THESIS

THESIS

Lansing, Michigan,
May 20, 1919.

To The Committee on Advanced Degrees,
Michigan Agricultural College,
East Lansing, Michigan.

Gentlemen:

Inasmuch as it has been necessary in a few instances to use illustrations cut from publications for illustrating my thesis, "Important Problems in the Inter-State Transportation of Fruits and Vegetables", I desire to make the following explanation:

In every instance where an illustration has been used in this thesis to clarify the same point that it was used to clarify in the Bulletin, I have been familiar with and actively engaged in the scientific work upon which the Bulletin is based.

The photographs so used were all taken either by myself or under my supervision. The original charts were drawn for the purpose of presenting the data in a more usable form for the investigators studying the work, and were not drawn for the purpose of publication in the Bulletin mentioned. Later, as need became apparent, Bulletins were issued and these charts made use of.

When I desired to illustrate similar points in this thesis, it seemed advisable to choose them from the original charts with the scientific work of which I was familiar. It would have been possible to draw two new charts from the original data, but this seemed useless and wasteful when exactly similar ones based on the identical data were already to be had.

This statement accounts for all except two of the illustrations used. These two were chosen at random from publications, because they happened to illustrate points that I wished. In their original place they were used to illustrate points of an entirely different character. As they also illustrated my points, and as it was physically impossible to secure other illustrations of my own making and which would show my points to better advantage, I used these.

Toward the last of the thesis, I have duly acknowledged the original ownership of all of the photographs and charts not actually my own property.

From the above explanation, it will be seen that any illustrations which might be in question are original so far as this thesis is concerned.

Trusting that this clarifies any question which may arise in your minds, I am,

Very truly yours,

H. S. Bird

HSB-E

IMPORTANT FACTORS

IN THE INTER-STATE TRANSPORTATION

OF FRUITS AND VEGTABLES

Thesis Presented by

Harold S. Bird.

THESIS

IMPORTANT FACTORS IN THE INTER-STATE TRANSPORTATION OF FRUITS AND VEGTABLES.

463

A billion and a quarter pounds of fruits, vegtables, meats and dairy products worth one-hundred twenty-five millions of dollars are wasted annually by the people of the United Stated during transportation to market.* Does not this help to explain why the grocer charges two dollars for a basket of peaches for which the grower received only one dollar?

The greatest part of this loss is paid by the comsumers. The shippers, railroads and dealers pass their bills for this loss to them, as does the grower to a lesser extent. The consumers pay not only for the goods that they receive in good condition, but also for those billion and a quarter pounds of waste for which they are not morally responsible.

As consumers, they have said that this is a problem for the growers, shippers and railroads. But the growers, shippers and railroads have taken advantage of this indifference and have not done their parts. Rather have they been content to charge proportionately more for the goods which they delivered in good condition.

The method of paying is such that evidently the consumer has

* The railroads of the United States, alone, were asked to pay approximately sixty million dollars in 1917 and one hundred million dollars in 1918 for damage to shipments injured in transit. However, this includes shipments of all commodities, and is not confined to perishables.

chosen to pay rather than to defray the cost of bettering conditions. It is true that during the War the Government did much to lessen this waste. As one familiar with some of the results, I may say that the cost already has been returned to the people of the United States many times over.

But that is not enough, for the field is scarcely broken. Investigations by unbiased persons must be carried on in a careful and exhaustive way. In the past, investigations by the railroads have nearly always proved to be prejudiced, as have been also those of growers, shippers, and dealers.

INHERENT NATURE AND CONDITION

There are well-defined factors responsible for the waste of perishables in transit. The most important is the condition of the produce when it is put into the cars. There are, of course, all grades of relative perishableness in various kinds of produce. Peaches will not carry in transit as well as apples. Everyone knows this; and most people know that no two cars of peaches will carry the same. In this latter case, the tendency is to lay the difference to the railroads, while actually it is more likely to be a difference in the peaches themselves. Did the producer harvest his peaches, or his pears, or his berries at the right stage of maturity? Were they bruised? Were the orchards or fields infected with some plant disease? Were those Louisiana potatoes allowed to lie in the hot Southern sun after digging, and were they cut and bruised by negro laborers walking on the sacks when they were being hauled to or loaded into the cars? Or, again, was the produce dry when loaded? Was it cool? It cannot be expected that peaches packed, handled, and loaded in the heat of a Georgia sun will refrigerate and cool to a satisfactory temperature as rapidly as peaches handled during the cooler parts of the day. All these factors and many others are vitally important.

CONTAINER

The selection of a satisfactory container often is neglected with disastrous effect. Take, for example, these data from Government reports: "One-fifth car of grapes mashed and worthless"; "One hundred twelve damaged crates of Texas onions in a car containing six hundred

fifty-two crates." In both cases unsatisfactory packages were responsible. These are not unusual records.

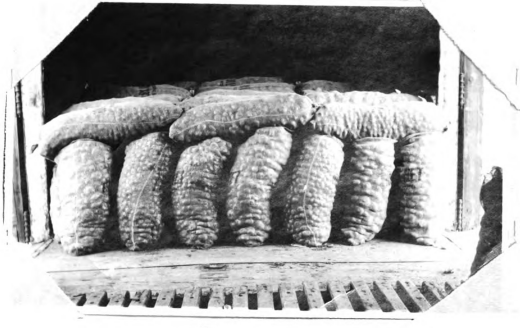
The containers, first of all, should be suitable for the particular kind of produce. A large light-weight hamper is suitable for spinach or kale, but will not do for peaches. At the same time, a basket crate (Georgia carrier) is almost ideal for certain classes of peaches, but it would be a ridiculous package for the spinach. Apples may be shipped in solid barrels, but new potatoes require barrels with holes, cut for ventilation; such, for example, as are illustrated in Figure 1 . Onions carry better in the open fiber-cloth sacks shown in Figure 2 than in burlap sacks. Cabbages require good ventilation such as is given by the Norfolk cabbage barrel crate in Figure 3 .

Generally speaking, open packages assist both ventilation and refrigeration. The widely-spaced slats of the cantaloupe crates in Figure 4 allow the cool air, as it passes from beneath the false floor up through the load, to absorb the heat. Had these cantaloupes not been wrapped in paper, the rate of cooling would have been much more rapid and their quality generally more satisfactory on arrival at market.

In winter, refrigeration and ventilation are not so important. It then becomes a problem of heating properly. The greater part of our Northern potato crop is moved during weather when it is necessary to provide for heating in transit. Much of the Pacific-Northwestern apple crop is shipped "under heat". Sweet potatoes require peculiar care in this respect. The United Fruit Company never moves a car of bananas North

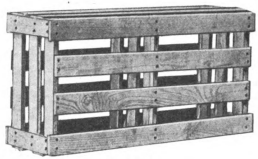
Ventilated Barrels

Figure 1 - Negroes loading a car of new (green) potatoes at Hastings, Florida, June, 1918. Notice the holes cut in the staves for ventilation.



Ventilated Sacks

Figure 2 - These sacks, made of wood fiber, are woven to permit ventilation. They are quite durable and, with the onions or potatoes showing through from the inside, offer a pleasing appearance.



(Norfolk)

CABBAGE BARREL CRATE

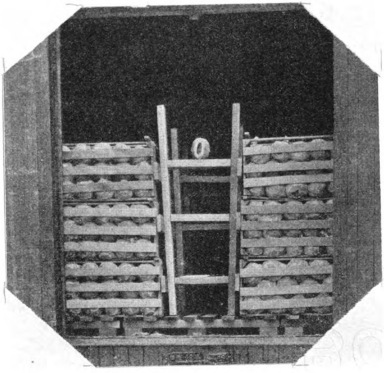
DIMENSIONS	12 x 18 x 33 inches, inside measurements.
CAPACITY	7128 cubic inches.
HEADS	Three heads made of nine head sticks not less than $\frac{7}{8}$ inch thick by $2\frac{3}{8}$ inches wide and 18 inches long and six short pieces for ends and centre not less than $\frac{7}{8}$ inch thick and $2\frac{3}{8}$ inches wide and 12 inches long securely nailed together with not less than six cement coated 5d nails two in each head stick.
SLATS (Top and bottom and sides of top and bottom)	Eight slats not less than $\frac{3}{8}$ inch thick and not less than $2\frac{3}{4}$ inches wide and $37\frac{3}{8}$ inches long.
SLATS (On sides between top and bottom)	Four slats not less than $\frac{3}{8}$ inch thick, $2\frac{3}{4}$ inches wide and $35\frac{5}{8}$ inches long.
MAKING UP	All slats to be securely nailed with not less than six cement coated 5d nails to each slat, two at each end and two in the middle.
WOOD Sawed	To be of seasoned pine or gum or wood of equal strength of sound material, free from injurious knots.

Articles to be shipped in this container:

CABBAGE, SQUASH, EGG-PLANTS, BEETS, CAULIFLOWER

Ventilated Crate

Figure 3 - This crate has been officially adopted as a standard container for the cabbage movement from the Southeastern states.



Cantaloupe Crates

Figure 4 - Crates of open construction assist both in ventilation and refrigeration.

and three

those

mly than

head.

of

cooling.

Moving

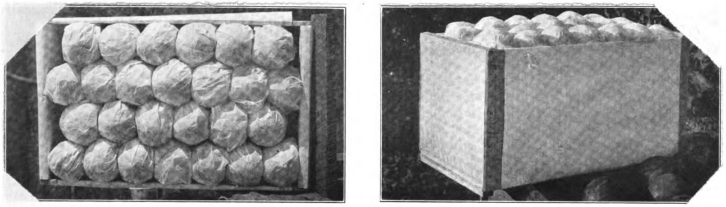
en during

during the winter without a messenger to attend to the heating. Oranges, lemons, and many other kinds of shipments must be protected.

The package plays its part in holding all of these at the proper temperature. Sweet potato hampers are lined with heavy paper. Bananas are packed in straw and burlap. Western pears and apples are packed in boxes with a wrapping of paper around each fruit and another sheet between the apples and the boards of the box, as illustrated in Figure 5 . Fruits wrapped in this way will stand cold temperatures much better than those not wrapped.

Competition between manufacturers has led to the production of cheap packages of inferior quality and strength. It is impossible to estimate the proportion of loss and damage in transit due to this one factor. But its enormity is such that the Government, and the railroads, package-manufacturers, shippers, and growers of the states south of Kentucky and Virginia and east of the Mississippi River, have within the past year held meetings in New York City, Philadelphia, Atlanta, Jacksonville, Memphis, and Chicago to consider it. These meetings have resulted in some rigid but effective regulations, specifying kinds and strengths of materials; nailing; and size and character of the packages for each type of perishable produce. They regulate the contents and the loading method, making provision for higher tariffs on shipments not up to the set standard.

It is surprising how important some apparently minor point may be. For example: one-half inch difference in the placing of a single nail may decrease the strength of a package as much as fifteen



COMPLETED BOX WRAPPED APPLES

Paper Helps to Prevent Freezing

Figure 5 - One of the principal purposes served by wrapping these apples is that of protecting them from cold.

per cent.

Growers like packages that will "nest" (i.e., set one within another). This accounts largely for the popularity of hampers and bushel baskets. A box or a crate occupies nearly as much space when empty as when full, but ten empty hampers or bushel baskets can be "nested" and occupy little more space than one or two that are packed with fruit. If it were not for this one advantage, these two packages probably never would have been manufactured. That they are unsatisfactory as shipping packages is illustrated by the two Figures 6 and 7. In these cases, however, had the packages been stowed properly and exactly, the breakage in transit would have been greatly reduced, especially if well-made packages had been used.

STOWING

Few of us realize the importance of stowing properly. As shippers, most of us see our goods only as they are placed in the car. "All cars look good when they are loaded" is a common saying among railroad men. But it is very often another and far different story when they are unloaded.

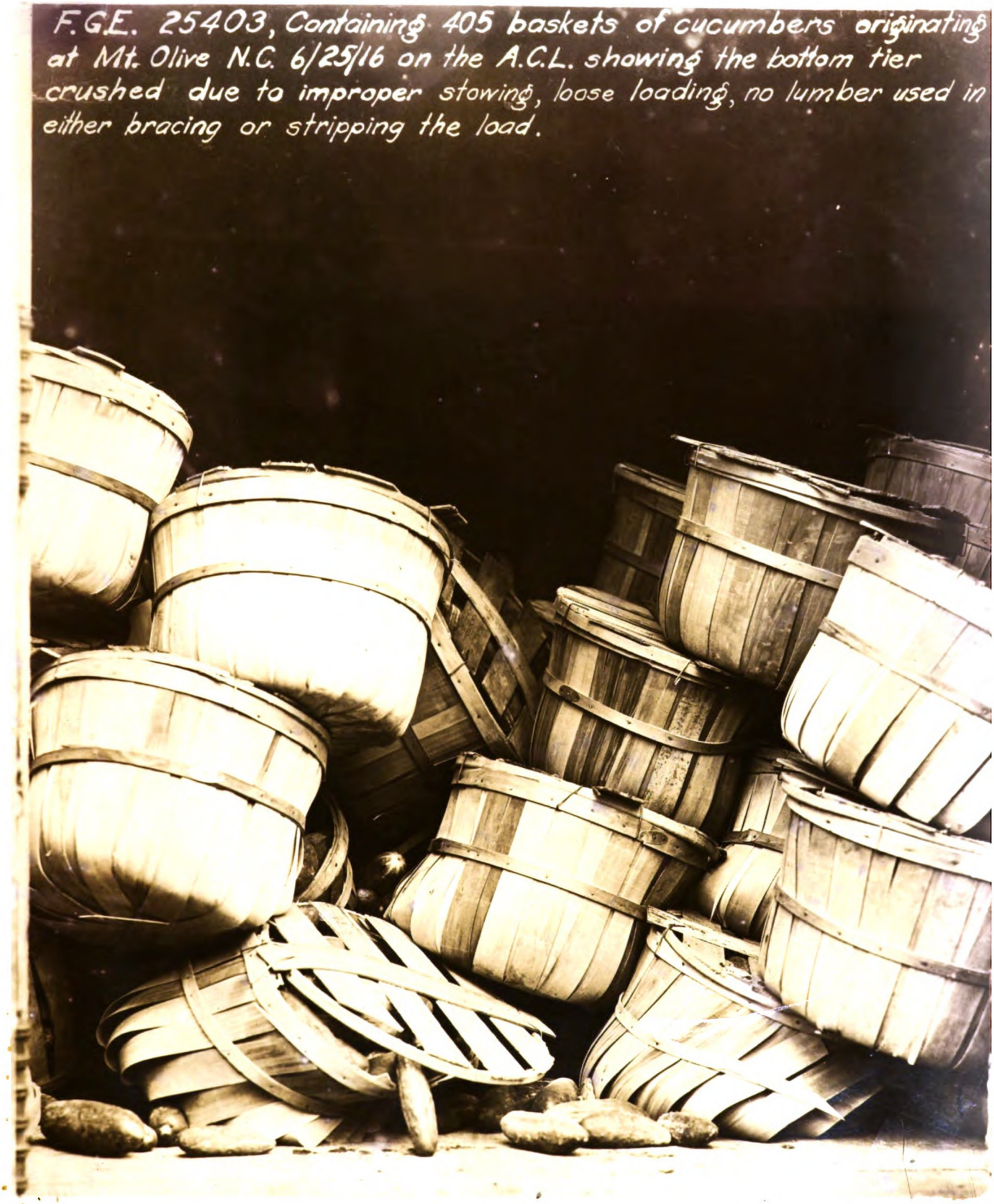
Bulk Shipments

In loading bulk shipments, we must first consider whether ventilation, refrigeration, or heat is necessary; or a combination of these. Cabbages, particularly those from Northern sections, are often shipped in bulk. They require good ventilation, and depending upon the territory through which they must pass, may require either

Hampers Are Difficult to Load

Figure 6 - This car is no worse than one can find almost any day in New York or Chicago. By actual counts, it has been found that twenty per cent of all hampers loaded on the side are more or less broken on arrival at market. The damage is much less when hampers are loaded on end with alternate packages inverted.

F.G.E. 25403, Containing 405 baskets of cucumbers originating at Mt. Olive N.C. 6/25/16 on the A.C.L. showing the bottom tier crushed due to improper stowing, loose loading, no lumber used in either bracing or stripping the load.



either refrigeration or heat. In any case, they are usually shipped in refrigerator cars. The cars should be fitted with false floors (illustrated in Figure 8), and good boards should be placed across each door opening to keep the cabbages from rolling out when the car is opened. This last seems like a superfluous caution, and it would be, were it not that very occasionally cars are shipped without this boarding.

In the winter, it may be necessary to place a stove in the doorway. When this is the case, good bulkheads must be built to hold the cabbages in place in the ends of the car. Figure 9 shows the best construction for such a bulkhead. If the weather is cold enough to require the use of a stove, it is also advisable to lay a tight floor with building paper and boards over the spaced false floor.

Bulk potatoes and most root crop shipments do not require as much care as cabbage, but practically the same loading methods apply.

Sacked Shipments.

Potatoes and onions are usually shipped in sacks, although, so far as Michigan, New York, Pennsylvania, and even Maine potatoes are concerned, bulk shipments are more common.

All Southern sacked potatoes should be loaded with the sacks standing on end to assist good ventilation. One hundred pound sacks are the best size. They will go three rows upright along each

UNITED STATES RAILROAD ADMINISTRATION

W. G. McADOO, DIRECTOR GENERAL OF RAILROADS

DIVISION OF OPERATION
CAR SERVICE SECTION

CIRCULAR CS-43

LINING AND FLOOR RACKS IN CARS

REFRIGERATOR CARS

NOVEMBER 15, 1918.

TO RAILROADS:

The railroads will supply refrigerator cars for perishable or semiperishable shipments to the extent of their ability. A certain percentage of this class of cars belonging to the various roads is already equipped with false floors or floor racks. It is contemplated to eventually equip all of the cars in this manner, but it is not thought that this can be done in time to fully meet present requirements. Therefore, when cars of this type not provided with floor racks are offered for loading perishable or semiperishable commodities, shippers will be privileged to construct and place in cars suitable racks of standard type, in accordance with detailed specifications shown on accompanying print, which denotes construction of a temporary floor rack.

The railroads will reimburse shippers for the value of floor racks so placed to the amount of fifty (50) cents per linear foot of the total inside length of car.

Any *lining* desired by shippers in refrigerator cars in addition to the floor racks must be placed by them at their own expense and in such manner as not to damage the car or insulation.

BOX CARS

When railroads are unable to meet the demand for refrigerator cars for above-named shipments, if shippers elect to make use of box cars and if, in their opinion, such cars require lining or floor racks, they (the shippers) will be given the privilege of equipping the cars with such lining or racks entirely at their own expense.

In the interest of promoting shipments and conserving food supply, it is suggested that the lining and racking of box cars, when done, conform to the following standard furnished by the Bureau of Markets, United States Department of Agriculture, which, it is believed, will give the best results:

> False floors, side and end walls shall be installed providing an unobstructed space for air circulation down between the car and walls and false end walls, and from there under the false floors to the doorways. This ventilating space must be kept clear of hay, straw, manure, shavings, and everything except the necessary false-floor supports. There shall be a space between the car side walls and the false side walls of not less than four inches at the top and six inches at the bottom.
>
> Each doorway shall be tightly boarded not less than twenty-four inches from the floor upward, the boards being nailed to the inside of the door frame to keep out cold winds.

For the same reason, it is further requested that shippers make it a practice to use box cars for the shorter hauls, reserving refrigerator cars for loading to the more distant points. Railroads will supply refrigerator cars preferentially, as compared with box cars, for the longer runs.

False Floors for Refrigerator Cars

Figure 8 - False floors greatly increase the efficiency of refrigerator cars for ventilation, refrigeration, and heating.

Box cars that may be lined by shippers will be furnished with a board on either side of uniform dimensions (24 inches by 30 inches) with lettering of suitable size, reading as follows:

RETURN TO

.....

(Insert name of shipper.)

AT

.....

(Name of station.)

..... RAILROAD

(Name.)

UNITED STATES RAILROAD ADMINISTRATION

These boards will be furnished by the railroads. Lined box cars so boarded will be returned free, with lining, to point of origin of load, and should be waybilled to such point, consigned to party or firm whose name the board bears. They may be loaded all or a part of the way on return trip with any suitable freight. They must not be loaded out of direct line, and care should be exercised to avoid damage to lining in loading or unloading.

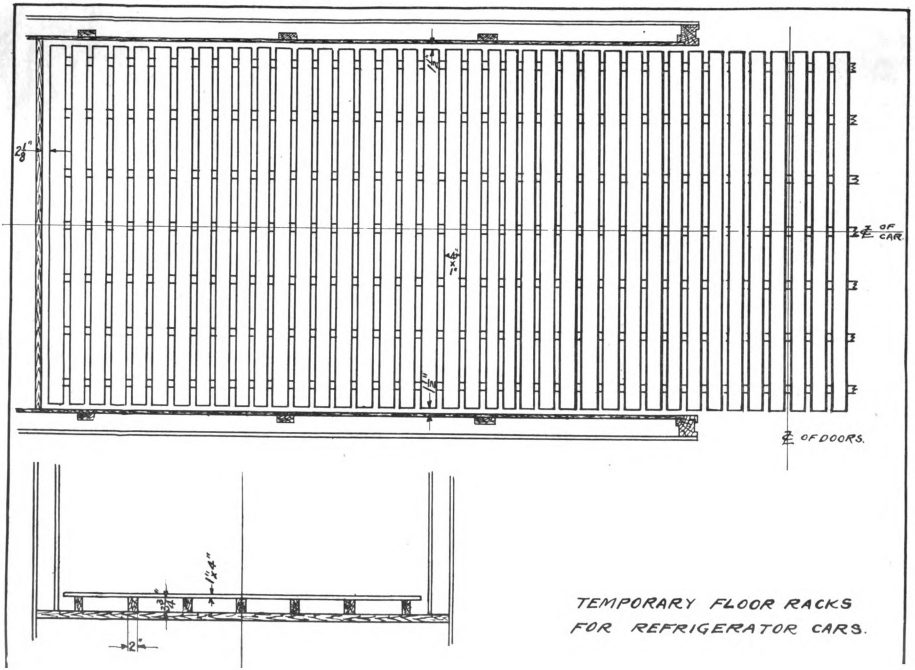
It must be understood that cars thus lined and boarded are subject to demurrage, either while awaiting loading or unloading.

The foregoing conditions are to apply from November 15 to April 1. Railroads on which the apparatus was originally placed in cars will reimburse shippers for the value of any racks or lining not returned to them within three months from the last-named date, but not exceeding fifty dollars ($50) per car.

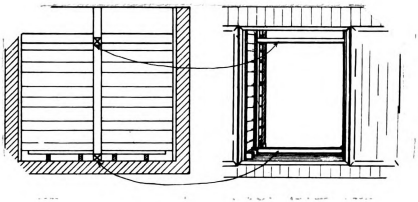
After April 1 shippers will be required to remove from cars any lining or racks which belong to them. Failing to remove such equipment, the work of removal will be performed by the railroads, but the latter will not be responsible to owners for the material or its value after removal.

W. C. KENDALL,

Manager, Car Service Section.



TEMPORARY FLOOR RACKS
FOR REFRIGERATOR CARS.



Temporary Bulkheads

Figure 9 - Good bulkheads are necessary to hold bulk shipments in place in the ends of the car. The braces should be of 4"x4" pieces.

Correct Loading for Southern New (Green) Sacked Potatoes

Figure 10 - With part of the sacks standing upright and an alley-way down the center, there is opportunity for good ventilation. This loading is the same from end to end of the car. Note that this is a stock car.

side of the car from end to end, and two layers of sacks flat on top, as illustrated in Figure 10 . Or, better still, is one solid layer of sacks standing upright on the floor and another on a deck. Under either refrigeration or ventilation, decked loads give the best results but are more expensive and harder to load.

Mature potatoes, as well as onions, do not require as much ventilation as new (green) potatoes, but during the summer and early fall, air circulation is important. Mature potatoes and onions are practically never shipped under refrigeration, and shipments are not confined to any one type of car. It is impracticable to load them as heavily in warm weather as in cool. "Under heat", in winter the main care should be to preserve the original warmth of the load.

It is customary to load cars of mature potatoes varying in weight from thirty-six thousand to about fifty-two thousand pounds with the sacks laid on the side. If a heater is to be placed between the doors, the sacks are usually loaded lengthwise of the car and corded up in such a way as to keep the doorway clear. Without heaters, the usual practice is to load through the doorway . If this is done, the sacks in the doorway should be spaced so that there are twelve inches or more between them and the doors. Then if the door cracks are properly papered over, there is comparatively little danger of cold winds causing freezing, especially in well-constructed cars.

Crated and Boxed Shipments

Crated and boxed shipments of perishable produce are loaded practically the same, whether for ventilation, refrigeration, or heat. For long hauls, in unusually hot weather or with particularly delicate shipments, the height of the load should be decreased. As with all perishable-produce shipments, false floors are important. In loading, the first thought is to so place the packages that they will not shift either lengthwise or sidewise. Even a few inches of surplus space is a starting point for shifting and chucking. All boxes should be loaded in rows, package tightly against package, from end to end of the car. Any surplus space must be taken up by bracing, such for example as is illustrated in Figure 11, or loss is sure to follow. Figure 12 shows a poorly-braced car of Georgia peaches which has traveled only fifty miles on its eight-hundred-mile journey to market. After looking at this, it seems incredible that Georgia peach shippers believe the three dollars they save by not providing suitable bracing is going to recompense them for the damage this car will show on arrival on the piers in New York City.

In one sense, we may say that breakage in transit is due to rough treatment by the railroads. But upon reflection we know that the railroad officials must be doing all in their power to prevent careless handling, for it costs the railroads heavily in the form of repair bills for damaged cars and in claims. The human element in the switching crew is the one at fault. As we think of it, however, are the men in

Diagram No. 100

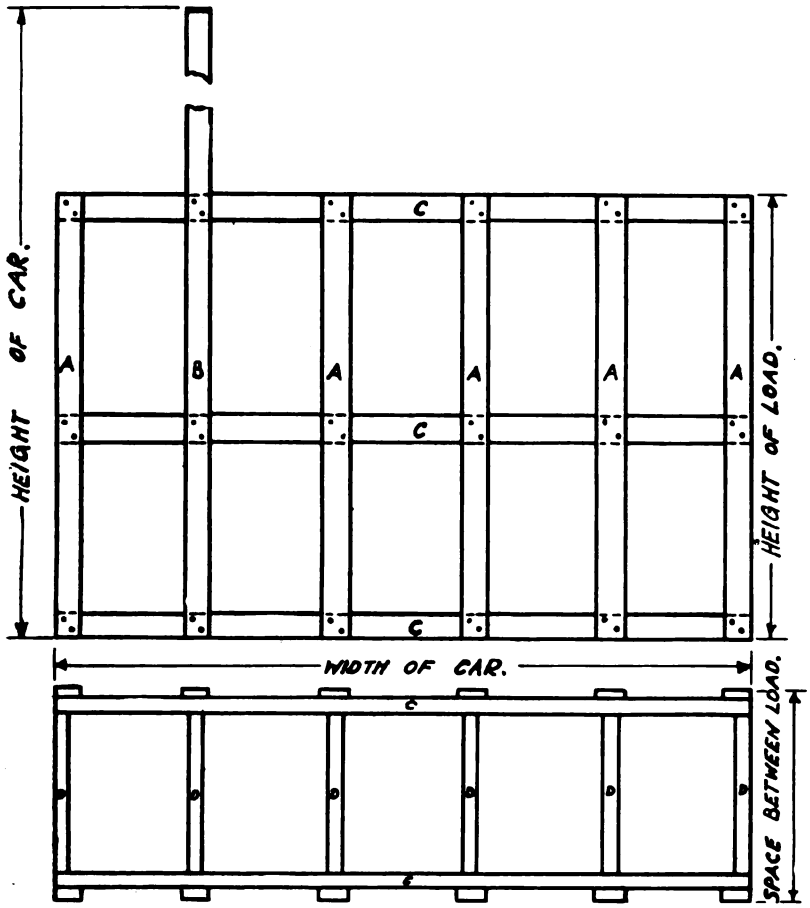


Figure No. 1

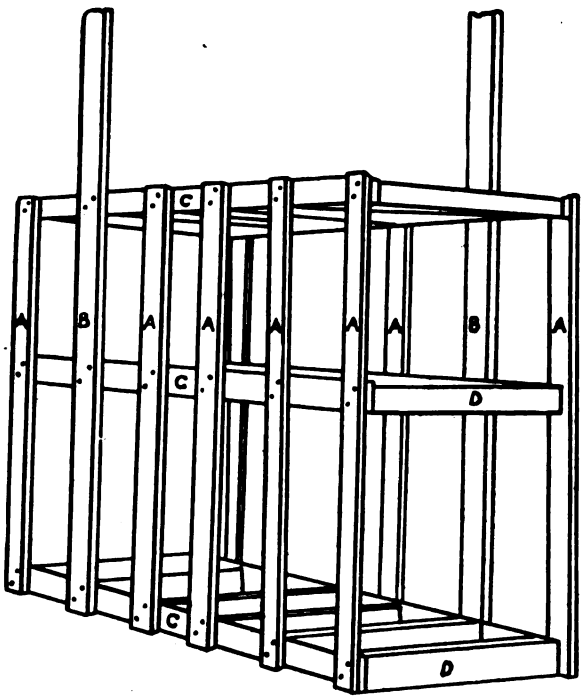


Figure No. 2

GATES FOR CENTER BRACING ON CARLOAD SHIPMENTS OF FRUITS AND VEGETABLES

Specifications:

Uprights (A and B) 2 x 4 inches or 1 x 4 inches.
Horizontal Strips (C) Not less than 2 x 2 inches.
Braces (D) 2 x 4 inches.

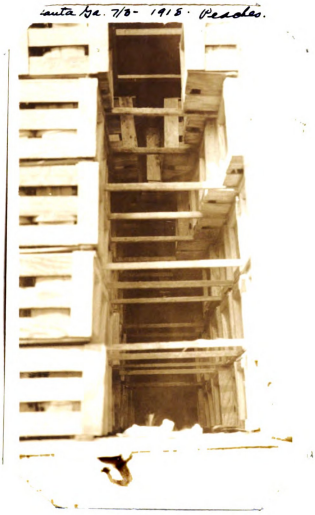
To prepare for bracing:

Make two gates (see Figure No. 1); uprights (A and B) to be in center of each row; horizontal strips (C) to be nailed to uprights (A and B) with 4 inch surface facing the uprights. Place gates against both ends of load with even surface of uprights towards packages. Use braces (D) between the gates at top, bottom and center, toe-nailing securely to horizontal strips (C). Braces (D) should be long enough to hold load in each end of car securely and thus prevent shifting. No nails should be driven into car floor, walls or ceiling.

Figure No. 2 shows brace assembled. Two uprights (B) extend to ceiling of car to prevent buckling of brace.

Bracing to Take Up Surplus Space from End to End of Car

Figure 11 - Even a few inches of surplus space is a starting point for shifting and chucking; and consequently breakage in transit.



Poorly-Braced Car of Georgia Peaches

Figure 12 - These crates have started to shift, although the shipment is scarcely more than started on its long journey to market. Bracing, such as is illustrated in Figure 11, should have been used.

the switching crew in the railroad yards less negligible of their duty when they "hammer" a string of cars into place than we are when we permit a shipment to start without providing suitable bracing.

With produce requiring spaced rows to provide for ventilation or refrigeration, wooden strips from side to side of the car should be used to prevent side-shifting. Each crate (or every other crate) should be nailed to one of the strips. A well-stripped car of crated asparagus is illustrated in Figure 13.

So simple a matter as placing crates or boxes the wrong way of the car may mean the difference between certain loss and almost perfect condition.

Bushel-Basket Shipments

Bushel baskets (this includes the one-half bushel, bushel, and bushel-and-one-half sizes)are one of the most unsatisfactory of packages from a shipping standpoint. In March 1919, the manufacturers representing approximately ninety per cent of the bushel-basket-making capacity of the United States met in Memphis, Tennessee, and adopted specifications to strengthen this type of package. Possibly with this result accomplished, it will now be possible to secure satisfactory loading.

A Well Loaded Car of Crated Asparagus.
Figure 13 - Notice that the crates are held firmly in place by strips running across the car throughout the load.

Bushel baskets of peaches and other soft fruits should never be inverted. The loading giving the best results is that of resting the baskets of each successive layer on the rims of the baskets below. There are several ways of doing this, the best being that of spacing four (or five) baskets across the end of a car, one basket in each corner and two (or three) equidistant between. The second layer should rest on the rims of baskets below and, like the first, should touch the car end wall. The baskets of the succeeding layers and stacks should alternate with these. For long hauls, three layers are as high as is consistent with safety. For short hauls, four layers are not too high if the baskets are well-made. If more are necessary, a deck such as is illustrated in Figure 14 , should be used.

With shipments of exceedingly light-weight commodities, which are not easily injured by crushing, it is not so harmful to invert part of the baskets. The dove-tail method (alternate-inverted) may then be used and is satisfactory, except that it does not admit of much ventilation or refrigeration. This method is illustrated in Figure 15 .

Hamper Shipments

Well-made hampers are satisfactory if the produce is not too heavy and not too easily injured when inverted. The dove-tail method for hampers (illustrated in Figure 16) is the only practical one. Loss and damage in transit results when hampers are

A.R.T. 10544 PEACHES, ORIGINATING ON THE ST. L.S.F.
AT MT. VERNON, TEXAS JULY 1916 SHOWING THE CORREC
MANNER OF LOADING A CAR OF BUSHEL BASKETS,
BEING PROPERLY SHELFED.

Dovetail (Alternate-Inverted) Loading for Bushel Baskets .

Figure 15 - This method is practicable only for light weight commodities such as spinach or kale. It does not permit the best of refrigeration and, with soft fruits, there is considerable cutting and bruising against the covers of the inverted packages.

Correct Loading for Hampers

Figure 16 - The only way hampers will carry in transit without undue breakage is by the dovetail (alternate-inverted) system of loading.

loaded in any other way. Figure 6 shows an improperly-loaded car of hampers from the South on arrival in Chicago.

Climax Baskot Shipments

Climax baskets, if well made and loaded, carry quite successfully. Recent concerted efforts to standardize and strengthen the package are bringing good results. During the 1918 shipping season, the Government conducted a campaign to improve the Climax basket loading. This was eagerly seconded by the railroads and good results obtainod, particularly with the shipments from the New York and Pennsylvania grape sections.

Particular care must be taken to completely fill the car floor space with Climax baskets, not only from end to end, but also from side to side. Surplus space from side to side practically always leads to loss such as is shown in Figure 17 , and is more destructive than even the railroads realize. Had this car been properly loaded with the last row placed diagonally (as shown in Figures 18 and 19), this loss would not have occurred. Most of the large annual destruction of New York, Pennsylvania, and Michigan grapes in transit could be eliminated in this way.

Shippers are careless in loading their goods, largely because they do not realize the results of carelessness or, in a few cases, because they expect to collect from the railroads for the damage. Under Government control this is being made very difficult, and the inevitable result is that shipments are being made with more care and there is less loss.

Breakage Caused by Side Shifting of Load Due to Poor Loading

Figure 17 - The floor space from side to side of this car was not completely occupied. With the sway of the train the Climax baskets shifted into this space, throwing the weight at an angle on the bottom packages causing heavy loss.

Taking Up Surplus Space from Side to Side of Car

Figure 18 - This illustrates a single layer showing how, by placing one row diagonally of the car, the surplus space may be occupied. The next figure shows how this diagonal row is built up.

At Market

Figure 19- The last row that was loaded into this car was placed diagonally as illustrated in Figure 18 . Notice the pleasing appearance presented when the car was opened on the Boston team tracks.

RAILROAD EQUIPMENT

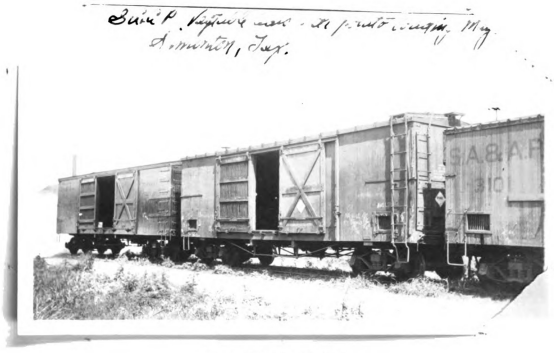
Much ill-feeling among the produce shippers is due to the short supply of suitable railroad equipment for transporting perishables. The refrigerator and produce cars are more often than not of poor consttuction or in poor condition. They are built on faulty principles and cannot give satisfactory results except under extremely favorable conditions.

Within the past four years, construction methods have been improved greatly, due almost entirely to the investigations and efforts of the Government Department of Agriculture through Dr. Mary E. Pennington and Mr. H. J. Ramsey. In 1916, the Pacific Fruit Express Company started building and rebuilding its cars along the improved lines, and that company expects by the fall of 1919 to have all of its fifteen thousand refrigerator cars in the best condition. The Baltimore and Ohio, Louisville and Nashville, Chicago and Northwestern Railroads, and others, before being taken over by the Government Railroad Administration, issued instructions that all new equipment be constructed according to these standards and all old equipment rebuilt along the improved lines. Later the Railroad Administration adopted them.

There are five general types of railroad cars used for transporting perishable produce: refrigerator, produce, ventilated-box, box, and stock cars. Refrigerator and produce cars are used for refrigeration, ventilation, and heating. Ventilated box cars are used for ventilation only. Box cars are sometimes used for ventilation and sometimes for heating. Stock cars can be used only for ventilation. Three of these types of cars are illustrated in Figures 20, 21, and 22,

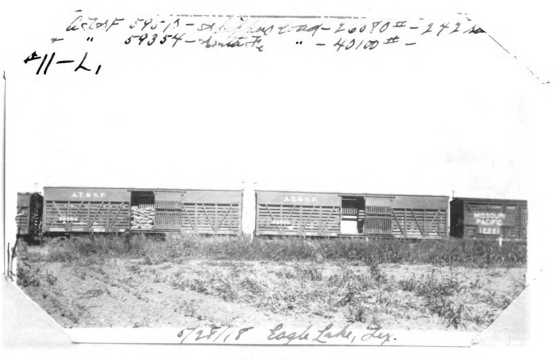
Refrigerator Cars

Figure 20 - Santa Fe Refrigerator Dispatch Company refrigerator cars ready for loading.



Ventilated Box Cars

Figure 21 - San Antonio and Arkansas pass ventilated box cars. Note the barrel door and the ventilation openings. These are extensively used for moving the Texas vegetable crop.



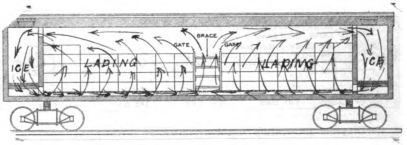
Stock Cars

Figure 22 - Atchison, Topeka, and Santa Fe stock cars handle much of the Texas new (green) potato movement. Stock cars give abundant ventilation but do not protect from rain or sun.

Refrigerator Cars

Refrigerator cars are primarily for carrying produce at low temperatures, although they are used also to provide ventilation, to protect from cold, or to give combinations of these. They are provided with insulated walls, floors, and ceilings, tight doors, and with compartments for ice. The insulation is the first and most important consideration. Various materials are used more or less successfully. They must be strong, effective in keeping out heat, and properly and well applied. Not only must the walls be insulated, but also the ice-bunker bulkheads, floor, and - most important of all - the ceiling.

Figure 23 illustrates the method of refrigeration in the Government standard refrigerator cars. The warm air rising from the produce toward the ceiling, passes into the ice-bunkers through the upper ice-bunker bulkhead ventilation openings; then down between the ice and walls of the ice-bunkers where it is cooled; and thence out through the lower ventilation opening into the space beneath the false floor. The cooled air is then forced up through the load by the differences in temperature taking up the heat as it passes. In this way, the temperature of the load is gradually reduced. The more rapid the air movement, the quicker is the cooling. At best, this movement is very slow and labored, and it is to assist as much as possible that basket-bunkers and false floors are so necessary.



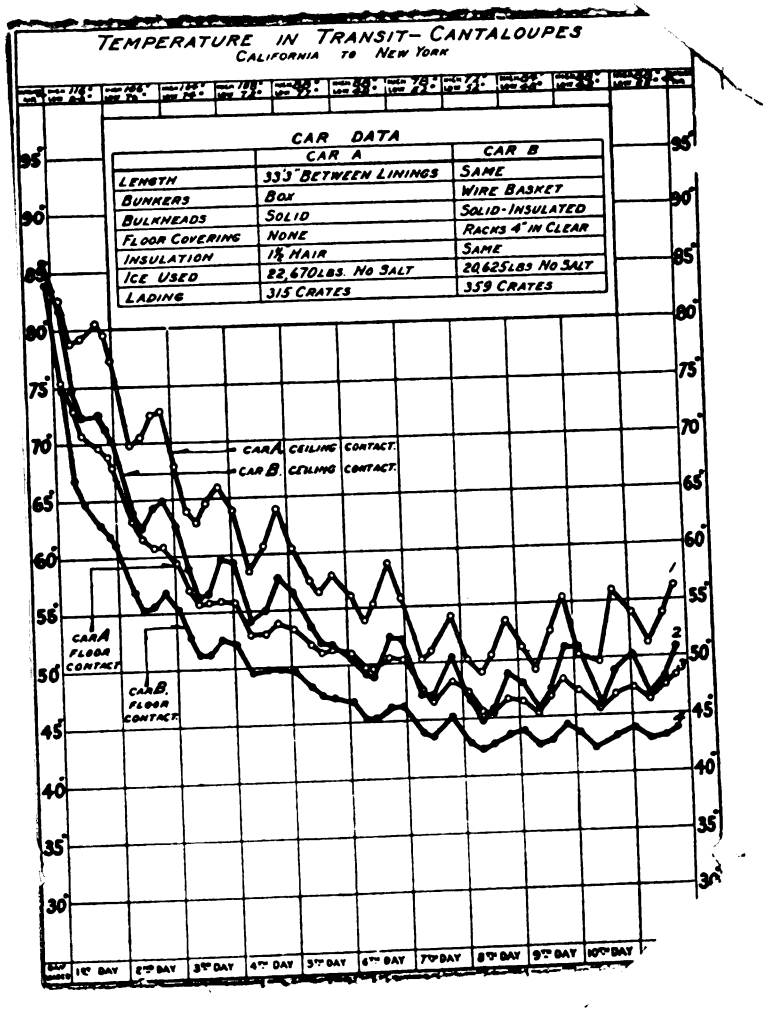
Circulation in a Standard Refrigerator Car Equipped with Basket-Ice Bunkers, Solid Insulated Bulkheads, and False Floors (as per Government Specifications.)

Figure 23 - Note the complete and even distribution of cool air throughout the load.

The older cars refrigerate in the same way but are not equipped with basket bunkers nor false floors. Consequently, the cooling rate is much slower, for the air cannot pass down around the ice easily nor work out under the load. Figure 24 illustrates how much more effective cars equipped with basket bunkers and false floors are than those not so equipped.

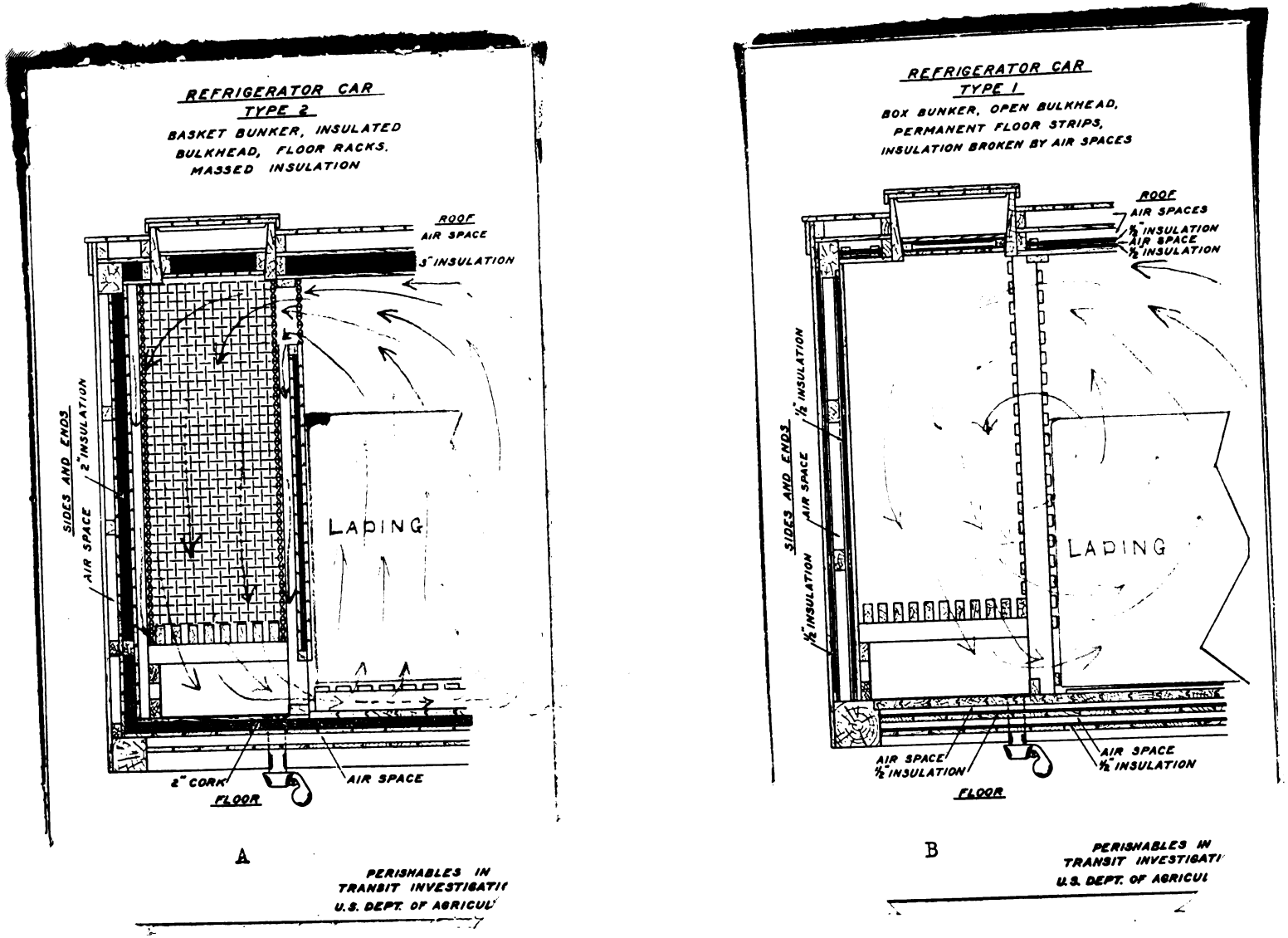
Solid insulated bulkheads and bulkheads of open construction which allow the air currents to "short circuit" are compared in Figure 25 . The open type does not give good refrigeration to the load except near the bunkers. You will notice from these figures that the solid type gives far better results. An additional advantage is that when the solid insulated type is used, salt may be mixed with the ice, greatly facilitating the rate of cooling. The effect of this is illustrated in Figure 26 .

There are several other types of refrigerator cars, the most common of which are the circulating brine types. These depend upon the circulation of brine from tanks containing salt and ice through pipes to the various parts of the car. However, none of these is really successful. An exception to this statement should be made in the case of the cars that use a brine-circulating system for meat shipments, but these are impracticable for vegetables. Many inventors are at work, and in all probability someone will eventually improve upon the present systems which are crude, at best.



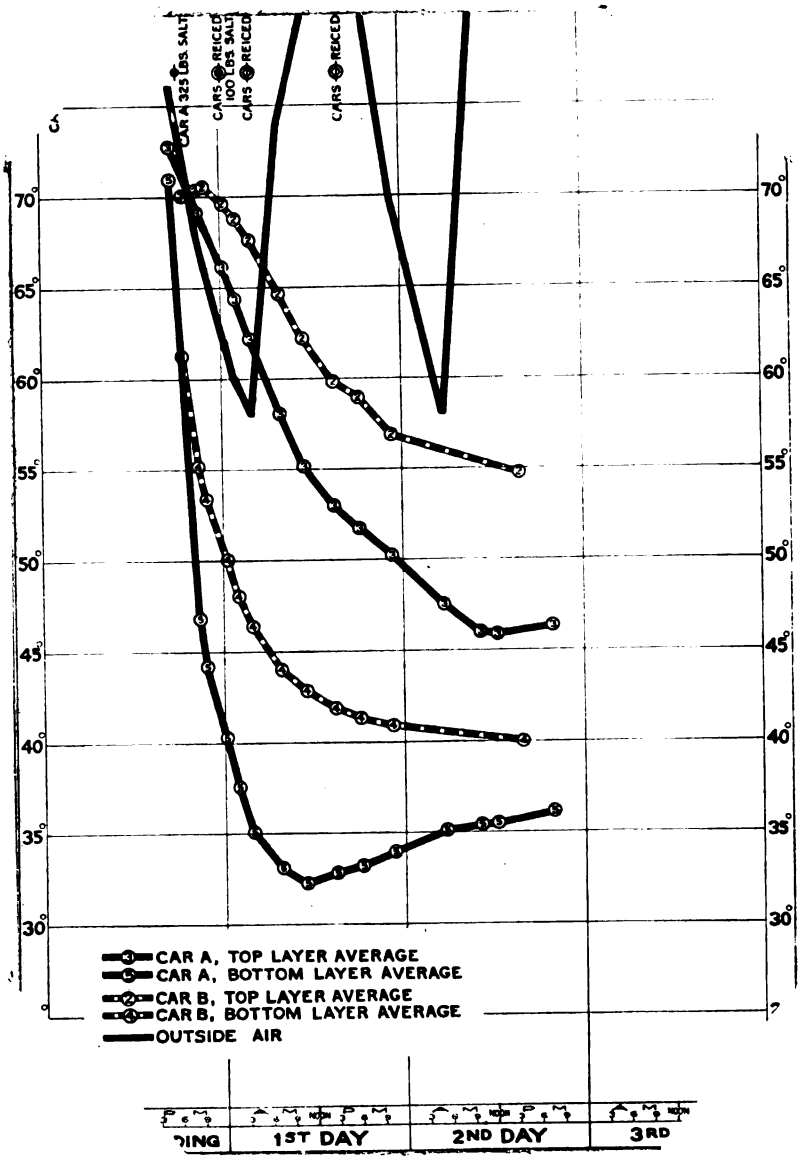
The Value of Basket Ice-Bunkers and False Floors

Figure 24 - Car A had neither of these improvements; Car B had them both. Otherwise the cars were identical except for an even heavier load in the latter. Note how much more rapidly Car B cooled down and stayed during the eleven-day trip. These are under actual commercial conditions.



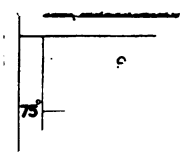
Solid Bulkhead Basket Ice-Bunker (A) Compared with Open Bulkhead Ordinary Ice-Bunker (B)

Figure 25 - Notice that with the solid bulkhead, there is no opportunity for the circulation to "short circuit". The false floor greatly assists in accomplishing this. With the open type, refrigeration tends to be limited to the space next to the bulkhead.



Pre-Cooling in Transit by Means of Salt Mixed with the Ice

Figure 26 - Note how quickly the temperatures in the "pre-cooled in transit" **Car (A)** fell, as compared with those in the "regular-iced" **Car (B).** The temperature of the load in **Car A** is much cooler on arrival at Chicago on the second day than those in Car B. This chart gives the temperatures in two cars of Louisiana strawberries.



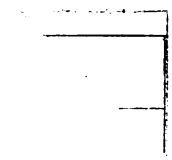


Fig
St.
atur
layer
splashb
and had
of 1
assur
uit ten
n the bo
oor and h
with a false
meets the two

Produce Cars

Produce cars are constructed the same as refrigerator cars, except that they do not have ice compartments nor false floors. Pieces of ice are sometimes loaded on top of, or in with, the load and a slight amount of refrigeration given in this way. But the purpose of a produce car is mainly to keep out the outside heat in hot weather and to retain the heat of the load in winter.

Ventilated Box Cars

Ventilated box cars are provided with openings for the outside air to enter. The distinguishing factors are barred doors in place of tight doors, and openings along the sides and ends. The greater part of the vegetable shipments from the South-Eastern states is carried to market in these cars.

Box Cars

When it is impossible to secure one of the above types, shipments are sometimes made in ordinary box cars. They are used extensively in the winter potato movement from the Chateaugay and Long Island sections of New York and the Aroostock section in Maine, and occasionally from points farther west.

Stock Cars

The open construction of stock cars lends them to use in ventilating Southern new potato shipments. However, they do not protect against sun and rain and have other disadvantages.

Refrigeration depends largely upon the circulation of cool air from the ice-bunkers through the load. The different practices are discussed below.

Regular Icing

Regular icing is the most customary method of refrigeration and consists of keeping ice in the bunkers from the time the car is loaded until it is unloaded. For some kinds of produce, this is satisfactory, especially when the weather is moderate, the haul short, and the car of the best construction. Taken in conjunction with pre-icing, it is much more effective. If precooling in transit is also practiced, the coldest temperatures are produced.

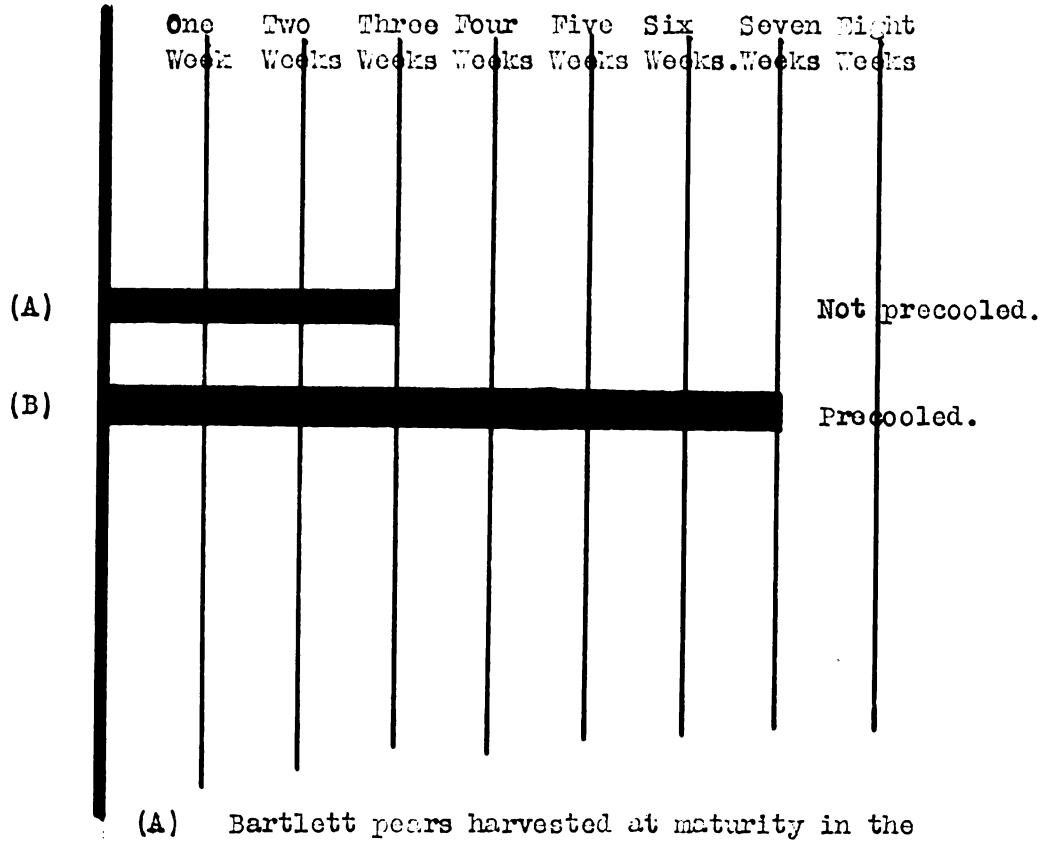
Pre-Icing

In many sections the shippers do not yet realize the value of pre-icing. This is the practice of icing cars several hours before loading. It cools the car, penetrating the insulation so that when the produce is loaded it cools more rapidly.

Precooling.

Precooling produce before it is loaded is practiced in certain sections. It results in lowering the temperatures more rapidly than has been possible in transit until recently. Figure 27 illustrates some results obtained. However, because of the loss of time and

TIME OF PICKING — Period (Average) the pears remained in good condition for market after picking.



(A) Bartlett pears harvested at maturity in the Rogue River Valley (Oregon) and shipped in refrigerator cars direct to market as soon as commercial practices in use would permit.

(B) Bartlett pears harvested at maturity in the Rogue River Valley (Oregon) and precooled and held in cold storage four weeks before shipping to market. Notice that this latter practice had the effect of extending the Bartlett car season about four weeks longer than was possible without precooling.

In neither case were the pears placed in cold storage after withdrawal from the refrigerator cars at marke

Effects of Precooling Raspberries for Shipment.

Figure 27 - Shipments of Raspberries from Puyallup, Washington to Grand Forks, North Dakota. Note the beneficial effects of this precooling.

difficulties in securing proper facilities, this process has not been as successful as many people expected.

Precooling in Transit

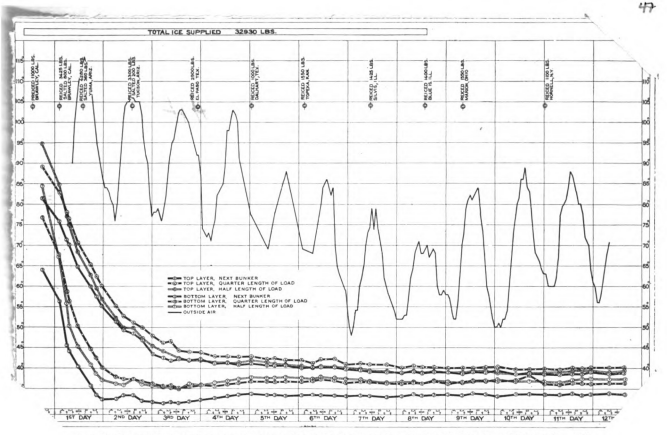
With false floors, basket ice-bunkers, solid ice-bunker -bulkheads, and other improvements, it is now becoming possible to secure nearly the same results while the cars are moving as is possible by precooling. This is accomplished by pre-icing the cars and using large amounts of salt during the first few hours in transit. The results of this method, as compared with the precooling and with regular icing, are shown in Figures 28 and 26. While the cooling rate is not quite as rapid as with precooling, this loss is more than recompensed by the saving in time in getting the goods to market. It is necessary to warn that precooling in transit with salt and ice should be done only when solid insulated ice-bunker bulkheads are used, as otherwise, there is danger of freezing the produce next to the bulkheads.

Initial Icing Only

Under favorable conditions, it is often practicable to ice cars only at the time of loading. This initial icing cools the shipment and the insulation of the car keeps the outside heat from raising the temperatures unduly. Under any but the most favorable conditions, this method is unsatisfactory.

VENTILATION

Ventilation is probably the most important factor in trans-



ram showing cantaloupe temperatures in a car equipped with basket bunkers, insulated bulkheads, and floor racks. Salt in this car as shown in the diagram. The car was in transit from Brawley, Cal., to New York, N. Y., June 26 to July

A

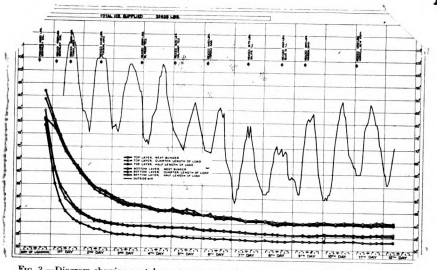


FIG. 3.—Diagram showing cantaloupe temperatures in a car equipped with basket bunkers bulkheads, and floor racks. This car was in transit from Brawley, Cal., to New York to July 8, 1917.

B

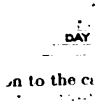
Pre-Cooling in Transit

Figure 28 - These two charts - A and B - compare two cars of a shipment of Imperial Valley cantaloupe to New York City. You will see that the temperatures in the "pre-cooled in transit" car (A) are much more satisfactory than those in the "regular iced" car (B). The only difference in the two cars was that Car A had salt mixed with the ice during the first few hours in transit, while Car B did not.

In an ic
ice alo
mixt
a

n when
the
ir

ıtaloupe



ɔn to the c

ca
at d
in Car

porting perishable goods. Vegetables, particularly, shrink and shrivel rapidly if given too much ventilation, but this is preferable to the development of the fungus and bacterial decays that would come if the produce were kept without a good supply of air.

Ventilation in refrigerator cars is provided usually by opening the ice-hatches. If the car has false floors, the ventilation is more complete.

In produce cars, there are usually special ventilators that can be opened or closed as is thought best. The construction and location of these ventilators vary.

Ventilated box cars are usually provided with a small amount of insulation in the walls, but otherwise are the same as box cars except that they have permanently provided ventilators. These are opened or closed according to the instructions of the shipper, or in the absence of such, according to the regulations of the railroads.

Box cars are often ventilated by fastening the doors partly open. Some are also provided with small doors at each end which may be opened to give ventilation.

Stock cars give abundant ventilation between the boards of the siding without special preparation. They do not protect against rain or the direct rays of the sun and are therefore suitable only for potato and root crops. Because of the excessive ventilation, there is a tendency for the produce to shrivel rapidly.

HEATING

Heating in transit has not received the consideration in the past that the annual loss from injury by cold would warrant. The first consideration is car construction. A well insulated car is usually a good car for heating.

Depending upon conditions, different means of heating are used. Generally speaking, these rely upon some kind of a car heater, burning either oil, charcoal, coal, wood, alcohol; or sometimes they depend on steam. These are only temporary, with the exceptions later discussed under "heater cars."

Pre-Heating

If the weather is moderate, the car well-built, the haul short, and other conditions favorable, shippers in many sections heat the car thoroughly before loading, withdraw the heaters, seal the doors shut, and then send them through, without additional heating, to their destination. If this is done, particular care is usually necessary to provide additional insulation around the load, and to paper the door and ventilator openings to keep out possible cold winds. In Michigan and New York, the bulk of the potato crop is shipped this way. While the results are often very unsatisfactory, yet with intelligent care, much can be accomplished. One of the greatest factors of success by this method is false floors. These should be about four inches in the clear, and should be supported by stringers running lengthwise (never crosswise) of the car. These provide for the interchange and the

equalization of temperatures around the load so that some of the heat that rises from the lading works around through the air passages to the space beneath the false floor where the temperature is coldest. The false floor also keeps the lading from direct contact with the car floor where there is most danger of freezing. Except where ventilation through the load is required, a tight false floor is better for protection from cold than one that is spaced. Layers of straw and building paper between the floor and sides and the lading is usually considered to be of assistance.

Local Heating

Local heating is used in some sections, notably in the Idaho and Colorado potato country and in the California citrus fruit sections. The greatest amount of freezing damage is along the floor at the doorways and at the ice-bunkers. To overcome this, local heating is adopted. That is: the practice of placing small heaters in the doorway or in the ice-bunkers, heating the nearby lading mostly by radiation. With this method, the ice-bunker ventilator openings should be papered over and the car prepared otherwise the same as for pre-heated cars sealed from the point of origin. Oil or charcoal heaters are used for local heating. Often these are taken out after the car has made part of its journey, as the heat will hold for some time thereafter.

Heating by Circulation

By far, the most reliable way of heating the car is by the circulation of a layer of warm air between the outside of the car and the lading. This is the customary method for Pacific-Northwestern

apples and for potatoes from Maine, Wisconsin, Minnesota, Washington, the Chateaugay and Long Island Sections of New York, and other districts. A single heater is placed in the car - usually in the doorway - or sometimes in an ice-bunker. Ventilation openings must be provided for the heated air to rise to the ceiling and spread out over the lading, then down through the ice-bunkers or constructed false end walls; thence under the false floor where heating is needed, and back to the heater again.

The openings for this circulation should never be less than four inches in the clear, and should extend the full width of the car. It is unfortunate that not until the heated air has lost most of its warmth in passing along the ceiling does it circulate to the floor and offer any protection. That, however, is the case, and consequently great care must be taken to make this circulation as free as possible. Some shavings or a few pieces of building paper working down beneath the false floor may almost completely block this circulation, and the heated air will be pent up at the top of the car as a result. This frequently results in overheating and destroying the top of the shipment, while at the same time there may be freezing at the floor. This condition is not usually harmful in moderate weather. But during cold weather when it is necessary to fire heavily, the warm air accumulates at the top of the car causing injury.

It will be noticed that the circulation method of protection does not depend upon heating the shipment itself. Its purpose is to provide a cushion of warm air between the shipment and the car floor and walls. This permits the lading to retain its original temperature which is precisely what should be desired. Coal and wood heaters

are usually used with the circulation method, although one occasionally finds charcoal or oil heaters.

While the above discussion on heating by circulation applies primarily to refrigerator cars, practically the same conditions exist with produce and box cars. These types are not provided with ice-bunkers and all heaters must be placed in the doorway. The circulation method of heating is the most satisfactory, especially in box cars, although pre-heating as discussed above is sometimes done in produce cars. False end walls and false floors must be provided as illustrated in Figure 29. A comparison of the circulation given in this illustration with that in Figure 30 emphasizes the points most generally neglected in providing circulation openings.

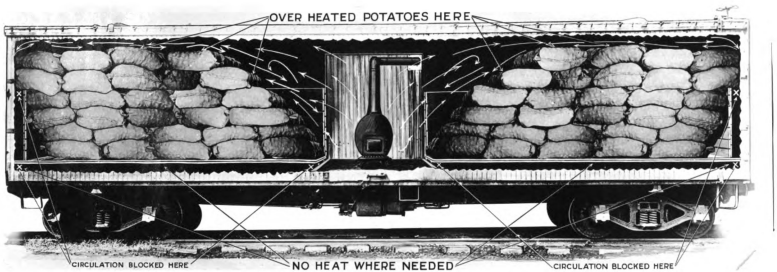
Box cars are used only when there is an insufficient supply of more suitable cars. This statement is not true as regards the Chateaugay and Long Island sections of New York and the Aroostock sections of Maine, for in these districts the railroads have caused the shippers to believe that heaters can be placed only in box cars. It is difficult to properly prepare a box car for protection from cold. It must be of good tight construction, and the floor, walls, and ceiling carefully papered over. False floors and walls must then be built, stoves placed, and provision made for the stove-pipes.

HEATERS

Oil and charcoal heaters require comparatively little attention. These are usually filled and lighted at the shipping point

A Well-Prepared Box Car for Heating Potatoes in Transit by the Circulation System

Figure 29 - Notice the false floor and walls providing never less than four inches in the clear for passage of warm air completely around the load. Compare this with Figure 30.



A Poorly-Prepared Box Car for Heating Potatoes in Transit by the Circulation System

Figure 30 - Circulation stopped at the several points indicated. Disregard of such points is responsible for most of the overheating and freezing of potato shipments during severely cold weather.

and will burn for from eighteen to thirty-six hours. They must then 55
be refueled if the shipment needs to be heated longer. The railroads have regular stations for attending to this, but their service is not entirely satisfactory, and shippers often prefer to care for the firing themselves.

With coal and wood heaters, it is necessary to refuel much oftener. Messengers accompany shipments using such heaters as far on their journey as is thought necessary.

RESPONSIBILITY

This leads to a question of responsibility for damage by freezing in transit. Unless the shipper can prove negligence on the part of the railroad, he cannot collect damages for goods frozen in transit. In certain mid-Western sections, it is possible for the shipper, by paying an increased freight rate, to place the responsibility of heating upon the railroads. In the Eastern states, however, the railroads acknowledge acceptance of the responsibility under almost no circumstances. In the far West, the railroads give some protection without extra charge. Most railroad men recognize that eventually they must furnish heater service the same as they now furnish icing service. To meet this, they are encouraging the development of heater cars.

HEATER CARS

Inventors have been trying for several years to perfect heater cars, but have not so far been very successful. A possible

exception to this statement might be the privately owned and operated Eastman heater cars which carry most of the Maine potato crop. These never pass beyond the New England States except to come to New York City. They have an oil heater in a box beneath each car, and the heat is distributed through ducts in the false floor and walls. These cars are undoubtedly the most successful yet produced on a commercial scale. But their success depends upon careful examination of the cars when passing through the Boston freight yards upon the completion of each trip. They are impracticable for any but a highly centralized and well-defined movement where systematic inspection such as this is possible. Their principle of supplying the heat beneath the false floor so that it may rise directly to the place where it is needed is the correct one.

The Moore heater cars used for part of the Washington, Montana, North and South Dakota, Minnesota, and Wisconsin potato movements have good coal heaters, but like the temporary heaters, they supply the warm air above the car floor, and it must pass to the ceiling and above the lading to the ends of the load before it passes down to the space beneath the false floor. The slight amount of success it has attained is due to an unusually well insulated car rather than to any excellence of the heating system. This is directly opposite to the Eastman cars which have a good heating system and very poor insulation.

The only other heater car in commercial use on a large scale in this country is a steam heated car used by the Northern Pacific Railway. This car depends upon steam circulating from the

engine through pipes to coils in the ice-bunkers. It is moderately successful.

Several other heater cars have been manufactured in an experimental way. All of them supply the heat above the false floor and for that reason it is improbable that they will ever be entirely satisfactory.

A year ago, the Government took this question in hand and, after careful study of the present patents produced what promises to be an unusually satisfactory car. Like the Eastman car, the source of heating is in a box beneath the floor, and the warm air is evenly distributed beneath the false floor by means of ducts. Unlike the Eastman car, these ducts do not extend up the walls. The car itself is well insulated and tight. In actual transit test conditions, the distributing system appears to be as nearly perfect as could be desired. A test train of cars loaded with apples from Wenatchee, Washington, to New York City in January, 1919, showed remarkable results for the Government car as compared with the others. Weather ~~as cold as seventeen~~ averaging five degrees below zero was encountered for a period of ~~eleven thirty-six~~ eleven hours, and during the entire trip there were unusually cold temperatures. Well insulated cars with temporary oil and charcoal heaters showed variation in different parts of the load of from ~~thirty-six~~ twenty-seven degrees Fahrenheit at the coldest place to ~~ninety-six~~ seventy-seven degrees at the warmest. Moore heater cars varied ~~thirty-nine~~ twenty-nine degrees to ~~seventy-six~~ seventy-six degrees. ABC heater cars (a new patent) varied ~~thirty-nine~~ twenty-nine to ~~fifty-six~~ fifty-one degrees. ~~and the Northern Pacific steam-heated cars varied thirty-six to sixty-six degrees.~~

Contrast these temperatures with the low and high temperature extremes in the new Government heater cars of ~~thirty-three~~ thirty-two to ~~thirty-seven~~ forty-one degrees, a variation throughout the whole load for the entire trip of but ~~four~~ nine degrees. Bear in mind that these are actual temperatures of the apples in various parts of the load: at the floor, middle, top, sides, ends, and elsewhere. The record made by the Government cars is nothing less than remarkable, especially considering the low installation and operation costs.

Complete satisfaction was not gained, however, in the operation of the heaters themselves. The kerosene heater required too much attention. The alcohol heater cost too much for fuel. All things considered, the cars with the steam heaters gave the best results and after once being coupled to the engine required almost no attention. The experimenters feared that the steam-heated car would not hold its temperature when disconnected from the engine. If a single test given it last year is conclusive, even this factor may not be important. In this test, a steam-heated car was disconnected for eleven hours on a siding at Minot, N. D. in an outside temperature of five degrees below zero, and the load fell only one and one-half degrees, the coldest apple temperature being thirty-two and one-half degrees. In each of the Government cars, the air ducts and circulation were the same, and a difference made only in the type of heater in the heater box.

It is entirely practicable to attach the Government system of heat distribution to the refrigerator cars now in use at an actual cost of not more than three hundred fifty dollars per car. It is,

however, necessary to raise the floor three inches and reduce the car capacity accordingly. As cars are seldom loaded higher than five feet, this is not a prohibitive feature. In building new refrigerator cars, it is not necessary to raise the floors and the present capacity need not be affected.

That there is a field for heater cars is made evident by the hundreds of thousands of dollars of produce damaged annually because of freezing. In addition to the damage, there is also the cost of sorting many other shipments.

At present, shippers sometimes pay as high as ninety dollars to protect a single shipment. With suitable equipment, this would not be necessary.

CLIMATE AND WEATHER

Climate and weather both play their parts. Northern shipments usually require less refrigeration and more heat than those in the South. Likewise refrigeration and ventilation are more important in summer, and heating is more important in winter.

ROUTING AND DIRECTION

The routing of the shipment also must be considered. If it were possible to handle all of the Washington, Oregon, and Montana winter apple and potato shipments by the Union Pacific via Pocatello, the heating problem would be greatly reduced. Because of the handling capacity of each road and for other reasons, the bulk of these ship-

ments travel by the Northern Pacific, the Great Northern, and the Chicago, Milwaukee, and Saint Paul Railroads. As these routes are much farther north than that of the Union Pacific, there is more danger of freezing.

Similarly, shipments under refrigeration from California to the East, routed by the Southern Pacific and other lines via Ogden, pass through cooler temperatures than those routed by the Santa Fe via Needles. There is consequently less difficulty in refrigerating the shipments made by the northern route.

The question of destination is an important one. Texas onion dealers like to ship to Denver, especially if their onions are showing signs of decay. The reason is that fungi spread slowly in the dry atmosphere of the country between Texas and Denver while the damp atmosphere between Texas and Chicago, for example, favors rapid decay.

Shipments going north under heat in winter have distinct advantage over the return movement. This is because the outside temperatures during the first part of the trip are usually nearer the desired car temperature. The reverse is true in summer.

DISTANCE, TIME, AND DELAY

Distance plays its part. A short shipment may require little or no special care, while a long one must be provided for the changes that would take place.

It is often possible by the selection of routes to decrease

P-30- . the time in transit materially. As an example of this: potatoes shipped from Wisconsin usually will reach Saint Louis two days sooner if routed around Chicago by the Elgin, Joliet, and Eastern Railway Belt Line, thirty miles outside the city, than if routed through Chicago; although the freight rates are the same and the mileage shorter through Chicago.

Some roads run special fast freight train service for perishables such as the thirty-six hour train on the Illinois Central Railroad from Louisiana points to Chicago. Time lost in moving freight is not usually due so much to slow trains as to delays at the terminals and at the division points. It is possible with a heavy movement like that of California oranges to Chicago to run a solid train the full distance without any changes except for the engine and crew. But such movements are the exception, and as a rule, new trains are made up at division points, one hundred and fifty to two hundred miles apart. While it usually takes only four or five hours for a train to run this distance, it may take three to twelve hours before another train can be made up to run the next division. At the terminals, it is often difficult to place the cars where they can be unloaded. In Chicago or New York, it is a delicate job to work each car over the networks of tracks and place it exactly where the consignee desires. This is especially true if the trackage space is filled with other cars as often happens. All of these delays mean damage to goods in transit.

The receiver does not always do his part, and until the recent very high demurrage rates became effective, it was not unusual

to hold cars for days or even weeks, hoping for a rise in the market or some other favorable condition.

Delays in unloading are sometimes due to bad weather. A delay of this kind is legitimate, for it would be folly, as for example, to heat a car of bananas from New Orleans to New York and then unload it with the thermometer at zero.

WHAT HAS BEEN ACCOMPLISHED

Now, as never before, the country recoginzed that excessive waste must be eliminated. Where the grower's one thought used to be to dispose of his crop at the least growing and handling cost, he now recognized a moral duty to do his share in seeing that it reaches the consumer in proper condition. Accordingly, he has, through his selling and trade organizations, conducted investigations and adopted reforms.

This movement more lately has become apparent among the package manufacturers. They are also seeking to make packages that, first of all, meet the requirements of convenience and protection to the contents, where formerly their one thought had become to produce packages at a lower cost than their competitors.

The shippers, too, are willing to do their part, and if the present indications hold good, much can be expected of them. Their organizations are becomming effective forces in doing away with wasteful methods, as are also those of receivers and dealers.

Railroads and refrigerator car lines are interested from two distinct standpoints. The first is that of developing and building up the country along their routes in order that their revenue may be increased. Elimination of waste means more profits and better felling generally, both for the railroads and their territories. The second standpoint from which the railroads view the elimination of waste is that of doing away with claims for damage in transit. For years the railroads have paid claims for which they were in no way responsible. Consequently they are interested in bringing about reforms that will eliminate these claims as well as those that are legitimate. The Government Railroad Administration has been a powerful factor in aiding this movement. While its methods often have been arbitrary, no one can doubt but that they have been effective.

The Government has, during the past few years, done much to create interest in doing away with waste in transit. The perishable produce industry in all parts of the country shows many effects of investigations and movements backed partially or entirely by Government agencies. Before the War, these were conducted entirely by the United States Department of Agriculture through several of its bureaus. With the establishment of the Food Administration, an organization of almost limitless power was placed behind these movements. Probably there never was as much done in spreading the doctrine of conservation as the Food Administration accomplished in its two years of existence. Many of its rulings were unpopular and some of them had

to be revised; but, considering the magnitude of its task, we must give it credit for accomplishing what no other existing agency could have accomplished.

The Government Bureau of Markets through its inspection service is a noteworthy force in improving conditions. It is a revalation to a great many shippers to review the Government reports showing the actual condition of their shipments as they reach market. It is a notable fact that, once shippers realize their shortcomings, many of them desire improvement.

The investigational and demonstrational division of the same Bureau is continually searching out and demonstrating improved methods. The shippers do not always take kindly to suggestions, but their effects are ultimately felt. A movement to improve the handling method, of cantaloupes, for example, may meet with the greatest of opposition by the trade; but the existence of the movement results in the trade thinking over the question involved. It may be that at last some shipper will test out a suggestion with the result that it is usually adopted. It is not unusual that the part of the Government agencies is forgotten; but if the shippers would trace back the originating movement behind a surprisingly large number of their improvements, they would find it to be the Government Department of Agriculture.

Only a small beginning has been made in solving the problems of transporting perishables. One unfamiliar with the well-nigh limitless number of factors to be considered wonders that progress is made so slowly. However, rather should one wonder that it has been made so rapidly, the problems are so intricate.

CONCLUSION

In writing this thesis, the attempt has been to present some of the problems that seem most important to the writer. To suggest solutions for all of them would be impossible in a paper many times this length, even were one qualified to do so. The few suggestions that are included are the results of investigations with which the writer is personally familiar through taking actual part in, or keeping closely in touch with, during their progress.

The topics discussed here are of too general a nature to summarize except in an exceedingly broad way. Briefly, we may say that there is at present too great a waste of perishables in transit to permit of continuation. This waste is due to ignorance, poor facilities, and carelessness. All of these are being faced squarely and with support by the general public, and it is reasonably possible that the existing agencies will bring about impovements.

GLOSSARY

Box Car: An ordinary railroad freight car not provided with insulation nor with special means of ventilation.

Lading: The goods with which a car is filled.

Layer: (A car-loading term) A course or stratum of a car-load, one package in height.

Local Heating: The process of heating portions of shipments only.

Precooling: The process of cooling shipments before they are placed in cars.

Precooling in Transit: The process of cooling shipments very rapidly the first few hours they are in transit.

Pre-Heating: The process of heating cars before they are loaded.

Pre-Icing: Putting ice in refrigerator cars before they are loaded.

Produce Car: A car provided with heavily insulated floor, walls, and ceiling, and with insulated doors, but with no ice-bunkers.

Regular Icing: The system of refrigeration in which ice is kept in refrigerator cars from the time they are loaded until they are unloaded.

Row: (A car-loading term) A pile, one package in width across the side of the car from end to end.

Refrigerator Car: A car with ice-bunkers, provided with heavily insulated floor, walls, and ceiling, and with insulated doors.

Stack: (A car-loading term) A pile, one package in length across the car from side to side.

Stock Car: A car with spaced siding built especially for transporting livestock, but sometimes used for vegetables.

Ventilated Box Car: A box car, sometimes with a small amount of insulation, provided with special ventilation doors and other openings for ventilation.

ACKNOWLEDGMENT

The writer desires to acknowledge the use of photographs and charts which are the property of the United States Department of Agriculture and of a few others from the files of the Illinois Central Railroad and Western Weighing and Inspection Bureau.