is generally equipped with cylindrical brushes, arranged horizontally in a series. These revolve rapidly so that as the fruit is conveyed onto them it is brushed in a solution pumped from the soaking tank. A fresh water rinse, preferably warm, is applied both after washing and treating.

Oranges, after washing, are dried by mechanical equipment that includes a series of propeller fans that move large volumes of air over the fruit. When dried, the fruit is polished and waxed, and then passed immediately to the grading table. After grading, it is conveyed to sizing equipment which separates the oranges into the standard sizes and drops them into bins for packing.

Grapefruit, after washing, should be packed over standard orange equipment and shipped immediately.

Lemons, after washing, are conveyed to a sorting table for color separation electronic means or by human eye. This is accomplished by selecting the lemons of each color desired and putting them loose into the packing cases in which they are to be stored for curing. Usually four colors are recognized and are designated as dark green, light green, silver and yellow. The dark green is a full green; the light green, a partially colored green (a green with color well *broken*); the silver, fully colored with a green tip (stylar end); the yellow, fully colored and mature with no green showing. This segregation is to determine quality, color of the fruit being the most practical distinguishing mark. The dark green has the longest keeping properties, and after curing, the best juice value. The yellow has poor keeping properties and is often marked by serious defects. Dark green has a normal storage life of from four to six months; light green, two to four months; silver, one to two months; and yellow, three to four weeks. These periods are approximate, as keeping quality of fruit varies considerably with season and grove. A light concentration of water wax emulsion is usually applied to lemons before they are put into storage. Following washing, lemons are allowed to dry off in storage.

Sizers have been added to lemon washer equipment, whereby the fruit, after washing, can be separated into three or more sizes before passing to the sorting tables for color separation. The separation of lemons into sizes and grades, as well as colors, at the washer, aids in the filling of orders and facilitates the elimination of certain lots of undesirable sizes and grades for shipment to by-product plants.

Directly after washing and separation by color, lemons, loose in packing cases, are conducted to the storage rooms by belt conveyor or elevator. Except where natural climatic conditions are usually favorable to maintaining satisfactory storage, lemon packing-houses generally maintain optimum conditions by well designed air conditioning and refrigeration equipment. Lemon storage will be more fully discussed in another section of this chapter.

After storage, lemons are graded and then sized and made accessible to shipping containers by means of a system of sizers, conveying belts and electric counters. They are usually waxed just before they are graded and packed.

Grading is usually accomplished by removing the lower grades from the first grade, allowing the higher grade to move forward without handling to the packing equipment. Sometimes *check-graders* are used to aid in maintaining a uniformly satisfactory grade. The grading operation is particularly important because it is the final classification of the fruit before shipment. Sound judgment and unusual care are required to determine the proper grading of each lot, because of wide variations in the quality of fruit from different groves. When lemons and grapefruit are taken out of storage for grading and shipment, fruit that has decayed is removed, and in addition all sound fruits touching decayed ones are discarded because they may be infected. Sound lemons touching spoiled ones and known as contacts are usually sent directly to a by-product plant.

The diseases most commonly seen in lemons and grapefruit after storage are green mold, blue contact mold, brown rot, sour rot, grey mold, cottony rot, Alternaria rot, and Trichoderma rot.

In addition to decay there are a number of other defects that have to be considered in grading citrus fruit. Each blemish is judged and the fruit affected placed in its proper grade according to the nature of the defect or as grade rules specify. Constant inspection by cutting is necessary to determine the internal quality of each lot, and often tests are made by cutting a sample of the fruit before or after grading to determine the exact percentage of off-grade fruit present and, therefore, the brand under which such fruit should be shipped. The segregation of frost damaged fruit and granulation of Valencia oranges are often accomplished by fluoroscopic examination.

Since the fiberboard carton has become the standard container for the greater part of citrus shipments, some of the older practices have been eliminated. Fruit packed in the fiberboard container is not wrapped. In the case of lemons, the fruit is bulk- or volume-filled instead of being place packed as is done by orange and grapefruit shippers.

The container has the printed name of the shipper, marketing organization and other information required by law. After being packed and filled with fruit, the flaps are closed and sealed on an automatic gluing and sealing machine.

After sealing, the packages are conveyed to the precooling rooms or to standard refrigerator cars for shipment to market. Containers are loaded into cars flat, usually five layers high in a chimney type stacking arrangement for more uniform distribution of air.

Accelerated Coloring or Sweating

Two varieties of oranges, Washington Navel and Valencia, constitute the major portion of the California crop. The harvesting of each variety requires approximately six months, but since the Navels mature in November and Valencias in May, fresh oranges are available throughout the entire year. Grapefruit from the desert areas of California and Arizona is available for seven to eight months of the year, and grapefruit from central and southern California is available for the remainder of the time.

All varieties of citrus fruit must be mature before they are picked. *Color is not always a criterion of maturity.* The natural change of color in oranges from dark green to deep orange is a gradual process while the fruit remains on the tree, the fruit remaining dark green from its formation to the time it is nearly full size and approaching maturity, when a stage is reached where the color changes may become very rapid. The color change is influenced greatly by temperature variations. A few cold nights followed by warm days may completely color oranges that were previously very green. The color changes in lemons and grapefruit are similar, except that the final color is yellow. Unfavorable weather conditions may delay coloring even after the fruit is fully mature.

Up to a certain point, the natural color changes in the Valencia orange follow the trend described, but complete or nearly complete orange color generally develops some time before the fruit is mature and green color may return after the fruit has reached its prime. Navel oranges and grapefruit harvested in early winter may be mature and of good eating quality although the rind is green in color. At certain times of the year only lemons green in color, although otherwise mature, are available for market. Since the consumer demands fruit of characteristic color, it is sometimes necessary to put the fruit through a coloring or sweating process. Special rooms are provided for this purpose.

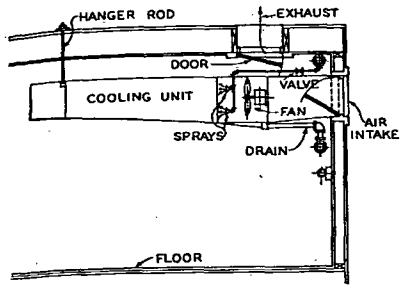

Fig. 1 .... Sweat Room Showing Evaporative Cooling Unit in Position

Sweat rooms are equipped with an evaporative cooling unit (Fig. 1) suspended from the ceiling. These units may also be equipped with an electric or steam coil for heating during cold weather. Air is circulated continuously to maintain a uniform temperature of 65 to 70 F during the sweating operation. One part of ethylene in 50,000 to 200,000 parts of air (the concentration depending upon the variety and the intensity of green pigment in the rind) is maintained in the sweat-rooms. During this operation fresh air is introduced into the room, and a relative humidity of 88 to 90 percent is maintained. To avoid excessive deterioration of the fruit during the sweating operation, it must be carefully done by trained personnel.

Oranges and grapefruit that require this treatment are placed in the sweat-rooms as soon as delivered to the packing house. Lemons are first washed and separated into color classifications according to their degree of maturity or color before being put into the sweat-rooms.

In Florida and Texas the methods of harvesting and packing-house handling of oranges and grapefruit are quite similar to those used in California. Legal standards of maturity vary somewhat from state to state, and in Florida, maturity of round oranges, tangerines, Temple oranges, and grapefruit is based on a designated break in rind color, a minimum volume of juice, minimum total solids content, and a graduated total solids-acid ratio. Standards are slightly higher in Florida for oranges given the *color-added treatment*. California oranges are not given the color-added dye treatment.

A high percentage of Florida's early and midseason varieties of oranges receive the color-added treatment. The treatment causes the rind of pale fruit to take on a brighter and more uniform color. Color-added is a certified food dye and the treatment is usually in addition to that of degreening by the use of ethylene gas. In this process, the fruit is subjected for two or three minutes to the dye solution, which is maintained at about 120 F. The color-added treatment can be given in an immersion tank filled with dye solution, or the dye can be flooded on the fruit as it passes on a roller conveyor. The color-added tank is located between the washer and antiseptic tank, with arrangements made for bypassing when the color-added treatment is not wanted. Oranges with desired color at harvest time, as well as tangerines and grapefruit, are bypassed around the dye tank, or the flow of dye may be cut off as the fruit passes.

The ½-bushel fiberboard carton and the ½-bushel wirebound crate have replaced the standard 1⅗-bushel, two-compartment, nailed box and the 1⅗-bushel wirebound crate for the shipment of fresh citrus fruits.

LEMON STORAGE

A large portion of the lemon crop is picked during the period of least consumption and must be held in storage until consumer demand justifies shipment.

To withstand transportion and different climatic conditions at distant sales points, lemons must first be properly conditioned or *cured;* consequently during the holding period, they must be stored under the most favorable conditions.

Since there are only a few days in each year when natural atmospheric conditions are favorable to the ideal storage of lemons, air conditioning is quite generally used.

In air conditioning lemon storage rooms, there are four major factors involved: *temperature control, relative humidity control, cleaning the air and ventilation,* and *circulation or distribution of the air.* All are important to a well-balanced system and the value of each is discussed to show its importance.

Uniform Temperature Control

The *maintenance of a uniform* temperature of 58 to 60 F is of great importance. Fluctuating or low temperatures in storage rooms cause lemons to develop an undesirable higher color or bronising of the rind, just as occurs in groves. Temperatures of 52 F and lower cause a staining or darkening of the membranes dividing the segments of the edible pulp and may affect the flavor. Temperatures much above 60 F shorten the storage life and are more favorable to the growth of decay-producing organisms.

To maintain uniform temperatures in lemon storage rooms during winter and summer, it is necessary to have both refrigeration and heat. If the outdoor atmospheric temperature is too low, it is best not to introduce outdoor air unless it is properly conditioned.

Proper stacking of the fruit in storage rooms is important to secure *uniform air circulation* and *temperature control.* There should be not less than 2 in. between stacks, 4 in. between rows, and at intervals there should be trucking aisles at least 6 ft wide.

Control of Relative Humidity

In some sections of California, a relative humidiy of 86 to 88 percent is usually ideal, while in other sections lower relative humidity would be more nearly ideal for curing the rind. The desirable relative humidity may also vary with the season, vitality of the fruit, and previous outdoor weather conditions. Unless normal shrinkage and curing of the rind are accomplished in the storage rooms, they will occur rapidly in transit to market, and cause unsightly appearing packages to be delivered to the buyers. Excessive moisture content in the air of storage rooms does not permit proper curing and favors the growth of molds on the fruit and on the wood of storage boxes.

The air washer, because of its utility and efficiency, is essential. The velocity of air should not exceed 500 fpm through the free area. A spray chamber with two banks of spray nozzles opposing each other produces fine spray under higher water pressure. This is desirable for air cleaning and high humidity control. Sufficient area and capacity to take full advantage of low outdoor wet-bulb temperatures are an operating economy to the owner.

All air-conditioning systems for lemon storage should be