UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 664

Contribution from the Bureau of Chemistry
CARL L. ALSBERG, Chief

Washington, D. C. ▼ April 25, 1918

THE PREVENTION OF BREAKAGE OF EGGS IN TRANSIT WHEN SHIPPED IN CARLOTS

By

M. E. PENNINGTON, Chief, Food Research Laboratory, **H. A. McALEER**, Investigator in Poultry and Egg Handling, and **A. D. GREENLEE**, Assistant Chemist, assisted by **F. X. DAILEY** and **H. C. ALBIN**

CONTENTS

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CONTENTS.

REASON FOR THE INVESTIGATION.

Breaking the shell of an egg shortens its market life in direct proportion to the extent of the damage. A complete mashing of the shell immediately renders the egg useless for food purposes; a crack visible to the naked eye foreshadows prompt decay, and necessitates immediate consumption; while even the slightest fracture of the shell makes impossible satisfactory preservation for use when eggs are scarce. The shell of the egg is fragile; yet it must frequently travel far by varied conveyances, and successfully withstand comparatively rough usage, if it is to satisfy marketing requirements.

The need for the elimination of waste and loss in the transfer of food from the producer to the consumer suggests that the breakage of eggs in transit carries with it a loss of both money and food which it is highly desirable to prevent. The investigation reported in this bulletin was undertaken to determine the causes of such damage. Suggestions for lessening the extent of the damage are also included. The investigation was made with the hearty cooperation of the shippers and receivers of eggs, as well as of the carriers. To obtain the maximum of ease and efficiency, the joint conference committee [1] acted for both shippers and carriers, and handled all matters requiring concerted action on the part of the cooperators. Without such an organization this investigation could not have been made, and this opportunity is taken to express to the committee, to the industry, and to the carriers an appreciation of the assistance rendered.

AMOUNT OF DAMAGE TO EGGS DURING MARKETING.

The amount of damage sustained in the marketing of eggs can not be stated with exactness. Estimates by those familiar with conditions, and experiments conducted to determine the rate of deterioration in eggs during their journey to the consumer, however, have given figures which are worthy of consideration. In 1909, Hastings [2] stated that the usual western produce dealer, whose supplies come by local freight, receives from 4 to 7 per cent of cracked eggs, and that 8 per cent of broken eggs from the hen to the market is probably a fair estimate. In 1913, Lamon and Opperman [3] studied egg deterioration between the farm and the egg-packing house, and shipped eggs under conditions distinctly better than the average. They reported 2.7 per cent cracked eggs, and so few leakers that the percentage is not given. A study made in the Food Research Laboratory, of the Bureau of Chemistry, instituted for another purpose, which will be reported in detail in another publication, showed that about 6.19 per cent of cracked eggs were received by one shipper in a western State during the months of April to August, inclusive, when the total volume of eggs handled amounted to over 1,357,000 dozen. In 1910, Pennington and Pierce [4] reported that the examination of over a quarter of a million dozen eggs, received in the city of New York, showed 8.98 per cent cracked.

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[1] The joint conference committee consists of representatives from the National Poultry, Butter, and Egg Association, for the industry, and from the General Managers Association of Chicago, for the railroads, in cooperation with a representative of the United States Department of Agriculture. Its object is, primarily, to improve the quality of poultry, butter, and eggs on the market, and prevent waste and loss.

[2] U. S. Dept. Agr., Bureau of Animal Industry Circ. 140.

[3] U. S. Dept. Agr., Bureau of Animal Industry Bul. 160.

[4] The Effect of the Present Method of Handling Eggs on the Industry and the Product. U. S. Dept. Agr. Yearbook (1910) Separate 552.

Mashed eggs were not recorded in any of these observations. In commercial practice such eggs are reckoned with the total loss, which includes also rotten eggs. Most of the cracked eggs found a market in the city, but their keeping quality was so impaired that consumption had to be immediate, and they were sold at a lowered price. In many instances, also, the cracked and leaking eggs provoked so much bickering between shipper, carrier, and receiver that the egg trade itself suffered. Quite aside from this phase of the situation, however, the actual damage to a valuable food product, as indicated by the foregoing figures, would abundantly warrant any reasonable reforms by which the amount might be lessened.

PROGRESS OF THE INVESTIGATION.

GENERAL PLAN.

The work here reported was begun in Texas, in March, in the early part of the carlot shipping season, and gradually progressed toward the north until September, when the investigators had reached Minnesota. The lack of eggs made it difficult to get carlots after the middle of September. Shipments went to eastern markets, ranging from Pittsburgh and Buffalo on the west, to Boston on the north, and to Philadelphia on the south.

The investigation was carried on for two seasons in 32 packing houses, 5 of which were under observation both years. The shipments were observed in 39 eastern terminals in 20 large and medium-sized cities. In 5 cities shipments were received during both years. The total number of consignees was 33. All of the shipments were made in refrigerator cars, 23 refrigerator car lines being represented. The various routings, combined, covered most of the great trunk lines passing from West to East, and involved 32 railroads. The average haul was 1,200 miles. Records at origin and destination of 147 shipments were kept. In addition to this, many examinations were made at the terminals of carlots, on which less definite information was obtainable, but from which, nevertheless, much that was instructive could be learned. Occasionally investigators accompanied freight trains on which experimental shipments were being carried to observe the effect of fast or ordinary running, switching, coupling, and other conditions in transit.

CONDITIONS AT POINT OF ORIGIN.

THE EGGS AND THE PACKAGE.

In order to determine the soundness of the eggs which left the point of origin the investigators examined from 3 to 10 cases, taken at random from the stack of cased eggs which had been candled or clicked and were ready for shipment. The number and character of the eggs with damaged shells were found by candling or clicking. Each egg was again placed in a new symmetrically made standard case, of gum, tupelo, or cottonwood, with new medium flats and fillers, evenly cushioned on the bottom with excelsior, and on the top with excelsior or with corrugated board laid over the top flat. The cushions were thick enough to fill the space between the eggs and lid, and were so evenly distributed that the lid exerted an even pressure over the whole top of the case. Five 3-penny, cement-coated nails to each joint were used in the experimental cases shipped.

The character of the shell of each egg, the size of the egg, and its location in the case were charted on a diagram by means of which permanent records were kept of the condition of every egg under observation. The cracked eggs were not removed from the case to be shipped, but the location of each cracked egg was recorded. The cases were marked so that they might be identified only by the investigators during the stowing or subsequent unloading of the car. A total of 5,490 dozen eggs examined in 12 packing houses during the first season showed that 19.22 eggs per case, or 5.34 per cent, were being shipped with shells lightly cracked or dented.[1] Leakers were seldom found, and when found were removed. During the later work in 27 packing houses, when a total of 16,800 dozen eggs were examined, 5.47 per cent of eggs with unsound shells were found.

This damage in cases of eggs as they leave the packing house is not the damage which is visible in the usual terminal inspection, as will be brought out more fully in the course of this report. It is detected when eggs are shipped to storage warehouses for long holding, and the condition of the cases is such that even those which do not show external damage must be rehandled and candled or clicked for cracks. Experiments on the shipments of checks, to be given later (Table 4), will further elucidate this subject. The number of eggs with cracked and dented, but not leaking, shells observed during the investigation in the cases leaving the various packing houses is given in detail in Table 3.

TRANSFER OF EGGS FROM PACKING HOUSE TO CAR.

The experiments on which this report is based included the carrying of the cases by hand from the stack or chill room to the car, as well as their transfer from like locations by means of 2-wheeled trucks, or, very rarely, 4-wheeled trucks. In one case, an autotruck carried the cases about 500 feet to the car. Usually wagons were used. The distance between the packing house and the car varied from the width of the loading platform to nearly a mile.

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[1] An experimental error of 1 to 2 eggs per case (0.28 to 0.56 per cent) should be allowed on all cases. It has not been found possible to rehandle 360 eggs without an occasional error.

STOWING THE LOAD.

During the earlier part of the investigation, no suggestions were made regarding the manner of loading the cars, but records were kept in detail of the routine in each house, and the effect of the various practices on the safety of the eggs. The effect of such practices as walking on cases, which materially increased top-layer breakage, and of rough handling given the cases as they were placed in the car, was evident at destination. The buffing of the cars, if any was used, and the manner of bracing were factors that showed even more plainly. The results obtained later in the work led the investigators to stow the load according to definite methods, and to make it as rigid as possible.

PLACING CASES IN CAR.

Two methods are commonly used in placing cases in the car, namely, the "straight-joint" and "step" or "broken-joint" loads.

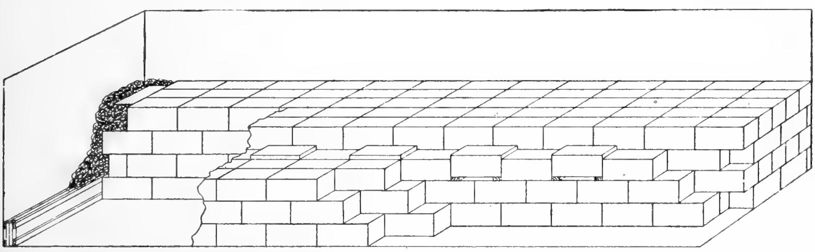

FIG. 1.—Car loaded from side. Frame to enable cold air from bunkers to enter the car. Note crosswise cases at end of the load in alternating layers, to give "step" effect.

In the first, a row of cases is set across the end of the car at the bunker, and others are placed on top until the desired height is reached; a second row is placed in front of the first, built up to the desired height; and so on to the center of the car. The other end of the car is then stowed, and any extra space which remains in the middle of the car is filled with wooden braces or some other form of buffing. The second method, by which the cases are placed like bricks in a wall (fig. 1), almost invariably entails walking on the cases, which is likely to cause breakage in top layers. It also necessitates placing a few cases crosswise at the bunker.

Primarily to avoid walking on the cases when making a step load, and incidentally providing many advantageous features, a few shippers have adopted what is termed the "side-load" method of placing cases (fig. 1, and Pl. I). This consists in placing a row[1] the entire length of the car against the far side, leaving the excess space at one or both bunker ends, as desired. A sufficient number of layers to

[1] "Rows" designate cases placed parallel to the side of the car. "Stacks" indicate the cases across the width of the car. "Layers" express the vertical stacking of cases.

give a load of the necessary height is placed on the first row. Then a second row is begun, and the layers added just as in the case of the first row. The building of rows is continued until the car is filled. The last row on the open-door side is built from both ends until a space for a stack of single cases only remains in front of the door. Any excess space in the width of the car is left on the loading side. If it is more than 2 inches, a "2 by 4"[1] of proper length should be wedged between ceiling and floor halfway between the door and the bunker in each end of the car, to guard against side shifting. The upright should not be nailed, merely wedged tightly. The buffing and bracing of such a load is described on pages 6 to 7.

All these methods of placing cases were studied at the shipping point, and diagrams were made of the load as it appeared when finished, that accurate information might be available at the terminal.

BUFFING THE LOAD WITH STRAW.

During the early part of this work no attempt was made to alter the routine buffing used by different shippers. The results of the various ways of applying straw or wood was noted when the cars reached destination. The study was begun about the time a general interest was awakened in straw buffing for bunker ends of cars, and to fill spaces when they occurred between the cases at the middle of the load. It was observed that there were almost as many ways of using straw as there were shippers sending cars so buffed. In many instances the straw was so loosely placed that it offered no resistance to the shifting load, which often showed twisting or even a complete overturning of the cases in transit.

Loading cars from end to center, when placing cases with either straight joints or step joints, makes the ramming of the straw between the load and the bunkers a difficult matter, even when the cases are freely walked over during the work. On the other hand, the method of loading from the side permits the operator to stand on the floor while placing the straw between the cases and the bunker. It is possible in the side-loading method to pack tightly, since the operator has the entire row of cases to push against as well as a freedom of action not possible when he works over the tops of the cases, which is the more common practice (Pl. II).

The cost of straw for buffing is ordinarily from $2 to $3 per car. Occasionally the price is so high as to be prohibitive. From 2 to 3 bales of straw per car are required.

Refrigeration in straw-buffed cars.—It has been observed that many shippers who use straw for buffing against the bunker close the lower opening through which the cold air enters the car. The

[1] The term applied to lumber cut 2 by 4 inches.

straw, if packed tightly enough to prevent the shifting of the load, greatly decreases refrigeration. In order to secure the benefit of the cold air from the bunkers (p. 25) and at the same time use straw as a buffing, a small frame was made from scantling, as shown in figure 2. It fitted closely across the car, was the height of an egg case, and just wide enough to go into the space not filled by the egg cases. The lids of cases were laid on the frame to keep the straw from falling through, and on them the buffing was placed in the usual manner. As an additional means of securing efficient refrigeration, one row of cases was omitted from the first layer, and the extra space divided into runways the entire length of the car. In this way it was possible for the cold air to circulate from bunker to bunker. The solid load above held the lower layer in place.

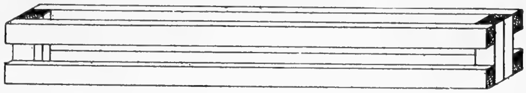

Fig. 2.—Frame placed in front of ice bunker to keep the straw buffing from blocking the cold-air exit in straw-buffed cars.

BUFFING THE LOAD WITH WOODEN FRAMES.

It has long been the custom of many shippers to fill the excess space in egg cars with some sort of wooden framework,[1] known as "braces," "racks," or "frames" (fig. 3). Grain doors, where available, are also employed for this purpose. The underlying requirement for the successful use of any of these devices is that the space shall be completely filled and the load in both ends of the car tight.

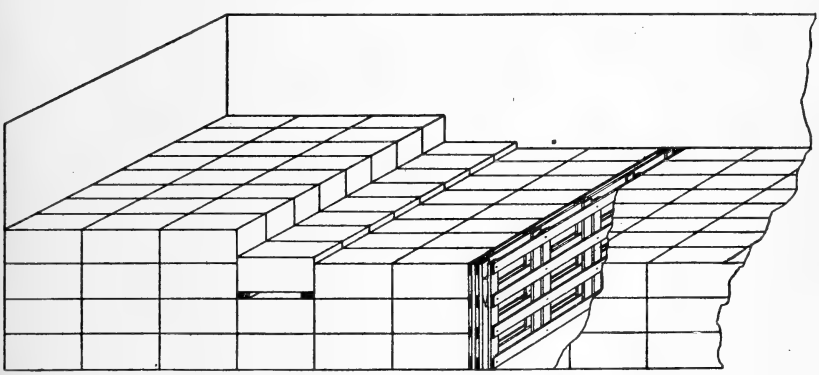

Fig. 3.—A modern frame used as buffing to fill a large space in doorway of car. Built of 2 by 4's made in 2 sections with struts between.

In a comparatively small number of cases ready-made frames of some sort are obtainable. Even so, the supply is not always ade-

[1] For the purposes of this report, the filling of excess space in the car to prevent shifting of the load during railway travel will be called "buffing," regardless of the kind of material used.

quate, for in the heavy shipping season a large number are required. At a much greater number of places ready-made frames have never been seen. Then the making of some such device devolves upon the shipper. He will find that 2- by 4-inch lumber is commonly the most satisfactory material. The frame must be very rigidly constructed, and must fit the space in the car that is to be filled. After the frames are placed in position, a wedge may be driven down between them to make them tight. The lumber needed to make such a frame costs from 30 cents to $2, depending upon the size of the space to be filled.

BRACING THE LOAD.[1]

Bracing is not needed when the number of cases in the load or the size of the car is such that the top layer of cases completely fills the car from bunker to bunker. Very commonly, however, there is a shortage of cases on the top layer, so that it does not extend from end to end or to the middle buffer.

The preliminary survey of the industrial practices showed that many loads were self braced—that is, the weight and position of packages were depended upon to keep them from shifting or roaming free over the interior of the car. Another practice is to nail beams over or in front of cases to be braced, the lumber being usually a 2- by 4-inch strip. These beams are nailed to the walls of the car, either directly or by way of blocks. Obviously, these nails ruin the insulation of the refrigerator car and almost always fail to hold the brace. The 2 by 4 is commonly placed with the 4-inch side vertical, making the strain come against the weakest dimension and causing it to snap. The time and expense in procuring, adjusting, and fastening these braces is practically wasted (p. 26).

This unsatisfactory condition led to a search for an efficient, cheap, and simple brace. In response to the need, a brace consisting of two 2 by 4's (fig. 4), so placed across the width of the car that the

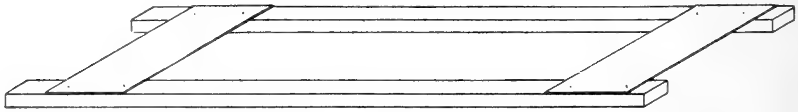

Fig. 4.—Brace of 2 by 4's to be used under cases and placed across the car to prevent shifting to top layer.

row of cases immediately in front of the incomplete top layer is raised about 2 inches (fig. 3), has been developed. If the strips are laid on the floor, the placing of the load must be accurately planned to make sure that they are in the proper position. If the

[1] For the purposes of this report, the term "bracing" will express the means by which a lesser number of cases than a full layer are prevented from roaming during transit.

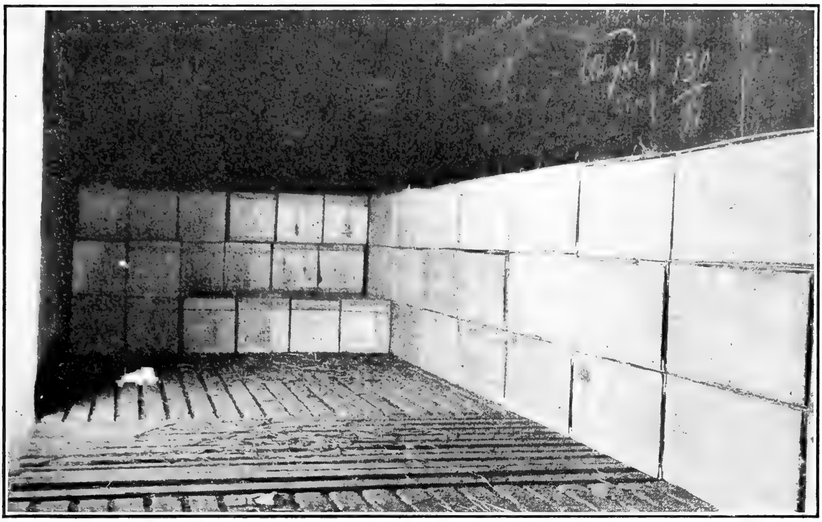

FIG. 1.—STRAIGHT-JOINT LOAD, PLACED FROM THE SIDE.

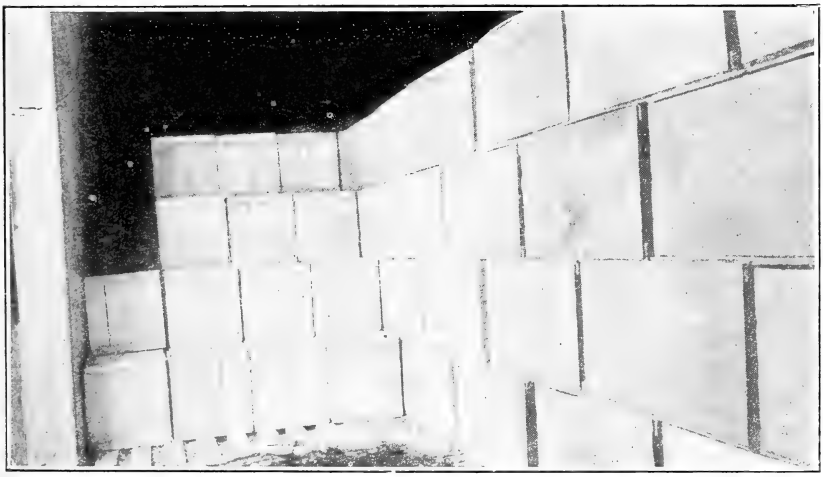

FIG. 2.—STEP-JOINT LOAD, PLACED FROM THE SIDE.

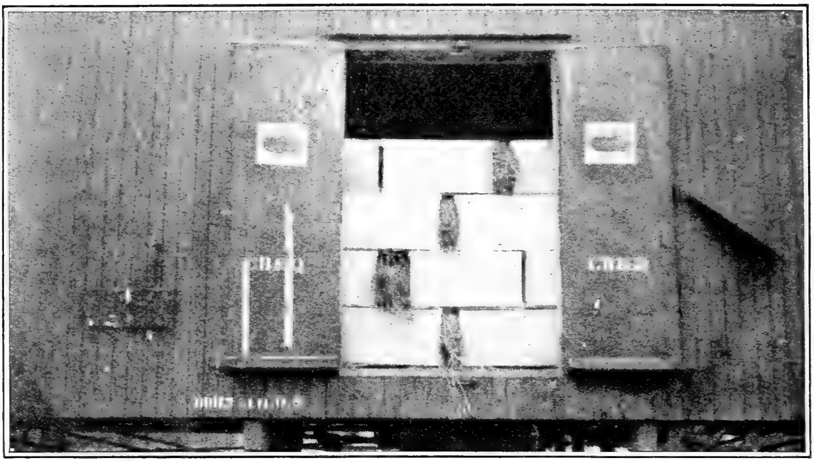

FIG. 1.—STEP LOAD, PLACED FROM ENDS, CENTER SPACES FILLED WITH STRAW. WORK UNUSUALLY WELL DONE.

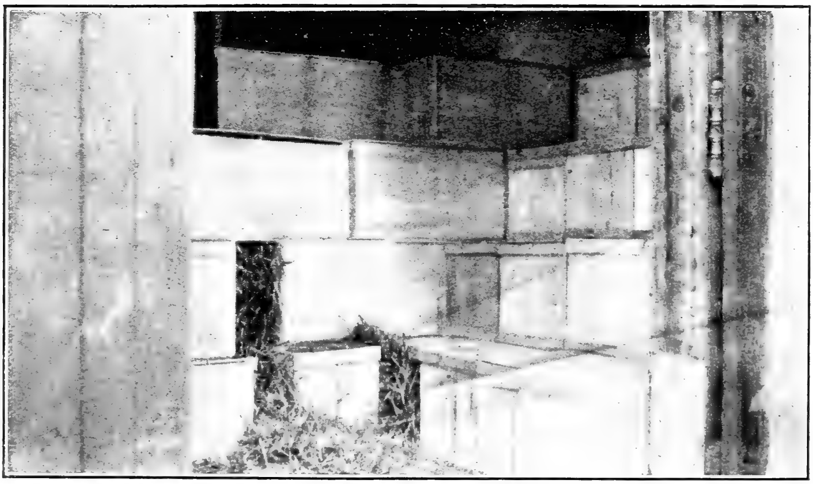

FIG. 2.—STEP LOAD, PLACED FROM ENDS. CONFUSION AT THE CENTER, AND SPACES LOOSELY FILLED WTH STRAW.

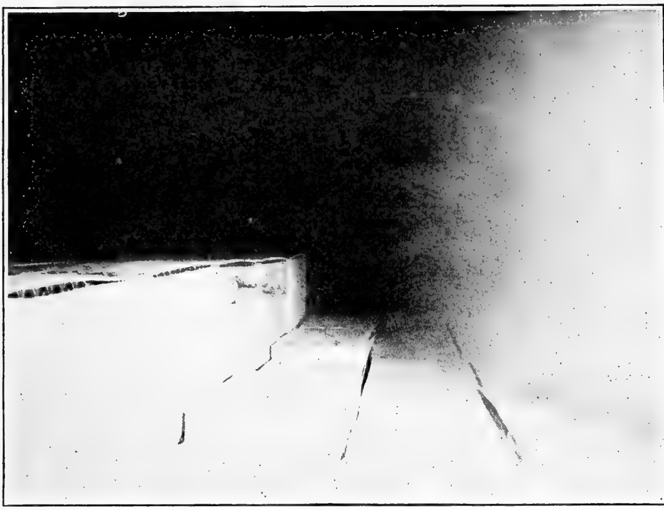

FIG. 1.—LATERAL BRACES UNDER ALTERNATE CASES, STEP-JOINT LOAD, PLACED FROM ENDS.

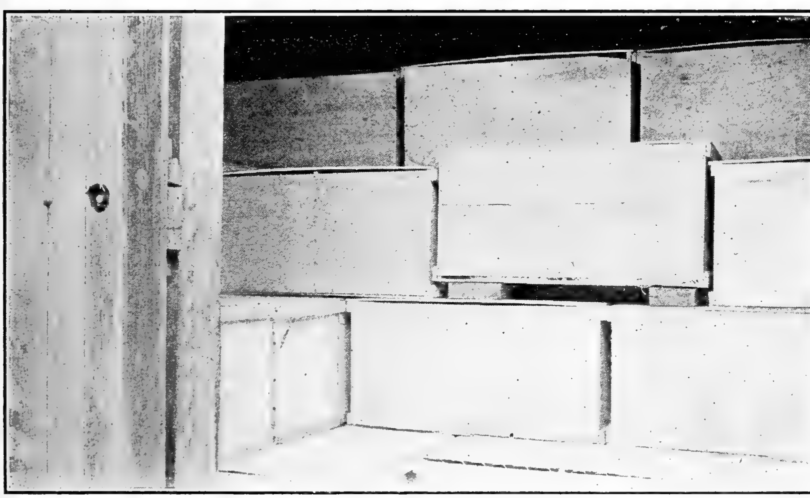

FIG. 2.—LATERAL BRACES UNDER ALTERNATE CASES, STEP-JOINT LOAD, PLACED FROM THE SIDE, SHOWING BRACES (VIEWED FROM DOOR.)

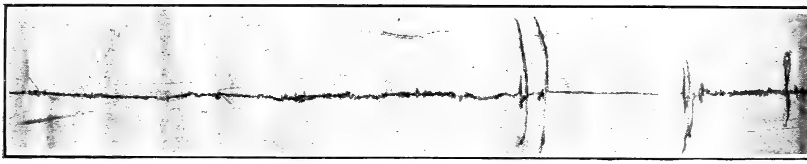

FIG. 1.—SLOW-RUNNING TRAIN.

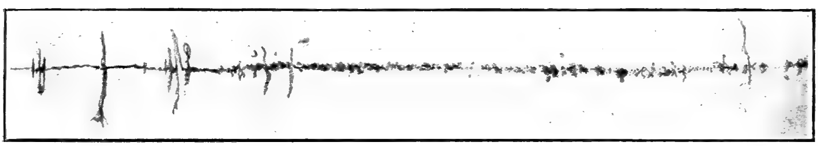

FIG. 2.—FAST-RUNNING TRAIN.

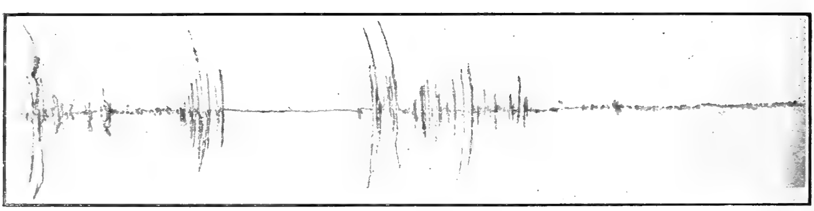

FIG. 3.—YARD SHIFTING.

SHOCKS TO EGGS IN TRANSIT, AS RECORDED BY THE IMPACTOGRAPH.

number of cases is indefinite, the strips may be laid under the desired row on the next to top layer, in which circumstance old case lids should be nailed from strip to strip, here and there, to insure their remaining parallel (fig. 5).

A strip the entire width of the car is available when the end form of stowing is used in placing a step-joint load, and also when the load is of the straight-joint type. If the step load, placed from the side, is to be braced, the same principle may be employed by cutting 2 by 4's into 11-inch lengths (fig. 5), fastening them together with old case lids, and putting one such brace under every other case on the row in front of that to be held in place (fig. 1). It will readily be seen that these lateral braces under the ends of the cases lend themselves to a great variety of puzzling situations. A few of the most usual ways in which they have been found useful are shown in figures 1, 3, and 6, and Plate III. These illustrations show cars stowed with straight- and broken-joint loads, in which the lateral braces under cases were used. If the method of side loading is used, the incomplete layer will extend the length, rather than the width, of the car. In this case the short braces, spaced by pieces of old case lids, as in the step-joint load (fig. 1 and Pl. III), are used.

FIG. 5.—Small brace, to be used under individual cases in step-joint load to prevent shifting of top layer.

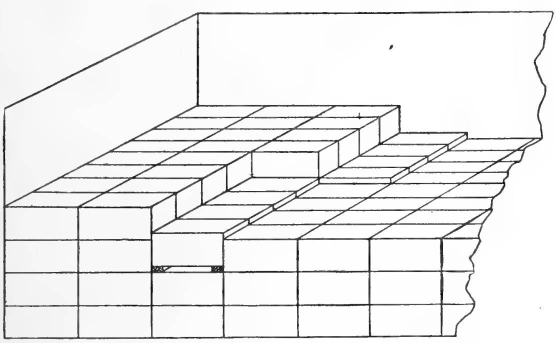

FIG. 6.—Lateral braces under cases in a straight-joint load. Layer 4, stack 3, contains only 4 cases. When such incomplete stacks are to be braced, the strips under the cases must be in at least 2 sections.

THE RAILROAD HAUL.

It has been difficult to devise a method of recording the shocks incident to ordinary freight-train running and handling as felt in the carload of eggs.

Several instruments termed "impactographs" have been devised, and these have been used in the egg car itself, as well as in the caboose which the investigators occupied in accompanying the carload of eggs under observation from origin to destination. A number of records, having the same general character as those shown in

Plate IV, have been obtained, but it has not yet been possible to assign to the tracings any accurate value in pounds pressure or other standard expression of force. To observe the working of the impactographs the investigators rode in freight cars with the machines and watched the records they made, noting by actual observation the relation between the character of the record of train movement and the condition of the eggs in the cases. Plate IV indicates that the shocks incident to yard shifting are much greater than those due to lurching and air brakes while running, even when the speed of a train of 60 cars reaches 45 miles an hour.

A very large amount of damage is caused because the packages get wet, especially those on the floor of the car. A wet filler affords practically no protection to the eggs. A wet floor is generally caused by faulty bunkers or clogged drains, due to dirt from the ice, or failure to remove the slime from the bunker. Observations made during one season showed that 38 per cent of all the egg cars examined were more or less damaged by water. Much, if not all, of this damage can be prevented by washing the ice more carefully befor it is placed in the bunkers, especially where natural ice, which has been packed in sawdust, is used. Too often the so-called washing merely pushes the sawdust around to the lower side of the cake of ice, so that it eventually enters the bunker.

CONDITIONS AT THE TERMINAL.

The 39 terminals at which shipments were received and observations made included freight houses on Manhattan Island, station piers,[1] to which the cars had been transferred by ferry, private warehouses, and the railroad yards of Philadelphia, Boston, and other cities east of Buffalo and Pittsburgh. A freight train upon arrival at destination is broken up into groups or strings of cars, which are shunted and shifted by yard engines in classifying them for delivery to the receivers. The receiving freight yard is usually a large one, and is generally located at some distance from the actual unloading terminus. The cars may have to pass through minor yards before they reach their proper station. The delivery is made at one of four receiving locations, namely, a freight house, a freight yard, a station pier, or a private warehouse or siding. A brief description of each form of terminal follows, and the general method of handling is indicated.

Freight houses are usually located near the point of commercial activity. They serve the purpose of inbound and outbound freight. Some have separate tracks and platforms for each, but often the same

[1] Droege, John A. Freight Terminals and Trains. (1912.) McGraw Hill Book Co., London.

tracks are used for inbound and outbound traffic. A car delivered at the station is unloaded by employees of the railroad, in gangs of such number that they may work rapidly without interference in going in and out of the car. In nearly every instance, as soon as the doors are opened, the cars are examined by an inspector, who notes and reports the condition of the load. The method ordinarily pursued in unloading egg cases is to use a 2-wheeled truck with 3 or 4 cases to the truck load. Three cases to the load were seen more often than 4. The cases were trucked to a designated section of the house, where the consignment was placed in stacks, usually 5 cases high. At the freight houses of one prominent railroad all cases of eggs have been handled by hand for a number of years, each case being carried out from the car to the stack by a man. All freight gangs are managed by a general foreman and numerous subforemen.

In a freight yard, where freight is delivered, the car tracks are usually arranged in pairs with driveways between to allow delivery from either track direct to wagons or trucks. The handling in fregiht yards is usually done by employees of the consignee.

A station pier is a water-front terminal, and contains no railroad tracks. It is usually a long pier, 600 or more feet, extending out into the harbor, with doors along both sides to facilitate delivery from the cars, which are on a boat, barge, or float tied up to the pier. Cars intended for such a station are loaded on huge floats (Pl. V, fig. 1), formerly made of wood, but now usually all steel. The floats hold from 12 to 24 cars, with an equal number on either side. When the float is to receive cars it is fastened to a transfer slip, an adjustable bridge capable of being raised or lowered. This operation, which requires most careful handling, is accomplished without any noticeable jolt or jar, so that damage at this point is rare. The floats are conveyed by a tug from the slip to the pier, to the side of which they are fastened securely, to await unloading (Pl. V, fig. 2). The handling on the station pier is similar to that at freight houses. In a tide-water port, such as New York City, the gangway from the float to the pier has varying inclines, depending upon the tide at the time of delivery (Pl. VI, fig. 1). When the incline is fairly steep, a buffer of sand is used at the end of the plank on the pier to retard the speed of the truck. While the incline is a hazard, loss on this account is unusual. At high tide, egg cases may be delivered from the car on the float to the pier by means of a sliding chute (Pl. VI, fig. 2). The goods are stacked along both sides of the station pier, leaving a driveway down the center.

The private sidings at which the investigators worked were numerous and varied. Sometimes the cases were delivered at the sidewalk in front of a commission house, and conveyed on 4-wheeled trucks to the house. At other places the cases were conveyed from a platform on trucks through long tunnels to private warehouses. In some instances the unloading was direct from the car on the same level as the house. This was especially true at platforms of cold-storage warehouses. Some of the warehouses used 4-wheeled trucks exclusively, while others used both 2-wheeled and 4-wheeled trucks. In one place, delivery was made direct from the cars on the float to a private warehouse. Whatever the manner of unloading happened to be, the experimental cases received exactly the same treatment as the other cases in the shipment.

Eggs received at various terminals in experimental shipments were examined individually, and charted on a diagram similar to that used by the investigators at the point of origin. A comparison of the two diagrams showed at a glance the damage which had occurred during transit to each individual egg in the case.

RESULTS OF THE INVESTIGATION.

FACTORS CONTRIBUTING TO TRANSIT DAMAGE.

A study of the conditions surrounding the transportation of eggs leads to the conclusion that the damage referable to transit may be reduced to less than 1 per cent, provided the eggs are shipped in carlots, packed in good, well-made, standard cases, with new medium or heavier fillers and flats, with properly placed and suitable cushions at top and bottom, and with cases tightly stowed and efficiently braced in the car. As a rule the average well-packed, well-handled carlot shipment shows a damage of less than 2 per cent.

TABLE 1.—*Damage in transit to eggs in well-stowed cars.*

Experiment No.	Damaged eggs per case.	Experiment No.	Damaged eggs per per case.
5117	2.0	5114	3.5
5118	3.5	5126	3.5
5120	3.0	5131	3.5
5121	1.5	5139	4.0
5122	2.0	5150	4.5
5124	2.0	5154	5.0
5127	2.5	5171	4.0
5129	4.5	5173	2.0
5130	3.0	5177	4.0
5132	5.0	5181	3.5
5135	3.0	5137	4.0
5104	3.0	5105	4.0
5172	5.0	5146	3.5

Table 1 shows the damage observed in some cars which, well stowed, buffed with either straw or wood, and well braced, traveled without any shifting of the load: all were handled during transit according to the usual railroad routine. Viewed from the aspect of eggs per case, the number is small. Viewed in the light of the egg trade in the United States, the damage is still sufficiently great to warrant its analysis and further efforts to reduce it. Viewed with the remembrance of the much greater amount of damage constantly visible wherever egg cars are unloaded, it seems highly desirable to discuss and weigh the routine of handling, stowing, bracing, and transporting by which the damage was kept down to the figures given in Table 1.

An analysis of the factors contributing to transit damage shows that it is principally affected by:

(1) The size of the egg.
(2) The soundness of the eggshell.
(3) The character of the package.
(4) The position of the egg in the package.
(5) The position of the case in the car.
(6) The character of the buffing and bracing of the load.
(7) The construction of the car.
(8) Shocks during the haul.
(9) Handling at the terminal.

THE SIZE OF THE EGG.

The relative safety during transportation of eggs which exactly fit the cells of the fillers as they are now made (1.75 by 2.25 inches), as compared with eggs which are too long, too short, and too narrow, is shown in Table 2.

TABLE 2.—*Damage in transit to long, short, narrow, and well-fitting eggs.*

Condition at packing house.	Individual eggs.	Eggs damaged in transit.	
	Number.	*Number.*	*Per cent.*
Well-fitting	33,626	639	1.90
Long	323	12	3.71
Short	1,170	11	.94
Narrow	467	7	1.49

The eggs which are too long for the fillers are, of course, most subject to injury. The study indicates that 18 per cent of the eggs marketed in northern Missouri were longer than the cells. More than 2 per cent were $\frac{1}{8}$ inch or more above the top of the cell (fig. 7). The proportion of large eggs would probably increase in some districts, where production has been placed on a more scientific basis, and decrease in others, where low-grade stock still predominates.

The eggs which are too large for the diameter of the filler press the walls outward, and secure sufficient space from the cells containing narrow eggs; for the eggs which are too long there is no such relief, and their liability to damage is nearly twice that of the well-fitting egg, even when, as in these experiments, care was taken to slant the egg into the most advantageous position. Figure 8 indicates the frequency of the occurrence of extra wide eggs.

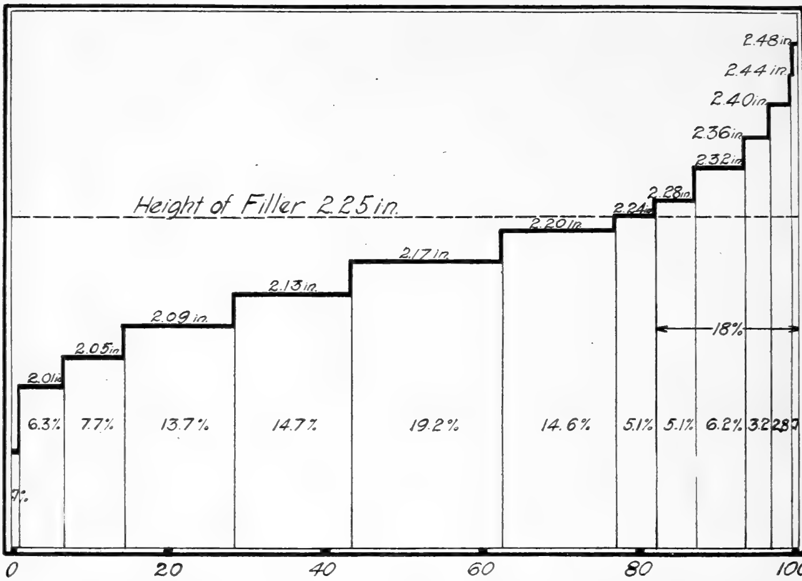

FIG. 7.—Relation of length of eggs to depth of fillers. Measurements made from 2,100 eggs.

THE SOUNDNESS OF THE EGGSHELL.

The number of eggs showing damage to the shell before shipment is given in Table 3. The presence of an average of 19 cracked eggs to the case, as it leaves the hands of the shipper, might lead to the inference that these eggs would be a fertile field for further and more

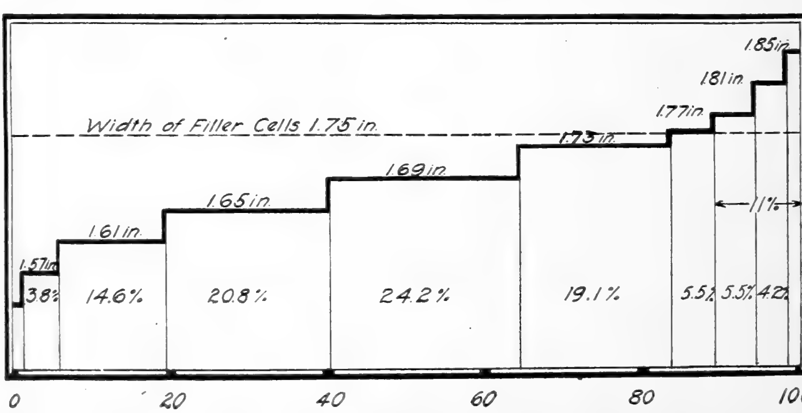

FIG. 8.—Relation of width of eggs to width of filler cells. Measurements made from 2,100 eggs.

serious damage during transit. It should be remembered, however, that these 19 eggs per case as they leave the shipper are not damaged to such an extent that they are detected in the usual terminal inspection, unless the inspection includes candling or clicking.

TABLE 3.—*Number of eggs with shells damaged before loading in car.*

Packing house No.	Number of experiments.	Number of eggs per case.							Total damaged eggs per case.
		Cracked.			Dents.			Total average damaged.	
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.		
									Per cent.
I	6	20.75	3.38	15.92	28.85	0.50	11.56	27.48	7.64
II	1	10.37	10.37	10.37	3.88	3.88	3.88	14.25	3.96
III	10	21.90	6.37	14.11	6.50	.25	2.56	16.67	4.63
IV	1	....	....	....	2.00	2.00	2.00	2.00	.56
V	15	18.00	4.33	10.00	12.67	3.00	8.11	18.11	5.03
VI	7	17.00	8.67	11.60	10.00	5.67	8.14	19.74	5.49
VII	11	23.75	11.25	19.30	8.63	.63	3.85	23.15	6.43
VIII	8	23.60	16.75	19.48	5.00	.75	2.45	21.93	6.09
IX	1	19.10	19.10	19.10	1.00	1.00	1.00	20.10	5.59
X	1	10.50	10.50	10.50	.63	.63	.63	11.13	3.09
XI	1	10.75	10.75	10.75	.75	.75	.75	11.50	3.20
XII	2	8.75	8.25	8.50	.75	.25	.50	9.00	2.50
XIII	1	12.75	12.75	12.75	2.25	2.25	2.25	15.00	4.17
XIV	1	12.25	12.25	12.25	.75	.75	.75	13.00	3.61
XV	8	20.40	8.67	14.80	6.00	....	2.85	17.65	4.90
XVI	2	23.00	15.50	19.25	1.50	1.25	1.38	20.63	5.72
XVII	8	23.00	8.88	17.10	.88	.29	.57	17.67	4.91
XVIII	7	23.00	.75	15.00	3.50	....	1.76	16.76	4.65
XIX	3	30.9	25.1	27.03	3.38	.75	2.46	29.49	8.20
XX	1	1.90	1.90	1.90	2.00	2.00	2.00	3.90	1.08
XXI	2	34.50	23.60	29.05	3.12	2.00	2.56	31.61	8.78
XXII	1	20.70	20.70	20.70	4.75	4.75	4.75	25.45	7.07
XXIII	1	18.30	18.30	18.30	3.63	3.63	3.63	21.93	6.08
XXIV	1	4.00	4.00	4.00	19.67	19.67	19.67	23.67	6.58
XXV	3	17.67	6.00	13.78	15.30	6.67	9.88	22.66	6.30
XXVI	5	16.00	5.67	9.73	19.67	6.33	15.20	24.93	6.92
XXVII	20	16.00	7.33	12.70	13.00	.75	4.50	17.20	4.78
XXVIII	8	17.67	8.00	12.50	8.67	.38	3.74	16.24	4.50
XXIX	1	6.00	6.00	6.00	5.00	5.00	5.00	11.00	3.06
XXX	9	26.40	5.00	16.20	5.67	....	.96	17.16	4.78
XXXI	1	4.33	4.33	4.33	.67	.67	.67	5.00	1.39
All packing houses	147	34.50	....	15.38	28.85	....	4.03	19.41	5.39

To determine the extent of the damage when the lightly cracked or dented eggs were well packed and well stowed, a comparison was made of the injury to sound and unsound eggs. The results are given in Table 4.

TABLE 4.—*Damage in transit to sound and unsound eggs.*

Condition at packing house.	Individual eggs.	Eggs damaged in transit.	
	Number.	*Number.*	*Per cent.*
Sound shells	76,386	1,162	1.77
Cracks	4,368	125	2.88
Dents	972	22	2.37

Little difference is shown between the amount of injury to checks and that to dents, when the shell membranes are not broken. There is, however, a distinct difference, approximately 1.1 per cent, between the sound and the unsound eggs. This figure, applied to case lots of unsound eggs, shows an additional damage having a commercial importance. Applied, however, to the case of rehandled eggs as commonly put up by the shipper, containing 19 with unsound shells, it amounts to only 0.2 egg per case, a negligible number. Apparently, then, the matter of the 19 cracked eggs, as found in the well packed standard package, becomes an economic question of keeping quality in cold storage and of marketing, not of transportation damage.

THE CHARACTER OF THE PACKAGE.

Strength of cases.—In the course of this investigation the standard egg package was subjected to various tests[1] to determine the relative strength of the three kinds of wood (gum, tupelo, and cottonwood) commonly used, the number of nails needed, the manner in which the cases failed when subjected to evenly exerted pressures, and to obtain other data bearing on the subject. A summary of results, the details of which are too lengthy to be included here, is presented in this bulletin. Table 5 gives the average number of pounds of evenly applied pressure which the different cases withstood before they failed or became crushed.

TABLE 5.—*Analysis of strength of egg cases.*

Material.	Type.	Strength.				Weight.
		Diagonal.	Lengthwise.	Sidewise.	Vertical.	
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Cottonwood	5 nails	590	2,214	9,810	20,343	7.25
Red gum	do	567	2,110	13,629	21,257	8.89
Tupelo	do	687	1,914	12,143	20,294	8.24

In spite of greater weight, the gum and tupelo cases offer no additional strength as compared with cottonwood. On the other hand, cottonwood presents certain advantages in that it is softer and odorless, and does not warp or crack as readily as the other woods. The results given in Table 5 are based on cases made up with 5 cement-coated 3-penny nails at each corner of the sides and bottom and at the center partition. If only 4 cement-coated nails are used the package is weakened; this was also the case with smooth nails, even when 5 were used. The use of 6 cement-coated 3-penny nails slightly increases the rigidity of the case, an important feature in safe transportation, since distortion of the case soon causes breakage. The same added rigidity is noticed when wire binding is used around the sides and bottom of the case at the ends; likewise when the lid is nailed in the center.

[1] The tests were made in cooperation with the Forest Products Laboratory, of the U. S. Department of Agriculture, and the Bureau of Standards, of the U. S. Department of Commerce.

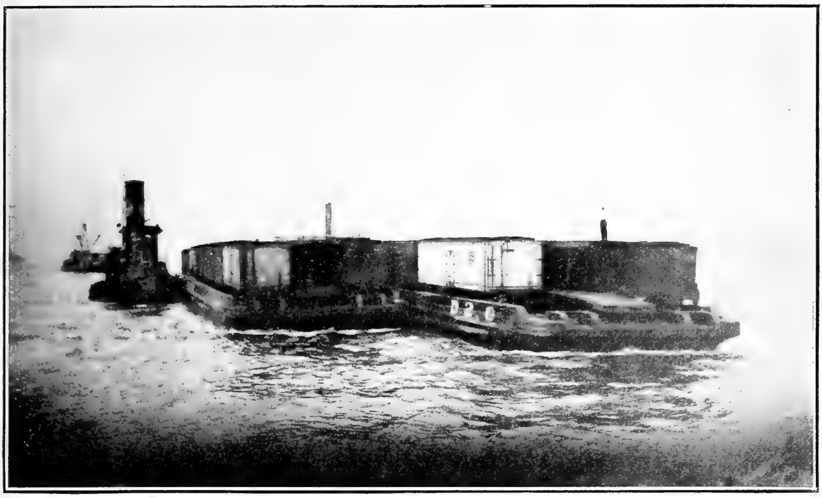

FIG. 1.—FLOATS CROSSING NORTH RIVER TO NEW YORK CITY.

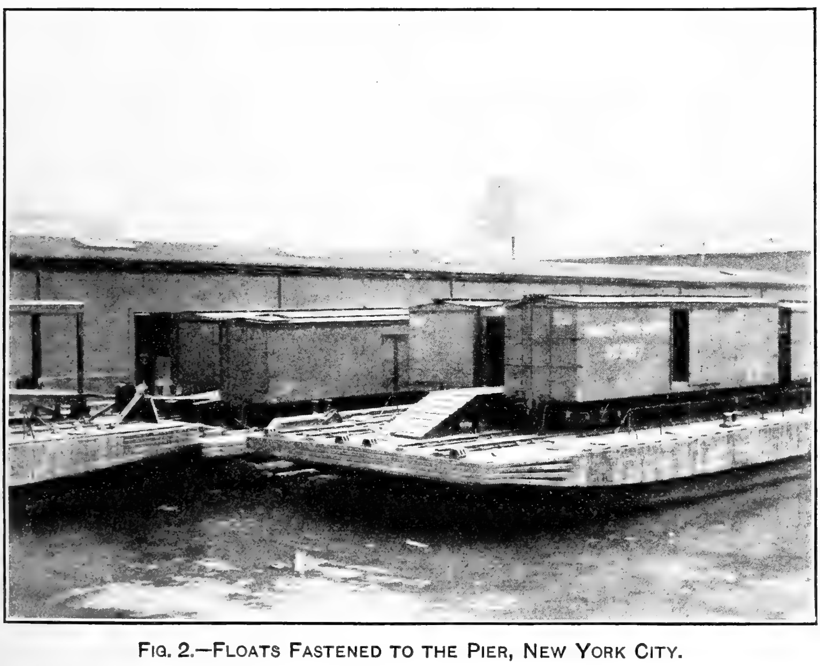

FIG. 2.—FLOATS FASTENED TO THE PIER, NEW YORK CITY.

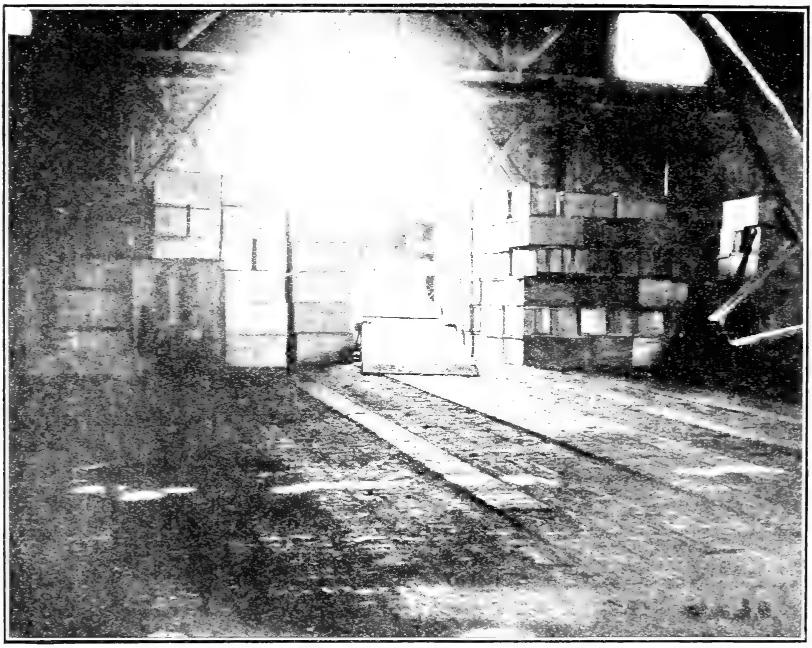

FIG. 1.—HIGH TIDE AT A STATION PIER.

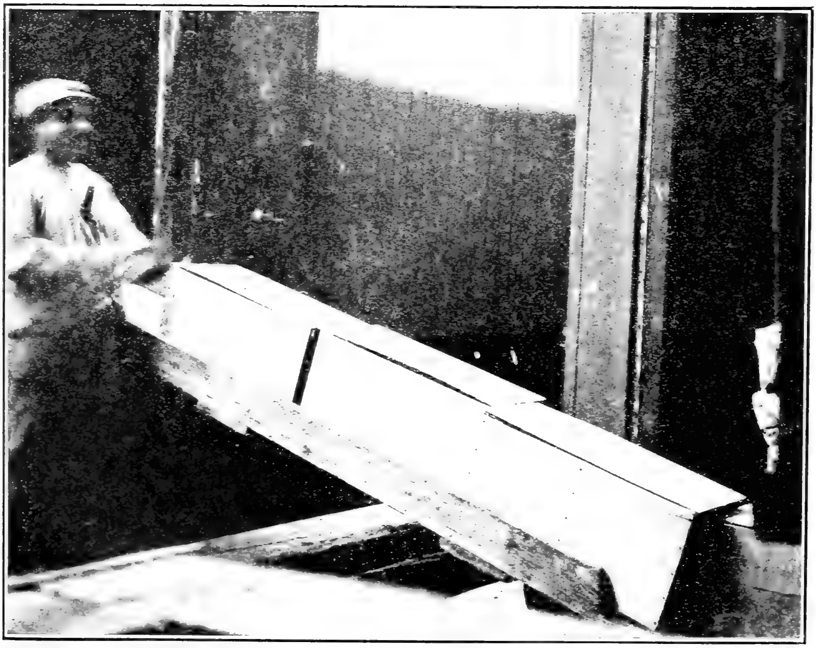

FIG. 2.—UNLOADING AT A PIER THROUGH A CHUTE.

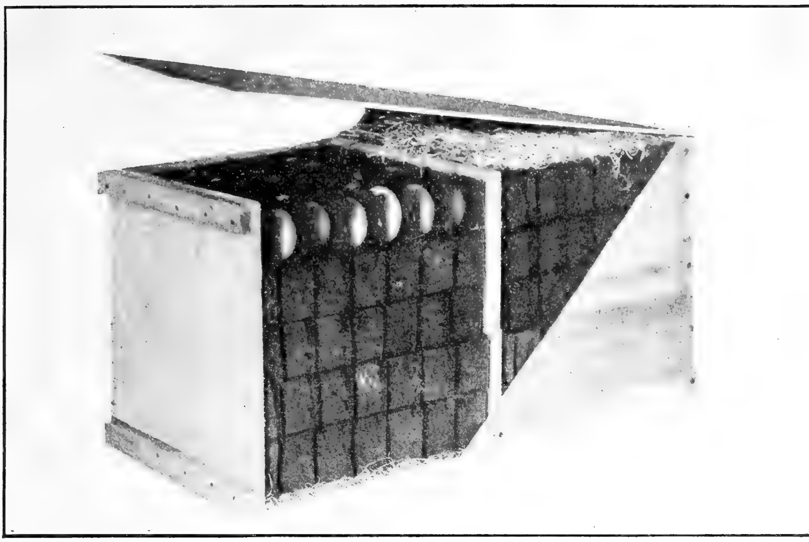

FIG. 1.—EXCELSIOR WELL PLACED.

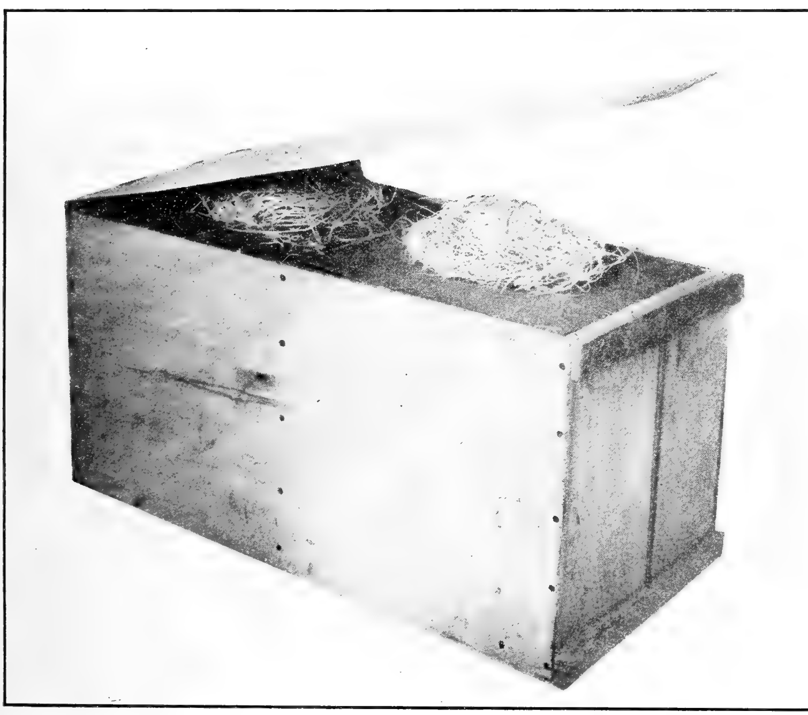

FIG. 2.—EXCELSIOR BADLY PLACED.

FIG. 1.—STRAW BUFFING LOOSE; LOAD SHIFTED.

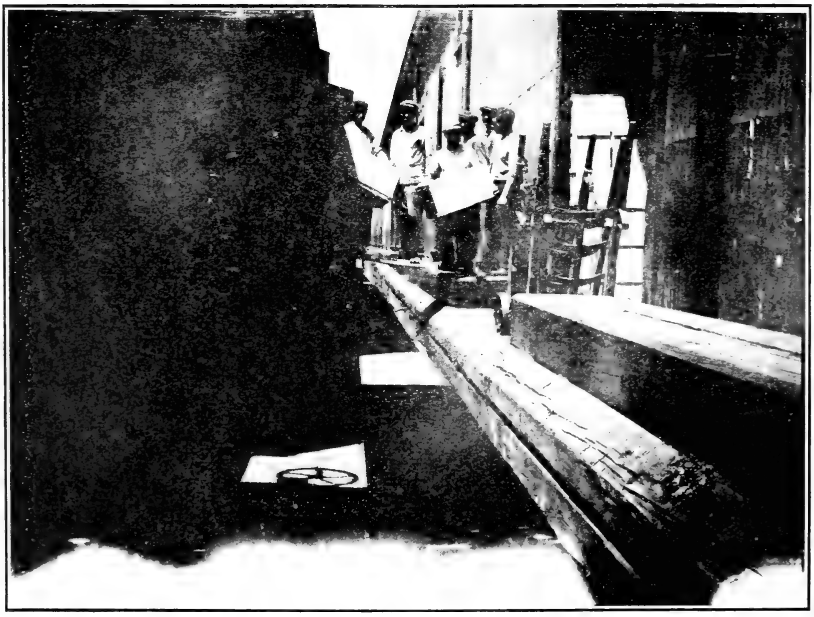

FIG. 2.—CONGESTION AT A STATION PIER.

Strength of fillers.—The strength of various grades of strawboard fillers on the market was accurately measured in compression machines, and, as indicated in Table 6, it varies with their respective weights.

TABLE 6.—*Crushing strength of fillers.*

Trade name.	Weight per set.		Crushing strength.	Strength of tips.
	Pounds.	*Ounces.*	*Pounds.*	*Pounds.*
No. 1	3	12	685	57
3 pounds	3	6	595	42
Medium	3	3	471	38
No. 2	2	8	325	36

The strength of the tips of the fillers was obtained by subjecting them to pressure in a like manner. The close relationship between filler tips and damaged eggs is seen throughout this investigation. It has been observed in field work, and amply proven in the laboratory. For example, the effect of measured blows delivered in a definite way against the end of the case did not wreck the shell of the egg until the tips of the fillers were bent so that the sides of the strawboard cell came in contact with the wood of the case. The tips of the so-called No. 1 fillers were found to protect the eggs on the ends from becoming leakers more effectively than 3-pound or medium fillers, but heavy shocks were observed to cause a light cracking before these heavy tips failed.

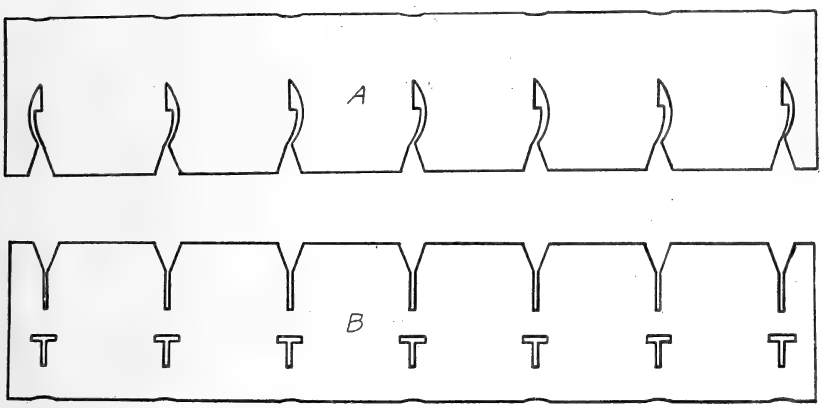

FIG. 9.—Longitudinal and transverse sections of an egg filler.

The strips which form the cell walls of an egg filler are solid (B) on one side and slit (A) on the other (fig. 9). When the filler is completed, half of the solid sides are upward in the filler, and the other half, running in a transverse direction, are downward. Added safety is gained by placing the upper solid side next to the end and center board of the case, as this prevents the egg from toppling over against the wood.

The increased protection afforded by strictly new, as compared with old, fillers is strikingly brought out in the laboratory tests, as well as under practical conditions. Of course, there is a wide variation in old fillers, if all fillers which have been used are so designated. Taking fillers which are distinctly defective, in having some bent and more or less softened tips, the damage is frequently five times that in new fillers. For example, 99 foot-pounds of energy delivered in the form of two blows, evenly distributed over the end of a case having 6 inches of sliding room, crushed 6.5 per cent of the eggs in old fillers, while the same treatment crushed only 1 per cent of the eggs packed in perfectly new fillers. Such results indicate that much stress should be laid upon the importance of new fillers in the safe shipping of eggs.

Top and bottom cushions.—The quarter filler recently brought into use as a cushion in the bottom of the egg case will support an evenly applied weight of 900 pounds, which is amply adequate to carry the load to which it is subjected. It provides a perfectly even cushion, another essential in securing safe transportation of eggs. If the bottom of the case becomes wet, this quarter filler is likely to flatten out, ceasing to act as a cushion. When excelsior is used as a bottom cushion it must be plentiful and evenly distributed, and a flat must always be laid over it before inserting the first filler. A comparison of the efficiency of corrugated flats and properly applied excelsior as a cushion in the top of egg cases showed that they afforded practically the same protection. Excelsior must be laid evenly over the top flat, and must be sufficient to fill the space in the top of the case, but not enough to cause a bulging of the lid. In no case should a wad of excelsior be placed on the center of the top flat (Pl. VII).

THE POSITION OF THE EGG IN THE PACKAGE.

Practical experience has shown that damage to the eggshell is more common in the rows next to the ends and center and in the top layer than in those deeper in the case. The relative safety of the different rows is seen from the data given in Table 7.

TABLE 7.—*Damage in different rows in the case.*

Description of cars.	Section of case.			
	End.	Second row.	Third row.	Center.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Straw buffed	1.39	1.04	0.95	0.97
Wood buffed	1.64	1.44	1.17	1.30
Poorly loaded	2.95	2.04	1.73	1.46

The center partition may be considered to form one end of the case. When a shock is received on the end of the case, it is transmitted to the eggs through the filler tips, if they are not bent, or through the walls of the cell, forcing the entire 15 dozen eggs back against the center board, where, again, the tips of the fillers are called upon to afford protection. If the tips fail, the eggs come into sharp contact with the case itself, and damage results. The extent of the damage at the center board is less than at the end of the case, due probably to the absorption of a certain amount of the shock by the packing and load of the case.

It will be observed that cars which were not well loaded show a greater amount of damage in each row, but that a difference between the end and the center board is maintained. Experimental observations in the testing laboratory have fully confirmed the records of the experimental shipments. The damage occurring in the different layers of the case is summarized in Table 8.

Table 8.—*Damage in various layers in the case.*

Description of cars.	Layer.				
	Top.	Second.	Third.	Fourth.	Fifth.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Straw buffed	1.41	1.11	1.11	0.84	1.05
Wood buffed	2.46	1.35	1.42	1.10	1.04
Poorly loaded	3.06	1.91	1.39	1.50	1.87

Many factors may contribute to increase the breakage in the top layer. Among them are walking on cases or climbing over them, an inadequate cushion, or the throwing of the eggs against the lid of the case during severe jolts. Experimental work in the testing laboratory indicated that the damage in the top layer caused by definitely administered shocks on the end of the case amounted to approximately 40 per cent of the total damage in the whole case. It is of interest to observe in Table 8 that damage, unless almost negligible, as in straw-buffed, well loaded cars, is approximately twice as heavy in the top layer as in any of the lower layers.

The question of buffing in the ends of the cases was also studied in the testing laboratory. If the center partition is properly placed, and the fillers and flats fit the cases, excelsior wads, corrugated flats, or other buffing is not needed, and does not afford additional protection. Improperly placed center boards or fillers that are either too large or too small are a prolific source of damage, and buffing in the ends of the cases can not be relied upon to afford adequate protection.

THE POSITION OF THE CASE IN THE CAR.

The data on the damage to the eggs, due to the part of the car in which the case is placed, are given in Table 9. These data are compiled for well and poorly loaded cars, and for both straw- and wood-buffed cars. In the straw-buffed cars, as the distance from the straw buffing increases, there is a slight but definite increase in breakage, amounting to about 1 egg per case. Although this increase is not visible in the wood-buffed loads, the total breakage with this form of buffing is slightly higher. Regardless of their position the rows show a uniform tendency toward an increased damage along the sides of the cars, becoming progressively less toward the center line. The layers of cases show no consistent tendency toward increased damage in any definite locality.

TABLE 9.—*Transit damage to eggs in different parts of the car.*

Description of car.	Stacks.						
	First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Straw buffed	0.69	0.88	0.73	0.90	0.84	0.90	1.06
Wood buffed	1.18	1.32	1.52	1.36	1.82	1.25	1.08
Poorly loaded	2.08	1.07	1.62	....	.88	1.72	2.40

Description of car.	Rows.				Layers.			
	Side wall.	Second.	Third.	Fourth.	Bottom.	Second.	Third.	Fourth.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Straw buffed	0.84	0.90	0.84	0.84	0.75	1.00	0.75	0.84
Wood buffed	1.60	1.36	1.32	1.28	1.24	1.07	1.25	1.90
Poorly loaded	1.68	1.60	1.50	1.40	1.50	1.40	1.94	1.18

THE CHARACTER OF THE BUFFING AND BRACING OF THE LOAD.

A correlation of the character of the stowing of the load at the point of origin and its effect on the amount of damage to the eggs apparent at destination soon convinced the investigators that a revision of many common practices must occur before any noteworthy improvement in the condition of the eggs at the market center could be expected.

The experiments here reported indicate that the load of egg cases must be a solid unit in the car, fitting in so tightly that not an inch of play is available, and its rigidity must be entirely independent of braces nailed to any part of the car. How such stowing and bracing can be readily and cheaply done is told on pages 5 to 9 of this report. Of all the various factors entering into the breakage of eggs during transportation, the placing of the load in the car and the maintenance of its rigidity during transit are the most important.

The damage in a number of cars, typifying good bracing, buffing, and stowing, is shown in Table 1. Table 10 shows the damage in some individual cars which were not stowed tightly enough to prevent a certain amount of shifting. In these cars, the shifting of the load was plainly visible on arrival at destination, and even before that time they had been classed as "poorly loaded" by the investigators in the producing territory. In no case, however, were these cars comparable with those known commercially as "in bad order," and none of them contained cases stained on the outside by liquid egg. In the language of the trade, there was no "visible damage." They are given here to illustrate how rapidly damage increases after the occurrence of a noticeable shifting, not as examples of the amount of damage often seen in cars commercially loaded.

TABLE 10.—*Damage in transit due to poorly stowed cars.*

Experiment No.	Damaged eggs per case.	Experiment No.	Damaged eggs per case.
5111	7.5	5141	9.0
5161	8.0	5180	9.5
5106	6.5	5107	7.0
5156	12.5	5165	9.5
5176	14.5	5186	7.5

A comparative study of the step-joint and straight-joint loads indicates that, all other conditions being equal, one is as efficient as the other, in so far as the safety of the eggs is concerned. Table 11 gives the damage in typical cars, when both forms of placing the cases were used, and when the buffing and bracing prevented the shifting of the cases during transit shocks.

TABLE 11.—*The relative damage in step-joint and straight-joint loads.*

Step-joint loads.		Straight-joint loads.	
Experiment No.	Damaged eggs per case.	Experiment No.	Damaged eggs per case.
5122	2.0	5121	1.5
5126	3.5	5124	2.0
5130	3.0	5114	3.5
5137	4.0	5117	2.0
5127	2.5	5118	3.5
5135	3.0	5120	3.0
5131	3.5	5129	4.5
5150	4.5	5139	4.0
5116	2.5	5171	4.0
5115	3.0	5173	2.0

During the early part of the investigation it was observed that while many step-joint loads showed damage at destination, they were invariably so stowed that shifting of the load had occurred during transit. Later on, when the investigators saw to it that the load was rigid, the results given in Table 11 were obtained. When shifting in this load does take place the three crosswise cases on alternate layers at the bunker are likely to fall down into the space, not only becoming crushed themselves but by grinding injuring other cases.

The rigidity of the load depends largely upon the character of the buffing and the manner in which it is placed in the car; hence it assumes an important rôle in preventing damage. The methods used by the investigators, in order to make observations upon loads buffed with either straw or wood (pp. 6 and 7), emphasize the necessity of packing the buffing so tightly that shifting can not take place. Unfortunately many shippers have failed to realize the easily compressible character of straw, to which fact is due much of the damage prevailing in straw-buffed cars (Pl. VIII, fig. 1). For example, out of 27 straw-buffed carlots studied during the early part of the investigation 18 showed serious damage or displaced cases on arrival at destination, simply because the straw had not been packed tightly enough.

During the survey of commercial practices made in the early part of this investigation it was observed that a relatively large number of carloads of eggs buffed with wooden frames arrived at destination in good condition. This was because the load was tighter and had shifted little, if at all, as it did when loosely buffed with straw. Observations were made on a number of carlots that had been packed with straw at the bunkers, and the load then made tight by frames at the middle. These also commonly arrived in good order.

A comparison of the damage observed in well stowed cars, buffed with straw, with that in well stowed cars, buffed with wood, shows a small margin (about 1.5 eggs per case) in favor of the straw, as may be seen by comparing the typical shipments listed in Table 12.

TABLE 12.—*Comparison of damage in straw- and wood-buffed cars.*

Straw-buffed cars.		Wood-buffed cars.	
Experiment No.	Damaged eggs per case.	Experiment No.	Damaged eggs per case.
5130	3.0	5102	5.5
5118	3.5	5103	6.5
5120	3.0	5104	3.0
5132	5.0	5105	4.0
5181	3.5	5140	6.0
5173	2.0	5146	3.5
5127	2.5	5148	5.0
5129	4.5	5172	5.0

The amount of damage given in Table 12 is, of course, the average for all parts of the car. Reference to the discussion of the damage in different parts of the car shows that the extra protection afforded by straw is largely distributed over the rows close to the straw, where apparently it visibly reduces the number of eggs broken. In the rows toward the middle of the car both forms of buffing, so long as the load is tight, are equally efficient.

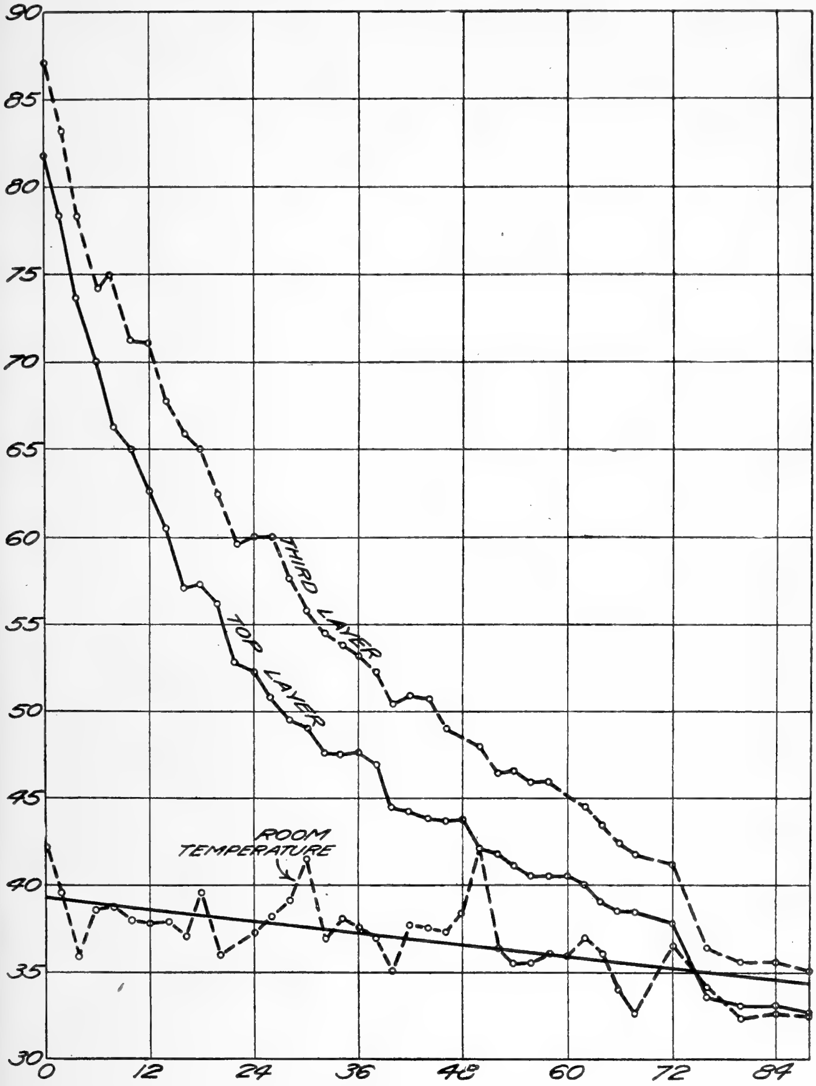

FIG. 10.—Rate of cooling of eggs in refrigerated storage room.

The effect of straw buffing on the temperatures maintained in refrigerator cars is too important to be omitted in a discussion of its relative value in the saving of waste in eggs. It is difficult to chill eggs packed in cases even when conditions are favorable. Figure 10 shows that in a mechanically refrigerated room about 72 hours were required to reduce the eggs in the center of the package from an

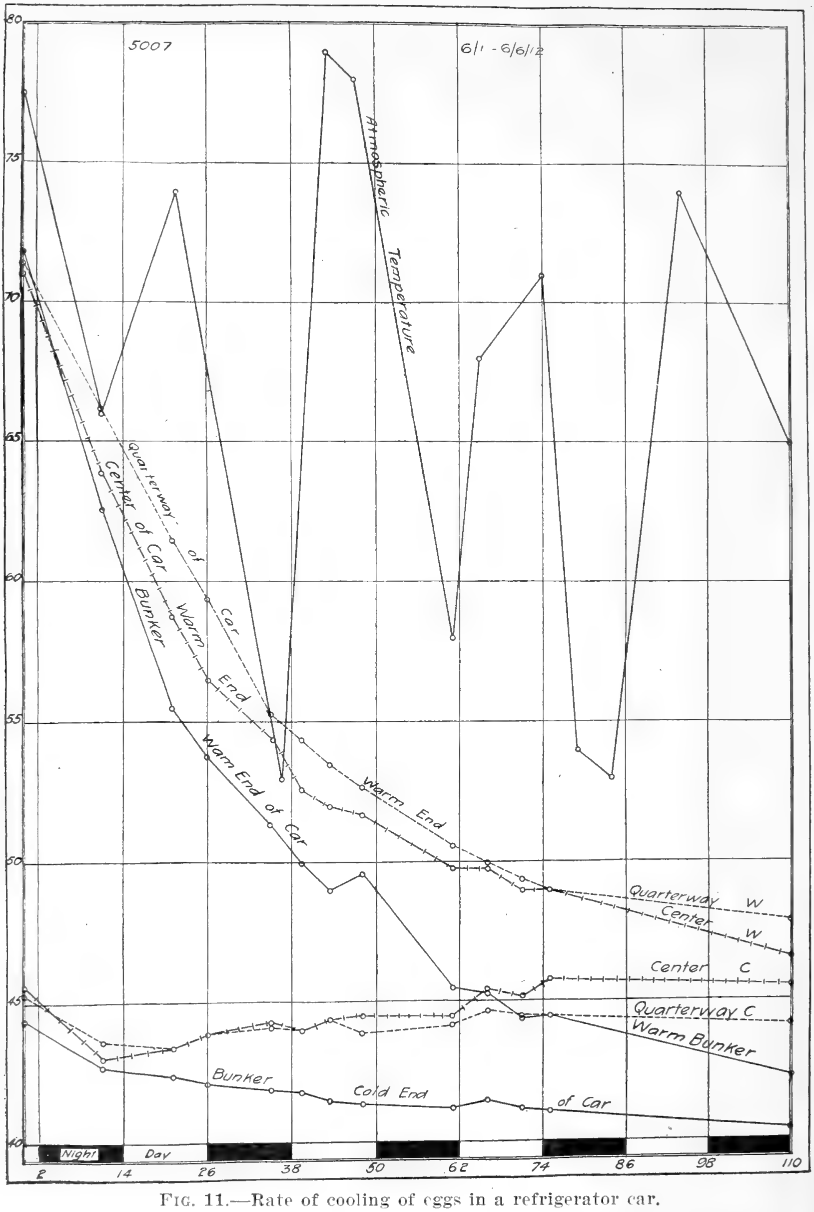

FIG. 11.—Rate of cooling of eggs in a refrigerator car.

entering temperature of 87° F. to 32° F., or the temperature of the room. Chilling in a good refrigerator car is, of necessity, a much slower process, as is illustrated in figure 11, which shows that 4.5

days were required to reduce the eggs from 73° F. to the temperature of the car, approximately 45° F. On the other hand, the maintenance of the desired temperature in precooled eggs is comparatively simple (fig. 11), experiments having shown that eggs reduced to a temperature of approximately 45° F. before loading maintained that temperature throughout the haul. The placing of straw buffing

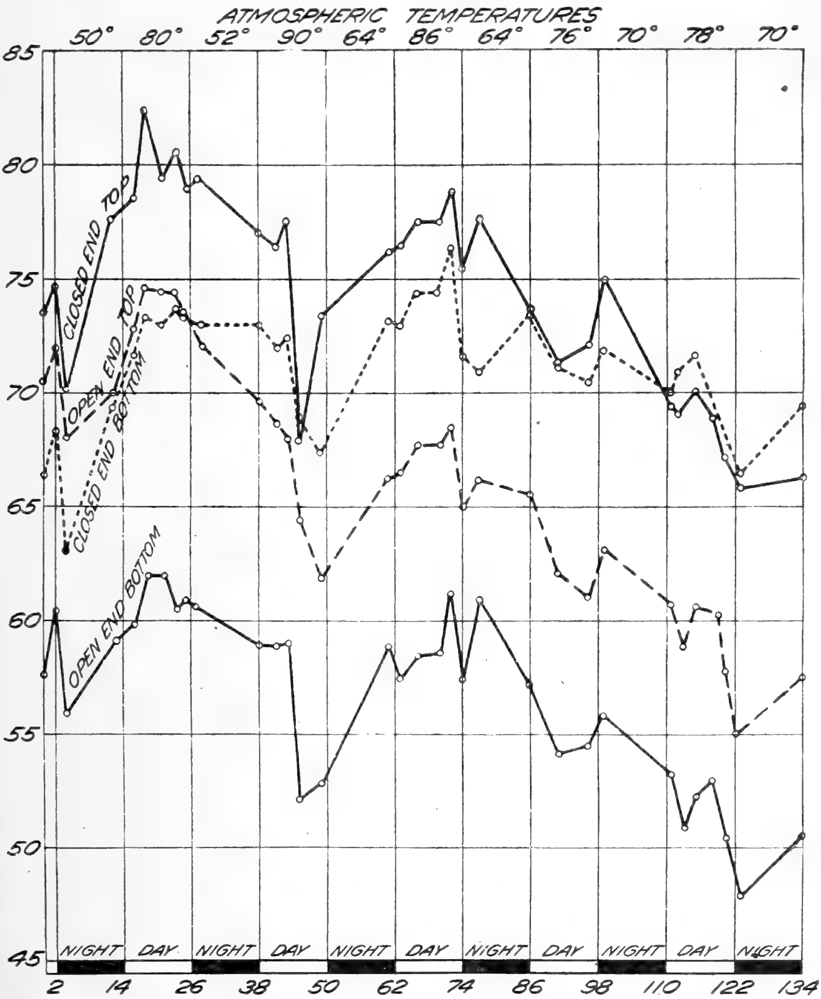

FIG. 12.—Car temperatures with open straw buffing and closed straw buffing.

from the top of the load to the floor of the car prevents the exit of cold air from the bunkers. To determine the extent of the loss of refrigeration under such conditions, temperatures were taken throughout the haul by means of electrical thermometers in cars having solid buffing at one end and a frame supporting the straw

(p. 7) at the other. The results are shown in figure 12, which indicates that approximately 50 per cent of the refrigeration available is lost by buffing solidly to the floor. During the early spring, when the weather is cool, this loss of refrigeration is not serious. When shipments are made in warm weather, however, it is a question which must be considered. The straw buffing, properly applied, may save damage to the shell of an egg or two per case, but if it permits of unchecked deterioration from heat it is of very doubtful economic value. Under warm weather conditions the shipper should consider the relative advantages of the small frame described in this report or of wood buffing.

If the load is to be a solid unit in the car, the form of brace to be used, in case the layers are not complete throughout, becomes an important matter. The mere weight of the cases in an incomplete top layer is not sufficient to keep them in place. In 16 of 36 such loads traced to the market serious damage occurred. Failure to brace an incomplete top layer, especially in mixed cars, is a frequent source of serious damage. A roaming case is not only damaged itself, but it damages other cases. The scantling braces nailed to the walls of the car seldom arrive in place. They should never be used. The most satisfactory braces found up to the present time are those described on page 8. It is readily seen that, if the load is to be a solid unit inside the car, the braces must be a part of the load itself, and must in no wise depend upon the car for resistance or strength. Nailed braces are a part of the car, not a part of the load.

THE CONSTRUCTION OF THE CAR.

Observations during yard shifting showed that freight cars having steel underframe construction do not react to shocks in the same way as do those having wooden underframes. Cars with wooden underframes give under impacts in such wise that the load receives less of a jolt than that in the steel-framed car. There is a slight increase in damage to eggshells when carried in steel underframe cars, all other conditions being equal, as shown in Table 13. This tendency is visible whether the load is buffed with wood or straw, or whether well or poorly stowed.

TABLE 13.—*Damage in cars with steel and wooden underframes.*

Steel straw-buffed car.		Wooden straw-buffed car.	
Experiment No.	Damaged eggs per case.	Experiment No.	Damaged eggs per case.
5114	3.5	5117	2.0
5126	3.5	5118	3.5
5131	3.5	5120	3.0
5139	4.0	5121	1.5
5150	4.5	5122	2.0
5154	5.0	5124	2.0
5171	4.0	5127	2.5
5173	2.0	5129	4.5
5174	6.5	5130	3.0
5177	4.0	5132	5.0
5181	3.5	5135	3.0
5183	6.0	5137	4.0

SHOCKS DURING THE HAUL.

This report does not attempt to locate any damage prior to the receipt of the eggs by the packer, although the transportation of eggs, from the viewpoint of damage, includes their transfer from the farm to the shipper, frequently via the country merchant or huckster, as well as the usage to which they are subjected after being cased by the shipper and en route to the consignee.

There is an opportunity for damage to the shells during the transfer from the packing house to the car, and again from the freight house at the terminal to the establishment of the consignee. Undoubtedly such damage sometimes occurs, but observations show that it is by no means so frequent as is commonly supposed. A comparison of breakage in shipments loaded directly from the packing house to the car, with only the width of the platform intervening, and in those transferred by wagon from the packing house to the loading platform showed practically no difference between the two. Approximately 65 per cent of the experimental shipments involved a wagon haul from the packing house to the car. The fact that the damage at destination is the same in either case confirms the finding of the investigators that where hauling is necessary it is ordinarily conducted in such fashion that breakage does not occur, provided the package is standard and well constructed. It is, of course, possible for careless handling and hauling of cases between the packing house and the car to cause damage.

It has been observed that the shocks received by cars are most severe during yard shifting. The relative intensity of shocks received during ordinary railroad handling are given in Plate IV, showing slow running, fast running, and yard shifting. The train which furnished these records was typical of our fast freight service.

Starting with but a few cars, it finally consisted of 65. Sometimes it attained a speed of 45 miles an hour. The special car under observation in this train contained 400 cases of eggs. It was of the wooden underframe type, with its load buffed with straw and braced with lateral braces under the cases. It traveled approximately 1,200 miles, transferring from western to eastern lines in the vicinity of Chicago. On arrival at the seaboard terminal the load had not shifted an inch, and the damage, including lightly checked eggs, was less than 3 eggs per case.

By actual observation of eggs in cases during the haul, by the condition of the cases and the eggs reaching the terminal, and by experimental work in the testing laboratory, it has been found that shocks have very little effect on the eggs unless the tips of the fillers break or bend, thereby permitting the wall of the filler to come in contact with the end or center partition of the case. Laboratory observations as well as those made under commercial conditions indicate that cases held rigidly permit less damage to their contents than when play is given. For example, when 296 foot-pounds of energy in the form of 6 blows had been distributed evenly over the end of a case held against a bumping post, 1.33 per cent, or approximately 5 eggs per case, were broken. Repeating the experiment, except that the case was placed 6 inches from the bumping post and hence traveled that distance after every blow, 12.22 per cent, or approximately 45 eggs per case, were damaged. In either case, damage was light until the tips of the fillers were distinctly bent. After they had flattened completely the eggshells were mashed. Apparently the same principles hold good when the cases in transit are subject to shocks; hence the need of strong filler tips, good, symmetrical cases, and tight stowing in the car.

HANDLING AT THE TERMINAL.

The terminal problem in most of the eastern cities in which the investigators handled shipments is very complex. Traffic has grown to such an extent that the terminal facilities are often inadequate for the proper handling of the volume received. Where congestion occurs (Pl. VIII, fig. 2), extra gangs are placed in houses and on piers already crowded, making confusion and haste unavoidable. In the height of the egg season in New York City, both sides of a station pier are, day after day, lined with floats, and the driveway is filled with wagons or trucks, while outside other wagons are waiting to get in. When the tide is high and the delivery plank is sharply inclined (Pl. VI, fig. 1), it would seem almost impossible to prevent serious loss. Nevertheless, damage of any sort at the terminal was very rarely found, and it was the opinion of the investigators who had followed all phases of the transportation of eggs that there is less damage at the destination than at any other point, considering the vast volume of goods handled.

As previously stated, the eggs under observation were treated exactly in accordance with the commercial routine, and the final examination was made when the commercial handling ceased, whether that was on the pier, in the freight yard, at the store of the consignee, or in a private warehouse. Damage due to a transfer from the pier to the store of the consignee or the private warehouse is much less than is commonly believed. The occasional dropping of a case or other mishap, serious in itself, is small when the huge volume of business handled each day is considered. A comparison between the handling at private warehouses and that at railroad terminals shows that while the railroad handling is usually more rapid, it compares favorably, on the whole, with the handling at private houses.

In order to obtain a definite idea of the actual damage caused by loading and unloading into wagons and hauling over rough city streets, eggs were followed from the store of the dealer to the warehouse where they were held in cold storage for several months, then back again by wagon to the store of the dealer. Each egg was examined before and after the double haul. The wagon was light; the load was heavy; the haul, 2 miles each way; the streets traversed were paved with cobblestones and were unusually rough; the handling at the warehouse included shifting to a second storage room and high stacking of cases. In spite of this excessive hauling and handling, the damage, as seen from Table 14, was only 3.5 eggs per case, or 0.97 per cent. This represents more than twice the amount of handling the egg cases ordinarily receive between the terminal and the store or warehouse. It may, then, be concluded that, with the allowance of 1 egg per case as experimental error, the damage due to the usual cartage is less than 1 cracked egg per case.

TABLE 14.—*Damage due to haul in light wagon over cobble-paved streets.*

Load No.	Number of individual eggs observed.	Eggs damaged.	
		Number per case.	Total.
1	1,080	3	8
2	3,240	5	44
3	5,400	3	42
4	5,400	3	43
5	5,400	2.5	38
6	5,400	4.5	65
7	5,400	4	53
8	5,400	4	57
9	5,400	5	77
10	5,400	3	49
11	2,160	3	18
12	3,240	3	25
13	4,320	3	37
14	4,320	3.5	41
15	4,320	2.4	29
16	4,320	2	26
17	4,320	3	35

SUMMARY.

(1) All the eggs observed during this investigation were rehandled and repacked at the packing house. They were put into new standard cases, with new medium (3 pounds, 3 ounces) fillers and flats. The work was done by the employees of the house. As the cases left the house they included approximately 5.39 per cent of lightly cracked and dented eggs. Leaking eggs were rarely found.

(2) All the shipments studied were in carlots. The average haul was over 1,200 miles. When the shipments arrived at destination each egg in the experimental cases was again individually examined, and its condition compared with that previously noted at the packing house. It was found that when eggs were shipped in carlots, packed in good, well-made, standard cases, with new medium or heavier fillers and flats, with properly placed and suitable cushions at top and bottom, with cases tightly stowed and efficiently braced in the car, and the car handled in accordance with good railroad practice, especially when switching, the total damage referable to transit was less than 2 per cent.

(3) The size of the egg influences its safety in transit. Eggs which were longer than the cells of the fillers showed 3.71 per cent damaged.

(4) The eggs with lightly cracked or dented shells, but with membrane unbroken, showed a transit damage of 2.88 per cent, as compared with 1.77 per cent for eggs with sound shells. Applied to case lots of broken eggs, the increased liability to damage is noteworthy. Applied to the 19 lightly cracked eggs in the rehandled and repacked case of commerce, the additional damage, referable to checks and dents, is $\frac{1}{5}$ egg per case.

(5) Egg cases must be standard, symmetrically made with 5, or preferably 6, 3-penny cement-coated nails at each corner of the sides and bottom and at the center partition. While cottonwood, gum, and tupelo cases vary but little in strength, the cottonwood case has, on the whole, the greatest number of advantages.

(6) Medium fillers (3 pounds, 3 ounces) or heavier should be used. It is absolutely necessary that the filler be perfectly new. Even a short-haul shipment into the packing house should disqualify the filler for further use.

(7) Suitable cushions of excelsior, with a flat, should be placed on the top and bottom of the case. The quarter filler is strong enough, and it forms an even cushion. Corrugated board on the top of the case affords practically the same protection as the excelsior cushion, provided it takes up the slack.

(8) More damage occurs in the top layer of eggs than in the deeper layers of the case, and more in the ends than toward the center.

(9) When cars are buffed with straw at the bunkers there is a slight but clear rise in damage as the cases near the center of the car. There is also a progressively increasing breakage in the rows as they progress from the middle line to the side of the car. The location of layers is apparently immaterial.

(10) The load of eggs must be a solid unit in the car, fitting without play. This is the most important factor in avoiding damage in transit. Either the step-joint or straight-joint load may be used.

(11) The amount of damage in properly loaded cars buffed with straw is slightly less than in the same cars buffed with wood.

(12) When the straw buffing is placed at the bunkers and extends from the top of the load to the floor of the car, at least 50 per cent of the refrigeration is lost.

(13) Braces nailed to the car seldom arrive in place. They cause much damage. Self-bracing of the load by means of suitable strips placed below the cases is most satisfactory.

(14) Cars having steel underframes show a slightly greater amount of damage than those with wooden underframes.

(15) The shocks incident to ordinary freight train handling while running seldom cause damage in well-stowed cars. The shocks incident to switching are sometimes destructive. More care should be exercised in switching cars containing eggs.

(16) While the haul in wagons or trucks between the railroad terminal and the warehouse or store may be responsible for some damaged eggs, the breakage is ordinarily not more than 1 cracked egg per case.

(17) By following good commercially practicable methods of packing, storing, and hauling, eggs can be transported in carlots with a total damage of less than 2 per cent. Under "experimental" handling, where the work is of a high grade, though still following the commercial routine, the total damage can be reduced to less than 1 per cent.

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