THE PRECOOLING OF FRUIT.


INTRODUCTION.

The term "precooling" has been applied to the rapid and prompt cooling of fruit or other produce before it is shipped or stored. Ice and salt or mechanical refrigeration are usually employed as the cooling agents. The object of precooling is to reduce the temperature of the fruit as quickly as possible to a point where ripening will be retarded and decay and deterioration prevented.

Probably no process of fruit handling has so rapidly attracted widespread interest within so short a time after it was first suggested as has this comparatively new idea in preparing fruit for shipment over long distances.

The purpose of this paper is to present in a rather conservative and concise form the progress and results of the investigations which have been made by the Bureau of Plant Industry and to give the exact status of the process as far as it has been applied under commercial conditions.

Many problems connected with the rapid reduction of the temperature of fruit remain to be solved. It is not yet certain just what system of cooling is preferable, whether the cooling should be accomplished before the fruit is loaded in the cars, or whether cooling after loading is most advantageous. Careful and comprehensive study of all phases of the subject and a long series of tests will be required before the problems are fully solved.

Precooling of fruit has already received commercial application. A number of plants have been erected and are in operation in California, and many more are projected in various parts of the country. Some of these plants, operated by associations of growers or shippers, precool the fruit before it is loaded; some, constructed by transportation companies and operated in connection with the refrigerator-car service, are car-cooling plants and accomplish the precooling after the fruit has been loaded and delivered to the railroads.

The ideal system of precooling for all conditions has not yet been found. While the process has not yet wholly passed the experimental stage, its importance as a means of promoting the safe trans-
portation of fruits for great distances has long been fully recognized and its use will be extended as rapidly as the principles can be worked out and their practical application under different conditions and to different crops demonstrated.

THE REASONS FOR PRECOOLING.

During the maturing of a normal fruit on the tree certain chemical and physiological changes are constantly taking place within the fruit itself. These changes, which result in the acquirement of quality and flavor, constitute the ripening processes. After a certain point is reached the fruit becomes overripe, quality and flavor are lost, and deterioration progresses until eventually the fruit is destroyed by fungous decay or fermentation, or through destructive physiological changes.

A fruit may be considered as a living organism which has a definite span of existence, the length of this span depending upon the conditions surrounding the organism. The most important factor which modifies this span of life is temperature. When the fruit is removed from the parent plant the life processes constituting ripening are materially hastened and the life span is greatly shortened if the fruit is allowed to remain warm for any considerable length of time. Hence, the importance of reducing the temperature as promptly and rapidly as possible after the fruit is picked.

The length of the life span differs with the character of the fruit. It is shortest in the soft fruits, such as berries, cherries, peaches, apricots, plums, and most pears, and longest for the harder fruits—citrus fruits and apples. It varies with different varieties within the same group of fruits. Some varieties of apples, for example, keep longer than others; lemons keep longer than oranges. The importance of quick and prompt cooling—precooling—then, is greatest in the case of the soft fruits and least for the harder fruits. Experience so far confirms this rule.

Aside from the breaking down from overripeness, fruits are subject to premature decay due to the attacks of various fungi. The most common forms of these fungi, however, have not the power to penetrate the sound, unbroken skin of a healthy, normal fruit. Most of the decay occurring in fruits in transit and storage starts at injuries and breaks in the skin, caused almost entirely by rough handling in preparing the fruit for market, either in picking, grading, hauling, or packing. Wounds, bruises, scratches, or abrasions of any kind allow the organism of decay to gain entrance. Other fungi which are not dependent upon injuries to start, attack fruits in transit and storage; but these forms of decay are much less prevalent.
The germination of the decay spores, which are analogous to the seeds of higher plants, is dependent upon proper moisture and temperature conditions. Germination does not take place while the fruit is perfectly dry or when the temperature is low. After the spores have germinated, however, and the decay has started within the fruit, even as low a temperature as 32° F. will not wholly check it. Growth of the mold is only retarded and the decay continues slowly to develop.

The prompt and rapid reduction of the temperature below the point where the decay spores will germinate prevents the development of the disease, and even fruit which has been rendered extremely susceptible through mechanical injury of some kind can be transported with only slight loss from decay when promptly cooled. It is not advisable, however, to depend upon precooling to prevent decay following injuries. The spores of the fungi are not destroyed by the low temperature. They merely remain dormant until conditions are favorable for their germination and growth. These conditions usually exist as soon as the fruit is unloaded from the cars, especially in humid, hot weather. The loss from decay is thus transferred to the market end, and such fruit will soon gain a reputation for poor market-holding quality and will be discounted accordingly. It is just as important that fruit remain in sound condition long enough after arrival in market to be sold and consumed as it is to get it to market sound. Precooling may not be legitimately substituted for careful handling in preparing fruit for shipment.

REVIEW OF PRECOOLING INVESTIGATIONS.

The precooling investigations of the Bureau of Plant Industry were begun in 1904, when, so far as is known, the first application of this principle to the handling of fruit was made by Powell, in Georgia, in connection with a study of the causes of decay in peaches during transit from the Southeastern States to northern markets. These investigations have been continued and extended as rapidly as the means at command would permit, and it will be necessary to continue the work for a number of years, as many problems remain unsolved. The work so far has included the cooling of peaches, oranges, and table grapes in California, and additional work on peaches in Georgia.

In the first peach work in Georgia and California (1904 and 1905) the precooling was done in ordinary refrigerator cars. The bunkers were filled with ice and salt and the fruit was stacked openly, half a carload being cooled at a time to allow free circulation of the cold air. These experiments were therefore of the "warehouse" type of precooling, which insures the thorough cooling of every package before it is loaded for shipment.
For the orange and grape work and for the later peach work in Georgia special equipment, using mechanical refrigeration, was provided. Most of the orange work was done in connection with commercial cold-storage plants, including cooling in refrigerated rooms before loading and by blowing cold air through the cars after loading.

Later, in 1908, a special, portable, experimental precooling plant was added to the Bureau equipment, which makes the work largely independent of commercial plants and renders it possible to carry on precooling investigations at any point having railroad facilities. The outfit consists of a 12-ton ammonia compression system installed in one end of a specially constructed freight car. The other end of the car is heavily insulated, and forms a coil room containing 5,000 feet of 1/4-inch ammonia expansion piping. Engines, fans, pumps, condensers, dynamos, and electric motors are included, and provision is made for accurately measuring the temperature, refrigeration, power, and other factors, so that full data can be obtained. The cooling is accomplished by circulating air over the piping in the coil room by means of a 45-inch exhaust fan of the centrifugal type, which forces the cold air through removable insulated 20-inch pipes to an adjacent car or building. Plate XLI, figures 1 and 2, show this plant in operation at Lodi, Cal. Since 1908 all precooling investigations of the Bureau have been made with this portable outfit.

The first car precooling of oranges was done by circulating cold air through the cars from a commercial cold-storage plant by means of fans and connecting tubes or ducts, provision being made to reverse the air current when necessary. During 1909 the car precooling of oranges was accomplished by means of the portable plant.

The cooling of oranges before loading was done in ordinary cold-storage rooms provided with a liberal amount of piping. The orange work is the most comprehensive of any precooling work done with fruits. The car-precooling work with this fruit included tests on 44 cars; in the warehouse storage-room cooling, 30 carloads were handled. The results of this work are corroborative and definite and show that to accomplish the precooling with any reasonable degree of rapidity after the fruit is loaded in cars requires the use of very large volumes of very cold air. The difficulty of cooling fruit wrapped in paper and tightly packed in boxes was strikingly shown, and where the time element is important heavy machinery and power must be provided. This work also brought out the impracticability of cooling all parts of the car equally; there were frequently differences of more than 20 degrees between the coldest and the warmest fruit in the same car after a run of 18 to 24 hours. It therefore becomes necessary in car precooling to chill some of the boxes as nearly to the freezing point as possible and then to depend upon an equaliza-
FIG. 1.—GENERAL VIEW OF PRECOOLING CAR (AT THE LEFT) CONTAINING THE MACHINERY AND COILS FOR COOLING THE AIR WHICH IS CIRCULATED THROUGH THE AIR PIPES SUSPENDED ABOVE TO THE CAR OF FRUIT BEYOND.

FIG. 2.—VIEW SHOWING THE COLD-AIR PIPES CONNECTED TO A REFRIGERATOR CAR LOADED WITH FRUIT.

FIG. 1.—GENERAL VIEW OF PLANT FROM THE EAST SIDE, SHOWING PRECOOLING BUILDING AND COVERED AIR DUCTS LEADING FROM IT TO THE CAR SHEDS ON EITHER SIDE.

Fig. 2.—INTERIOR OF PRECOOLING SHED, SHOWING FLEXIBLE AIR-PIPE CONNECTIONS FOR WITHDRAWING AIR FROM CARS.

RAILROAD CAR-PRECOOLING AND ICING PLANT AT COLTON, CAL., BUILT AND OPERATED BY ONE OF THE TRANSCONTINENTAL RAILROAD LINES.
FIG. 1.—ADJUSTABLE DOOR CONNECTION FOR BLOWING COLD AIR INTO DOORWAYS OF CARS, SHOWING CURVED BAFFLE PLATES FOR DISTRIBUTING AIR INTO UPPER PARTS OF CARS.

[In use at the car-prec当地ing and icing plant at Colton, Cal.]

FIG. 2.—PRECOOLING ROOM IN AN ORANGE-PACKING HOUSE AT UPLAND, CAL., SHOWING AIR DUCTS FOR DISTRIBUTING COLD AIR THROUGH PERFORATED FALSE FLOOR AND CEILING.

[Cold air forced into the room through holes in the floor is withdrawn through holes in the ceiling.]
FIG. 1.—GENERAL VIEW OF ICE-STORAGE BUILDING AND PRECOOLING SHED.

FIG. 2.—END VIEW OF PRECOOLING SHED.

[Under the icing platform, between the two tracks, are the cold-air supply and return ducts whereby cold air is circulated through the cars by means of the adjustable swinging air pipes overhead]

CAR-PRECOOLING AND ICING PLANT AT SAN BERNARDINO, CAL.
FIG. 1.—**Canvas Hoods used at an Orange-Precooling Plant at East Highlands, Cal., to Prevent Loss of Cold Air in Loading Precooled Fruit into Cars.**

[When in use, the hoods are extended against the sides of the cars; at other times the hoods are folded back against the building.]

FIG. 2.—**Precooling Room in an Orange-Packing House at East Highlands, Cal., Showing Roller Conveyor for Carrying the Packed Boxes of Fruit into the Precooling Room.**

[The marking on the floor is intended to facilitate regularity in stacking so as to provide proper air-circulation spaces between the boxes.]
tion of the fruit temperatures to bring the carload as a whole down to the desired point. It was found that the wrapped and tightly packed oranges can be exposed for several hours to a direct blast of air many degrees below the freezing point of the fruit without danger of freezing.

In the storage rooms the time element is not so important. From 36 to 48 hours, depending upon the initial temperature of the fruit and the efficiency and capacity of the refrigeration, were required to cool the fruit to the temperature which would be maintained by the iced refrigerator cars en route.

As already mentioned, the peach precooling work in Georgia in 1904 and the California work of 1905 were of the “warehouse” type of cooling. This work was fundamental, and all subsequent investigations along these lines were based upon the results there obtained.

The possibility of safely transporting fruit which had been well ripened on the tree and preserving its quality and flavor was fully demonstrated. In addition, the loss from decay was materially reduced in the precooled cars. The equalization of temperature conditions in the refrigerator cars was strikingly shown. There was far less difference between the top and bottom tiers of the load than is usual under ordinary icing methods.

The work done with the portable plant in Georgia in 1910 was of the car-cooling type. Fourteen cars of peaches were precooled after loading. Much more rapid cooling was accomplished than was possible with oranges, as the Georgia peach is packed in 6-basket slatted carriers without wrapping. The average initial fruit temperature was 73.9° F.; an average reduction of 21.1 degrees was accomplished, the time of running averaging 5 hours 35 minutes. Insufficient water supply prevented the operation of the plant to its full capacity; otherwise better results would undoubtedly have been possible.

The average decay found in the “extra fancy” fruit on arrival at New York was 7 per cent in both the fourth and bottom tiers in precooled, as compared with 19.45 and 8.2 per cent on the fourth and bottom tiers, respectively, of nonprecooled cars. In the “fancy” grade the decay averaged 5.8 and 2.9 per cent, respectively, in the precooled fourth and bottom tiers, and 14.1 and 6.2 per cent for the same tiers, respectively, in nonprecooled shipments. The extra fancy grade was larger and softer fruit and received more squeezing and bruising in handling and packing; hence the larger percentages of decay. The equalizing effects of precooling and the avoidance of excessive decay frequently occurring in fruit loaded on the upper tiers are thus strikingly shown.

The California table-grape precooling of 1909 and 1910 was of the car-cooling type after loading. The results of this work are rather indeterminate and no satisfactory conclusions can be drawn. The
precooling was effective in checking the decay which ordinarily follows injuries to the grape berries due to careless handling, but it proved less effective and in some shipments failed to prevent the development of other forms of decay occurring after wet weather. The results of the two seasons are corroborative and show that some problems in the precooling of grapes in cars still remain which are thus far not fully understood. The question arises whether the unavoidable inequality of cooling of the grapes in the cars is responsible for the inconsistent results, and if this is the case serious doubt may be thrown on the practicability of cooling this class of fruit after loading.

**TYPES OF PRECOOLING PLANTS.**

**METHODS AND CONDITIONS.**

The precooling plants thus far in commercial use are of two different types. In one, the cooling is accomplished before loading in cars; in the other, after loading by forcing cold air through the cars. Plants for cooling before loading consist of insulated rooms provided with means for thorough cooling and do not differ greatly from ordinary cold-storage warehouses; they have been termed "warehouse precooling plants" to distinguish them from the car-precooling type.

The car-precooling plant must be equipped with refrigerating machinery of relatively large capacity in order to accomplish the cooling as rapidly as possible without danger of unduly chilling any portion of the contents of the cars. The construction of numerous plants of this type at points where but few cars are to be cooled is impracticable on account of the relative cost of the machinery required and the short time each day that this machinery can be utilized. If plants are not located at all principal shipping points the delay and additional cost of switching cars to the plants are disadvantages. To avoid extra switching, the cooling and icing of the cars must be accomplished at the same plant. For these reasons the cooling of fruit in cars can be performed to advantage only by the transportation companies in connection with the refrigerator-car service.

With refrigerator cars as at present constructed and with the arrangement for circulating the cold air through the cars at the cooling plants so far erected, there is unavoidably a very considerable leakage of cold air and loss of refrigeration. The colder the air the greater the cost of producing it and the larger the loss of refrigeration by leakage. The jolting and racking of the cars in service tends to open crevices and seams, so that except when new they are far from being tight enough to prevent a considerable loss of air, with only very slight air pressures.
To precool fruit quickly in cars and to make up the unavoidable losses of refrigeration due to the leakage of the cold air requires a considerably larger and more expensive cooling plant than is necessary to cool the same quantity of fruit more slowly in a well-constructed warehouse room. In the warehouse there is less necessity for hastening the cooling; the air need not be so cold nor circulated so rapidly; the room can be more tightly constructed and better insulated than a refrigerator car; the loss of cold air and refrigeration is not so great; and the cooling is accomplished at less cost. The warehouse type of plant is the only practicable one for the shipper who desires to precool his own fruit.

The types of packages and methods of packing at present in use do not admit of a sufficient circulation of air through the packed fruit to cool it at all rapidly. Thorough cooling is necessarily somewhat slow unless very cold air is used. Rapid cooling of packed fruit will necessarily be very unequal, the fruit in the outer portions of the packages cooling very much more quickly than that in the interior. Too long an exposure to extremely cold air will result in freezing the outer fruit before that in the interior is thoroughly cooled. On the other hand, those who have not made actual tests of the temperature of the fruit under such conditions will probably be surprised at the length of time that warm fruit may be exposed to extremely cold air before becoming unduly chilled. The temperature of the air surrounding the fruit package does not indicate at all the temperature of the fruit itself unless it has been exposed to the air temperature for many hours. This is particularly true of the fruit in the centers of tightly packed boxes or crates and of fruit wrapped in paper. The blowing of cold air over fruit has very little or no effect in preserving it unless continued until the temperature of the fruit itself is actually lowered. This fact has not been entirely appreciated in some of the commercial precooling work so far performed. It has been assumed apparently that because the fruit packages have been exposed for an hour or more to moderately cold air the fruit is therefore cold, which may be far from being true.

Car-precooling plants.

Three plants of the car-precooling type have been erected in California. All of these combine ice manufacturing and car icing with the precooling and are operated by railway companies in connection with the refrigerator-car service. The plants are located at important junction points connecting directly with the main lines to the East. Long sheds protect the cars, cold-air ducts, and icing platforms from the direct heat of the sun. The cars are iced immediately after precooling without additional switching.
The precooling plants at Roseville and Colton, Cal., are nearly alike in size and arrangement, having been installed by the same company. Plate XLII, figure 1, shows a general view of the plant at Colton. Large exhaust fans force the air through an insulated coil room containing many thousand feet of ammonia expansion or cooling coils into the cold-air duct which extends alongside the precooling track under the icing platform. Flexible branch pipes connecting with the cold-air duct carry the air into the cars through false or temporary doors which are set into the car doorways. Plate XLIII, figure 1, shows the adjustable door connection as it appears when disconnected and swung aside. After passing through the cars the air is withdrawn through the ice hatches at both ends, which are connected by means of flexible branch pipes to the return-air duct located above the cars. (Pl. XLII, fig. 2.) When desired, an intermittent system of circulation can be put into operation. Under this system the air is drawn from the cars by the fans and discharged alternately into the coil room and the outside air, the discharge in each case continuing for a few seconds. During the interval of the discharge into the outside air the cold-air supply is cut off, while the fans continue to exhaust from the cars, and the air pressure in the cars is thus very slightly reduced. The intermittent circulation is employed for a few minutes at a time several times during the cooling of a car. It is claimed that this intermittent exhaust tends to remove from the cars and air ducts the exhalations from the fruit which are supposed to promote decay if allowed to remain. It is claimed that rapidity of cooling is promoted by the alternate slight variations of air pressure in the cars, which are supposed to assist in working out the warm air from the interior portions of the fruit packages.

The Roseville plant accommodates 20 cars at one setting. The refrigerating machinery, which can be employed for either ice making or precooling, has a capacity of 260 tons (i.e., equal to that furnished by 260 tons of ice) per 24 hours. The Colton plant is provided with refrigerating machinery of the same capacity, but has two precooling sheds, as shown in Plate XLII, figure 1. Each shed accommodates 20 cars at one setting and is intended to be used alternately with the other, the cold-air blast being delivered to either shed, as required, while the cars in one are being iced and switched.

The precooling plant at San Bernardino, Cal., includes two adjacent tracks, as shown in Plate XLIV, figure 1. Sixteen cars on each
track can be precooled at one time. A concrete structure between the tracks incloses both the cold-air supply and return ducts and supports the icing platform. The branch pipes connecting with the ice hatches at both ends of the car arch over from the main air ducts to the tops of the cars. These connecting pipes are insulated and are in two sections, swiveled together, so that the free end of the outer section may be swung to any position. A bellows-like section on the free end admits of adjustment for cars of any height (Pl. XLIV, fig. 2).

The particular features of this plant are those relating to the control of the air pressure in the ducts according to a system designed to minimize the effect of air leakage from the cars. Two sets of fans are used, one set drawing the air from the suction duct and discharging into the coil room, the second set drawing the cold air from the coil room and forcing it into the cold-air supply duct. The speed of these two sets of fans is so regulated that the air pressure in the supply duct is maintained as much above atmospheric pressure as that in the suction duct is below that of the atmosphere, a system of automatic air valves at the end of the ducts farthest from the fans assisting in this regulation. The object of this air-pressure regulation is to maintain in the cars which are being precooled an air pressure as nearly as possible exactly equal to the pressure of the outer air, thus preventing any leakage of air either inward or outward. The air is cooled by passing over cold-brine piping in the coil room. The air ducts, which are insulated, are also refrigerated by brine piping to prevent the air in the ducts from becoming warmed by heat leakage through the walls. Brine, which is cooled by the ammonia system, is used for distributing the refrigeration, as it admits of storing up refrigeration in the cold brine in the intervals while no cars are being cooled. This stored refrigeration is utilized to give a colder air blast and promotes rapidity of cooling at the beginning of the run. The volume of air forced through each car is estimated at 6,000 cubic feet per minute.

PLANTS FOR PRECOOLING BEFORE LOADING IN CARS.

THE INSULATED-ROOM METHOD.

Five plants for precooling before loading in cars are now in operation in California. They have been installed by shippers or by local associations of growers and shippers. They consist of one or more insulated rooms, with arrangements for refrigerating the same either by mechanical means or by the use of ice and salt; provision is also made for air circulation through the rooms, usually by means of fans.
PRECOOLING PLANT AT POMONA, CAL.

The plant at Pomona comprises 6 insulated rooms, which are located in the basement of an orange-packing house. A large fan circulates the air from these rooms through a cooling room containing about 11,500 feet of ammonia expansion piping. Immediately after packing, the fruit is transferred to one of the cold rooms. The transfer of the packed boxes both into and out of the cooling rooms is accomplished by automatic mechanical conveyors, with a minimum of hand labor and with little loss of refrigeration by the opening of doors. About 6 cars of oranges per day are precooled to a temperature of 35° F., the usual period of cooling being about 48 hours. When used as a storage plant, 42 cars of fruit can be held in the cold rooms.

The ammonia for cooling the air blast is obtained by a pipe line from an adjacent ice-manufacturing plant, the charge for the refrigeration being based on a fixed price per box of oranges precooled.

PRECOOLING PLANT AT EAST HIGHLANDS, CAL.

The plant at East Highlands has 6 insulated fruit-cooling rooms on the first floor of an orange-packing house. It is a combined precooling and ice-making plant, the ice manufactured being used partly in icing the cars of fruit shipped from the packing house and partly disposed of in the local retail ice trade. The packed boxes of fruit are carried by automatic conveyors from the packing house into the cold rooms, and after precooling are trucked from the cold rooms into the cars. Folding canvas hoods, or vestibules, shown in Plate XLV, figure 1, extend against the sides of the cars and provide closed passages into the cars. Plate XLV, figure 2, gives a view in one of the cooling rooms, showing a portion of the conveyors and the method of marking the floor to insure regular placing of the boxes so as to leave proper spaces for air circulation. Each room is cooled by about 1,450 feet of 2-inch ammonia expansion piping arranged in a loft immediately above the room. No forced circulation is used. The ammonia plant used for precooling has a cooling capacity equal to 20 tons of ice a day. The plant is designed to cool the fruit from 90° to 34° F. in 48 hours at the rate of 2,600 boxes (about 7 carloads) per day. The rooms have a combined storage capacity of 24 cars of packed fruit.

PRECOOLING PLANT AT UPLAND, CAL.

The plant at Upland has 4 insulated fruit rooms, which are situated in the basement of an orange-packing house. The cooling is accomplished by the use of manufactured ice, which is crushed mechanically, mixed with coarse salt, and placed in large tanks located above the rooms to be cooled. In these tanks are coils of pipe filled
with calcium brine, which is chilled by the low temperature produced by the ice-and-salt mixture. The brine chilled in these coils circulates automatically by gravitation through another set of coils in a room below. The air in the fruit room is chilled by being forced over these cold-brine coils. Plate XLIII, figure 2, gives a view in one of the fruit rooms, showing the air ducts for distributing the cold air through a perforated false floor and ceiling. This system has been patented.

For the first 36 hours after warm fruit is placed in the precooling rooms the cooling is accomplished by a forced circulation of air through the ice-storage room in the basement and through the fruit rooms, in order to perform as much cooling as possible by the use of ice alone without additional expense for handling, crushing, and salting. After the fruit is partly cooled, lower temperatures are obtained by circulating the air from the fruit rooms over the colder brine coils. The usual period of cooling is about 72 hours, the temperature of the fruit at the end of this time being 38° to 40° F. The plant is designed to precool 3 cars of oranges a day and has storage capacity for 16 carloads of packed fruit.

**PRECOOLING PLANTS AT NEWCASTLE, CAL.**

The two plants at Newcastle are practically identical and form part of a proposed system of small plants operated from a common central refrigerating plant which furnishes cold air for the individual small precoolers. Each precooler consists of a single insulated room located on the main floor of a loading shed. At one side of the room is the precooling compartment proper, through which the packed boxes or crates of fruit are carried back and forth several times by a mechanical conveyor, which is the special feature of these plants. A strong blast of cold air is forced by a fan through the precooling compartment, which is but little larger than is necessary to allow the boxes or crates to pass through, so that the air current is confined closely to the fruit. After passing through the precooling compartment the escaping cold air cools the room which is used for holding the precooled fruit until it is loaded into the cars. By regulating the speed of the conveyor the time the fruit remains in the precooler may be varied from 20 to 80 minutes, according to the degree of cooling desired. On account of the short time that the fruit is exposed to the cold air, the actual reduction of temperature is small.

**SMALL PRECOOLING PLANTS COOLED BY ICE AND SALT.**

For several years orchardists in the valley of the Hudson River, in eastern New York, where natural ice is ordinarily obtainable at low cost, have used small cooling plants consisting of one or more
rooms, usually insulated with sawdust-packed walls and cooled by a mixture of crushed ice and salt, contained in upright tubes or cylinders of galvanized sheet iron ranged along the walls of the rooms. At the top the tubes terminate in a small box or tank of galvanized iron which is set into the floor above and covered with a tight-fitting lid. The ice and salt are hoisted to this upper floor and dumped into the tubes. Suitable gutters at the bottom of the tubes carry away the drip from the melting ice-and-salt mixture. The temperatures of the rooms are controlled by varying the proportion of salt used with the ice, temperatures as low as 32° F. being easily and steadily maintained.

On account of the proximity to important markets, the necessity for precooling fruits in these sections is not very urgent and these plants are used mainly for storage purposes, to enable the growers to pick and market their crops to best advantage. These plants may also serve for precooling on a small scale. The construction is simple and inexpensive, and the plants appear to be well adapted for the precooling or storage of fruits on a small scale in any locality where the cost of ice is not too great.

CONCLUSION.

Precooling has become a very important factor in the transportation of fruit. To the grower and shipper it is important as a means of extending the marketing area of the product by assuring its delivery in sound condition over long distances. To the carrier the sound condition of the fruit is an important consideration, but mainly from the traffic standpoint. Precooled fruit may be loaded more closely and heavily, thereby increasing the carrying capacity of the cars, and less ice will be consumed en route. But whether the reduction of the initial temperature is properly the function of the shipper or the carrier is still an open question.

As an adjunct to careful handling in preparing fruits for market, precooling will materially assist in minimizing losses from decay and deterioration in transit. It is in no sense a panacea for all the difficulties of carrying fruits in sound condition to distant markets. It can not improve the quality or condition of the product packed and can only temporarily retard decay following injuries made by rough handling; but it renders unnecessary the packing of such fruit as peaches, plums, and apricots in a hard, green condition in order to offset the ripening which takes place in cars under ordinary icing methods. It reduces the differences frequently occurring between the top and bottom tiers of the load by equalizing temperature conditions within the car.