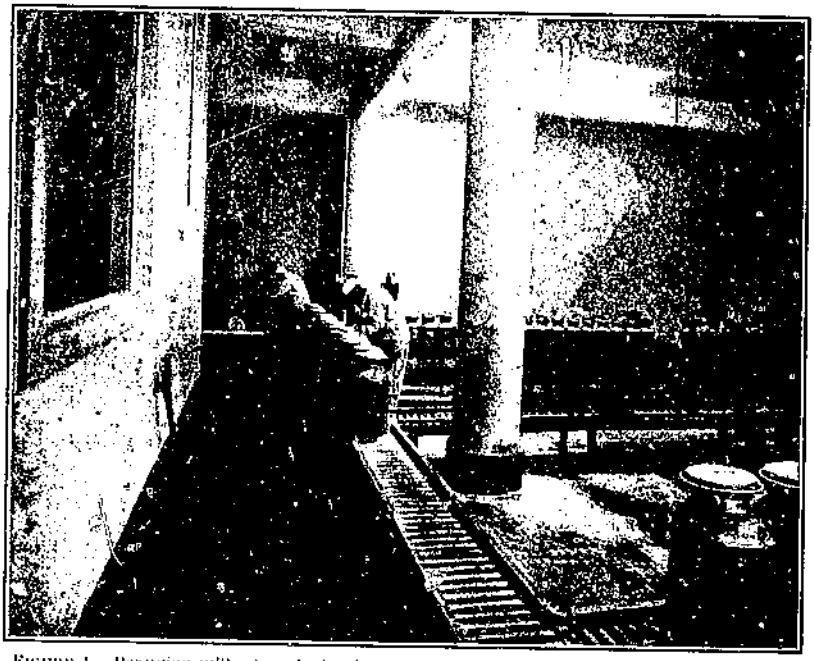

FIGURE 1.—Receiving milk at a plant using system 6. At 23 plants using systems similar to this an average of 2,334.4 gallons per hour and 459.6 gallons per man-hour was received

256.7 to 690.5, with averages of 2,334.4 and 459.6 gallons, respectively. Seventy-four per cent of the milk received at the plants in this group was weighed, and 65 per cent of the plants weighed all the milk, which is a larger percentage than in most of the other groups of plants. This system is very efficient as to labor required and is desirable for either small or large plants, unless, in the case of small plants, system 4 can be used. With system 6 the milk was received and weighed very rapidly with a small amount of labor. One plant with well-arranged conveyors received the milk at the rate of 708.8 cans per hour and 71.9 cans per man-hour.

TABLE 1.—*Comparison of the results obtained from the use of seven systems of receiving milk at 63 plants*

System [1]	Plants	Milk handled daily per plant		Help employed per plant	Time required		Milk received per—			
							Hour		Man-hour	
	Number	*Gallons*	*Cans* [2]	*Number*	*Hours*	*Man-hours*	*Gallons* [3]	*Cans* [3]	*Gallons* [3]	*Cans* [3]
1	3	5,083	525	4.0	5.2	17.3	983.9	101.6	293.3	30.3
2	2	5,435	544	4.5	5.5	24.5	988.1	98.8	221.8	22.2
3	20	4,399	500	3.5	4.1	15.2	1,079.6	124.3	289.9	33.5
4	7	5,433	549	2.4	3.6	8.9	1,506.1	152.1	613.4	61.9
5	3	14,042	1,367	3.3	6.3	25.7	2,217.1	215.8	547.1	53.3
6	23	9,642	1,172	4.6	4.1	21.6	2,334.4	283.2	459.6	55.9
7	5	16,220	1,576	6.8	6.9	47.4	2,353.6	228.8	342.2	33.3

System [1]	Time required to receive—				Milk weighed at plant	Plants weighing milk
	100 gallons		100 cans			
	Minutes [4]	*Minutes* [4]	*Minutes* [4]	*Minutes* [4]	*Per cent*	*Per cent*
1	6.0	6.1	57.6	59.1	36.1	33.3
2	6.3	6.1	62.4	60.7	100.0	100.0
3	6.6	5.6	60.2	48.1	55.8	60.0
4	5.3	4.0	50.5	39.5	22.4	28.6
5	3.0	2.7	31.7	27.8	0.0	0.0
6	3.9	2.5	36.2	21.2	74.1	65.2
7	3.0	2.6	29.6	26.3	31.6	40.0

[1] For descriptions of these systems, see p. 1.
[2] Most of the milk was received in 10-gallon cans but other sizes were used in some cases.
[3] True or weighted average.
[4] Average of averages.

System 1 was not a common system, and the table shows that it was not an efficient one. The smallest number of gallons per hour was received at the three plants using this system. The number of cans received per hour was slightly greater than at the plants using system 2. This was due, however, to the fact that at plants using system 1 a number of small-sized cans were used, whereas at the plants using system 2 only 10-gallon cans were used. With the exception of the plants using systems 2 and 3, those using system 1 received the smallest quantity of milk per man-hour.

Extra men and time were required at the plants using system 2 because of the transferring of milk from one floor to another. There were well-arranged conveyors on the second floor for bringing the milk to the dump tank and the cans from the washer. An average of only 98.8 cans per hour and 22.2 cans per man-hour was received at the two plants using this system.[2]

At the 20 plants using system 3 (fig. 2) an average of only 1,079.6 gallons of milk per hour and 289.9 gallons per man-hour was received. The average time required to receive 100 gallons of milk varied from 3 to 17.3 minutes, with an average of 6.6 minutes. Because of the small size of the plant, only one man was used at the plant requiring 17.3 minutes per 100 gallons, and the number of gallons received per man-hour was greater at this plant than at the average plant of the

[2] Similar results were reported in the following publication: KELLY, E., and CLEMENT, C. E. CITY MILK PLANTS: CONSTRUCTION AND ARRANGEMENT. U. S. Dept. Agr. Dept. Bul. 849, 35 p., illus. 1920. This bulletin shows that at four plants using this system an average of 101.5 cans was received per hour.

group. The number of gallons received per day at the plants in this group varied from 1,200 to 11,250, with an average of 4,399. This system of receiving milk appears to be desirable only for those plants that are unable to adopt either system 4 or 6. System 3 required much extra handling, which could be eliminated by having the weigh can near the receiving-room door or by installing a well-arranged conveyor to the weigh can and from the can washer.

Most of the plants using system 4 (fig. 3) were small. There was, however, one large plant, which received 13,500 gallons of milk per day. This was handled and the cans washed by 4 men in four hours, thus making an average of 3,375 gallons per hour and 843.8 gallons per man-hour. Many large plants are so arranged that this system

FIGURE 2.—Receiving milk at a plant using system 3. An average of 289.9 gallons per man-hour and 1,079.6 gallons per hour was received at 20 plants using this sytem

can not be conveniently used, but for small plants it is very satisfactory. An average of only 2.4 men, varying from 2 to 4, was used per plant. This was the smallest number used with any of the systems.

The three plants using system 5 ranked higher than those using system 4 in the number of gallons of milk received per hour. Although the plants using the former system were larger than those using the latter, more men were used, resulting in a smaller number of gallons received per man-hour. None of the milk at the plants using system 5 was weighed, for which reason less labor was required. A larger average daily quantity of milk was received at the plants using system 5 than was received by any other plants except those using system 7. This is true also of the average number of hours required per plant to receive the milk.

System 7 required more labor than did system 6, as extra men were needed to put the cans of milk on the lift and to take off the empty cans. Therefore, although more milk was received per hour than with the other systems, the number of gallons received per man-hour was considerably less than with some of the other systems. No milk pump was required at the plants using this system, as the milk flowed by gravity from the dump and receiving tank through the pasteurizing outfit to the bottle fillers. This is a desirable system for large plants which are so arranged that it is preferred to receive the milk on a higher floor and where it is not desired to use a milk pump; but, as is shown in Table 1, considerable labor could be saved if the milk were weighed on the street floor and system 6 or even

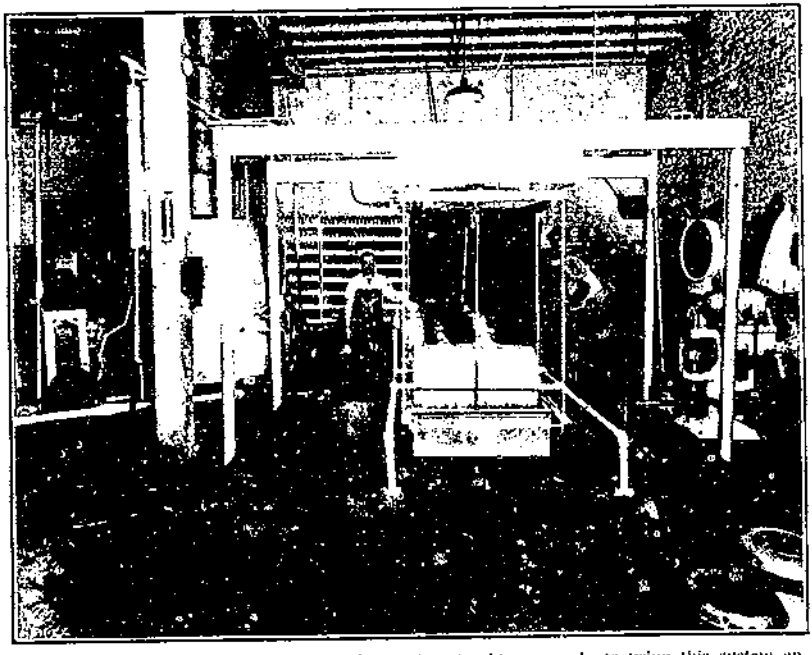

FIGURE 3.—Receiving milk at a plant using system 4. At seven plants using this system an average of 1,500.4 gallons per hour and 613.4 gallons per man-hour was received

system 5 used. The plants using system 7 required an average of 6.8 men, a much higher average than was required under any other system.

When all factors are considered, system 6 seems to be the most efficient one. Although at the particular plants studied less milk was received per man-hour than at plants using systems 4 or 5, more was received per hour than with either system 4 or 5, and more cans of milk were received per man-hour than at plants using system 5, there being fewer of the smaller-sized cans at the latter plants. Furthermore, system 6 is the most adaptable to plants having various arrangements of equipment. The plants using system 4 required the least number of men, but these plants were smaller than most of the others studied. Systems 1, 2, and 3 were the lowest in average number of gallons handled per hour and per man-hour.

COMPARISON WITH OTHER METHODS OF RECEIVING MILK

During recent years increasingly greater quantities of milk have been transported to the city in large tanks mounted either on automobile trucks or on railroad cars. Where the railroad car can be loaded at the country plant and can be switched on a siding to the plant in the city, it is used to a considerable extent. In other cases the tank truck is used to transfer the milk from the country plant or from the tank car in the city railroad yard to the city plant.

In some sections of the country full carloads of milk in cans are switched to the city-plant receiving platform and the cans transferred directly from the car to the plant receiving room. In some cases the cans of milk are transferred by means of platform trucks from the cars to the receiving room (fig. 4), and after the cans are emptied and washed they are returned to the car by truck, or they are carried by the men. In other cases a dump tank is placed in the car and con-

FIGURE 4.—Unloading milk from cars switched alongside plant receiving platform

nected with the receiving tank in the plant by sanitary piping, and the cans are emptied before being removed from the car. These cans are then transferred to the can-washing room, and after being washed they are returned to the car.

In Table 2 a comparison is made of the time and labor required at 123 plants, 91 of which received the milk in cans from trucks, which is the method used at the plants previously described (method 1); 24 of which received the milk from tank trucks or cars (method 2); and 8 of which received it in cans from cars switched alongside the plant receiving platform (method 3).

An average of only 1,540 gallons of milk per hour and 197 gallons per man-hour was received at the plants using method 3. The quantity received per hour was nearly as great as that received at plants using method 1, but the quantity received per man-hour was much less because of the fact that a large number of men were required to transfer the milk and cans from place to place. The method of receiving milk directly from the cars at the plant appears

to be very desirable, as it eliminates trucking from the railroad yards. Moreover, by the use of a properly arranged conveyor system, such as some of the plants using method 1 have, it should be possible to reduce the labor required at these plants. On account of the long railroad siding required, however, most of the plants using method 3 are long and narrow. (Fig. 5.) In this type of plant it is often very difficult to effect a convenient and efficient arrangement. At these plants the labor includes not only the removal of the cans of milk from the car but also the return of the empty cans to the car. This latter work is not included in the labor at the plants using method 1. In comparison with the plants using the other two methods, the number of men required in the plants using method 3 was excessively large.

TABLE 2.—*Comparison of the results obtained from three methods of receiving milk at 123 plants*

Method	Plants	Milk received daily per plant	Help employed per plant			Milk received per—		Time required to receive 100 gallons		Milk weighed at plant	Plants weighing milk
			Men	Time required		Hour	Man-hour				
	Number	*Gallons*	*Number*	*Hours*	*Man-hours*	*Gallons* [1]	*Gallons* [1]	*Minutes* [1]	*Minutes* [2]	*Per cent*	*Per cent*
(1) In cans from trucks	92	7,326	3.9	4.6	19.1	1,565	384	3.8	5.7	63.8	64.8
(2) From tank trucks or tank cars	24	8,162	1.6	4.4	6.2	1,834	1,309	3.3	3.7	38.8	33.3
(3) In cans from cars switched along plant receiving platform	8	9,445	8.4	5.9	46.5	1,640	197	3.9	4.1	22.0	25.0

[1] Weighted average. [2] Average of averages.

At the 24 plants receiving the milk in tank trucks or cars an average of 1,309 gallons was handled per man-hour. This is more than three times as much as the average amount handled per man-hour at the plants using method 1 and more than six times the average amount handled by the plants using method 3. The method of receiving from tank trucks or cars requires much less labor than does receiving the milk in cans, as the washing and steaming of the tanks is a small task compared with the washing of the large number of cans. Furthermore, the milk is transferred from the tanks to the weigh can or receiving tank by pump, gravity, or air pressure, so that no handling is required.

CHECKING IN THE ROUTES

The operation of verifying the driver's count of empty bottles and unsold goods and keeping the platform clear is called "checking in the routes." As a rule, the driver sets the bottles on the platform or on conveyors or trucks, if they are used; and the checker, after verifying the driver's count, transfers the bottles to another point. In some cases, however, he transfers the bottles from the platform to the conveyors or trucks. He also usually dumps or otherwise takes care of the unsold goods which are returned. The time required for the latter work, however, is not included in the time

required to check in the routes. From a study carried on at 82 plants, the following classifications have been made of the systems used in checking in routes:

(1) Bottles are checked in on a gravity conveyor which leads to the bottle-washing room or an adjoining storage room where they are stacked by the checkers. They are later removed from the stacks by the bottle-washing crew and transferred to the washer or to a conveyor leading to it. This system is used at plants where the bottles are not checked in and washed in one continuous operation.

(2) Bottles are put on one or more conveyors by the drivers, and after the count has been verified they pass direct to the washers and are washed immediately. A small proportion of the bottles, however, must be stacked because the pints and quarts can not be washed at the same time.

(3) Bottles are put on one conveyor by the drivers, and after the count is verified they go direct to the washer. Many of the bottles, however, must be stacked because they come in too fast for the washer to handle, since in practically

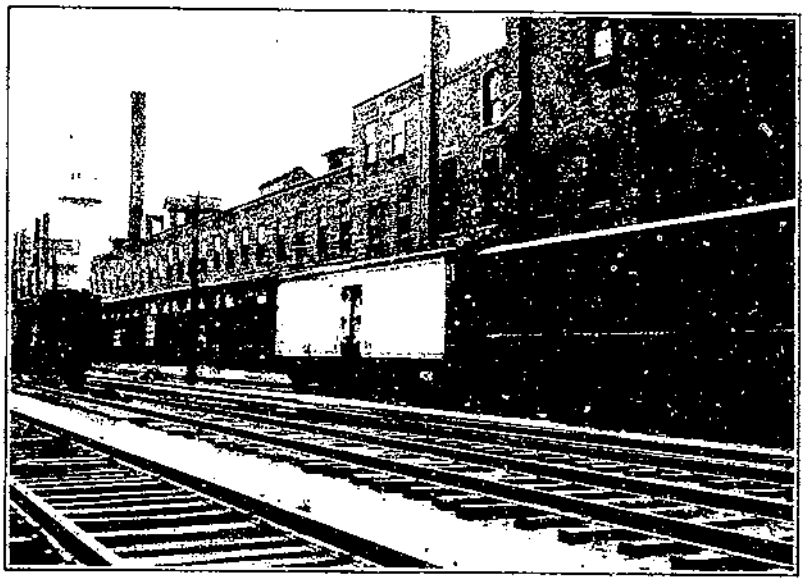

FIGURE 5.—Type of plant used where milk is received in cans from cars switched alongside of plant

all the plants in this group only one bottle-washing unit is used. Stacking is also necessary in most of the plants because pints and quarts can not be washed at the same time.

(4) Same as system 3 except that two or more conveyors are used. In some cases all the bottles from one wagon are unloaded at one conveyor, whereas in others pints are unloaded at one conveyor and quarts at another. In either case two or more routes may be checked in at the same time. The continuous or direct system of washing and filling is generally used.

(5) Bottles are unloaded and checked on the receiving platform at three or more points. Quart bottles are usually checked in at one point, pints at another, unsold goods at another, and so on, the driver going from one point to the next and several routes being checked in at the same time.

(6) Bottles are unloaded and checked on the platform close to the washer so that very little transferring is required. This system is adaptable only to small plants where the washer can be located in close proximity to the checking-in platform.

(7) Bottles are unloaded and checked on the platform, and the stacks of bottles are dragged back with hooks or by hand by the checkers to the washing room or adjoining storage space. As this is a slow process, the routes can not be checked

in at a very rapid rate. Since the washing room is usually nearby, the distance that the stacks of bottles must be transferred is short.

(8) Bottles are checked in and stacked on the platform and are then sent on conveyors to the washers by the checkers. At two of the three plants in this group the bottles were sent to another floor to be washed. At another plant they were checked in on a long platform at a considerable distance from the washing room. The two departments were so located, however, that the bottles could not pass in a straight line directly from the checking-in platform to the washer, as in the case of systems 2, 3, and 4. At this plant several routes could be checked in at the same time.

(9) Bottles are checked in on the platform and transferred to the washing room or adjoining storage space by means of lift trucks, dolly trucks, or the ordinary 3-wheel or 4-wheel platform trucks. The lift trucks consist of platforms with skids under which a wheel truck is run; the platform is raised by the lever of the truck; and it, with the full load of bottles, is wheeled away to the washing or storage room. The dolly truck is a small truck with small wheels or castors. Four stacks of bottles can usually be piled on this truck, which is then pushed away by hand.

(10) Bottles are checked in and stacked on the platform and transferred to the washing room or adjoining storage space by means of the ordinary barrel or warehouse truck, which usually carries six or seven cases to a load. This type of truck may have an attachment by means of which a man can readily transfer bottles stacked 10 cases high. At the particular plants studied, however, none of this latter type of trucks were in use. The bottles are usually checked in and stacked on a long platform, several routes often being checked in at the same time.

TABLE 3.—*Comparison of the results obtained from the use of 10 systems of checking in routes at 82 plants*

System	Plants	Routes per plant			Checking-in requirements			
		Wholesale	Retail	Total	Men	Hours	Man-hours	Per route
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Minutes*
2	8	2.1	71.1	73.2	2.8	3.2	9.0	2.7
6	7	.3	21.7	22.0	1.3	2.8	3.3	7.6
5	4		152.3	152.3	7.0	3.8	27.0	1.5
3	18	5.0	57.9	62.9	2.5	4.3	11.4	4.5
7	11	2.5	30.0	32.5	1.9	2.9	6.3	5.3
4	5	8.6	93.2	101.8	5.8	4.2	25.4	2.5
1	12	4.8	58.5	63.3	3.4	4.8	16.7	5.2
9	10	7.0	39.4	46.4	3.2	4.6	12.8	5.9
10	4	18.0	46.0	64.0	3.0	6.6	20.2	6.2
8	3	10.3	60.7	71.0	5.0	5.2	25.5	4.4

System	Routes checked in per—		Man-hours sorting and getting bottles to washer		Routes per man-hour [2]	Time required per 100 routes for—	
	Hour	Man-hour	Number	Per cent [1]		Checking in alone	Checking in including sorting and getting bottles to washers
	Number	*Number*			*Number*	*Man-hours*	*Man-hours*
2	22.5	8.1	0.1	50.3	4.1	12.4	24.4
6	7.9	6.7	1.4	29.8	4.7	14.9	21.3
5	40.6	5.6	27.6	50.5	2.8	17.9	35.7
3	14.5	5.5	11.1	49.3	2.8	18.2	35.7
7	11.4	5.2	5.8	47.9	2.7	19.2	37.0
4	24.5	4.0	19.8	43.8	2.3	25.0	43.5
1	11.5	3.8	14.3	47.0	2.0	26.3	50.0
9	10.1	3.6	16.2	55.9	1.6	27.8	62.5
10	9.7	3.2	22.9	53.1	1.5	31.3	66.7
8	13.7	2.8	27.7	52.1	1.3	35.7	76.0

[1] Per cent of total man-hours used for checking in, sorting, and getting bottles to washers.
[2] Including sorting and getting bottles to washers.

COMPARISON OF DIFFERENT SYSTEMS AS TO TIME AND LABOR REQUIRED

Table 3 shows the results of a study of the systems used in checking in routes at 82 plants. The table is arranged according to the efficiency of the systems in respect to the number of routes checked in per man-hour.

In the last column of this table are shown the total number of man-hours required to check in 100 routes, to sort the bottles, and to get them to the washer. This is the most important column in the table by which to determine the most economical system of checking in routes as regards labor. In some plants the routes may be checked in at a low labor cost, but much additional labor may be required to transfer the bottles from the checking-in platform to the bottle

FIGURE 6.—Unloading bottles on a conveyor at a plant using system 2. An average of 22.5 routes per hour and 8.1 routes per man-hour was checked in at eight plants using this system

washers, in which case the system can not be considered economical of labor.

System 2 (fig. 6) was the most economical in respect to the labor required for actual checking in. Plants of all sizes used this system, the number of routes per plant varying from 9 to 144. At 5 of the plants 1 conveyor was used, at 2 plants 2 conveyors were used, and at 1 plant 4 were used. At the plant using 4 conveyors, the routes were checked in at the rate of 60 per hour. The average length of time required to check in the routes at all the plants was only 3.2 hours. The plants using system 2 checked in more routes per hour than did any others except those using systems 4 and 5.

An average of only 2.8 men per plant was used for checking in with system 2, and more routes were checked in per man-hour than with any of the other systems. Only a small amount of handling and very little storage space were required. Only system 6 required fewer man-hours per 100 routes than did system 2 to check in the routes and to get the bottles to the washer.

At plants using system 6 the routes were checked in at the rate of 6.7 per man-hour, and only 21.3 man-hours were required to check in 100 routes and to get the bottles to the washer. Fewer routes were checked in per hour, however, with this system than with any other, and it is adapted only to small plants.

System 5 was found to be the most efficient in regard to the number of routes checked in per hour. (Figs. 7 and 8.) The average number of routes at the four plants using this system was 152.3, the number varying from 120 to 190. At these plants, because of their size, it was necessary to check in a large number of routes in a limited time, and more men were required than were required at plants using other systems. Some of the plants had as many as five unloading points, which permitted five routes to be checked in at the same time. This necessitated at least one man at each unloading point. The number of routes checked in per man-hour was therefore less than at plants

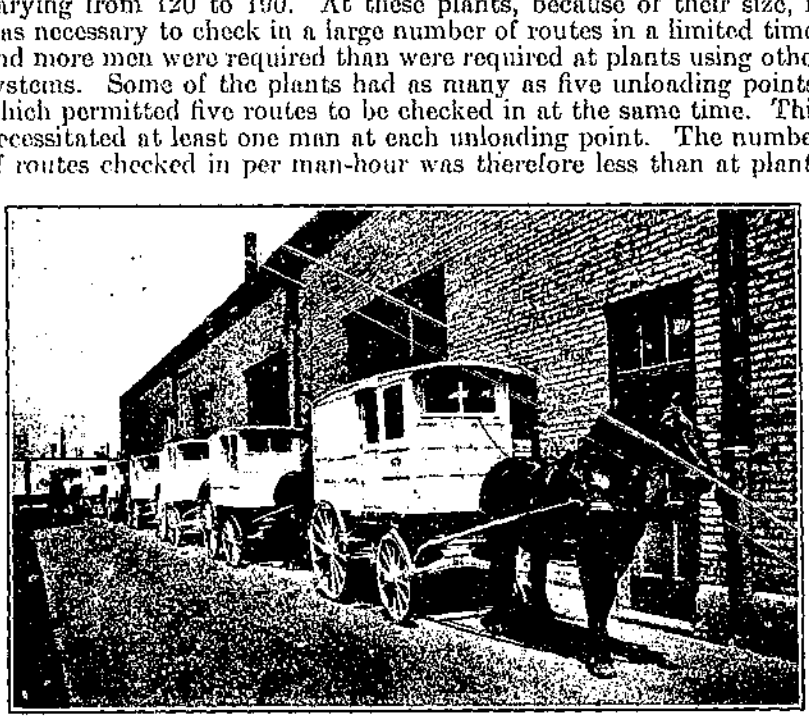

FIGURE 7.—Checking in routes at a plant using system 5. An average of 40.6 routes was checked in per hour at four plants using this system

using some of the other systems. Considerable labor was required to get the bottles to the washer, an average of 35.7 man-hours being required to check in 100 routes, sort the bottles, and get them to the washer. At some of these plants conveyors led from each unloading point to the washers, whereas others were so arranged that the bottles were first stacked on the platform and later sent to the washing room on conveyors. Considerable storage space for dirty bottles and ample platform space were required when this system was used. It was found primarily at plants the arrangement of which was such that other systems could not be adapted to them.

The plants using system 3 checked in practically as many routes per man-hour as those using system 5. System 3 was the most popular one, there being 18 plants in this group. Fewer men were required than with some of the other systems, an average of only 2.5 men per plant being used in checking in routes and stacking bottles. More than twice as many men were used at the plants using system 4 (with two conveyors), although considerably more routes were checked in

per hour with the latter system. As a large proportion of the bottles were stacked, considerable storage space was required, and a large amount of labor was used in getting the bottles to the washer. An average of 35.7 man-hours per 100 routes was required in system 3 to check in and to get the bottles to the washer. The average number of routes at the 18 plants using system 3 was 62.9, the number varying from 21 to 120.

System 7 was the next most efficient system as to labor required per route. (Fig. 9.) Fewer men were required than with most of the other systems, but it is adaptable only to small plants. Considerable labor was required to get the bottles to the washer, and much storage space for the bottles was necessary. Although an average of only 19.2 man-hours was required to check in 100 routes, 37 man-hours

FIGURE 8.—A line of wagons waiting to be checked in at the plant shown in Figure 7

was required when the labor of getting the bottles to the washer was included.

With system 4 fewer routes were checked in per man-hour than with system 3, where only one conveyor was used, but considerably more were checked in per hour, as many as 30 routes per hour being checked in at some of the plants. This system is better adapted to large plants than is system 3. The five plants studied varied from 41 to 140 in number of routes and averaged 101.8. Less storage space for dirty bottles and less labor in getting the bottles to the washer were required than with some of the other systems.

System 1 required a good deal of labor both for checking in the routes and for getting the bottles to the washer. An average of only 3.8 routes was actually checked in per man-hour, and only 2 per man-hour when the labor required to get the bottles to the washer was included. Considerable storage space for the bottles was also required.

System 9 (fig. 10) was not economical in number of routes checked in per hour and per man-hour and in number of men used. An average of 62.5 man-hours per 100 routes was required for checking in and getting the bottles to the washer. Considerable storage space for the bottles was also necessary. Although as a rule this system is not economical in the number of routes checked in per hour and per man-hour and in the number of men required, it is as well adapted to some small plants as is the conveyor system.

The principal advantage of the use of trucks, such as those used with system 9, over the use of conveyors is that the checking of the returned bottles is facilitated and there is less likelihood of difference between the checkers' and drivers' counts. When the full load is placed on one truck the driver can readily see how many bottles he has; whereas when they have passed on a conveyor with returns

FIGURE 9.—Checking in routes at plant using system 7. At 11 plants using this system an average of 11.4 routes was checked in per hour

from other routes, mistakes are sometimes made, and a recount is very difficult.

System 10 was one of the least economical systems both as to time and labor required. (Fig. 11.) Since the four plants using this system were all located in the same city, its use seems to be the result of custom rather than of economy. The fact that end-door delivery wagons were used at these plants also seems to be one reason for the use of this system of checking in routes, as some of the other systems were not so well adapted for receiving the bottles from end-door wagons.

System 8 was not commonly used, as is shown by the small number of plants in this group. It was not economical so far as the use of labor is concerned, as there was a great deal of transferring of bottles. An average of 35.7 man-hours per 100 routes was required for checking in alone, and an average of 76.9 man-hours when the labor of getting the bottles to the washer was included.

Figure 12 shows the relation between the number of man-hours required for checking in alone at plants using the systems previously described and the total number of man-hours required for checking in the routes, sorting the bottles, and getting them to the washer. The systems are arranged in order of greatest economy as to labor required for checking in alone.

Figure 12 shows that a comparatively large amount of labor was required to get the bottles to the washers at the plants using systems 1, 9, 10, and 8. With system 1 considerable time was used to transfer the bottles from the storage room to the washer. Since trucks were used with systems 9 and 10, much handling was necessary before the bottles reached the washers. In the case of system 8, the large number of extra men required in getting the bottles to the washers was due

FIGURE 10.—Checking in routes at a plant using system 9. An average of 10.1 routes was checked in per hour at 10 plants using this system

to the transferring from the stacks to the conveyors leading to the washers. Only a small amount of labor was required to get the bottles to the washer at the plants using system 6 because with this system the bottles are unloaded close to the washer.

RELATION OF SIZE OF PLANT TO SYSTEM USED

It is desirable for plants of all sizes to employ a system by which all routes can be checked in in at least four or five hours. As a rule the large plants have adopted systems which are the most economical in the use of time. Figure 13 shows the relation of the size of plant to the system used at the plants studied. Dotted line A–B connects the blocks representing the average number of routes operated by the groups of plants using the various systems of checking in and dotted line C–D connects the blocks representing the average number of routes checked in per hour by these systems.

The lines are far apart for systems 8, 10, and 1, and they are very close together for systems 6 and 7. Systems 8, 10, and 1 are less efficient as to time required per route than would be expected from the number of routes at the plants in these groups. As before stated, the use of system 8 is due more to the peculiar arrangement of the particular plants than to the economy of the system. The plants using system 1 were not so arranged and the operations were not so coordinated that the bottles could pass directly to the bottle washers from the checking-in platform. As before stated, the use of system 10 is restricted to a certain locality where custom and the use of end-door wagons seemed to be the principal reasons for its existence.

Systems 6 and 7, at which the dotted lines in the figure come very close together, are adaptable only to small plants. Where only a

FIGURE 11.—Checking in routes at a plant using system 10. An average of only 3.7 routes per hour and 3.2 routes per man-hour was checked in at four plants using this system

few routes are to be checked in, there is no necessity for installing conveyors or for any special arrangement as long as the bottle washer is close to the receiving platform. System 7, as the lines in the figure indicate, is used at slightly larger plants than is system 6. This is due to the fact that with the former system the cases of bottles are pulled out of the way immediately.

BOTTLE WASHING AND FILLING

Bottle washing and filling are two of the most important operations in the milk plant. The amount of labor used in washing and filling bottles at 104 plants was found to be nearly 50 per cent of that required for all the principal operations, including receiving milk, washing cans, pasteurizing and cooling, storing the milk, and loading and unloading delivery wagons.

A study of the operation of bottle washing and filling in milk plants to determine the relative merits of the systems used entails the con-

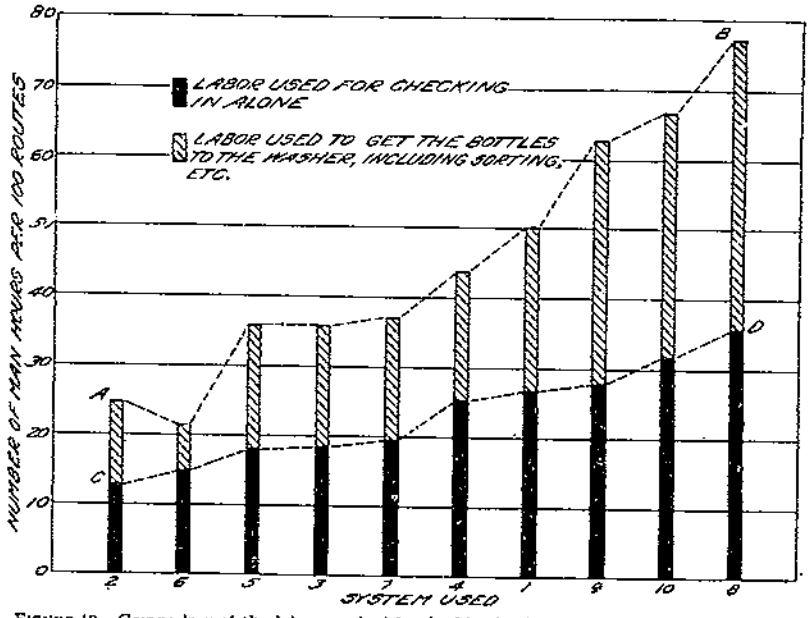

FIGURE 12.—Comparison of the labor required for checking in alone (C–D) with that required for checking in the routes, sorting the bottles, and getting them to the washers at plants using various systems (A–B)

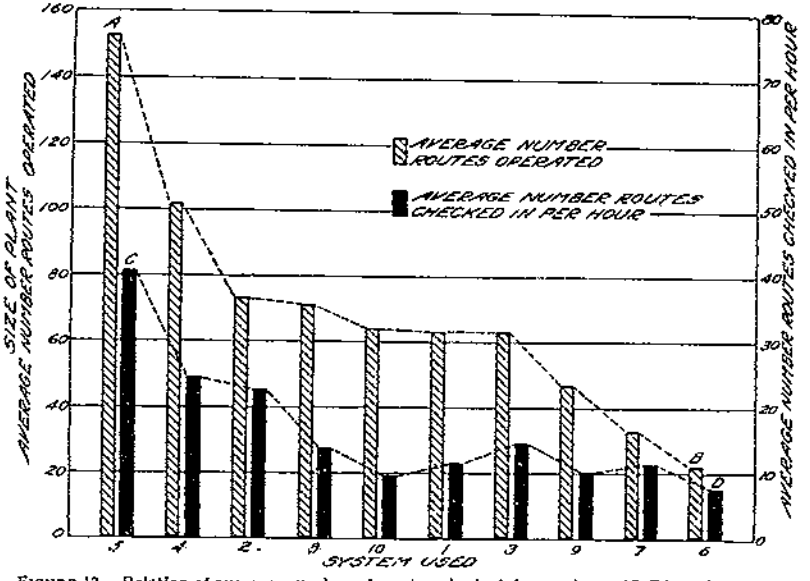

FIGURE 13.—Relation of average number of routes checked in per hour (C–D) to the size of plant (A–B)

sideration of a number of factors, the most important of which are as follows: (1) Method of checking in the bottles from the routes;

(2) whether or not the bottles are sorted, and if so, the number of men required; (3) method of getting the bottles from the checking-in platform to the washers, from the washers to the fillers, and from the fillers to the storage room; (4) number and type of machines used; and (5) number of men used for inspection.

Studies made at 171 milk plants showed a great variation in the amount of labor required at plants using different systems of getting the bottles to the fillers. The following three systems were considered: Direct, indirect, and semidirect. In the direct system (figs. 14, 15, and 16), no handling of bottles between the washers and fillers is required. After being removed from the cases, the bottles are washed and sterilized and are then cooled in the washer, from which they pass automatically on conveyors direct to the fillers.

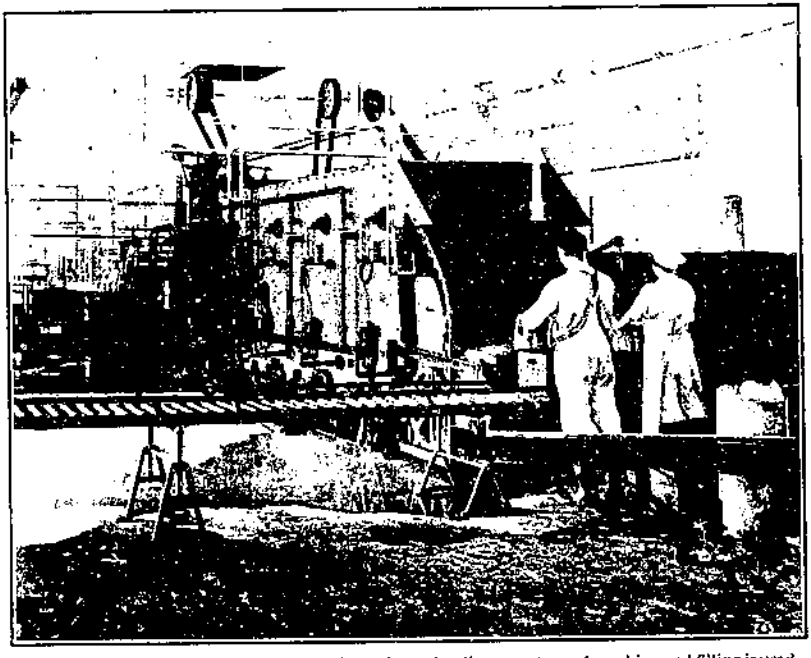

FIGURE 14.—Feeding bottles to the washer where the direct system of washing and filling is used. The bottles pass from the washer on conveyors directly to the fillers

In the indirect system (fig. 17) the bottles, after being washed in the cases, are stacked either in the bottle-filling room or in a special clean-bottle storage room and allowed to cool, after which they are removed from the cases and fed into the fillers by hand. Thus this system not only requires considerably more labor in handling bottles than does the direct system, but it offers a greater chance for the bottles to become contaminated, either while in storage or by the hand feeding to the fillers.

Only a few plants use the semidirect system. These plants use the same types of bottle washers as are used with the indirect system except that a cooling arrangement is attached. As soon as the bottles have been washed and sterilized, they are cooled in the cases, after which they pass on conveyors to the fillers, where they are removed from the cases and fed to the machines by hand.

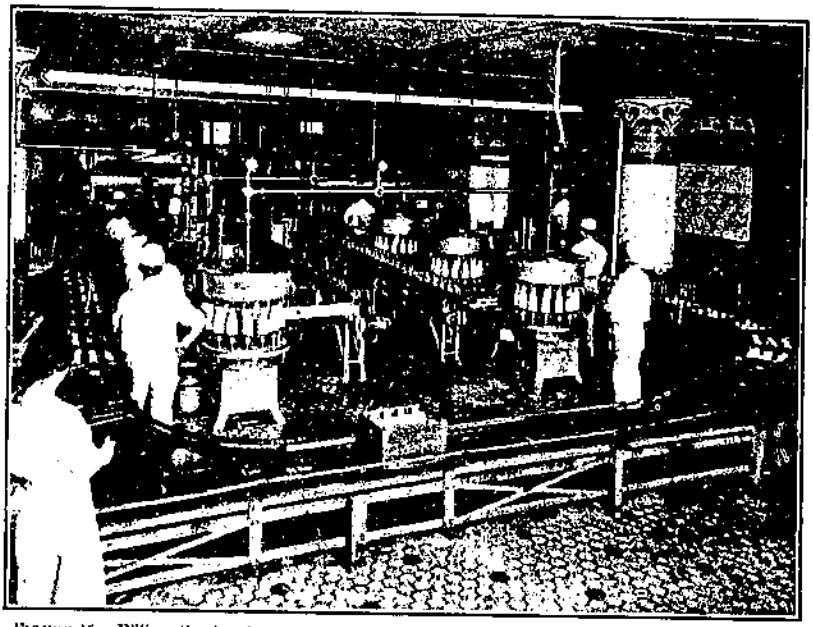

FIGURE 15.—Filling the bottles at a plant using the continuous or direct system of washing and filling

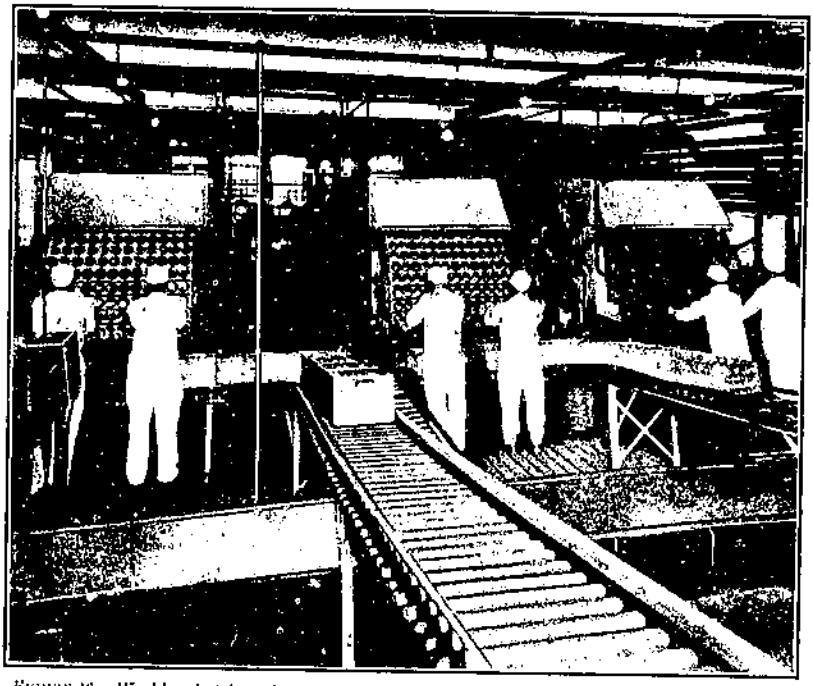

FIGURE 16.—Washing bottles where the direct system of washing and filling is used and where system 2 is used in checking in the routes. At eight plants using this combination an average of 8.1 routes was checked in per man-hour and 1,204 bottles washed per man-hour

Table 4 shows the importance of the system used in washing and filling the bottles. The average number of bottles washed per man-hour was 748.4 for the 97 plants using the indirect system, 1,251.9 for the 6 plants using the semidirect system, and 1,016.2 for the 68 plants using the direct system. The number of bottles filled per man-hour was 731.7, 902.5 and 1,392 respectively for the three systems, indirect, semidirect, and direct.

At many plants where the number of bottles washed per man-hour was small, the number filled per man-hour was great, and vice versa. The average number of bottles washed and filled per man-hour is,

FIGURE 17.—Washing bottles at a plant using the indirect system of washing and filling

therefore, the best indication of the efficiency of the system. The number of bottles washed and filled per man-hour by the indirect, semidirect, and direct systems was 370, 525.4, and 586.8, respectively. The plants using the semidirect system washed, filled, and capped 42 per cent more bottles per man-hour than those using the indirect system. The percentage increase of the direct system over the indirect system was 58. Although no comparison of these systems has been made as to initial cost of machinery, cost of upkeep, or of steam and power required to operate the machines, these figures indicate a distinct advantage in favor of the direct system as far as labor is concerned. The trend at the present time is toward the use of this system.

TABLE 4.—*Comparison of direct, indirect, and semidirect systems of washing and filling bottles as to average time and labor requirements at 171 milk plants*

System	Number bottles handled daily	Plants	Washing bottles					
			Bottles per plant	Men per plant	Time required per plant		Per hour	Per man-hour
					Hours[1]	Man-hours[2]		
		Number	*Number*	*Number*			*Number*[1]	*Number*[2]
Indirect	5,000 or fewer	8	4,148	1.0	3.9	0.1	1,070	694
	5,001 to 10,000	16	7,231	2.8	3.5	10.2	2,049	707
	10,001 to 15,000	13	11,545	3.7	4.6	17.8	2,502	648
	15,001 to 20,000	14	17,803	3.8	6.6	26.5	2,708	675
	20,001 to 30,000	14	25,258	4.4	8.4	32.4	3,064	780
	30,001 to 50,000	10	40,223	5.4	7.2	45.5	5,578	884
	50,001 to 100,000	13	73,527	12.0	8.0	105.5	9,138	697
Total or average		97	27,043	4.0	5.9	30.1	4,594	748.4
Semidirect	20,001 to 30,000	2	28,667	2.8	6.3	23.4	4,267	1,140
	30,001 to 50,000	4	38,088	3.3	8.4	20.4	4,543	1,297
Total or average		6	34,281	3.1	7.7	27.4	4,471.4	1,251.9
Direct	5,001 to 10,000	5	8,625	1.5	4.3	7.0	2,008	1,232
	10,001 to 15,000	9	12,209	2.0	5.4	10.7	2,242	1,130
	15,001 to 20,000	6	18,323	3.0	6.6	19.4	2,783	944
	20,001 to 30,000	6	24,728	3.0	6.8	20.1	3,663	1,231
	30,001 to 50,000	16	33,611	5.1	7.2	37.4	5,514	1,059
	50,001 to 100,000	14	68,309	9.0	8.4	74.0	8,118	923
	Over 100,000	9	126,894	14.4	8.4	121.6	15,097	1,043
Total or average		68	47,075	6.1	7.1	47.2	6,788	1,016.2

System	Number bottles handled daily	Filling bottles					Washing and filling bottles		
		Bottles per plant	Men per plant	Time required per plant		Per hour	Per man-hour	Bottles per plant	Time required per plant	Per man-hour
				Hours	Man-hours					
		Number	*Number*			*Number*	*Number*	*Number*	*Man-hours*	*Number*
Indirect	5,000 or fewer	3,883	2.1	3.3	7.1	1,172	550	4,015	13.1	306
	5,001 to 10,000	7,160	2.8	4.1	11.3	1,762	636	7,195	21.5	335
	10,001 to 15,000	11,357	3.5	4.7	15.8	2,440	720	11,451	33.6	341
	15,001 to 20,000	17,170	4.6	6.2	27.1	2,817	644	17,684	53.6	330
	20,001 to 30,000	25,105	5.7	6.5	36.6	3,867	686	25,182	69.0	365
	30,001 to 50,000	38,539	7.1	6.8	45.3	5,667	850	38,331	90.8	434
	50,001 to 100,000	72,337	12.9	7.7	109.5	9,451	710	72,932	206.1	384
Total or average		20,412	5.7	5.8	36.1	4,500.6	731.7	26,728	72.2	370.0
Semidirect	20,001 to 30,000	25,167	5.0	6.3	31.5	4,027	799	25,017	54.9	472
	30,001 to 50,000	37,732	5.0	8.0	40.0	4,717	943	37,910	69.4	546
Total or average		33,544	5.0	7.4	37.2	4,522.8	902.5	33,012	64.6	525.4
Direct	5,001 to 10,000	8,604	1.3	4.0	4.8	2,151	1,792	8,604	11.8	730
	10,001 to 15,000	12,000	1.3	6.3	7.1	1,893	1,688	12,104	17.8	670
	15,001 to 20,000	17,956	2.5	7.2	17.3	2,506	1,036	18,140	36.8	491
	20,001 to 30,000	24,470	2.3	7.2	18.6	3,414	1,317	24,599	38.7	636
	30,001 to 50,000	38,534	3.3	7.3	22.4	5,339	1,738	39,222	59.8	656
	50,001 to 100,000	67,628	7.0	8.8	53.9	7,680	1,254	67,909	128.6	531
	Over 100,000	125,814	11.1	9.3	92.4	13,450	1,362	126,354	214.0	590
Total or average		47,390	4.5	7.5	34.0	6,334.9	1,392	47,983	81.3	580.8

[1] No junk bottles included.

[2] Includes washing junk bottles.

RELATION BETWEEN NUMBER OF FLOORS USED AND MAN-HOUR REQUIREMENTS

The tendency at the present time is to confine plants to one or two floor levels. Many of the recently constructed plants have one story or one story with a mezzanine floor for the pasteurizing equipment, laboratory, etc. The machinery used in the direct system of washing and filling is well adapted to the 1-floor plant.

At many plants bottles are washed and filled on the street floor. At some plants, however, more than one floor is used for these operations. The bottles as they are received from the drivers may be sent to the basement or even to the second floor to be washed, and they are then sent up or down, as the case may be, to the street floor to be filled. In some cases bottles are filled on the second floor and are sent to the milk-storage room on the street floor. At all the plants the storage room is on the street floor.

Table 5 shows the number of man-hours required per 1,000 bottles washed and filled at 79 milk plants using either one floor or more than one floor for washing and filling the bottles.

The number of man-hours per 1,000 bottles washed and filled was 20 per cent greater for the plants using more than one floor than for the plants using only one floor.

TABLE 5.—*Man-hour requirements per 1,000 bottles washed and filled at 79 plants using either one floor or more than one floor for washing and filling bottles*

System	Plants using one floor		Plants using more than one floor		Difference between (A) and (B)
	Plants	Time required (A)	Plants	Time required (B)	
	Number	*Man-hours*	*Number*	*Man-hours*	*Per cent*
Direct	32	1.51	11	1.69	11.9
Semidirect	9	1.93			
Indirect	21	2.27	6	3.10	36.6
Total or average	62	1.83	17	2.19	20.0

Table 6 shows the relation between the number of floors used and the man-hour requirements for washing and filling bottles at 43 plants using the direct system. The number of man-hours required for the major [3] operations does not differ greatly at any of the plants. The number of man-hours required for the accessory [4] operations is greater at all the plants using more than one floor than at plants using only one floor, except at those plants handling 50,001 to 100,000 bottles daily. In this group slightly more man-hours per 1,000 bottles were required at the 1-floor plants than at the plants using more than one floor. At each of the latter plants only one man was required in getting the bottles to the washer. At the six plants in the group handling 50,001 to 100,000 bottles and using only one floor the number of man-hours required for miscellaneous operations was great, thus making the total amount of labor for accessory operations large. The principal reason for this was the large amount of labor used at these six plants for sorting and inspecting bottles both before and after they were filled.

[3] See footnote 2 under Table 6.

[4] See footnote 1 under Table 6.

TABLE 6.—*Relation between the number of floors used and the man-hour requirements for washing and filling bottles at 43 plants using the direct system*

Bottles handled daily	Floors used	Plants	Bottles handled daily per plant	Man-hours required per 1,000 bottles for—				
				Accessory operations [1]			Major operations [2]	Total operations
				Getting bottles to washer	Miscellaneous	Total		
		Number	*Number*					
20,000 or fewer	1	9	12,553	0.38	0.10	0.48	1.04	1.52
	More than 1	1	11,908	.76	.38	1.14	1.14	2.28
20,001 to 50,000	1	15	32,816	.19	.14	.33	1.12	1.45
	More than 1	5	34,614	.31	.29	.60	1.00	1.60
50,001 to 100,000	1	6	69,073	.20	.45	.74	.99	1.73
	More than 1	2	57,740	.13	.51	.64	.96	1.60
100,001 or over	1	2	114,855	.11	.30	.41	.82	1.23
	More than 1	3	130,886	.25	.65	.90	.82	1.72
Total or average	1	32	39,044	.26	.20	.46	1.05	1.51
	More than 1	11	15,027	.30	.44	.74	.95	1.69

[1] Such as getting the bottles to the washers and fillers and transferring them from place to place.
[2] Such as feeding the washers and fillers and taking bottles away from the washers and fillers.

The direct system of washing and filling is well adapted to plants of one floor. Of the 43 plants using this system, only 11 used more than one floor.

Table 7 shows the relation between the number of floors used and the man-hour requirements for washing and filling bottles at 27 plants using the indirect system.

TABLE 7.—*Relation between the number of floors used and man-hour requirements for washing and filling bottles at 27 plants using the indirect system*

Number of bottles handled daily	Floors used	Plants	Bottles handled daily per plant	Man-hours required per 1,000 bottles for—						
				Accessory operations [1]					Major operations [2]	Total operations
				Getting bottles to washer	Disposing of bottles from washer	Getting bottles to filler	Miscellaneous	Total		
		Number	*Number*							
20,000 or fewer	1	6	8,490	0.12	0.19	0.29	0.15	0.75	1.55	2.30
	More than 1	1	19,000	.34	.16	.34	.42	1.26	2.23	3.49
20,001 to 50,000	1	10	34,329	.18	.22	.24	.24	.88	1.23	2.11
	More than 1	4	30,522	.33	.30	.36	.76	1.75	1.36	3.11
50,001 to 100,000	1	5	75,701	.33	.25	.37	.60	1.55	1.03	2.58
	More than 1	1	75,000	.32	.21	.21	.22	.96	1.70	2.66
100,001 or over	1									
	More than 1									
Total or average	1	21	35,797	.20	.20	.29	.30	.99	1.28	2.27
	More than 1	6	40,014	.33	.26	.34	.61	1.54	1.56	3.10

[1] Such as getting the bottles to the washers and fillers and transferring them from place to place.
[2] Such as feeding the washers and fillers and taking bottles away from the washers and fillers.

For plants of all sizes the number of man-hours required per 1,000 bottles washed and filled was greater for those using more than one floor than for those using only one floor. The labor employed for accessory operations was greater for all plants using more than one floor than for those using only one floor, with the exception of the one

plant in the group handling between 50,001 and 100,000 bottles. At this plant the extra labor used was for major operations, so that the total for all the operations was greater than for the 1-floor plants in the group.

The results shown in Tables 6 and 7 seem to indicate that as a rule, regardless of the system used or the size of the plant, more labor is required to wash and fill bottles where more than one floor is used than where only one floor is used. Often some extra labor is required in transferring the bottles from one floor to another, even when conveyor systems are used. For example, at one plant where the bottles were received on the second floor and washed on the first floor an extra man was required to keep them in line on the conveyor leading from the second floor to the washer on the first floor.

PASTEURIZING AND COOLING MILK, CLEANING EQUIPMENT, AND STACKING BOTTLED MILK IN STORAGE ROOM

Table 8 shows the relation between the size of plant and labor requirements for pasteurizing and cooling the milk, for cleaning the equipment, and stacking bottled milk in the storage room at 112 plants. According to the table, labor for pasteurizing and cooling milk can be used more economically in large plants than in small ones. At least one man must be detailed to the pasteurizing department in plants of all sizes. Even in small plants this man can do little more than attend to the pasteurizing equipment during the operation. Since large plants usually require not more than two men, the quantity of milk handled per man in large plants is much greater than in small plants.

At small plants the man who operates the pasteurizer often does some cleaning during the last part of the run. This fact partly accounts for the comparatively small number of man-hours for cleaning charged to these plants, as shown by Table 8. Many large plants have found it desirable and economical to employ men to spend their entire time in cleaning the pasteurizing and cooling equipment. This system, however, would not be practical for small plants. When the total amount of labor for pasteurizing the milk and cleaning the equipment is considered there is not a great difference between the quantity of milk pasteurized per man-hour at the small plants and at the large ones.

TABLE 8.—*Relation between the size of plant and labor requirements for pasteurizing and cooling the milk, cleaning the equipment, and stacking the bottled milk in storage room at 112 plants*

Group	Milk handled (gallons)	Plants	Milk pasteurized and cooled per man-hour	Labor required per day for cleaning pasteurizing equipment	Milk pasteurized and cooled per man-hour (including cleaning equipment)	Bottles stacked in storage room per man-hour
		Number	*Gallons*	*Man-hours*	*Gallons*	*Number*
1	3,000 or less	24	439	3.7	246	1,907
2	3,001 to 5,000	22	690	5.0	341	2,152
3	5,001 to 10,000	38	982	9.3	434	2,340
4	10,001 to 15,000	17	1,290	17.3	476	2,238
5	Over 15,000	11	1,588	24.4	450	2,462

The number of bottles stacked in the storage room per man-hour is fairly uniform for plants of all sizes. Practically the same system is used at all plants, and one man can handle about the same number regardless of the size of the plant.

CHECKING OUT THE ROUTES

The time required to check out a given number of routes depends a good deal on the system used. In a study carried on at 93 milk plants the following 8 systems for checking out the routes were found: (1) Direct from the storage room through one door or chute; (2) use of barrel or warehouse trucks;[5] (3) direct from the storage room through two doors or chutes; (4) use of wheel platform or dolly trucks;[5] (5) use of lift trucks;[5] (6) direct from storage room through three doors or chutes; (7) direct from storage room through four or more doors or chutes; and (8) from seven or more loading points.

Table 9 shows the results of a study at 19 plants that checked out routes direct from the storage room through one door or chute. This system is employed usually only at small plants. At several of the plants studied only one man was used, and at only four plants were more than two men used.

TABLE 9.—*Labor and time required at 19 plants for checking out routes through one door or chute*

Plant No.	Routes			Men employed	Hours of work	Man-hours[1]	Routes per hour	Routes per man-hour[1]	Time required per route
	Wholesale	Retail	Total						
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Minutes*
1	0	8	8	1.0	1.5	1.5	5.3	5.3	11.3
2	0	9	9	3.0	1.0	3.0	9.0	3.0	6.7
3	2	8	10	1.0	2.5	2.5	4.0	4.0	15.0
4	0	10	10	1.0	1.0	1.0	10.0	10.0	6.0
5	1	10	11	2.0	1.5	3.0	7.3	3.7	8.2
6	2	16	18	2.0	2.0	4.0	9.0	4.5	6.7
7	1	21	22	2.0	3.0	6.0	7.3	3.7	8.2
8	0	23	23	2.0	2.0	4.0	11.5	5.7	5.2
9	0	24	24	1.0	3.0	3.0	8.0	8.0	7.5
10	0	26	26	2.0	1.5	3.0	17.3	8.7	3.5
11	5	22	27	2.0	3.5	7.0	7.7	3.9	7.8
12	3	25	28	1.0	5.5	5.5	5.1	5.1	11.8
13	0	28	28	2.0	2.0	4.0	14.0	7.0	4.3
14	1	27	28	2.0	1.5	3.0	18.7	9.3	3.2
15	0	32	32	3.0	4.0	12.0	8.0	2.7	7.5
16	6	32	38	2.0	3.0	6.0	12.7	6.3	4.7
17	5	36	41	2.0	3.5	7.0	11.7	5.9	5.1
18	0	48	48	3.0	3.0	9.0	16.0	5.3	3.8
19	6	42	48	3.0	3.0	9.0	16.0	5.3	3.8
Average	1.7	23.5	25.2	1.9	2.5	4.9	10.0	5.1	6.0

[1] Number of man-hours required for putting up orders is included.

Table 9 shows considerable variation in the time required to check out one wagon at the different plants. At plant 3, 15 minutes was required for each route, whereas at plant 14 only 3.2 minutes was required. At plant 3 one-fifth of the routes were wholesale, and only one man was used; whereas at plant 14 only 1 of the 28 routes was wholesale, and two men were used. When only one man

[5] A description of these trucks is given on p. 10.

is used, it is not possible to load out as fast as when two or more men are used. This system, however, is well adapted to small plants, and although the actual time required per route may be higher than with other systems, fewer men are used.

As a rule at plants using this system only one wagon could be loaded at a time, although at a few plants the conveyor from the storage room led to a platform alongside of which two or three wagons could be loaded simultaneously. This was true in the case of plants 18 and 19. More men were required where this was done, and such an arrangement was not always desirable.

Table 10 shows the results of studies at six plants checking out routes by the use of barrel or warehouse trucks. All these plants were located in New England, where this system was fairly common when the data were obtained. One of the reasons for the use of this system was the type of delivery wagon used in that section. At most of the plants studied, end-door wagons were used. These wagons had to be loaded at the rear instead of at the side. They had to be backed to the loading platform; and since it was usually desirable to put the full load on at one point, this type of wagon was not adaptable to the system of loading direct from the storage room through several chutes. When the latter system was used the route driver usually obtained the quarts of milk at one door, pints at another, and so on. In some plants neither conveyors, lift trucks, nor loading direct from the storage room could be employed because of the location of the storage room in respect to the loading platform, and at these plants a system such as this was necessary.

TABLE 10.—*Labor and time required at six plants for checking out routes by the use of barrel or warehouse trucks*

Plant No.	Routes			Men employed	Hours of work	Man-hours [1]	Routes per hour	Routes per man-hour [1]	Time required per route
	Wholesale	Retail	Total						
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Minutes*
1	6	32	38	3	3.0	21	12.7	1.8	4.7
2	10	20	48	6	7.0	42	6.9	1.1	8.7
3	20	50	70	8	4.5	36	15.6	1.9	3.8
4	0	42	42	4	5.0	20	8.4	2.1	7.1
5	19	50	69	8	4.5	36	15.3	1.9	3.9
6	10	42	61	7	6.0	42	10.2	1.5	5.9
Average	13.8	40.8	54.7	6	5.0	32.8	10.9	1.7	5.5

[1] Number of man-hours required for putting up orders is included.

At the plants using this system a considerable number of men were employed, the average being six per plant; at each of two plants eight men were used. The time required was also rather long, the average being five hours. The fact that many of the plants had a large proportion of wholesale routes partly accounts for the average number of routes loaded per hour being small.

Where several wagons can be loaded at one platform at a time and the plant is so laid out that a system of direct loading through three or more chutes is not possible, good results as to time may be obtained by the use of barrel or warehouse trucks. This is illustrated in the case of plant 5 where four or five wagons could be loaded at the same time.

With the use of barrel or warehouse trucks in checking out routes considerable extra labor is required to get the orders ready before the delivery wagons arrive. Where the plant is so arranged that several wagons can be loaded at the same time and the men come a little early and pull out several loads ahead, the actual loading time may be comparatively short. This extra labor, however, must be considered.

Table 11 shows the results of studies made at 24 plants checking out routes direct from the storage room through two doors or chutes. (Fig. 18.) A considerable variation was found in the results obtained both as to routes checked out per hour and per man-hour. At plant 15, for example, an average of 21.6 routes were checked out per hour, and 10.8 per man-hour; whereas at plant 16, which is of about the same size, only 14 and 4.7 routes were checked out per hour and per man-hour, respectively. The arrangement of the milk and cream in

FIGURE 18.—Loading a delivery wagon at a plant checking out routes through two doors or chutes. (Only one chute was in use at the time the photograph was taken.) An average of 13.6 wagons per hour was loaded at 24 plants using this system, and the average time required to load one wagon varied from 2.7 to 7.9 minutes.

the storage room had much to do with the results. In some cases the bottles were so crowded that the men did not have enough room to work conveniently, whereas in other plants the bottles were arranged very conveniently so that the milk and cream could be quickly sent out on the wagons with a minimum of handling. The average number of routes at the plants in this group was 48.3, and the average time required to load out the routes at each plant was 3.6 hours, which indicates that this is a satisfactory system for plants of medium size. Two wagons were loaded out at the same time. One man usually put the bottles of milk out at one door while another man checked out the cream, etc., at the other door. The number of men used varied from two to five, indicating that labor was used more economically at some plants than at others. This was due to the more convenient arrangement of the storage room and conveyors.

TABLE 11.—*Labor and time required at 24 plants for checking out routes through two doors or chutes*

Plant No.	Routes			Men employed	Hours of work	Man-hours [1]	Routes per hour	Routes per man-hour [1]	Time required per route
	Wholesale	Retail	Total						
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Minutes*
1	3	17	20	2	2.0	4.0	10.0	5.0	6.0
2	5	16	21	2	2.0	4.0	10.5	5.3	5.7
3	0	23	23	2	2.5	5.0	9.2	4.6	6.5
4	0	25	25	2	3.0	6.0	8.3	4.2	7.2
5	0	33	33	2	2.5	5.0	13.2	6.6	4.5
6	0	34	34	2	4.5	13.0	7.6	2.6	7.9
7	0	35	35	2	3.0	6.0	11.7	5.8	5.1
8	0	36	36	3	3.0	9.0	12.0	4.0	5.0
9	0	40	40	2	2.0	8.0	20.0	5.0	3.0
10	0	42	42	2	3.5	7.0	12.0	6.0	5.0
11	2	40	42	2	5.0	10.0	8.4	4.2	7.1
12	2	43	45	3	3.5	14.5	12.9	3.1	4.7
13	20	29	49	2	5.0	10.0	9.8	4.9	6.1
14	14	38	52	8	5.0	23.0	10.4	2.3	5.8
15	3	51	54	2	2.5	5.0	21.6	10.8	2.8
16	6	50	56	3	4.0	12.0	14.0	4.7	4.3
17	10	48	58	5	4.5	22.5	12.9	2.6	4.7
18	3	58	61	4	3.0	12.0	20.3	5.1	3.0
19	0	62	62	3	4.75	14.3	13.1	4.3	4.6
20	15	48	63	4	4.0	16.0	15.8	3.9	3.8
21	7	62	69	4	4.0	16.0	17.3	4.3	3.5
22	4	68	72	5	4.0	20.0	18.0	3.6	3.3
23	0	76	76	4	4.0	16.0	19.0	4.8	3.2
24	4	86	90	4	4.0	16.0	22.5	5.6	2.7
Average	4.1	44.2	48.3	2.9	3.6	11.4	13.6	4.2	4.4

[1] Number of man-hours required for putting up orders is included.

Table 12 shows the results obtained at six plants checking out routes by wheel platform or dolly trucks. This was not a common system, as the number of plants in the group indicates. It was used at plants of all sizes, the number of routes per plant varying from 10 to 120. There was also a great variation in the number of men used, varying from 1 at plant 2 to 6 at plants 4 and 5. Primarily because of this difference in number of men used, the time required to check out one route varied from 2.5 minutes at plant 6 to 18.2 minutes at plant 3. At the larger plants using this system several routes could be checked out at the same time.

TABLE 12.—*Labor and time required at six plants for checking out routes by wheel platform or dolly trucks*

Plant No.	Routes			Men employed	Hours of work	Man-hours [1]	Routes per hour	Routes per man-hour [1]	Time required per route
	Wholesale	Retail	Total						
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Minutes*
1	0	10	10	2	2.5	5	4.0	2.0	15.0
2	2	10	12	1	2.0	4	6.0	3.0	10.0
3	7	6	13	2	4.0	8	3.3	1.6	18.2
4	4	65	69	6	4.0	30	17.3	2.3	3.5
5	6	82	88	6	4.0	24	22.0	3.6	2.7
6	21	99	120	4	5.0	30	24.0	4.0	2.5
Average	6.7	45.3	52	3.5	3.6	16.8	14.5	3.1	4.1

[1] Number of man-hours for putting up orders is included.

Table 13 shows the results obtained at 10 plants checking out routes by the use of lift trucks. At 7 of these plants the routes were principally retail, whereas the other 3 had a large proportion of wholesale routes. The variation in the size of the loads was one of the principal causes of the large variation in the number of routes checked out per hour and per man-hour. The time and labor required were naturally much greater for the plants having principally wholesale routes, as larger loads were carried.

At plants so arranged that several wagons could be loaded at the same time, a large number of routes were checked out per hour. This was the case at plant 6, where 31.3 retail routes were checked out per hour. Twelve men were used at this plant, however, and the number of routes checked out per man-hour was only 1.3. At plant 9, 25 routes were checked out at the rate of 12.5 per hour, which compares favorably with the other plants when it is considered that all the routes at plant 9 were wholesale. Ten men were used at this plant, however, so that although the number of routes checked out per hour was comparatively large, the number checked out per man-hour was small.

TABLE 13.—*Labor and time required at 10 plants for checking out routes by lift trucks*

Plant No.	Routes			Men employed	Hours of work	Man-hours[1]	Routes per hour	Routes per man-hour[1]	Time required per route
	Wholesale	Retail	Total						
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Minutes*
1	2	12	14	1	1.5	3.0	9.3	4.7	6.5
2	0	17	17	1	1.0	5.0	17.0	3.4	3.5
3	0	20	20	10	1.0	14.0	20.0	1.4	3.0
4	0	37	37	5	1.5	13.5	24.7	2.7	2.4
5	0	41	41	4	3.0	20.0	13.7	2.1	4.4
6	0	47	47	12	1.5	36.0	31.3	1.3	1.9
7	0	58	58	7	3.5	24.5	16.6	2.4	3.6
Average	0.3	33.1	33.4	5.7	1.9	16.6	18.0	2.0	3.3
8	15	0	15	3	3	13	5.0	1.2	12.0
9	25	0	25	10	2	22	12.5	1.1	4.8
10	26	11	37	11	6	66	6.2	.6	9.7
Average	22	3.7	25.7	8	3.7	33.7	7.0	.8	8.5

PLANTS HAVING LARGE PROPORTION OF RETAIL ROUTES

PLANTS HAVING LARGE PROPORTION OF WHOLESALE ROUTES

[1] Number of man-hours for putting up orders is included.

Table 14 shows the results obtained at 14 plants checking out routes direct from the storage rooms through three doors or chutes. Although there was not a great variation in the time required per route, there was a great variation in the number of routes checked out per man-hour. This was due to the different arrangements of the storage rooms and the different methods of getting the milk to the chutes, resulting in a larger number of men being required at some plants than at others. For example, at plants 5 and 8, which checked out an especially large number of routes per man-hour, the bottles in the storage room were so arranged that they could be sent out on the conveyors with very little handling and only four and five men respectively were used at these two plants. At plants

4, 9, 13, and 14, however, the arrangement was not so convenient, and much handling was required, especially at plants 9 and 13, where trucks were used to a considerable extent to get the cases of milk to the conveyors leading to the chutes. The number of men used at these plants was large. Furthermore, 3 man hours were required at plant 4 and 10.5 man hours at plant 9 to put up orders beforehand. The reason for the small number of routes checked out per man-hour at plant 7 was that 14 man-hours was used in putting up orders beforehand.

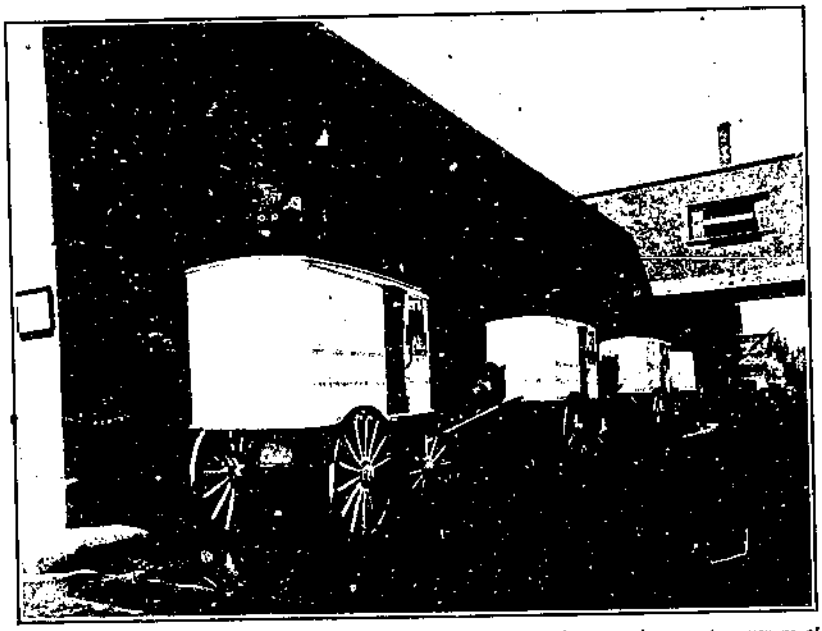

FIGURE 10.—Checking out routes at a plant using four or more doors or chutes. An average of 42.3 routes per hour and 4.4 routes per man-hour was checked out at 10 plants using this system

TABLE 14.—*Labor and time required at 14 plants for checking out routes through three doors or chutes*

Plant No.	Routes			Men employed	Hours of work	Man-hours [1]	Routes per hour	Routes per man-hour [1]	Time required per route
	Wholesale	Retail	Total						
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Minutes*
1	0	41	41	4	1.5	6.0	27.3	6.8	2.2
2	6	56	62	4	4.0	16.0	15.5	3.9	3.9
3	2	73	75	4	4.5	22.0	16.7	3.4	3.6
4	0	76	76	8	2.0	19.0	38.0	4.0	1.6
5	0	80	80	4	1.5	6.0	53.3	13.3	1.1
6	7	77	84	6	2.5	15.0	33.6	5.6	1.8
7	8	77	85	5	2.5	26.5	34.0	3.2	1.8
8	0	87	87	5	1.5	7.5	58.0	11.6	1.0
9	0	88	88	13	3.5	56.0	25.1	1.6	2.4
10	0	90	90	8	2.0	16.0	45.0	5.6	1.3
11	0	90	90	7	1.5	10.5	60.0	8.6	1.0
12	6	86	92	5	4.0	20.0	23.0	4.6	2.6
13	0	109	109	9	3.0	27.0	36.3	4.0	1.7
14	0	60	60	8	2.5	20.0	24.0	3.0	2.5
Average	2.1	77.9	79.9	6.4	2.6	19.1	30.7	4.2	2.0

[1] Number of man-hours for putting up orders is included.

Table 15 shows the results obtained at 10 plants checking out routes through four or more doors or chutes. (Figs. 19 and 20.) The driver usually received quarts of milk at one door, pints at another, and so on, although at some plants a full load was obtained at each door. In most cases no extra time was required to put up orders; the required quantity of goods was put out at the various doors as the wagons arrived. Side-door wagons are desirable for the use of this system. The time required to check out one route was fairly uniform for all the plants in this group, although there was considerable variation in the number of routes checked out per man-hour. At plant 2, which required more time than the average, no

FIGURE 20.—A plant where routes are checked out through four loading doors

conveyors were used because the storage room was rather narrow. The men therefore had to transfer the cases of milk and cream by hand for a short distance to the various doors. Plant 4 had comparatively few routes checked out per man-hour, principally because of the fact that 16 man-hours was used for putting up orders beforehand. Especially good results were obtained at plants 6, 8, and 9. Each of these plants had six or more loading doors, and the result was that the wagons were loaded out very rapidly. Large plants can use to advantage the system of checking out routes through four or more doors or chutes. The average time required to check out one route at the 14 plants using this system was only 1.4 minutes, and at some plants routes were checked out in less than 1 minute.

TABLE 15.—*Labor and time required at 10 plants for checking out routes through four or more doors or chutes*

Plant No.	Routes			Men employed	Hours of work	Man-hours [1]	Routes per hour	Routes per man-hour [1]	Time required per route
	Wholesale	Retail	Total						
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Minutes*
1	4	76	80	6	2.5	15.0	32.0	5.3	1.9
2	2	88	90	8	3.5	28.0	25.7	3.2	2.3
3	0	102	102	7	3.0	21.0	34.0	3.5	1.8
4	[2] 31	83	114	8	2.5	36.0	45.6	3.2	1.3
5	6	118	124	11	5.0	55.0	24.8	2.3	2.4
6	0	144	144	6	2.0	12.0	72.0	12.0	.8
7	7	148	155	8	3.0	30.0	51.7	5.2	1.2
8	20	170	196	14	3.0	42.0	65.3	4.7	.9
9	0	180	180	6	2.5	15.0	72.0	12.0	.8
10	21	84	105	8	3.5	28.0	30.0	3.8	2.0
Average	9.1	119.0	129.0	8.2	3.1	29.0	42.3	4.4	1.4

[1] Number of man-hours for putting up orders is included.
[2] Many of these routes were mixed wholesale and retail.

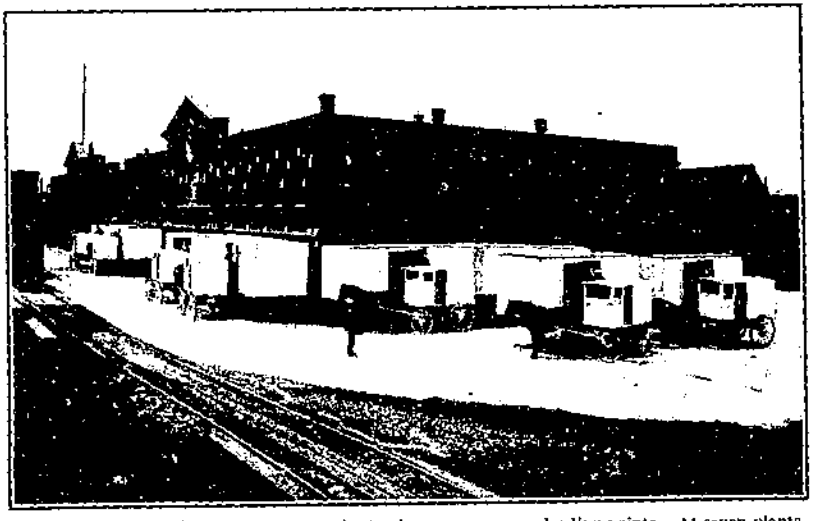

FIGURE 21.—Checking out routes at a plant using seven or more loading points. At seven plants using this system an average of 53.8 routes was checked out per hour

Table 16 shows the results obtained at seven plants checking out routes from seven or more loading points. (Fig. 21.) Usually where this system was used special milks, such as grade A, certified milk, and buttermilk, were loaded from trucks or trailers conveniently located so that the drivers could go from one to another in one continuous line. As a rule cream was checked out from a point on the platform, and the quarts and pints of regular milk were checked out from the storage room through two or three doors or chutes, although in some cases these were loaded from trailers also.

TABLE 16.—*Labor and time required at seven plants for checking out routes at seven or more loading points*

Plant No.	Routes			Men employed	Hours of work	Man-hours [1]	Routes per hour	Routes per man-hour [1]	Time required per route
	Wholesale	Retail	Total						
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Minutes*
1	0	120	120	11	3.00	33.0	40.0	3.6	1.5
2	0	126	126	12	3.00	36.0	42.0	3.5	1.4
3	0	140	140	12	3.00	36.0	46.7	3.9	1.3
4	0	162	162	14	3.25	45.5	49.8	3.6	1.2
5	0	173	173	12	3.00	36.0	57.7	4.8	1.0
6	0	190	190	14	3.00	47.0	63.3	4.0	.9
7	15	190	205	20	2.50	50.0	82.0	4.1	.7
Average	2.1	157.3	159.4	13.0	3.00	40.5	53.8	3.9	1.1

[1] Number of man-hours for putting up orders is included.

Although the number of routes checked out per man-hour at all the plants using this system was fairly uniform, there was a considerable variation in the number of routes checked out per hour. At the larger plants more men were used, but the time required per route was much less than at the smaller plants in the group. As a rule more loading points were used at the larger plants. At the three largest plants the routes were checked out at the rate of one per minute or less.

COMPARISON OF DIFFERENT SYSTEMS AS TO LABOR AND TIME REQUIRED

Table 17 shows a summary of the results obtained at 93 plants using the eight systems of checking out the routes. The systems in the table are arranged in the order of the number of routes checked out per hour. This arrangement is also in accordance with the average number of routes at the plants, except in the case of systems 2 and 5, indicating that as a rule the larger dealers have adopted systems which are the most economical as to the time required.

Although the plants using system 1 checked out the fewest routes per hour, few men were required; this resulted in the average number of routes loaded out per man-hour being greater than under any of the other systems. The time required to check out one route was longer under system 1 than under any of the other systems; but as time is not so important a factor at small plants as at large ones, this system is well adapted for that type of plant. Furthermore, where the storage room is so located that the wagons can drive up alongside it, this system is very convenient, as no other space in the plant is taken up in the loading operation and, except for sometimes a conveyor across or lengthwise of the storage room, no special equipment is required.

The plants using system 2 checked out the smallest number of routes per man-hour. While it might not be possible to load the wagons direct from the storage room at these plants, it might be possible to use lift trucks, as in system 5. In comparison with plants using system 2, those using system 5 checked out nearly twice as many routes per hour and slightly more per man-hour. While the lift-truck system requires added investment in platforms and trucks, this investment might be justified at some plants by the

increase in the amount of work that could be done per hour and per man-hour. In some cases it might even be desirable to rearrange the plant so that either system 3 or 6 could be used.

TABLE 17.—*Comparison of different systems of checking out routes as to labor and time required*

Group	System used	Plants	Routes			Men employed	Hours of work
			Wholesale	Retail	Total		
		Number	*Number*	*Number*	*Number*	*Number*	*Number*
1	One chute direct to wagon	19	1.7	23.5	25.2	1.9	2.5
2	Barrel or warehouse trucks	6	13.8	40.8	54.7	6.9	5.0
3	Two chutes to wagon	24	4.1	44.2	48.3	2.9	3.6
4	Wheel platform and dolly trucks	6	6.7	45.3	52.0	3.5	3.6
5	Lift trucks	7	0.3	33.1	33.4	5.7	1.9
6	Three chutes to wagon	14	2.1	77.9	79.9	6.4	2.0
7	Four or more chutes to wagon	10	9.1	119.9	129.0	8.2	3.1
8	Loading from seven or more points	7	2.1	157.3	159.4	13.0	3.0

Group	System used	Man-hours [1]	Routes per hour	Routes per man-hour [2]		Time required per route	
						Minutes [3]	Minutes [4]
		Number	*Number*	*Number* [3]	*Number* [4]		
1	One chute direct to wagon	4.0	10.0	5.1	5.1	6.0	6.9
2	Barrel or warehouse trucks	32.8	10.9	1.7	1.8	5.5	5.7
3	Two chutes to wagon	11.4	13.6	4.2	4.5	4.4	4.8
4	Wheel platform and dolly trucks	16.8	14.5	3.1	3.8	4.1	8.7
5	Lift trucks	10.6	18.0	2.0	3.1	3.3	3.6
6	Three chutes to wagon	19.1	30.7	4.2	4.7	2.0	2.0
7	Four or more chutes to wagon	29.0	42.3	4.4	4.9	1.4	1.5
8	Loading from seven or more points	40.5	53.8	3.9	4.0	1.1	1.1

[1] Man-hours required for putting up orders is included.
[2] Man-hours required for putting up orders is not considered.
[3] Weighted average.
[4] Average of averages.

System 3 was the system most commonly used at the plants studied. An average of only 2.9 men was used at each plant, and an average of 4.2 routes was checked out per man-hour, which is a higher average than was checked out at the plants using most of the other systems. The only plants with a higher average were those using systems 1 and 7. A slightly longer time was required on an average to check out one route than was the case at the plants using wheel platform or dolly trucks or lift trucks, but the average number of routes loaded out per man-hour was much greater than at the plants using either of these two systems. Furthermore, with system 3 no investment in trucks is necessary, and where plants are so arranged that the wagons can be loaded direct from the storage room this system seems to be much more desirable than either system 4 or 5.

System 4 was not a common system, although it was in use at a few rather large plants. Only slightly better results as to number of routes checked out per hour were obtained at plants using this system than at plants using systems 1, 2, and 3, whereas the number of routes checked out per man-hour was smaller than at the plants using most of the other systems.

Although plants using system 5 ranked higher than systems 1, 2, 3, and 4 in the number of routes loaded per hour, they averaged 5.7 men, whereas those using system 3 averaged only 2.9 men and those

using system 1 averaged only 1.9 men. The number of routes loaded out per man-hour was only 2 at plants in Group 5, as compared with 4.2 at the plants in Group 3 and 5.1 at plants in Group 1.

The use of lift trucks gives better results than the use of barrel or warehouse trucks, as is shown by the fact that the number of routes checked out per hour and per man-hour was greater for system 5 than for system 2. However, in respect to the average number of routes checked out per man-hour the plants using system 5 ranked lower than those using systems 1, 3, and 4 and only slightly higher than those using system 2. On account of the large number of men required where trucks are used, it appears that more efficient results can be obtained when the wagons can be loaded direct from the storage room through two or more doors. However, at plants so arranged that the wagons can not be loaded direct from the storage room, system 5 seems to be the most satisfactory one.

One advantage of the use of lift trucks and of wheel platform and dolly trucks over the conveyor systems is that mistakes in counting are less likely to occur. When conveyors or chutes direct to the wagon are used (systems 1, 3, 6, and 7) it is not uncommon for differences to arise between the driver and the checker as to the number of cases that have been sent through. When trucks are used, the cases can be counted by both the checker and the driver before they are removed.

The average time required to check out one route at the plants using system 6 was only 2 minutes, whereas the shortest time required for any of the first five systems was 3.3 minutes for system 5. More men are required where system 6 is used, for there must be at least one man at each of the three doors to handle the cases of milk, besides one or more checkers. Table 17 shows that more than twice as many men were employed at plants using system 6 as at those using system 3, where only two doors were used. For plants checking out more than 50 routes, however, system 6 would be more desirable than system 3 because of the extra time that would be required with the latter system.

As the number of loading doors or loading points increases (systems 7 and 8) more men are required, so that the number of wagons loaded per man-hour will not increase in the same ratio as the number of wagons loaded per hour. The time required per route was, of course, less the more doors were used. Thus system 7 with four or more doors or chutes checked out an average of 42.3 routes per hour as compared with 13.6 routes checked out with system 3 (2 doors or chutes), and 30.7 routes with system 6 (3 doors or chutes). In number of routes checked out per man-hour with these 3 systems, however, the difference was not so great, as shown in the table. The plants using system 8 checked out the greatest number of routes per hour, the average being nearly one per minute. Not only is time saved by the use of this system but where it is necessary to truck special milks from another plant or from the railroad station the transfer of the milk to the storage room is saved as well as space in the storage room. Since the greatest number of men are required where this system is used, the average number of routes checked out per man-hour is less than with some of the other systems. At the seven plants using this system an average of 13.6 men was used, and the average number of routes checked out per man-hour was only 3.9.

As a rule the greatest number of men is required to operate the systems which are most efficient as to time required per route. As the number of chutes or loading points are increased, the number of

men must be correspondingly increased. It is desirable that all the routes be checked out in three or four hours, and large plants must use several chutes or loading points in order to get the routes out on time, even though more men are required.

NUMBER OF MEN REQUIRED TO OPERATE A MILK PLANT

The number of men required to operate a milk plant depends on other factors besides the plant arrangement and types of equipment, which have been discussed. Chief among these are the size of plant and the number of stories in the plant.

RELATION BETWEEN SIZE OF PLANT AND LABOR REQUIREMENTS

Table 18 shows the relation between the size of plant and the number of men required at 92 plants, grouped according to number of gallons of milk and cream handled daily. As a rule, there is an increase in the number of gallons handled per man as the size of the plant increases. In small plants it is usually necessary to shift a man from one job to another, whereas in large plants one man often is on the same operation for the full day. This specialization of labor naturally effects economies in operation. At large plants, however, on account of this very fact of specialization, more supervision is required, and more special and miscellaneous men are used, so that the difference in the number of gallons handled per man at the large and small plants is not so great as might be expected. This difference is somewhat greater, however, when bottled milk alone is considered.

TABLE 18.—*Relation between the size of plant and labor requirements*

Group No.	Plants	Milk and cream handled daily per plant: Quantity	Milk and cream handled daily per plant: Average	Milk and cream handled daily per plant: Bottled	Total men per plant [1]	Milk and cream handled per man: Total	Milk and cream handled per man: Bottled
	Number	*Gallons*	*Gallons*	*Per cent*	*Number*	*Gallons*	*Gallons*
1	13	2,000 or less	1,407	81.0	6.8	208	169
2	21	2,001 to 5,000	3,398	88.2	15.3	216	194
3	34	5,001 to 10,000	7,342	85.1	34.5	213	181
4	9	10,001 to 15,000	11,504	82.0	46.0	249	205
5	8	15,001 to 20,000	17,393	87.0	78.6	221	192
6	7	Over 20,000	27,448	88.0	103.0	267	235

Group No.	Special help employed: Relief men	Checkers	Engineers and maintenance men [2]	Miscellaneous men [3]	Help employed per 1,000 gallons milk and cream handled: Total men	Relief men	Checkers	Engineers and maintenance men	Miscellaneous men
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
1	0.3	0.9	0.5	0.5	4.808	0.219	0.629	0.383	0.328
2	1.1	2.2	1.4	1.1	4.618	.317	.669	.425	.331
3	2.2	6.7	3.4	2.3	4.704	.305	.906	.457	.309
4	1.9	7.3	5.0	5.8	4.015	.164	.637	.434	.502
5	6.9	13.4	8.9	5.5	4.522	.395	.769	.510	.316
6	6.0	13.4	8.7	9.3	3.753	.219	.489	.318	.338

[1] Including men whose time was chargeable to the market-milk department. If they were used in other departments also, time was prorated. Clerks and bookkeepers were not included.
[2] Employees who were engaged in the repair and upkeep of equipment and whose time was chargeable to the market-milk department.
[3] Such as foremen, janitors, and elevator men.

Table 18 shows two exceptions to the rule that the number of gallons of milk and cream handled per man increases as the size of the plant increases. These exceptions are the plants in Groups 3 and 5. They can in part be explained by the fact that there were no 1-story plants in Group 5 and only 6 out of a total of 34 in Group 3. As is shown on pages 37 and 38, less labor is usually required to operate 1-story plants.

The table shows no relation between the number of relief men used per 1,000 gallons handled and the size of the plant, as the number is dependent largely on the practices followed in the city where the milk plant is located. In some cities no relief men are required, as all the men work a full week of seven days. In others, the men work only six days per week so that an extra man is required for each six men. There is also very little relation between the size of plant and the number of checkers used per 1,000 gallons of milk and cream handled as this is determined primarily by the system of checking routes in and out. The table shows that, although the number of miscellaneous men employed increases with the size of the plant, the number of these men per 1,000 gallons of milk and cream handled is fairly uniform for plants of all sizes except Group 4, in which it is higher than in the other groups. The fact that this group contained only plants of more than one story is the principal reason for the large number of miscellaneous men.

RELATION BETWEEN NUMBER OF STORIES IN PLANT AND LABOR REQUIREMENTS

The number of men required to operate a milk plant seems to be affected to some extent at least by the number of stories in the plant. As a rule, fewer men are required in plants using only one story than in plants using several stories.

Table 19 shows the relation between the number of stories in the plant and the labor requirements.

More milk was handled per plant employee in the 1-story plants than in the 2-story plants, and with only two exceptions more was handled in the 2-story plants than in the plants of three or more stories. In Group 6 less milk was handled per man in the 2-story plants than in the plants of three or more stories. One of the reasons for this was that one of the 2-story plants was a grade A plant [8] and handled only 188 gallons of bottled milk per plant employee, which lowered the average for the group. The other exception was the one plant of three or more stories in Group 4. In this plant the milk was pasteurized on the second floor and was bottled on the first floor. The bottles were washed in the basement, but the bottle washer elevated the bottles to the first floor, where they were filled, thus eliminating the necessity of conveyors or elevators.

From the survey that was made it seems apparent that best results as to labor required are obtained where the bottle-washing and filling departments and the milk-storage room are on the street floor. The principal reason for this is that a minimum of handling and of supervision is required at this type of plant. Where the bottles are washed in the basement and the bottle washer delivers the bottles to the fillers on the street floor, nearly as good results are achieved.

[8] This plant, because it handled grade A milk, met special requirements of the city health officials.

TABLE 19.—*Relation between the number of stories and labor requirements in milk plants*

Group No.	Plants	Milk and cream handled per plant			Employees	Milk and cream handled per employee		
		Quantity	Average	Bottled		Total	Bottled	Exclusive of checkers[1]
	Number	*Gallons*	*Gals.*	*Per cent*	*Number*	*Gals.*	*Gals.*	*Gals.*
PLANTS HAVING ONE STORY								
1	5	2,000 or less	1,314	83.7	5.8	227	190	263
2	10	2,001 to 5,000	3,152	88.9	11.0	287	255	341
3	6	5,001 to 10,000	7,570	90.1	28.2	280	201	361
4	2	10,001 to 15,000	10,975	84.5	30.0	366	309	422
5		15,001 to 20,000						
6	1	Over 20,000	25,000	82.0	67.0	333	257	344
PLANTS HAVING TWO STORIES								
1	8	2,000 or less	1,468	78.6	7.4	199	158	228
2	11	2,001 to 5,000	3,631	85.7	19.0	180	164	220
3	23	5,001 to 10,000	7,103	84.9	34.4	206	175	252
4	6	10,001 to 15,000	11,742	80.6	52.5	224	189	263
5	4	15,001 to 20,000	16,875	83.7	57.3	295	247	343
6	3	Over 20,000	25,201	88.1	102.6	246	217	277
PLANTS HAVING THREE OR MORE STORIES								
1		2,000 or less						
2		2,001 to 5,000						
3	5	5,001 to 10,000	8,169	82.7	45.0	182	150	235
4	1	10,001 to 15,000	11,150	88.0	41.0	272	239	372
5	4	15,001 to 20,000	17,910	89.3	100.0	179	160	220
6	3	Over 20,000	31,783	89.3	115.3	276	246	327

[1] At some plants the checkers are not included with the plant employees but with the delivery or sales employees.

COMPARISON OF THE AMOUNT OF LABOR USED IN PLANTS IN VARIOUS SECTIONS OF THE COUNTRY

More of the favorable features of milk-plant arrangement naturally are found in plants of some sections of the country than of others. Table 20 shows a comparison of the amount of labor used in plants grouped according to sections of the country. In the plants in the Chicago district relatively few men were used per 1,000 gallons handled. Inasmuch as higher wages were paid to plant employees in this district, however, than in most other districts, it was possible for the plants to employ more efficient men. The actual cost of operation of these plants per unit, therefore, may not have been less than the cost in other districts.

The plants in the Detroit district also used comparatively few men, except miscellaneous men. A large number of these were required, partly because several of the plants were of more than one story, one plant containing five stories, thus necessitating extra foremen, elevator men, conveyor men, etc.

The plants in the New York City district used a large number of checkers and relief men as compared with the number in the other groups. The men in most of these plants also worked on a basis of six days per week. Although the plants in this district had very efficient systems of checking the routes in and out as far as time required is concerned, they nevertheless used a large number of men in this work. The checkers performed no other work nor were any

men transferred to this department from other departments during rush periods or emergencies as was sometimes done at plants in other sections. It was therefore necessary to have a full quota of men in this department at all times.

TABLE 20.—*Comparison of the amount of labor used at milk plants in different sections of the country*

Section of country	Plants	Milk and cream handled daily per plant	Help employed					Help employed per 1,000 gallons milk and cream handled				
			Total men	Relief men	Checkers	Engineers and maintenance men	Miscellaneous men	Total men	Relief men	Checkers	Engineers and maintenance men	Miscellaneous men
	Number	*Gallons*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Chicago	24	8,852	31.8	3.9	4.4	2.4	1.8	3.588	0.437	0.497	0.273	0.205
Detroit	9	10,025	38.1	0.8	5.7	4.7	5.4	3.588	.073	.538	.439	.513
Northwest of Chicago	13	8,038	20.8	1.8	4.7	2.3	1.8	2.603	.219	.582	.280	.220
Philadelphia	9	9,482	35.7	0.3	5.8	3.6	3.8	3.763	.035	.610	.381	.399
Middle West (except Chicago and Detroit districts)	10	7,782	31.4	0.9	5.4	4.3	2.4	4.036	.116	.691	.553	.309
Baltimore and Washington	8	7,821	33.1	0.8	8.0	2.5	2.1	4.233	.096	.767	.320	.272
South Central	12	9,581	44.5	3.7	6.4	4.7	1.7	4.645	.383	.665	.487	.174
New York State (except New York City district)	5	3,416	17.4	1.4	3.0	2.3	0.8	5.088	.400	.877	.673	.234
New York City	9	16,767	89.7	9.4	17.6	7.8	4.9	5.355	.503	1.047	.464	.292
Southern	16	3,211	17.5	0.5	2.5	2.1	1.0	5.451	.152	.771	.650	.296
New England	10	6,611	38.3	2.1	6.8	3.9	3.3	5.704	.318	.999	.583	.499

The large number of checkers per 1,000 gallons handled at the plants in the New England, New York State, and southern districts was due to the comparatively inefficient systems used at some of these plants for checking the routes in and out. Some of these plants were quite small. The fact that many of the plants in New England were more than two stories high contributed to the comparatively large number of miscellaneous men required. This was also true in the case of the plants in the New York City districts.

It will be noted that the plants in the southern and New England districts used comparatively large numbers of men per 1,000 gallons handled in most departments. At many of the plants studied in these sections comparatively inefficient systems in respect to labor requirements were used for many of the operations, such as receiving the milk and checking the routes in and out. It should be noted that the average size of the plants studied in these sections was small, which fact tended to increase the average amount of labor required per unit for the plants in these groups.

SUMMARY AND CONCLUSIONS

Milk-plant operators should study their labor costs with a view to reducing them where possible.

Less labor is required for receiving and weighing milk at plants where the dump tank is near the receiving-room door or where conveyors are used than where the cans of milk are rolled or trucked in from the receiving platform.

Where milk is received from tank trucks or tank cars the labor required for receiving the milk is much less than where the milk is received in cans.

At the particular plants studied, where the milk was received in cans directly from the cars considerable labor was required because of the difficulty of effecting efficient arrangements for receiving the milk at these plants.

Less labor is required for checking in the routes at plants where conveyors are used than at plants where trucks of various kinds are used.

The operations of washing and filling bottles require nearly 50 per cent of the labor used for the principal operations in a milk plant.

The per unit labor requirements for washing and filling the bottles depend more on the system used than on the size of the plant.

The direct system of washing and filling bottles requires much less labor than does the indirect system.

Less labor is required for washing and filling bottles where the operations are performed on one floor than where two or more floors are used.

The quantity of milk pasteurized and cooled per man hour is much less at small plants than at large plants. This difference is not so great, however, when the labor for cleaning the equipment is included.

The number of bottles stacked in the milk-storage room per man-hour is fairly uniform for plants of all sizes.

The time and labor required to check out routes depend on the system used. Large plants require a system which permits many routes to be checked out in a short time.

The greatest number of routes are checked out per hour at plants where several loading points are used or where the wagons are loaded direct from the storage room through four or more small doors or chutes.

The number of routes checked out per man-hour does not vary greatly with the number of chutes used, since the more chutes used the greater the number of men required.

As a rule, trucks of various kinds are less economical as to labor required for checking out routes than is loading the wagons directly from the storage room through small doors or chutes.

An advantage of the use of trucks as compared with loading the wagons direct through chutes or from conveyors is that a more accurate check on the quantity of goods delivered to the driver is possible and that there is less likelihood of dispute as to the count.

Since it is necessary to check the routes in and out within a limited time the large plants as a rule have adopted the more efficient systems in respect to time required. The man-hour requirements per route checked in or out, however, are not always lower at the large plants.

As a rule, the number of gallons handled per plant employee is greater in large plants than in small ones.

The total number of men required is greater in plants of more than one story than in 1-story plants of similar capacities.

The number of gallons of milk handled per plant employee varies considerably in different sections of the country, in a large degree at least, because of the different plant arrangements and systems used.

U. S. GOVERNMENT PRINTING OFFICE: 1929

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