U. S. DEPARTMENT OF AGRICULTURE
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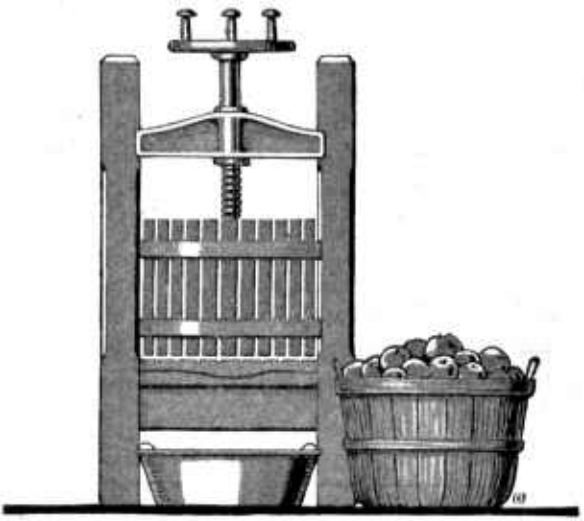
FARM MANUFACTURE *of* UNFERMENTED APPLE JUICE



UNFERMENTED APPLE JUICE, or sweet cider, is our most popular and least expensive beverage juice, and its manufacture on a small scale is a very widely distributed farm industry. It is now very largely a seasonal product, made and consumed during the period in which apples are plentiful and practically unobtainable for the remainder of the year.

General understanding on the part of apple growers of proper methods for pasteurizing and preserving this juice would increase the production and use of sweet cider, thus offering greater opportunities for the profitable utilization of surplus and unmarketable apples, and providing a healthful and refreshing beverage, already known to consumers, available for use at all seasons of the year.

In order that sweet cider made and preserved on the farm may become a staple product salable at a profit, increased attention must be given to selecting the fruit with reference to its maturity and suitability, and particularly to mixing or blending varieties in order to produce well-balanced palatable juices of pleasing character.

Two alternative methods for the preservation of the juice either on a small scale for home use or on a larger scale are discussed, and full directions are given for each step in the processes of pressing, sedimenting or clarifying, packing into final containers, and pasteurizing. The selection of equipment, its operation, and the care of the plant are also considered.

The purpose of this bulletin is to supply a fairly complete handbook which will enable any intelligent fruit grower without previous experience in cider making to produce an acceptable sanitary product of good quality.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C. May, 1922

FARM MANUFACTURE OF UNFERMENTED APPLE JUICE.

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PRODUCTION AND USES OF SWEET CIDER.

UNFERMENTED APPLE JUICE, or sweet cider, may justly be called the great American beverage. It is more generally popular and is made and consumed in much greater quantities than any other beverage juice. As the making of cider is regarded by fruit growers as the surest means of securing an outlet for surplus fruit, it is a very widely distributed farm industry, the total production fluctuating greatly from year to year. Thus, in 1899 the production of cider on farms reported in the census was 55,280,199 gallons, with an additional 12,363,656 gallons converted into vinegar. In 1909, a year in which the apple crop of the Middle and South Atlantic and East North-Central States was a partial failure, the production of cider on farms dropped to 32,583,998 gallons, with 7,246,632 gallons of vinegar. The widespread character of cider making as a farm industry and its safety-valve relationship to the growing of fruit are indicated by the fact that this total production was reported from 332,810 separate farms, representing every State in the Union, and that the average production per farm was slightly less than 100 gallons. While the figures upon production obtained by the last census are not yet available, it is certain that the increased demand for nonalcoholic beverages has resulted in a considerable increase in the production of cider on farms as well as in commercial plants.

While cider is in strong demand for use in the making of apple butter, jelly, and various minor products, the chief purpose for which it is employed is as a beverage. There are few individuals to whom good cider does not appeal, and the fact that apples are so

widely grown in the United States should make it possible for consumers to obtain supplies irrespective of their location.

Unfortunately this is not the case. Sweet cider is very largely a seasonal product, made only during the period immediately following the apple harvest and usually consumed within a few days. After the close of the pressing season it disappears from the market and is practically unobtainable except for the small quantities sold by the glass through soda fountains and drug stores. As a consequence there is a large consumption of commercial grape juice and of synthetic soft drinks in apple-growing districts and even in the families of apple growers.

The reason for this situation is that only comparatively few small-scale producers of apple juice practice the pasteurizing of their product, so as to make it available for use in a sweet condition at any season of the year. Either through ignorance of the methods to be employed in pasteurization or a misapprehension as to the difficulty and expense of the process, large quantities of apple juice are yearly allowed to ferment and ultimately to become vinegar, while its place as a beverage is taken by synthetic soft drinks of greater cost, lower food value and palatability, and often of doubtful character so far as their cleanliness and freedom from bacterial contamination are concerned. What is even worse from an economic point of view, large quantities of apples which might be converted into a healthful refreshing beverage available at all seasons are allowed to go wholly to waste.

The process of preserving unfermented apple juice is in reality very simple, as easily mastered as that of canning fruits and requiring no more special equipment. As in canning, success depends upon the strict observance of a few simple rules. In the following pages these rules are stated, with the reasons for them, together with considerable additional matter designed to aid the cider maker in producing the best possible product from the materials at hand.

USE OF TERMS.

There is some confusion in the use of the terms applied to unfermented apple juice. The term "cider" has been in the past applied to the juice both before and after fermentation, usually with "sweet" or "hard" prefixed to indicate whether fermentation has not or has occurred, but the single word "cider" is also widely used for the unfermented juice. In England and France "apple must" and "apple juice" are terms used to designate the freshly pressed sweet juice, while the word "cider" used alone refers to a fermented product, our "hard cider." "Unfermented apple juice" has the merit that its meaning is unmistakable, but it is too long and clumsy for constant repetition. As this publication has nothing to do with fermented or "hard" cider, the terms "unfermented apple juice,"

"apple must," "apple juice," and "cider" are used interchangeably for apple juice in which no alcohol has been allowed to develop.

USE OF CHEMICAL PRESERVATIVES.

Many persons unfortunately have the erroneous idea that it is practically impossible to preserve apple juice merely by the use of heat and sealing, without the addition of some chemical substance to act as a preservative. This notion is entirely incorrect. Various chemical preservatives have been more or less used to prevent fermentation. Among these are salicylic acid, formic acid, benzoic acid, boric acid, sulphurous acid, and various compounds which upon being added to the juice are decomposed to set free some one of these substances. The use of benzoate of soda in an amount not to exceed one-tenth of 1 per cent in juices offered for sale is tolerated by the officials charged with the enforcement of the food and drugs act, provided the fact of its use is declared on the label. The use of other chemical preservatives is forbidden.

It should be clearly understood that the use of any preservative in fruit juices is entirely unnecessary if the juice is properly pasteurized and sealed and that there is no preservative which when used in quantities permitted by the law or with ordinary regard to the health of the user will prevent fermentation in juices which have not been pasteurized and sealed or which are opened to the air after pasteurization and sealing. No chemical preservative of any character should be used, since its use is in any case either entirely ineffective or wholly unnecessary. Intelligent employment of the methods to be subsequently described will enable anyone to preserve fruit juices with an extremely small percentage of loss from infection with organisms producing fermentation.

ARRANGEMENT AND EQUIPMENT OF THE CIDER PLANT.

The equipment used in cider making will vary so widely with the scale of operations and the purpose, home use or commercial sale, that such suggestions regarding its arrangement as are made must necessarily be of the most general character. Their objects are the securing of cleanliness and the elimination of unnecessary labor.

If only small quantities of cider are being made with a portable hand-operated press, the grinding and pressing may very well be done in the open near the kitchen door and the remainder of the work in the kitchen. If cider is being made at various times during the season, even in small quantities and with a portable mill, a definite place under roof is a necessity, in order that the work may go on regardless of the weather. In choosing a place, cleanliness is the first consideration, to which even convenience should be secondary.

If the room chosen must be used for other purposes than the making of cider it should be kept clear of stationary bins and anything which will prevent the thorough cleaning of the equipment, walls, and floor. It should not be a part of the general storage room for fruits and vegetables, as such a room is heavily seeded with yeasts and spores of fungi, and juice pressed in it is extremely likely to become infected. A cement floor is preferable; if the floor is of wood it should be tight and should be oiled to keep down dust. The walls and ceiling should be of such a nature that they can easily be kept clean, and there should be sufficient windows to give an abundance of daylight illumination in every part of the room. All doors and windows should be provided with properly fitting small-mesh screens to keep out insects.

The arrangement of the equipment should be determined by convenience and with the idea of eliminating unnecessary labor and repeated handling of the material. Even in the smallest plant a surprising saving of time and labor can be made by arranging the equipment so that the material moves through the various steps of the process in a straight line without returning upon itself or being carried back and forth across the room. The tank in which apples are washed should be placed just inside the door through which the apples are received, in order that they may be dumped directly into it and the empty crates stacked outside, thus keeping the room clear. The press should be near the washing tank, in order that washed fruit may be lifted from the tank directly into the hopper of a hand press or the elevator of a power-driven press. The barrels or tanks in which the freshly pressed juice is placed should stand on the opposite side of the press from the washing tank and within convenient reach, with an extra barrel or tank beside them for use in blending. If filtering, placing in containers, and pasteurizing are carried on in the same room, the arrangement of the equipment ought to follow the same plan, making it unnecessary to move the juice more than a foot or two in order to begin the next stage of its treatment. Such an arrangement minimizes the labor necessary and eliminates the delay and confusion which would result if workmen were moving fruit and juice back and forth across the room. It also makes it possible to prevent delays in handling the juice by making it easy to assign to each person a definite part of the work and to hold him responsible therefor.

CLEANLINESS.

An abundant water supply is a necessity if the plant is to be kept in a clean, sanitary condition. The fruit brought into the plant carries with it great numbers of yeasts and decay-producing organisms, which become scattered over walls, floor, and apparatus. Every de-

caying apple, puddle of spilled juice, or fragment of pomace allowed to remain neglected in a corner furnishes food material in which such organisms may multiply. Press cloths, pails, and barrels which are allowed to remain wet with juice from day to day also become fruitful fields for the growth of such organisms, as do fragments of pomace adhering to the crusher or press. Many of these fungi, if left to grow undisturbed for a short time, form reproductive bodies, or spores, which become scattered everywhere in the room, with the result that many of them find their way into the juice. As the spores of many fungi are highly resistant to heat, they escape destruction during pasteurization and subsequently germinate and grow in the juice in the containers. While a few of the common molds are harmless, in that they merely consume sugar without producing substances having a disagreeable odor or flavor, many others utterly ruin any juice in which they grow by producing disagreeable flavors. The loss of juice through infection with the spores of these fungi can only be avoided by the most thorough cleanliness. This is impossible when the room in which the work is done is also a storage place for fruit, empty crates, and barrels, juice containers, and similar material. Fruit should be brought into the room only as it is worked up, and the crates or boxes in which it is brought in should be at once removed and the room generally kept clear of everything not actually in use, in order that all parts of it may be thoroughly cleaned. Pressed pomace, if not used at once for making apple butter or jelly, should be removed and stored elsewhere, and never allowed to accumulate for more than a day.

All containers in which juice is temporarily stored should be provided with covers, preferably large squares of closely woven cloth, which may be washed when they become soiled or wetted with juice. Juice should never be allowed to stand in uncovered vessels, as infection with yeasts and mold spores from the air is certain to occur.

At the close of each day's work all the equipment should be thoroughly washed. A supply of water under pressure is a great aid, but merely washing off with a hose is not sufficient and must be supplemented by handwork. The apple grater always retains a mass of crushed fruit, and the pomace chute is lined with a layer of adhering material. In order to remove this, the hopper and pomace chute should be removed and washed in a tank of water and the grater cleaned by pouring water through it while it is running. The press and racks also should be thoroughly cleaned and the press bed and cider tank flushed out with plenty of water. The press cloths need special attention; they should not only be washed daily in cold water to wash out the juice and remove adhering pomace, but should also be placed in boiling water for a short time, to destroy any organisms present. Vessels in which juice is stored for settling should also be

washed out every time they are emptied. If a filter, milk separator, or centrifuge is used, it must be taken apart and washed thoroughly. Lastly, the floor should be flushed with a sufficient quantity of water to carry off all spilled juice and bits of pomace and leave it thoroughly clean. Cold water used in abundance will suffice for the daily cleaning, but at least twice a week everything should be thoroughly cleaned with hot soapsuds, followed by rinsing with clear water.

SELECTION OF THE FRUIT.

The necessity of employing intelligence and care in the selection of the fruit can not be overemphasized, for the quality of the product is largely determined by the fruit used. It is, of course, possible to make poor cider from the finest fruit by lack of cleanliness and the use of improper methods, but the most perfect equipment and scrupulous care while employing the best methods will not enable one to make high-grade cider from poor raw material.

MATURITY.

The first essential in the making of cider of high quality is that only fully matured, tree-ripe, perfectly sound fruit be used. An apple is in ideal condition for making into cider—that is, is "cider ripe"—when about midway between "market ripe" and "dessert ripe," having attained full size and color and developed the flavor and odor characteristic of the variety. Such fruit has begun to soften very slightly, but is still too firm for eating out of hand.

If the cider maker is working up the product of his own orchard and can control the time at which the fruit is picked, the portion intended for cider making should be allowed to remain on the trees until fully mature. In most cases, however, the making of cider is incident to the primary business of growing apples for the market, and the material used is obtained by the grading out of the small, superficially blemished or otherwise unmarketable fruit from the general crop as picked for market. Such fruit, though market ripe, is not sufficiently mature to produce an unfermented juice of the highest grade, and the quality and palatability of the product can be greatly improved by holding the fruit under proper conditions for two or three weeks, until it becomes "cider ripe."

If cull apples sorted out of fruit picked for the market are being used, or if necessity compels the harvesting of the crop before full maturity is reached, the quality of the product will be markedly improved by ripening or "sweating" the apples before they are pressed. This is best done by laying a false floor over the floor of a dry airy room or roofed shed by placing loose boards or pieces of 2 by 4 inch stuff to raise them above the floor and piling the fruit on the boards to a depth not greater than 3 feet. None but perfectly sound fruit should be placed in the piles, and the false floor should never be

omitted, as it permits the circulation of air beneath the fruit. The fruit may remain in the piles for two to four weeks in good weather with advantage to the quality of the cider, but should be worked up before it has attained the degree of softness characteristic of prime condition for eating.

This treatment is very different from the too general practice of piling low-grade and partially decayed fruit in heaps on the ground in the orchard and allowing it to remain there until it can be worked up at leisure. Such treatment can only result in the loss of fruit and the making of an indifferent product. Rains spread the organisms of decay through the pile, and the fruit next the ground becomes covered with dirt and takes on earthy, foreign flavors from contact with the soil, with the result that the juice is poor in quality and flavor and difficult to sterilize. This slovenly and economically unsound method of handling his fruit must be avoided by every cider maker who is ambitious to make a high-grade product.

Considerable quantities of windfall apples are made into cider, especially in those districts which are subject to heavy winds before or at the beginning of the picking season. Whether the practice is to be permitted or condemned depends in any particular case upon the degree of maturity which has been attained before the fruit falls from the tree. If the fruit is mature enough to be stored and ripened in the manner described it may yield an acceptable cider if so treated, especially if it be blended in grinding with larger quantities of more mature fruit. Partially grown, odorless, flavorless early windfalls in which the starch has not yet been converted into sugar are worthless for cider making and should never be used, as a small quantity of the tart, astringent juice will ruin a large volume of high-grade cider.

STORAGE OF FRUIT INTENDED FOR CIDER MAKING.

It is readily possible to prolong the cider-making season over several months after the close of picking if provision is made for proper storage of the fruit. The factors which govern the keeping quality of cider fruit in either common or cold storage are identical with those governing the keeping of marketable fruit of the same varieties. There is the same necessity for the exercise of care in picking and handling the fruit, in cooling the fruit rapidly to storage temperature to check the ripening process, and in maintaining control of temperature and humidity in the storage house after it is filled with fruit. Also, there is the same necessity for a close watch upon the progress of ripening in the fruit, in order that overripening may not be permitted to occur.

When fruit is to be stored for subsequent pressing, the ripening or "sweating" treatment discussed in the preceding section should be omitted and the fruit, after sorting over to remove decayed apples,

should be placed at once in the storage room in field or lug boxes, so stacked as to permit free circulation of air. In so far as possible, varieties should be kept separate, and the storage behavior of the different varieties should be kept in mind as the house is filled, in order that short-lived varieties may be removed as they become ready for pressing, without disturbing the others.

The apples may be removed for pressing as they reach the proper degree of maturity, or may be ripened as needed by removing them from the storage house to a warm room.

The cider maker who provides facilities for storing his fruit thereby gains a number of advantages. He is enabled to postpone the work until after the close of the picking and packing season, when labor is more readily obtained. He can secure fruit culled out in the course of packing, which is usually of better grade than orchard culls. The postponement of the work until cool weather decreases danger of loss of juice by fermentation during sedimentation. A very decided advantage is gained, if juice is being marketed fresh from the press, in that the product is placed on the market after other makers have ceased to operate, and consequently finds increased demand at better prices.

SOUNDNESS.

In districts which have a heavy infestation of bitter-rot or the various soft rots large quantities of specked and partially decayed fruit, unmarketable for other purposes, are used for making cider and vinegar. That the general quality of these products suffers as a result of this practice is beyond question. Anyone who attempts to make a first-class beverage by pressing partially rotten fruit is undertaking the impossible. It is possible, however, to make a good product by working over specked fruit by hand, using a knife to remove every particle of decayed material together with a surrounding zone of sound flesh and washing the trimmed fruit very thoroughly to remove adhering bits of decayed material. Whether the labor involved is justified must be determined in any particular case by the available supplies and comparative costs of specked and sound fruit, the cost of labor, and other factors.

SUMMER AND WINTER VARIETIES.

The manufacturer who operates in a small way will necessarily be limited in his choice of varieties of apples to use to those grown in his orchard or in the immediate vicinity. In most districts, however, a sufficient range of varieties is available to make possible some degree of selection. This selection is indispensable to the making of a high-grade beverage, for while any apple which makes good cider

has good dessert quality it is by no means the case that all apples which are good for eating out of hand will make palatable, full-flavored cider.

Broadly speaking, the early maturing or summer varieties of apples are not good material for making high-grade ciders. As a class they are characterized, as compared with the later maturing varieties, by a low sugar content, relatively high malic-acid content, and fairly large amounts of tannin. Such fruit yields juices which are tart and astringent, with a bitter aftertaste that makes them unpleasant to most palates. Most of the early maturing "sweet" varieties are so called for the reason that while they have little, if any, more sugar than others of their season, they are much lower in acid. Their juices are consequently insipid and lacking in the tartness desired by most people. For these reasons none of the summer varieties used alone will yield juice which comes up in palatability and flavor to the standards set by discriminating users. The cider maker who is restricted to early varieties must resort to the mixing of two or three unlike varieties in order to obtain a product in which the proportions of sugar and acid are well balanced; and at best his product will be low in sugar content and lacking in what cider makers call "body." The cider maker who is free to choose between summer and winter varieties would do well to use the summer varieties for apple butters, marmalades, and similar products, employing his winter varieties in cider making, for the sake of the better flavor, higher sugar content, and greater food value of the product.

BLENDING.

Blending or mixing the juice of two or more varieties is indispensable in the making of first-quality unfermented apple juice. To be acceptable to the user, a fruit beverage in addition to having the aroma and flavor characteristic of the fruit from which it is made must have the three constituents, sugar, tannin, and acid, present in amounts which bear a rather definite ratio one to another. The absolute quantities of these constituents may vary within wide limits without affecting the palatability of the product, provided the ratio they bear to each other is maintained. Very few apple or grape juices have these constituents present in such balanced proportions as to make the strongest appeal to the consumer; Concord grape juice and Winesap apple juice are among the few exceptional juices which would not be considerably improved for most palates by modification of either the acidity or the sugar content. If the tannin content of a juice is high in relation to its sugar and acid, as in many crab apples, the juices will be harsh and astringent; if the acidity is high, as in the Oldenburg (*Duchess of Oldenburg*), Kentucky Red, Okabena, Monmouth, Red Canada, and Milam varieties, the juice

will be sour; while if the sugar content is high in relation to the other constituents, as in the Tolman (*Tolman Sweet*), McIntosh, Grimes (*Grimes Golden*), Delicious, and the so-called "sweet" apples, the juice will be more or less insipid and lacking in sprightliness. Moreover, apple varieties differ greatly in the amount of characteristic apple flavor possessed by their juices. Such ciders as are made from the Ben Davis, Collins, Northwestern (*Northwestern Greening*), and Alexander varieties may give very little suggestion that they were made from apples, while the juices of Delicious, Roxbury (*Roxbury Russet*), Black Gilliflower, Northern Spy, and Ribston apples possess an agreeable aroma and a rich fruity flavor, even though some of them are deficient in other respects, which almost invariably find favor on the part of consumers.

For these reasons the maker who desires to turn out a high-grade product must devote considerable thought to the selection and blending of his material. The number of apple varieties in cultivation is so large and the various apple-growing districts differ so greatly in the kinds grown that the working out of a mixture of varieties which will yield a properly balanced well-flavored juice must be in each case a matter of experiment with the materials at hand. In such experimentation a few general principles will be of much greater value than any number of specific examples. In order to state such principles it is necessary to make a rough classification of apples into groups on the basis of their outstanding characters as cider material. In the classification here attempted, the basis employed is the character of the fruit when in proper condition for making into cider, which differs considerably from the character displayed when it has attained prime eating condition.

(1) **Sweet-subacid group.**—Most of our widely distributed and popular varieties of apples are grown primarily for dessert use; hence they conform more or less closely to the ideal of an apple to be eaten out of hand. Consumers demand that an eating apple shall be free from astringency and neither distinctly sour nor markedly sweet, and in consequence the larger number of popular dessert varieties are in a group which ranges from very mildly subacid to subacid. Examples are the Baldwin, Esopus (*Esopus Spitzenburg*), Hubbardston, Fameuse, McIntosh, Northwestern (*Northwestern Greening*), Rome Beauty, and Stark. These apples and others of the subacid class when pressed at the proper stage of maturity yield juices which are sweet and of good flavor, but which are somewhat lacking in the acidity and tartness which discriminating consumers demand. Since the great bulk of widely grown home-orchard varieties, as well as most of the dozen leading commercial apples, fall in the sweet-subacid group, the cider maker, regardless of his location, will usually find that apples of this group form the great bulk of the material available to him. They may furnish him three-fourths to nine-tenths of his total volume of product and are consequently the basic stock with which he works.

(2) **Mildly acid to slightly tart group.**—A smaller number of popular dessert varieties are mildly acid to slightly tart. Winesap, Jonathan, Yellow Newtown, Stayman Winesap, Northern Spy, and York Imperial are the more widely

grown varieties of this type. When pressed at the proper stage of maturity, these varieties yield juices which stand nearest the ideal in single-variety unfermented beverage juices, as they then have a degree of acidity and a suggestion of astringency which give the proper balance to their sugar content, while all of them are sufficiently high in apple flavor and aroma to be pleasing in these respects. Any of these varieties may be used to make a good single-variety juice, and any one or more of them may be advantageously used for blending with the juices of varieties of the sweet-subacid group to improve the balance by increasing the acidity and adding flavor. Any one included in the list if combined with any one or more mentioned in the basic-stock list given under the first numbered paragraph might be expected to give a blend of good balance and acceptable quality.

A number of additional varieties of the acid or slightly tart group are not prominent as commercial varieties, but are more or less widely distributed in home orchards. Among these might be mentioned Arkansas Black, Babbitt, Collins, Lawver, Missouri (*Missouri Pippin*), Rhode Island Greening, Golden Russet, Red Canada, Milam, Okabena, Kentucky Red, Twenty-Ounce, Walker Beauty, Wealthy, and Yellow Bellflower. These, with some others which might be named, make up a group varying widely in flavor and generally inferior in this respect to Winesap, Jonathan, and Grimes, but agreeing with these varieties in possessing juices which are moderately to decidedly acid when pressed at the proper stage. Some one or more varieties of the group are necessary in the proportion of 5 to 20 per cent of the total for blending with the larger quantities of subacid stock used.

(3) **Aromatic group.**—A third small group of apples is of high value to the cider maker for the reason that, while their juices are not well balanced in sugar and acid, they possess exceptional fragrance and aroma and agreeable flavor which are carried over into the cider made from them. Among these Delicious, Golden Delicious, Lady, Black Gilliflower, White Pearmain, Banana (*Winter Banana*), Ribston, Ortley, Roxbury, McIntosh, Sops of Wine, and Bonum might be named, and with them the reader may place any local variety which is notable for its spicy agreeable flavor and especially marked aroma. Apples of this character may be designated as the aromatic or flavoring group. They are of special value to the cider maker who is ambitious to make juices of the highest possible quality, as the addition of 5 to 10 per cent of such fruit to his basic stock will give his cider a distinctive flavor and aroma which will greatly increase its appeal to consumers.

(4) **Astringent group.**—The most difficult constituent to obtain in making high-grade ciders is tannin. To find favor with the largest number of customers a cider must have a slight astringent aftertaste or "bite" upon the tongue, such as is given by Concord grape juice. Many of the seedling apples found growing without cultivation in the New England States have a tannin content which makes them highly prized for cider making. Our generally cultivated apples are so low in their tannin content that it is very difficult or impossible to obtain the required pungency and tang in a blend made up of dessert varieties alone. It may best be obtained by the addition of a small percentage of crab apples, if these can be obtained. Florence, Hibernal, Soulard, Red Siberian, Hyslop, Transcendent, Launette, Martha, and Yellow Siberian (also known as Golden Beauty) are examples of varieties desirable for this purpose on account of high tannin content. As their juices in most cases are also rather highly acid they have a twofold value for blending. From 3 to 5 per cent of crab-apple juice, which may be so harshly astringent and highly acid that drinking it alone is quite out of the question, will give an added tang and zest to the finest juice that it is possible to produce without its use. The securing of this quality will well repay the additional trouble and labor it may cost.

In the absence of available supplies of crab apples, the cider maker must make shift to find a substitute in the material available. The use of small quantities of market-ripe fruit in the blend is suggested. Most apples are rather astringent, some of them markedly so, at the stage at which picking for market usually occurs, and the ripening period shows a progressive decline in astringency and acid content. The use of a small proportion of hard-ripe or market-ripe fruits will give zest and tang to juices which would otherwise be sweet, bland, and characterless. These additions must be made with care and must be balanced by adding fruit of the aromatic group to give aroma and flavor, which will suffer from the addition of such underripe juice.

(5) **Neutral group.**—A last group of apples may be mentioned, not because they can contribute any desirable quality to cider, but in order to give a warning which their mediocre character makes necessary. A considerable number of apples, of which the Ben Davis, Black Ben, Gano, Willowtwig, Missouri (*Missouri Pippin*), Alexander, Wolf River, Buckingham, and Limbertwig are examples, owe their presence in orchards to the productiveness or hardiness of the trees, the market or storage quality of the fruit, or its fitness for culinary uses, rather than to dessert quality or high flavor. Apples of this type are so numerous and so generally distributed that they will usually be available in quantity at a lower cost than choicer varieties. This fact should not lead the cider maker, if he is ambitious to make high-grade cider, to substitute them largely or wholly for the better varieties of the "basic-stock" group. The juices made from these apples are no better, often decidedly not so good, as the fruits from which they come, being characterless and devoid of distinctive flavor even when fairly well balanced in sugar and acid content. Consequently, they make no positive contribution to the product when used in blending, and care must be taken that their addition does not "flatten out" the cider and render it flavorless and unattractive. If one is using good basic stock he may add 10 or 20 per cent of the fruit of these varieties in order to give bulk, but must be very careful to balance them by making an increased addition of apples of varieties of the acid and aromatic groups.

From the preceding suggestions and the examples given, the cider maker who is reasonably familiar with the apples which he has available or can procure should be able to assign the various varieties to the groups—sweet subacid, acid, aromatic, astringent, and neutral. In classifying his material he must be guided, of course, by its character in the hard-ripe stage, as previously pointed out. Having classified the fruit he is ready to make up his blend. It will be necessary to do considerable experimenting with small lots and to subject the results to critical comparison and testing. In this the best results are obtained by taking the various steps in the order here outlined.

Start by mixing together a quantity of the varieties which are to serve as basic stock, using each in about the proportion it will have in the total season's crop, and press them. The juice obtained will be fairly well flavored, but will be low in acidity and will therefore appear to be somewhat too sweet. Now press a quantity of the most tartly acid varieties available. Place equal quantities of the basic-stock juice in a number of tumblers, add to the first a small quantity, say 5 per cent of its volume, of the acid juice. To the second add a slightly larger quantity, possibly 8 per cent; add 10 or 12 per cent

to the third, 15 per cent to the fourth, and so on through the series. Now sample the mixtures carefully and repeatedly, taking them sometimes in regular order, sometimes in haphazard fashion. Usually the palatability of the mixture will increase with each increase in the amount of the acid juice up to a certain point, beyond which the mixture becomes too tart and falls off in its appeal to the palate. If necessary, in order to locate this point with certainty, repeat the series, making larger or smaller differences in the proportion of acid used. When this point is determined, make a note of the amount of basic stock entering into the mixture and make up a quantity of the mixture to serve as material for further experiments. Divide a portion of the juice into small lots and by adding small quantities of crab-apple or other astringent apple juice ascertain whether the mixture is improved by the addition of a juice high in tannin and determine the proportion which gives the best results in improvement of flavor. Lastly, determine in the same manner the quantity of the high-flavored aromatic varieties necessary to add to the blend in order to give the resulting mixture the maximum appeal to the nostrils and palate.

This seems like a rather laborious process, as in fact it is, but the cider maker who works carefully over his available material in the manner outlined will be well repaid, since he will be able to make a rather uniform, properly balanced product having the maximum appeal to the consumer, in contrast to the rule-of-thumb worker to whom apples are apples and whose apple juice is consequently only juice. For example, a built-up juice made in the writer's laboratory used as basic stock 50 per cent of Stark with 30 per cent overripe, rather soft Ben Davis apples. To this sweet, flavorless juice was added 10 per cent Northern Spy, made from fruits which were slightly underripe. This gave the mixture even more than the desired acidity and a slight astringency, while it still lacked aroma and fruity flavor. These were supplied by adding 5 per cent each of Delicious and Stayman Winesap, which at the same time reduced the acidity. None of the juices entering into this product was attractive when tested alone, while some of them were distinctly mediocre or poor, but each was used for the sake of a specific characteristic which it could supply to the mixture. The resulting blend was pronounced superior not only to the various separate juices entering into it but also to such high-quality single juices as those of Winesap, Yellow Newtown, York Imperial, and Jonathan varieties.

When the proportions of the blend have been established by test, blending may be accomplished by mixing the apples in the desired proportions prior to grinding or by pressing them separately and combining known quantities of juice either at the time of pressing or at a later period, as convenience may determine.

WASHING AND SORTING THE FRUIT.

Thorough washing of all fruit prior to grinding is an absolute necessity to the production of a sound, clean cider. It may advantageously be combined with sorting to remove specked and decayed fruit, leaves, and other foreign matter. The methods for accomplishing this part of the work are various and may be made to fit the particular case. The essentials are that the work be thoroughly and carefully done and that water be unsparingly used.

In small-scale operations washing may be done in a tank or large tub, into which the apples are dumped, stirred thoroughly, and lifted out by hand. This gives an opportunity for sorting out defective fruit, but has the disadvantage that in practice the water is not changed frequently enough and hence becomes heavily loaded with suspended mud, bits of decayed pulp, and spores of fungi, which are loosened from one fruit only to be carried to the press upon another. This can of course be corrected by changing the water frequently. In larger installations the washing tank may be provided with a stirring arrangement to agitate the apples and with a constant-renewal water supply. Water flows in from a faucet at the top and is constantly withdrawn by a siphon made of a piece of rubber hose dipping nearly to the bottom of the tank and thus keeping it clear of sediment. Fruit may be automatically carried from the washing tank to the grinder by arranging a conveyor with one end dipping beneath the water of the tank and the other delivering into the hopper of the mill. An attendant stationed beside the conveyor sorts the fruit as it passes, throwing out defective apples.

A still better arrangement for large installations employs an inclined sorting table, down which the fruit rolls between the sorters, who cull out defective fruit. The lower end of the sorting table is made of large-mesh wire netting or wooden slats and has arranged above it a series of perforated pipes supplied with water under pressure. Twigs and leaves drop through the openings along with dust and bits of decayed pulp washed off the fruit, while the clean fruit passes on to a conveyor which carries it to the grinder. This arrangement is ideal, since the dirt is washed away instead of being in part transferred from one apple to another. The fruit is consequently delivered to the mill with the number of adhering yeast cells and spores of fungi greatly reduced.

Washing and sorting should immediately precede pressing, to allow no opportunity for the fruit to become reinfected with decay-producing fungi. When convenience demands it, the fruit for a day's run of the presses may be washed and conveyed into a clean bin, covered with a tarpaulin or cloth to exclude dirt, from which it is delivered to the crusher; but the quantity of fruit thus prepared in advance should not be greater than can be worked up with-

in the next 24 hours. In such cases, the bin may be located on the second floor above the press and the apples delivered to the crusher by a chute.

GRINDING AND PRESSING THE FRUIT.

Grinding and pressing are practically one continuous operation, and for this reason the equipment is usually combined into one machine, which makers and dealers speak of as a "press." A great variety of such machines, ranging in capacity from 20 bushels to several thousand bushels a day, are on the market, and the cider maker will have no difficulty in finding one of a size adapted to his needs.

BARREL PRESSES.

Small machines consist of a crusher and a screw press mounted in a frame and operated by hand. The crusher of such a machine consists of two corrugated steel rollers set side by side and turning toward each other, with a third flanged roller placed above them in the base of the feed hopper. The flanges of the upper roller catch the apples and press them against a metal plate which forms one side of the hopper, splitting them into pieces, which are then forced between the parallel corrugated rollers, which complete the crushing. The efficiency of such a crusher depends upon keeping the lower rollers set very close together by means of the adjusting screws. Unless this is done large bits of fruit will pass through with the cells intact, and the yield of juice will be low. The crushed fruit drops into a "barrel" made of wooden strips fastened to iron hoops, which is placed beneath the crusher. The press consists of a heavy iron screw mounted in a frame at the opposite end of the machine. When full, the "barrel" is pushed beneath the screw, a lattice of wooden strips being placed under it, a heavy circular wooden block is put on top, and the screw is forced down by the use of a lever. A press of this type is shown in figure 1.

This "barrel" type of press has two rather serious defects. The physical effort required to force down the screw is very considerable, and in order to obtain a pressure sufficient to give anything approaching the possible yield of juice the full strength of two or three men is called for. In consequence the extraction is usually very imperfect and the yield low. Also the pressure must be very gradually applied, or juice will spurt through the openings between the slats of the barrel, wetting the floor and the clothing of the operators. This may be prevented in part by nailing wide boards upon either side of the frame, but there is always considerable loss of juice unless the operation is very slow. When heavy pressure is applied

or when the fruit used is somewhat soft, much pulp oozes through the openings of the barrel, with the result that the juice contains much pomace.

RACKS AND CLOTHS INSTEAD OF BARRELS.

For these reasons it is recommended that users of the barrel type of press discard the barrels and replace them by racks and cloths. (Fig. 2.) The quantity handled at a single pressing will be considerably increased, a better extraction of juice will be obtained in a

FIG. 1.—Hand-power cider press equipped with a "barrel" for holding the fruit. The pressing is very imperfect and the yield of juice low, while the oozing of pomace through the "barrel" makes the work unpleasant.

shorter time, and losses caused by the juice spurting through the barrel and difficulty due to the presence of pulp in the juice will be avoided. To make the change it is only necessary to make up 10 to 12 square wooden racks of such size that they will fit loosely into the bed of the press. (Fig. 3.) Each rack is made of hardwood strips, seven-eighths or 1 inch wide and five-sixteenths to one-half inch thick, cut to the proper length. Lay the strips on a floor, parallel and about one-half inch apart. Lay upon them at right angles a second set, equally spaced, and fasten them together with wire nails

or staples. This makes a rack with the two sides alike. Basswood, beech, elm, or some other hard wood which will not flavor the juice should be used. Now, cut four strips of five-sixteenths or one-half inch material, 2 inches wide, to a length $2\frac{1}{2}$ inches less than the width of the racks; nail them together on edge into a square frame. This makes a bottomless box, called a form, which is placed upon each rack as it is filled, to support the cloth and furnish a guide in building the cheese.

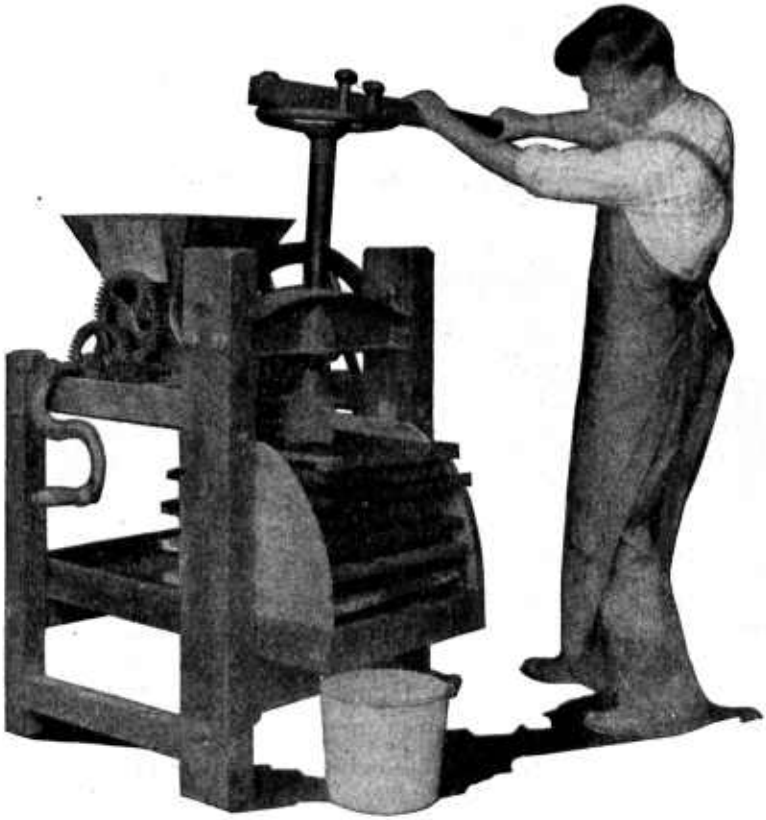

FIG. 2.—The substitution of racks and cloths for the barrel increases the capacity of the press and allows the operator to get out more of the juice in a shorter time and with less effort.

Press cloths may be purchased of dealers in cider-making equipment at little expense. Fairly satisfactory cloths may be made from burlap or from flour, grain, or coffee sacks, cut into squares one and one-half times as long on the sides as the racks with which they are to be used, boiled for one or two hours, and thoroughly rinsed before using. In using racks and cloths, place a rack beneath the crusher, set the form upon it, lay on a previously moistened cloth in such fashion that the margins of the cloth are equal on all sides, and

grind until the form is filled. Level off the mass of pomace as evenly as possible, fold over the margins of the cloth smoothly, remove the form, place a second rack upon the top of the cheese, replace the form, using care to see that the edges are directly over those of the first cheese, and repeat the process until a sufficient number of cheeses for a pressing have been made. Avoid making cheeses more than 2 inches thick, as thick cheeses do not drain thoroughly, and they cause more difficulty in pressing than thin ones, through their greater tendency to slip. (Fig. 4.) Apply pressure until rapid flow begins; then begin grinding and making up a second set of cheeses. At short intervals give the screw a few turns. When the flow has practically stopped run it down as far as the power available makes it possible to turn it. Keep it at that point until the second lot of cheeses is ready for pressing, when the first is usually sufficiently well drained to be discarded.

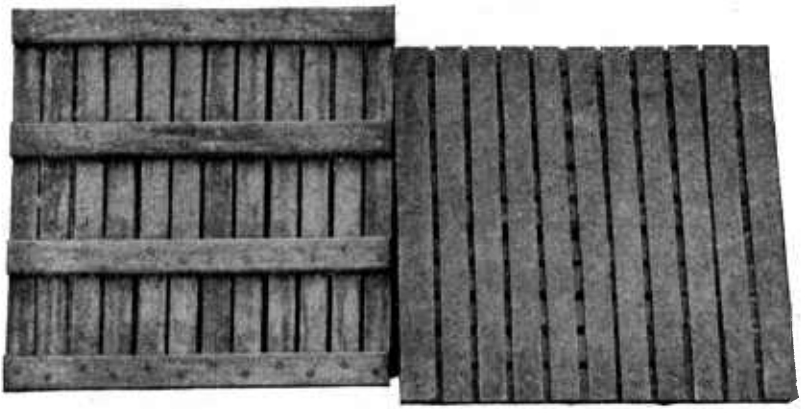

FIG. 3.—Good and bad types of racks. The crosspieces of the left-hand rack prevent uniform pressure on the cheese and cause strains which injure the press cloths.

POWER PRESSES.

Power-operated presses range in size from those requiring 2½ or 3 horsepower to operate and having a capacity of 8 to 12 bushels of apples at a pressing up to those having five or six times this capacity and requiring correspondingly increased power, but all are of the same general type and differ only in details of construction. (Fig. 5.) Instead of a crushing arrangement such as is found upon small hand-power machines, the fruit is ground by a grater, which is mounted above the machine and fed with apples by a chain-and-slat elevator. The grater consists of a heavy steel cylinder, geared to revolve about 2,400 times per minute and grooved at equal distances to receive the knives, which are six or more pieces of tempered steel three-eighths of an inch thick and having one edge cut to form teeth three-eighths of an inch square with intervals of one-fourth of an inch between them. The knives are adjustable by set screws, and

should be set so that the teeth project not more than three-sixteenths of an inch above the surface of the cylinder. One side of the cylinder housing is made up of the concave, which consists of three or four heavy curved iron plates, each attached by its top to the housing and adjustable at the bottom end by a heavy spring. The plates of the concave should be so adjusted that the tips of the cylinder teeth barely clear them (one-sixteenth of an inch or less) when the cylinder is rotated. The springs at the lower end of the concave plates permit them to give way and allow stones or other hard objects to pass through without injury to the knives. When properly adjusted, a grater is much more efficient than any roller-crushing device, since each apple is carried down against the concave and held there while it is very finely shredded or rasped by the knives. The fruit is much more finely divided and has a much larger percentage of cells broken than when crushed between rollers, with the result that the yield of juice from a given quantity of fruit is at least 10 per cent greater.

Practically all power presses now in use are of the hydraulic type. (See fig. 5.) In most of these the ram chamber is beneath the floor

FIG. 4.—Good and bad cheeses. That at the left is uniform in thickness, well covered by the cloth, and will not creep or spread in pressing. That at the right is too thick and will spread out beyond the racks when placed under pressure, making the proper extraction of the juice impossible. The two cheeses were pressed after photographing. The yield from the thin cheese was 64 per cent of the weight of the fruit used and that from the thick cheese 52 per cent.

of the press bed and requires an excavation in the floor of the room to receive it. In such presses the movement of the ram is upward, lifting the cheese against a press block at the top of the frame. In others, the so-called "inverted" press, the ram chamber is at the top of the press frame and the movement of the ram head is downward, the load resting on a stationary press block which is a part of the floor of the press bed. In this type of press all parts are readily accessible in case of need. No excavation in the floor of the pressroom is required, which is an advantage in keeping the room clean and in good sanitary condition.

A second advantage of power-operated presses, in addition to the more efficient grating of the fruit, lies in the fact that much greater pressure is developed upon the cheese than it is possible to get with the hand-operated press; also the pressure is maintained constantly at the maximum for any length of time desired, as the press automatically follows up the shrinkage of the cheese due to drainage.

The combination of greater force and uniformity of pressure gives a considerably better extraction than can be obtained by hand. It is impossible to determine the increase in yield due to these factors apart from that resulting from the more effective pulping done by the grater, but as a general statement it is true that 125 to 135 gallons of juice per ton of apples represents the average yield when a hand press is used, while yields of 150 to 165 gallons per ton are the average with power presses giving working pressures of 100 to 160 pounds per square inch.

A few suggestions derived from practical experience with hydraulic presses may be of service to inexperienced operators.

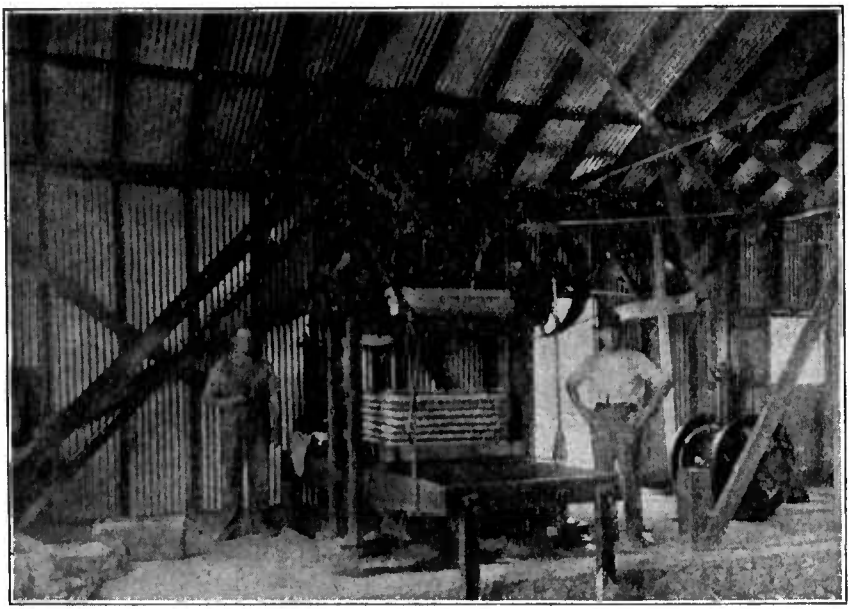

FIG. 5.—A hydraulic cider press operated by power.

SUGGESTIONS REGARDING HYDRAULIC PRESSES.

Do not attempt to operate a press of the hydraulic type without equipping it with a pressure gauge, and do not risk damage to the mechanism by forcing the pressure above the safety limit. Many small presses have no gauge, but have a safety valve, operated by a lever and counterpoise, which opens when the pressure has attained the maximum. It is not unusual to find weights added to the counterpoise in order to increase the pressure. Such a practice throws upon the hydraulic mechanism a strain which it was not designed to endure and involves serious danger of bursting the pressure chamber and possibly injuring the operator. The safe and practical way to increase the pressure is to cut down the size of the cheese by making a smaller form, thus exerting the full pressure of the ram head

upon a smaller area. For example, a certain press had a form 40 by 40 inches in size, giving an area of 1,600 square inches, upon which it delivered a pressure of 100 pounds per inch, or a total of 160,000 pounds. By cutting down the form to 32 by 32 inches, giving an area of 1,024 square inches upon which the same total pressure was exerted, the pressure upon each square inch of the cheese was increased to 156 pounds. The change reduced the load which could be handled at a pressing to two-thirds the former capacity, but also reduced the time necessary for pressing a load from 35 minutes to 25. Consequently, the quantity of fruit which could be handled through the press in a day was decreased less than 10 per cent, while the yield of juice obtained per ton of fruit was increased from 141 to 162 gallons, or 15 per cent.

Special care must be exercised in packing the cylinder of a press of the usual upward-thrust type in order to make sure not only that there is no leakage and loss of power but also that the ram is properly centered. If this is not done, the ram head will bear against one of the guides as it rises. The resulting friction not only cuts down the pressure delivered upon the cheese and reduces yield, but it strains the press frame and may result in breaking out the bolts by which the head is attached to the ram, or in other damage.

The oil chamber of the pump must be kept filled with oil of the type and grade recommended by the press manufacturer and kept closely covered in order to exclude water, juice, and dirt. Water or juice which gets into the oil chamber ultimately finds its way into the ram chamber, where it rusts the shaft, rots out packing, and causes leakage.

When pressure is put upon a fresh cheese, allow it to increase until something like half or two-thirds the maximum pressure has been developed; then trip the valve and allow the press to maintain the pressure without increase for a few minutes. When rapid flow has ceased, set the counterpoise at safety and allow the press to develop maximum pressure. By following this method one avoids the strain on the cloths which would result from putting full pressure on the cheese before drainage had begun, and is freed from the disagreeable spurting of juice and oozing of pomace which would otherwise occur.

Go frequently over the conveyor which elevates apples to the grater, looking carefully for split conveyor slats, loosened nuts, or broken bolts. Many breakdowns occur from the dropping off of a conveyor bolt or slat, which passes on into the grater and breaks the knives. A careful inspection of all set screws and bolts at frequent intervals will pay dividends in the increased life of any machine, and especially is this the case with a press.

RE-PRESSING THE POMACE.

Whether re-pressing the pomace will prove profitable depends upon the thoroughness with which the first pressing has been done and

upon the use which is to be made of the pomace. If the plant in addition to making cider manufactures apple jelly, the pomace may profitably be used for this purpose without re-pressing. If it is to be discarded or used as stock feed, it may be found worth while to re-press it, especially if the press used is one which develops a working pressure of 100 pounds or less per square inch.

For preparing pomace for re-pressing, a pomace picker, a device for tearing the compact cakes into pieces, is a necessity. Press manufacturers offer them in several sizes, but an ordinary mechanic can make a very effective device. The picker consists of a wooden cylinder, 10 to 14 inches in diameter, of a length equal to that of the press cakes with which it is to be used. Teeth made of an iron rod, one-half inch square and finished with a point or screw thread at one end, are driven into the surface of the cylinder in rows or lines extending spirally around it, with the square ends projecting 1½ or 2 inches above the surface. The cylinder is mounted at the base of a wide feed hopper, and the side of the hopper toward which it revolves is studded with similar teeth. The apparatus may be set near the press and geared to the main power shaft and the cakes of pomace dumped directly into the hopper as they come from the press, the broken cakes being received in a bin, from which they can be shoveled to the press platform for re-pressing.

In re-pressing pomace, particularly with a small press or one which has a maximum pressure of 100 pounds per square inch or less, it is an excellent plan to have a smaller form to use especially for this purpose. It should be made enough smaller to give a working pressure of 150 to 160 pounds per square inch, as the increased yields of juice obtained will pay for the longer time required to handle the material with the lowered capacity.

OBTAINING COLOR FROM THE POMACE.

Many consumers express a decided preference for deeply colored golden brown ciders over others of equal quality but of lighter color. It is within the power of the cider maker to control in some degree the depth of color which the juice possesses. The color of cider is due to chemical changes in the fruit which set in as soon as the material is brought into contact with the air by crushing. Some of the colored products, together with the colorless compounds from which they are formed, are carried into the juice in pressing, and the deepening of the color of the liquid continues for some time when in contact with the air. The same changes go on more rapidly in the pomace, as shown by its change of color, by reason of the large surface which is exposed to the air. When pomace is re-pressed after standing a few hours, the juice obtained is much deeper in color than that from the first pressing and at the same time somewhat more astrin-

gent by reason of its higher tannin content. The maker who finds that his customers show a preference for deeply colored juices may meet the demand by re-pressing a part or all of the pomace after allowing it to stand for some hours exposed to the air and using the juice thus obtained to blend with the first pressed juice to deepen the color. If this is done, great care must be taken to protect the pomace by storing it in a covered bin until it is re-pressed, and re-pressing must never be delayed until fermentation of the pomace has begun. If the weather is quite cool pomace may be held for 24 hours without danger. In warm weather it can be held only a few hours, but the higher temperatures accelerate the oxidation processes which produce the coloration, so that the same degree of color may be obtained in the shorter period.

If it is difficult to obtain the desired suggestion of astringency in the product, it will be found advantageous to place some of the pomace in a suitable vessel or tank, add enough freshly pressed cider to wet the mass thoroughly, allow it to stand for an hour or two, and re-press. This treatment extracts color and tannins more thoroughly than merely re-pressing without the addition of juice. It is to be preferred to the practice of some makers, who grind the fruit and allow it to stand in tanks or barrels overnight, or for 24 hours, before pressing. This method of handling the material is said to "bring out the flavor," but it is not clear that it accomplishes this more effectively than the treatment here suggested, while it is open to several objections. The repeated handling of the crushed fruit is laborious and difficult, and unless the temperature is low and can be kept under control fermentation will set in; consequently such treatment can not be recommended.

USES OF APPLE POMACE.

Under ordinary working conditions a ton of apples yields about 700 pounds of pomace. In most cases no systematic attempt is made to utilize this material; some of it may be consumed by stock, but in large part it is allowed to decay unused, either near the plant, where it constitutes a nuisance, or at a distance after the proprietor of the plant has been put to the expense of having it hauled away.

While the subject can not be discussed in detail, it may be briefly pointed out that apple pomace has a number of uses. One of these is as a food for stock. For feeding purposes it is most nearly comparable in composition and digestibility to corn silage and is regarded by authorities as having a feeding value approximately equal to that of corn silage. As it may be kept in good condition for several months in a silo, covered pit, or compact covered pile, its value for feeding purposes justifies attempts to preserve it for such uses when no other means of utilization is feasible.

If the plant, in addition to cider, also manufactures apple butter and marmalade or cider jelly, more profitable use can be made of the pomace. When cooked until soft and passed through a colander or cyclone the pomace is freed from peels, seeds, and cores, and the resulting pulp may be used in making apple butter or marmalade. As pectin, the constituent of fruits which causes their boiled extracts to set into jellies upon the addition of sugar, is only very slightly soluble in fruit juice, the pomace from a ton of apples contains practically all the pectin of the entire fruit. Consequently, pomace may be cooked with water, re-pressed, and the water extract added to cider preparatory to boiling down into jelly. There is a limited demand for dried apple pomace for use in the manufacture of commercial concentrated pectin, and the cider maker who does not make other profitable uses of his pomace and has a drier available may find it advantageous to dry his pomace for sale to such manufacturers, provided his production is large enough to enable him to ship in carload lots.

HANDLING THE JUICE.

SEDIMENTATION.

As rapidly as the juice is expressed it should be placed in temporary storage vessels to permit sedimentation. Sedimentation is always necessary, since the freshly pressed juice contains considerable quantities of finely divided pomace which will separate out on standing, and it is necessary to free the juice from this material as completely as possible. To obtain rapid and complete sedimentation the juice should be placed in deep, relatively narrow, containers rather than in shallow, broad vessels. For small quantities, deep earthenware jars or old-fashioned cylindrical churns are ideal containers. For larger quantities oak barrels of 30 to 40 gallons capacity, with one head removed, are excellent. They must be very thoroughly cleaned with boiling water, and, if possible, with live steam prior to use, and steaming or washing should be repeated at intervals of not more than two days during the season. They should be placed in the coolest room of the building and should be raised a foot or more above the floor, by means of trestles, to facilitate siphoning off the juice from the sediment. They should be provided with covers of denim or some other closely woven cloth to exclude dirt; these should be thoroughly washed in hot water two or three times a week, and after being allowed to become wet with cider should never be used until they have been washed.

The coarser particles of pulp should be removed as completely as possible before the cider is placed in the sedimentation vessels. This may be done by using a straining cloth, which may be fastened in place over the barrel by means of a hoop. The cloth used should be open enough in texture to permit the juice to pass through quite

readily; the use of closely woven cloths in an effort to remove finer particles is useless, as they clog very quickly, yet will fail to remove a great deal of fine material which will separate by sedimentation if given an opportunity to do so.

The barrels should be filled one at a time to within 6 or 8 inches of the top, covered closely, and allowed to remain undisturbed during the sedimentation period. The length of time necessary for settling will depend upon the character of the juice; most juices made at the proper stage of ripeness of the fruit will settle fairly satisfactorily overnight or in 12 to 15 hours, but in the case of some sweet, full-bodied juices, and especially with soft, overripe fruit, 24 to 36 hours may be necessary. Whether time enough can be given to permit complete settling will depend upon conditions. If the juice can be kept at a temperature of 50° F. or less, it may be held for 24 to 72 hours, if necessary, without danger of appreciable fermentation. If the weather be warm and no means of artificially controlling the temperature is available, it may not be possible to hold the juice for more than six hours or overnight before fermentation sets in. In such cases it is a good practice to have the sedimentation vessels only partially full, thus giving a shorter distance through which particles must pass in settling and correspondingly reducing the time allowed for the process. It should be understood that sedimentation is at most merely a convenient method of getting rid of material which can be removed in other less simple ways, and it should never be pushed to such an extent as to endanger loss of juice through fermentation.

SIPHONING OFF THE JUICE.

When settling has been completed the juice must be drawn off without disturbing the sediment. This is most conveniently done by using a piece of rubber hose as a siphon. An added convenience which guards against drawing sediment into the siphon is made by bending a piece of glass, copper, or brass tubing about 12 inches long into a J shape, letting the short arm of the J be about 3 inches long. Slip the long arm into the end of the rubber tube and lower it into the container until the base of the J rests on the bottom with the open end of the tube up. Then start the siphon, which will draw off the juice to within 3 inches of the bottom without stirring up the sediment.

The sediment which is left behind may be handled in one of several ways, depending upon the facilities available and the scale of operations. If the work is on a small home scale, the residues from the sedimentation vessels may be collected, filtered through several thicknesses of closely woven cloth, and used for vinegar. If on a larger scale, they may be poured together and a further quantity of juice siphoned off after permitting settling to occur, if the temperatures prevailing are such as to prevent fermentation. If a filter is available

the sediment may be passed through it separately from the siphoned juice, though filtration of such material is usually a very slow, troublesome process.

BLENDING THE JUICES.

If juices of several varieties ripening at the same time are to be mixed to obtain a uniform product, as previously described, the work may be most conveniently performed at this point, the various juices being mixed in previously determined proportions as they are siphoned off from the sediment. The blending tank may thus serve as a container from which the juice is drawn for further treatment, as explained in the next paragraph. The detailed methods to be employed in blending, as well as the advantages of the process, have already been discussed. If juices of varieties ripening at different periods are to be mixed, the work is done at a later period, as mentioned on page 36.

CLARIFIED AND UNCLARIFIED JUICES.

If placed directly in containers and pasteurized after blending, the resulting product would throw down a more or less heavy sediment in the containers, but this sedimentation would be quite incomplete and enough finely divided material would remain in suspension to give the liquid the familiar tawny yellow color and turbid, more or less completely opaque appearance of fresh cider. While large quantities of cider of this character are consumed, it is not attractive to many people, and it is clear that a larger demand for commercial cider, as well as increased home manufacture, would result if the product could be made more attractive to the eye. Various methods of treatment designed to bring about this result have been more or less generally employed with varying degrees of success, but the product always falls considerably short of being a truly "clarified" cider. A method of treatment developed in the laboratories of the Bureau of Plant Industry of the Department of Agriculture offers an improvement over others in that by its use it is possible to completely remove suspended solid materials from the liquid before pasteurization, with the result that the pasteurized juice remains perfectly clear and transparent and does not deposit any sediment in the container.

The decision as to the method of handling the juice which shall be employed in any particular case must be made at this point. Consequently the various methods of clarification which have been proposed will be discussed in outline, after which the two general methods of handling which are regarded as feasible will be described in detail, in order that the individual operator may make an intelligent choice between them.

CLARIFICATION BY HEAT TREATMENT.

When the method of clarification by heat treatment is employed the juice is transferred directly from the settling tanks into containers, which are sealed and pasteurized, or it is passed through a continuous pasteurizer into containers, as described in a subsequent section. In either case the application of heat causes the formation of a considerable coagulum, which gradually settles to the bottom of the container, where it forms a rather unsightly layer that readily becomes stirred up when the container is disturbed. In order to get rid of this sediment it is customary to siphon off the juice after sedimentation becomes complete, fill it into final containers, and pasteurize it again. This method is laborious and time consuming. At best the coagulation by heat is very incomplete, and the juice is quite opaque, owing to the presence of much suspended matter. These facts have led most large-scale makers to adopt other methods of clarification in an attempt to reduce the labor and cost of handling and secure a more attractive product.

CLARIFICATION WITH THE CENTRIFUGE.

The use of centrifugal force to bring about a mechanical separation of finely divided solids from cider has been suggested. The ordinary cream separator has been used for the purpose with fairly good results; somewhat better separation is obtained with special high-speed machines of the supercentrifuge type. When a separator is used, the juice is brought to it directly from the press, passed through the machine once or twice, bottled, and pasteurized. While juice so treated is very much clearer than untreated juice, the material removed from the juice soon clogs the machine and makes frequent cleaning necessary; also, much of the material which is coagulated by heat is not removed from the juice even by repeated passage through the machine, and consequently comes down as a rather unsightly coagulum in the container after pasteurization, while enough material remains in suspension to make the juice rather turbid. For these reasons the use of a centrifuge with freshly pressed juices is rather unsatisfactory, although fairly good results are obtained when juices which have previously been pasteurized and allowed to settle are passed through the machine.

CLARIFICATION BY FILTRATION.

Paper or wood pulp filters of the type used for the filtration of wines and vinegars have been used for filtering freshly pressed juices, but with results of a rather unsatisfactory and disappointing character. Freshly pressed apple juice contains considerable quantities of pectins and gummy substances which are arrested at the surface of a pulp or paper filter, forming a dense slimy layer which is almost impervious and quickly stops the action of the filter. For this reason, most cider makers who have attempted to use filters of this type with freshly

pressed juice have abandoned the attempt. While the filtrate obtained is clear, the clogging of the filter occurs so frequently that a very large filtering surface and a correspondingly high labor cost make the method too expensive for practical use. When pasteurization, followed by storage to permit sedimentation is practiced, the decanted juice may be passed through a pulp filter prior to bottling and final pasteurization, as the operation is then much less difficult.

CLARIFICATION WITH PRECIPITATING AGENTS.

Wine makers have long added to wines such materials as tannin and gelatin (isinglass), white of egg, casein, and blood in order to clarify them. When such substances come into contact with the liquid the chemical reaction results in the formation of a bulky, flocculent precipitate which is distributed throughout the vessel, gradually sinking and carrying down with it much of the finely divided material in the juice. The use of such means of clarification is extremely unsatisfactory for fruit juices. The precipitation is very slow and incomplete, necessitating the holding of the juice in cold storage to prevent fermentation, and the flavor of the juice is modified both by the removal of some of its natural flavor and by the development of foreign and disagreeable flavors. Unless the added material can be completely removed, which is usually difficult or impossible, the danger of spoilage of the juice by the growth of organisms in it is considerably increased. For these reasons the use of such materials with fruit juices can not be too strongly condemned.

CLARIFICATION WITH INSOLUBLE AGENTS.

Certain insoluble substances, finely ground and thoroughly mixed with the liquid, are also much used in clarifying. By reason of the very large total surface offered by the great number of fine particles, much of the suspended material in the liquid is attracted to the surfaces of the particles and carried down by them as they settle. Examples of such materials are Spanish clay, which is used by wine makers; fuller's earth, extensively used in bleaching and clarifying oils and fats; and animal charcoal and various vegetable carbons, used in clarifying and decolorizing cane and beet juices in sugar making. Rather extended studies of these various materials with reference to their adaptability for use in clarifying fruit juices have been carried on in the Bureau of Plant Industry. All are open to serious objection, as they remove a large part of the characteristic flavoring substances of the juices. Carbons have the additional disadvantage that they are very effective decolorizing agents and almost wholly remove coloring substances as well as flavor from juices treated with them. For these reasons none of the materials mentioned can be recommended as suited for use with fruit juices.

COMBINATION TREATMENTS.

By way of summary of the foregoing discussion it may be pointed out that none of the first four treatments discussed when used alone gives entirely satisfactory results. Consequently, manufacturers of pasteurized cider on a large scale, in an attempt to produce juices relatively free from sediment and fairly uniform in appearance, have made various combinations of two or more treatments. What is probably the most satisfactory of these composite methods for ordinary home use will be described in detail, as many makers, by reason of possession of the necessary equipment, personal preference, or other causes, will desire to use it. This is called Method I. The description is followed by a statement of a newer method developed in the laboratories of the Bureau of Plant Industry, which is called Method II.

PRESERVATION BY METHOD I.

After the juice has been freed from pulp by settling and has been blended to give the desired flavor, the subsequent steps in the process consist of filling the juice into containers and pasteurizing; storing until the coagulum produced by heating has settled; decanting or siphoning off; passing through a pulp filter, milk separator, or centrifuge, if available; filling into the final containers; and pasteurizing. These steps will now be discussed in detail.

PASTEURIZATION FOR STORAGE.

The purpose of this treatment is the protection of the juice against fermentation while gradual sedimentation in storage is occurring. It may be carried out in one of two ways: Either by filling the juice into containers which are then sealed and subjected to pasteurizing temperatures in a water bath or steam box, or by passing the juice through some form of continuous pasteurizer into sterilized containers which are immediately sealed. In either case the essential feature is that the juice is brought to 175° F. and subsequently protected from exposure to the air.

PASTEURIZING IN CONTAINERS.

Containers.—When small quantities of juice are being preserved for home use, ordinary glass fruit jars of the quart or half-gallon size are excellent containers. The jars used should not be of the screw-cap type; any of the various lightning-seal or other glass-topped types which do not permit contact of the contents with metal may be used. Crown-cap bottles, such as grape-juice bottles, are also good, but their small capacity makes their use rather laborious. In case somewhat larger quantities are to be handled, glass jugs of 1 or 2 gallons capacity, made to be closed with crown caps, are highly

satisfactory and cheaper than any other containers of equal capacity. Glass carboys of the straight-walled type, holding 3 to 5 gallons, such as are used for table and medicinal waters, are rather expensive and difficult to obtain, but stand sterilizing temperatures well and are much to be preferred to carboys of the pear-shaped type, which are usually so thin walled that there is heavy loss from breakage in heating and handling. In the absence of more suitable containers any good-sized bottles which can be fitted with corks may be successfully used.

Washing and sterilizing.—Whatever the nature of the containers, they should be thoroughly washed, with the caps or tops which are to be used in sealing them. After washing, both the jars and tops must be sterilized. This is most conveniently done by placing the jars on their sides in a wash boiler or other good-sized vessel, setting it on the stove, pouring in enough cold water to completely cover the jars, bringing the water to boiling, and keeping it at that temperature for 10 or 15 minutes. It is a good plan to sterilize the containers and covers just before they are to be used and to take the sterilizing vessel off the fire and allow the containers to remain in the water until they are used. If bottles which are to be closed with corks are used, corks which are free from cracks and openings and which are a little larger in diameter than the necks of the bottles should be selected. Melt a quantity of paraffin, drop the corks into it, put a bit of board on top to keep them beneath the surface, and keep the paraffin hot for an hour or more in order that the corks may become thoroughly filled with it. A better method is to keep the corks in the hot paraffin until used, lifting them out as needed and placing them directly in the bottles. In filling the containers it is necessary to remember that considerable expansion occurs when a liquid is heated from ordinary room temperature to pasteurizing temperature; for example, a rise of temperature from 60° to 175° F. produces an expansion of very nearly 2.7 per cent in volume. Allowance must be made for this expansion in order to avoid bursting the containers by the production of excessive pressure during heating.

Sealing.—As rapidly as the containers are filled they should be closed and sealed. In the case of fruit jars, carefully selected, previously sterilized rubber rings should be put in place and the tops clamped down. Crown-cap bottles or jugs should be capped. If bottles or carboys closing with corks are being used, the corks, previously boiled in paraffin and preferably lifted directly from hot paraffin, are set in place and pushed down loosely. Such bottles are put in the pasteurizer with the necks projecting above the water and must be sealed at once after pasteurizing. This is done by pushing down the cork, which will be somewhat softened, until it is slightly below the level of the top and completing the seal while the juice is still hot by pouring paraffin over the top.

It will be noted that the sealing of containers before pasteurization is recommended. There are three reasons why this recommendation should be followed wherever the type of containers used makes it possible. A minor reason is that the sealing of hot containers is an unpleasant and hurried task attended by some danger of loss of juice and of injury to the operator by breakage. A more important reason is that the substances which give the characteristic odor, or bouquet, to apple juice are partially lost when the juice is heated in open containers to 175° F. In sealed containers the escape of these volatile substances into the air is prevented and they are reabsorbed by the juice as it cools. At the same time access of air to the hot juice, which would permit oxidation processes that may have an effect upon flavor, is prevented by sealing. For these reasons juices should never be pasteurized by heating in open containers when it is possible to avoid it, and when it is necessary the container should be of such a form that the surface of the juice exposed to the air is as small in area as possible. Most important of all, the portion of the jar which is above the water level does not reach the temperature of the bath, and any organisms present on cap and rubber or on the inner surfaces of the jar may escape destruction. Sealing and inverting wets these surfaces. Unless care is exercised in selecting a good quality of rubber rings for fruit jars an occasional jar may be lost through "blowing" the rings, but good rings will withstand the pressures developed at pasteurization temperatures.

Pasteurizing.—For pasteurizing juices in bottles on a small scale an ordinary tin wash boiler is perfectly satisfactory. A false bottom or rack must be used to raise the jars above the bottom, to permit the circulation of water beneath. A few light wooden strips cut to the proper length and nailed to short crosspieces may be placed in the bottom of the boiler. A small hole should be made in the lid of the boiler to admit a long-stemmed thermometer, which should be hung so that the bulb reaches to within 2 or 3 inches of the bottom of the boiler.

For pasteurizing juices in bottles on a larger scale or for handling large jugs or carboys a pasteurizing tank is a necessity. In its simplest form this is merely a tight wooden box, preferably provided with a lid to keep in the steam and lined with soldered sheet iron or copper to prevent leaks. It is provided with a steam coil for heating, a slatted rack to support the containers, and a reliable thermometer to permit control of the temperature. Satisfactory heating may be obtained by the use of waste steam by running a perforated exhaust pipe into the box beneath the false bottom and allowing the steam to escape into the water. If this is done care must be taken that the perforations are so placed that jets of steam can not strike directly

upon the bottles. When pasteurizing sealed containers in a wash boiler, put the boiler over the fire with the false bottom in place, add a small quantity of water, and fill it with bottles or jars, laying them on their sides or inverting them. This insures the destruction of any organisms present on the caps or lids by keeping the liquid in contact with them during the heating. Add enough cold water to cover the topmost jars completely; put on the lid with the thermometer in place, and raise the temperature gradually to 175° F. In case bottles are being pasteurized in a steam-heated tank, crates which can be filled with bottles will be a great convenience in handling, but the bottles should be inverted or laid on their sides, for the reason already stated.

The essential feature in pasteurizing is to bring every portion of the juice to a temperature of 175° F., keeping it at this point for about 10 minutes, and then allowing it to cool slowly without exposure to air. In order to bring all the juice to this temperature it is necessary to keep the bath at 175° F. for a longer period than 10 minutes, in order to afford time for the temperature outside and inside the containers to become equalized. The temperature of the juice will lag behind that of the surrounding water by a period of time proportional to the size of the containers. In pint jars or bottles this time will be about 5 minutes; in quarts and half gallons, 10 and 15 minutes, respectively; in 1-gallon bottles, 20 minutes; 2 gallons, 25 minutes; and 5 gallons, 45 minutes. In order to determine the length of time for which it is necessary to hold the temperature of the pasteurizing tank at 175° F. after it has reached this point, add 10 minutes to the figures given above for the size of container being used and keep the bath as nearly at 175° as possible for that length of time. As no injury to the juice results from being kept at this temperature for moderate periods, it is a better plan to exceed the time slightly than to risk shortening it. Care should be taken, however, that the temperature is not allowed to rise above 175° F., or the juice will develop a "cooked" taste.

When the required time is up the heat should be turned off and the jars of juice allowed to remain in the water until they have cooled sufficiently to be handled, when they may be removed, examined for defective seals, and stored. If it is necessary to remove the jars while hot, great care must be taken to avoid loosening the seals by rough handling. The containers should be again examined for leaks as they become cool, since the contraction of the cooling juice produces a partial vacuum which may cause leakage.

PASTEURIZING WITH A CONTINUOUS PASTEURIZER.

A continuous pasteurizer consists essentially of a coil of aluminum pipe, equipped with a valve, through which juice can be passed by

gravity from a tank. The coil is placed within a sheet-iron cylinder, which is fed with steam or hot water from a boiler, or it may be placed in a wooden tank or barrel filled with water and heated by a steam pipe. The aluminum coil has a side arm near the outlet for receiving the bulb of a thermometer, which shows the temperature reached by the juice as it passes through the coil. By regulating the flow of steam or other source of heat supplied to the cylinder surrounding the coil and manipulating the valve on the juice line, the heating and rate of flow of the juice are so regulated that the thermometer in the coil shows a constant temperature of 175° F. The hot juice is received directly into previously sterilized carboys, which are closed immediately with corks previously boiled in paraffin and sealed by pouring hot paraffin over the tops. Casks are sometimes used, in which case they must be treated with repeated changes of hot water, to remove all soluble materials from the wood, after which they are thoroughly sterilized with live steam and painted with hot shellac, to make them leak-tight prior to use. As rapidly as they are filled they are closed with tight bungs previously boiled in paraffin, and the sealing is completed with applications of hot paraffin. It is needless to say that casks must not be roughly handled in moving them about after filling, as such treatment will greatly increase the loss from broken seals, which is likely to be considerable when casks are used, even under the most favorable conditions. The further fact that it is impossible to observe the progress of sedimentation in casks or barrels and difficult to draw off the juice without disturbing the sediment makes the use of such containers inadvisable.

STORAGE FOR SEDIMENTATION.

After the first pasteurization the juice must be stored, in order to permit the settling of the material coagulated by the heating. This process may require from two or three weeks to twice as many months, as the rate varies widely with the character of the juice, the size of the containers, and the temperature of the storage room. It occurs most rapidly and completely when the juice is kept at fairly constant and moderately low temperatures. A cool, dark cellar, which can be protected against freezing, is an ideal storage room. The containers should be transferred to the room immediately after pasteurizing, stored on shelves or racks in order that the juice may be siphoned off without the necessity for moving or lifting them, and left undisturbed until sedimentation is complete. They should be examined from time to time, in order to detect any breakage of seals or the beginning of fermentation.

In some cases the cider maker may have an opportunity to sell his pasteurized cider in bulk for immediate consumption, especially if he is located near a large city or industrial center. Pasteurized cider in bulk usually sells at rather low prices as compared with the bottled

product which has undergone further treatment, but immediate sale in bulk may in some cases yield a fair margin of profit. Nearness to markets, amount of competition, labor supply, storage facilities, the character and extent of equipment available, and the comparative demand for bulk and bottled cider are some of the factors which must be considered in deciding whether the product shall be disposed of as soon as pasteurized or subjected to further treatment.

DECANTING OR SIPHONING OFF.

When sedimentation has become complete, as shown by the formation of a rather compact layer at the bottom of the container and uniform clearness throughout the liquid, the juice is ready for further treatment. The nature and extent of this treatment will vary with the quantity to be dealt with and the equipment available. If only small supplies for home use are made, the cider may be used as needed without further treatment, merely by decanting or siphoning it off from the sediment. If this is to be done, small containers should be used, as fermentation will promptly occur in the unused portion left in a container which has been opened. If the cider is intended for sale, removal of the coagulum and repacking in small final containers are necessary. The first step in the process is removal of the juice from the storage containers with as little disturbance of the coagulum as possible, either by decanting and pouring off or more conveniently by the use of a siphon made as described on page 27. No matter how carefully the work of siphoning or decanting may be performed, the juice will not be perfectly clear, for the reason that a portion of the suspended material is not coagulated by the heat employed in pasteurization. This material is in the form of extremely fine particles so light that they do not settle, no matter how long the liquid may be allowed to remain undisturbed in storage. Consequently the cider will appear murky or turbid and will be more or less dull and opaque when viewed in a tumbler held against the light even when quite free from particles large enough to be visible to the eye. Fastidious consumers object to such ciders on the ground that they are "muddy" in appearance, and for this reason various methods are employed in attempts to increase the clearness and brilliancy of the product. Several of these methods are outlined in the following paragraphs. The choice of the method to be used will depend in any particular case upon the quantities to be handled and the facilities available.

If juices of two or more varieties which ripen at different periods are to be used in making a blend, so that mixing of the freshly pressed juices was not possible, the blending should be done at this time. The details of blending have already been given. When juices differing considerably in character are mixed, as when a juice high in

acid content is added to a sweet or subacid juice, the mixture may become somewhat more turbid and opaque than the separate juices and may throw down a small quantity of precipitate on standing. This is a result of the change in acidity and tannin content of the mixture. The reactions are quickly completed, and such blended juices clear up quite as satisfactorily as single-variety juices by the methods of treatment now to be described.

CLARIFYING BY FILTERING OR CENTRIFUGING.

The simplest but at the same time the least effective method of clarifying the juice is to strain it through cotton or cloth. When only small quantities are to be handled with limited equipment this method may be used. A large piece of canton flannel, folded so as to give three or four thicknesses, may be stretched over the top of a vessel or suspended by the corners after the fashion of a jelly bag and the juice poured through it. As the effectiveness of such a filter depends upon the gradual filling up of the openings in the cloth by particles from the juice, it is usually necessary to pass the juice through such an arrangement three or four times in order to make any very decided improvement in the clearness and brilliancy of the liquid. The chief value of such a simple straining process lies in the fact that it removes any portion of the sediment which may have been stirred up in taking the juice from the storage containers.

For handling larger quantities of juice, pulp filters are very generally employed. These are of two general types. In one type the filter may be described as a heavy-walled wooden tub provided with a false bottom upon which the wood pulp which is used as a filtering medium is packed to a depth of 1½ to 3 inches. Juice is delivered from a supply tank through a pipe equipped with a float and cut-off, so that a constant level of liquid is maintained on top of the filter pulp, and is drawn off at the bottom of the filter by a line of pipe connected with a suction pump. The filter pulp, after repeated washing in hot water, is packed into the filter wet, the juice turned on, and the pump started. The first filtrate is discarded until pure juice comes through. Like the jelly bag, the efficiency of a pulp filter depends upon the gradual filling up of openings in the filtering medium by particles from the juice. Consequently, the first juice which comes through should be returned to the supply tank and bottling begun only when the juice comes through clear. Lack of care in packing the filter, and particularly in getting close contact between the pulp and the wall of the tub, is sometimes responsible for a slight seepage, which produces persistent turbidity of the filtrate, and it is a good plan to work around the edge of the filter with a rammer after the pump has been started in order to close up any slight openings which may exist.

In another type of pulp filter a series of tinned or silvered plates, each of which carries an independent filter disk made of pulp, is arranged one above the other and fed by gravity through a feed pipe from a supply tank. (Fig. 6.) This type of filter has the advantage that it gives a large total filtering surface within a very small and compact apparatus, and it can also be used to handle very small quantities or to finish up the last of a batch by using only one or two filtering disks. As it is fed by gravity, the rate of flow through the filter depends upon the height of the supply tank above the apparatus, which should be placed in a basement or ground-floor room and supplied by a pipe or hose from a tank on an upper floor. When a force pump capable of giving a pressure of 12 to 20 pounds per square inch is available it may be substituted for the gravity-feed arrangement.

A milk separator, clarifier, or supercentrifuge may be used for clearing the juice, in case such an instrument is available. In passing through the machine a portion of the suspended material is thrown out by centrifugal force and adheres to the wall of the bowl. The efficiency of the treatment depends upon the degree of force developed, and consequently high-speed machines, running at 20,000 to 40,000 revolutions per minute, will produce better clarification than the usual types of separators running at lower speeds. Whatever type of machine may be employed, it should be operated at the full speed recommended by the makers.

No matter what method of clearing is employed, whether filtration or the use of a separator or centrifuge, a perfectly transparent, water-clear product is not obtainable by these methods. The juice will have a somewhat smoky or murky semiopaque character, owing to the presence in suspension in it of exceedingly fine particles which can not be removed by centrifuging or filtration. These treatments, if properly performed with good equipment, have the very great advantage, however, that they remove from the juice such larger floating particles as would ultimately unite and fall out to form a sediment upon the bottom and sides of the bottle after the final pasteurization. As the presence of such sediment in bottles is a rather serious handicap to the sale of cider, through the generally existing although entirely erroneous impression that it consists of dirt and is proof positive that unsanitary methods have been employed in handling the juice, any treatment which will prevent its formation in the final container is well worth while.

CHOICE OF FINAL CONTAINERS.

In the selection of containers in which the finished product is to be placed (fig. 7) there is very much less choice than in the selection of storage containers. Since the latter containers are not to be handled and are opened only when the contents are to be transferred to

final packages, the primary consideration is capacity, and almost any container which can be sterilized and made air-tight and which does not expose the liquid to contact with metal will serve. The situation is quite different with respect to the final package. If intended for home use it must be of such size that the contents may be at once used after opening or a part of the contents will be lost. If intended for sale, the same consideration applies, and the package must stand shipment and repeated handling without serious danger of breakage of the seal, while it must also be made attractive to the eye through labeling.

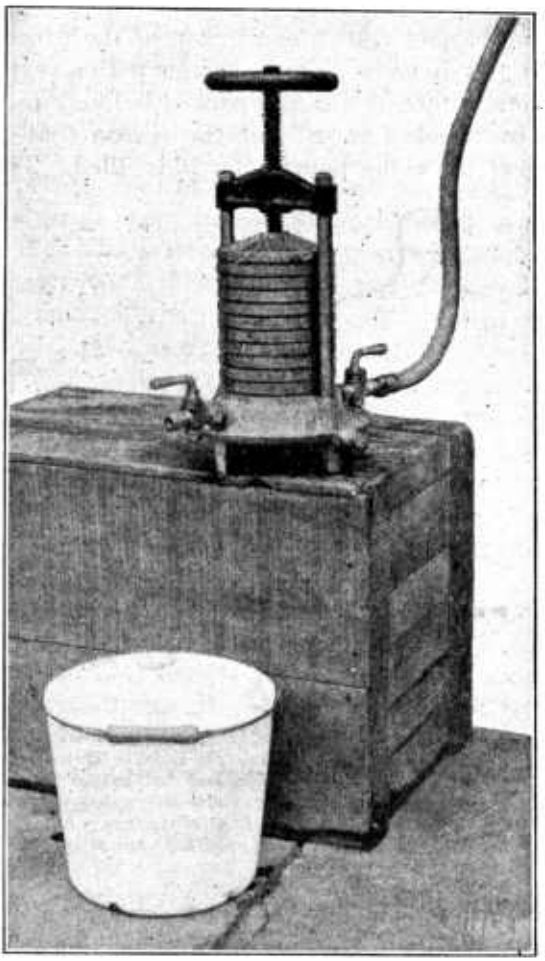

FIG. 6.—A type of filter in which the juice is forced through disks of wood pulp. Each of the 10 disks is a separate filter, giving a large working surface in a compact portable apparatus.

For strictly home use pint and quart fruit jars or the smaller sizes of crown-cap bottles may be used. Where the juice is to be sold there are two possibilities; crown-cap bottles ranging in size from half pint to quart, which are suitable for general use, and 1-gallon and 2-gallon crown-cap glass jugs or 5-gallon lacquered cans for the soda-fountain and ice-cream-parlor trade, in which the juice is transferred to the fountain before it is served. Whether bottles or jugs are to be used will depend in any particular case upon the relative demand for cider in the two forms of containers. Containers employing corks should never be used as final packages for juices intended for sale. The use of crown caps necessitates a machine for capping bottles. Such machines are on sale in a great variety of types, ranging from a very simple hand device to large-capacity auto-

matie machines, so that it is easy to secure a capper suited to the individual needs.

Kegs and barrels.—While there was formerly a considerable trade in cider in bulk in kegs and barrels, and some demand for juice in such containers still exists, it is clear that they can not be used with success in the future. It is possible with intelligent care in selecting barrels and in every step of the proeesses of filling and sealing to put up sweet eider in barrels with a very small loss from fermentation, although cider so packed is likely to have a somewhat unpleasant "cooked taste" for the reason that the large package retains heat for many hours after it is filled. The chief difficulty with the bulk paekage arises after it comes into the hands of the retailer. The quantity contained is sufficient to serve the needs of the average soda fountain for several days; hence, the barrel is opened daily in order to refill the fountain receptacle. At eaeh opening it is exposed to infection with yeasts, and as very few retailers have eold rooms the conditions are usually such as to permit fermentation. Benzoate of soda in the amount tolerated under the food and drugs act—one-tenth of 1 per eent—can not be depended upon to prevent fermentation in a container which is being opened repeatedly so that there is free access of air. Consequently, some portion of the eontents of the barrel may develop more than one-half of 1 per eent of aleohol before it is used up. The dealer is then liable to prosecution under the national prohibition act, as the possession, sale, or offering for sale of sueh cider is eontrary to law. The manufacturer is also involved, since it is incumbent upon him to prove that the aleohol content of the liquid was less than one-half of 1 per cent by volume at the time the package was sold by him.

FIG. 7.—Good types of containers. The 5-gallon bottle is a satisfactory storage vessel. It must be sealed with a paraffined cork. The gallon and half-gallon jugs and the pint and quart bottles which are sealed with cork-lined metal caps are good final containers. A satisfactory inexpensive device for applying caps is seen in the foreground of the picture.

In view of these facts, the producer who puts up eider in barrels is likely to encounter considerable diffieulty in marketing it, as re-

sponsible dealers dislike to assume the risk of a violation of law and demand a package of such size that the contents can be used within a short time after opening.

Two types of containers would appear to meet this demand reasonably well, namely, crown-cap glass jugs of 1 or 2 gallons capacity and 5-gallon enamel-lined tin cans. For handling equal quantities of juice the costs of tin and glass are not greatly different. Each type of container has certain advantages coupled with some disadvantages.

Glass jugs.—In the case of 1 and 2 gallon jugs the advantages are that they are readily capped by machines, the contents are protected against contamination by metal, and the contents are visible at all times, thus protecting the producer from shipping and the dealer from accepting moldy or fermenting juices. The jugs are returnable, are readily cleaned, and may be used repeatedly. Their disadvantages are that they add materially to the weight of the package, thus necessitating heavier and more expensive crates and increasing the shipping costs, while the transportation charges on returned empties are also considerable. There is a certain unavoidable loss from breakage in sterilizing, pasteurizing, and handling glass containers. Lastly, the larger sizes of glass jugs cool rather slowly, so that there may be danger of developing a "cooked taste" from prolonged high temperature.

Cans.—Rectangular tin cans of 5 gallons capacity have long been used for oils and similar materials. When coated internally with an acid-proof shellac or lacquer they are successfully used for various food products. They have certain very decided advantages for fruit juices. They add little to the weight of the product, the packing and shipping costs are small, and their rectangular form economizes space in storage. They may be transferred directly from the pasteurizing tank into cold water, thus cooling the contents quickly and preventing the cooked taste of the juice. The cans if heavily lacquered may be returned and used again. The disadvantages of such containers are that the product can not be inspected until opened, the cans are rather difficult to clean thoroughly after use because of their shape, and sealing is somewhat less simple than in the case of glass. Also, since the interior of the can can not be inspected, it is impossible to detect and throw out those in which the lacquering is defective. The interior of the sanitary or open-top gallon or No. 10 lacquered can may easily be examined, but for some reason it has not been extensively used for the canning of apple juice. Ordinary plain tin containers should never be used for fruit juices, as the acids of the juice attack and dissolve the metal to an extent which may make the product injurious to consumers.

Glass and tin containers alike have decided advantages for the dealer in that the entire contents of a package can be transferred to the iced service container as soon as opened, or, if this is not possible, the package is not too large to be stored in the ice chest. In either case there is ample security against fermentation after the package is opened.

PACKING IN THE FINAL CONTAINERS.

As rapidly as the juice is filtered or passed through the separator it should be placed in the final containers. Promptness in handling the juice at every stage of the process after the storage containers are opened is, of course, a necessity, since the liquid is subject to contamination by yeasts and fungous spores from the air and will undergo fermentation and spoilage by these organisms as readily as freshly pressed juice. Therefore, the containers in which the juice is to be packed should be selected, sterilized, and made ready for use before the opening of the storage containers is begun.

PACKING IN BOTTLES AND JUGS.

The sterilization of bottles or jugs preparatory to use is carried out in the same fashion as that of the storage containers, by placing them in cold water which is brought to boiling and held at that temperature for some minutes, the caps or tops being subjected to the same treatment.

If small quantities for home use are being bottled, the filling may be done by means of a funnel, which should be sterilized by boiling, as are bottles and caps. In filling bottles or jugs with a funnel care must be exercised to avoid underfilling and at the same time to allow sufficient space for the expansion of the liquid during pasteurization.

If considerable quantities are being packed, a bottle-filling machine is a necessity. This machine consists of a rectangular supply tank with a number of filling tubes. These are siphons, each of which is equipped with an automatic cut-off device which can be adjusted to stop the flow at any desired point, thus filling all containers exactly alike. The operator merely removes filled containers from the filling tubes and replaces them with empty ones, passing the filled ones on to the capping machine. This machine should be placed beside the filler, and the containers should not be allowed to remain open after filling.

Most of the difficulty with the growth of molds or yeasts in juices in bottles or jugs is due to imperfect sterilization of the crown caps. These should be sterilized in boiling water just prior to use, and unnecessary handling or exposure to the air after sterilization should be avoided. A properly made crown cap should have a lining of compressed composition cork or compressed glazed paper not less than three-thirty-seconds of an inch thick and should stand boiling for 10 minutes without softening or showing signs of going to pieces. Some

crown caps on the market have a lining which, instead of being made from compressed ground cork or paper, is merely a disk cut from a thin sheet of cork. Such caps are worse than useless for sealing vessels which are to be pasteurized, as the contraction of the juice after heating draws in air through minute openings in the cork, thus carrying yeasts or spores into the container.

The proper sealing of crown caps on the bottles or jugs is a very important step in the process, and the capping machine must be carefully watched to see that it is doing its work properly. It is well to take a few containers at random from time to time and remove the caps for examination. If the machine is doing its work properly, every cap should be driven down with sufficient force to compress the lining and leave a distinct sunken ring in it when the cap is lifted. The cap should be so firmly crimped against the glass of the neck that it is impossible by exerting all one's force to turn it with the fingers. Unless the machine is sealing the caps in this manner it should be repaired or discarded, as the loss in spoiled juice may amount to several times the cost of a new machine.

PACKING IN CANS.

If juice is being packed in tin cans, the cans should be sterilized in boiling water. It is an excellent plan to take the cans directly from the hot-water tank as they are filled, as this will reduce infection from the air to a minimum. For the same reason, the cans should be closed and sealed immediately after filling. Some of the cans on the market are closed with a lined metal cap which is fastened on by the machine in the same way as the ordinary bottle cap. This is the most desirable type and should be secured if possible. Another type of can is sealed with a tin disk which is soldered on, while still others are closed with corks. Whatever the type of can being used may be, great care is necessary to secure perfect sealing, as practically all loss of juice packed in cans is due to imperfect sealing.

CARBONATING JUICE BEFORE BOTTLING.

Many people prefer juices which have been carbonated prior to bottling, as the sharpness and "tingle" of such juices is considered to give them increased palatability. A second advantage claimed for carbonated juices is that they may be pasteurized at lower temperatures than uncarbonated juices, as organisms find it more difficult to grow when the air in the bottle has been largely or wholly replaced by carbon dioxid under pressure.

Carbonation consists in treating the juice with carbon dioxid under pressure until no more will be absorbed and then promptly sealing the containers. An effective apparatus for carbonating the juice consists of a beer keg or similar heavy-walled tight container

with which a cylinder of compressed carbon dioxid can be connected by a regulating valve and a length of heavy-pressure hose. Fill the barrel completely with juice, close the faucet, and gradually admit carbon dioxid, rocking or rolling the barrel at intervals for 10 or 15 minutes until the pressure on the gauge of the cylinder stands steadily at 15 pounds. Then draw off, bottle, and seal as rapidly as possible, opening the gas inlet occasionally, so as to keep the pressure in the barrel at 15 pounds.

Carbonation is usually confined to the smaller sizes of bottles; containers of 1 gallon or more are rarely carbonated, since the juice is transferred to the magazine of the soda fountain and charged in the glass, if desired, as it is served.

As the quantity of carbon-dioxid gas which a liquid will absorb increases very rapidly as the temperature of the liquid decreases, carbonation is most effective when carried out with juices at a temperature of 40° F. If the plant has facilities for cooling the cider to this temperature the work may be done at any time; otherwise, carbonating and bottling should be postponed until cold weather gives proper temperatures. In no case should the operation be attempted without having a reliable pressure gauge so placed on the line through which the gas is led into the container that it is within constant sight of the attendant, as the rapid expansion of the liquefied carbon dioxid may otherwise burst the container and cause injury to the operator.

FINAL PASTEURIZATION.

PASTEURIZING IN BOTTLES OR JUGS.

As rapidly as the juice is bottled and sealed, with or without carbonation, it should be transferred to the pasteurizer. Pasteurization has already been discussed in detail in connection with the treatment of the freshly pressed juice in storage containers, and it will be unnecessary here to do more than point out a few precautions to be observed. The bottles or jugs should be placed on their sides or inverted in the pasteurizing tank, covered completely with cold water, and slowly heated.

It is important that the temperature reached in this pasteurization should not quite equal that employed in the first pasteurization. The reason for this caution is that not all the material which can be coagulated by heat is thrown down by the first pasteurization. Some of it remains in suspension in the liquid even after the most careful filtering. If the juice is again heated to a temperature higher than that used in the first pasteurization some of this material is coagulated and comes down as a precipitate, marring the appearance of the finished product. To guard against this, the processing temperature used in the final pasteurization should be 5° lower than that first

used. As 175° F. has been recommended for pasteurization in storage containers, the treatment in the final containers should be at 170° F., but should not be allowed to exceed this temperature. The temperature of the pasteurizing tank should be brought up to this point and held as nearly constant as possible for the period of pasteurization. This period is determined by the size of the container and should be the same as that recommended for the container of the same size in the first pasteurization.

In the case of juices which have been carbonated prior to bottling, the temperature may be lowered somewhat and the time of heating correspondingly extended. The reason for this difference is that the juice has been charged with all the carbon dioxed it can absorb while cold. As the temperature is raised the solubility of the gas in the juice is greatly reduced, with the result that a very considerable gas pressure develops as the temperature goes up. If the juice were heated to 170° F, this pressure would become so great as to burst the containers. Since the destruction of organisms by heat depends upon the time during which heating is continued, as well as upon the temperature which is reached, this difficulty can be avoided by employing a temperature of 150° F. in pasteurizing carbonated juice and maintaining this temperature for twice the length of time recommended for uncarbonated juice. Thus, for pint bottles the total time for which the water of the pasteurizing tank is kept at 150° F. should be 25 minutes; for quarts and half gallons, 30 and 35 minutes, respectively. With carbonated juices it is certain that an occasional bottle will burst under the pressure developed during heating; consequently, it is well to place the bottles during pasteurization in crates which can be covered and to avoid handling the bottles until they become cool; otherwise the operator may be injured.

PASTEURIZING IN TIN CANS.

In pasteurizing juices in tin cans, the cans may be filled with the hot juice as it flows from a continuous pasteurizer, if the plant has such a machine. The cans are immediately sealed, placed in a hot-water tank, kept at 170° F. for 12 to 15 minutes, removed, and plunged into cold water. If the cans have been filled with cold juice, they should be sealed, placed in the hot-water tank at 170° F. for 50 to 55 minutes, removed, and plunged at once into cold running water until cooled to room temperature. Submersion in cold water should never be omitted, as an undesirable cooked taste develops in large containers which are left to cool slowly in air.

LABELING.

Some cider makers label and pack their product directly from the pasteurizer as soon as the bottles have become cool enough to permit handling. This is not a good practice. Even with the most careful

oversight of every stage of the process, a small percentage of defective caps or nicked bottles will be used. In such cases the bottles are not sealed and organisms are drawn in along with air as the juice cools, with the result that spoilage occurs. When the juice is packed at once, such imperfectly sealed packages escape detection until they reach the consumer, who receives an unfavorable impression of the maker and resents having paid for something which is unfit for use. This can be avoided by storing the juice after pasteurization for 10 days or more and observing it at intervals during that time, as any mold growth or beginning of fermentation will usually become evident within that period. It may then be labeled and crated.

The essential facts which must be stated on the label in the case of juices offered for sale are the name of the product, the net weight or volume of the contents, and the name of the maker. If a preservative is added, this fact must be declared, and if none has been used, a statement to that effect may be made. A guarantee that the product contains less than one-half of 1 per cent of alcohol should be added. In its simplest form a label might read: "One full pint of Johnson's Pasteurized, Unfermented Apple Juice, made by John Johnson, Raleigh, N. C. No chemical preservative used. Alcohol content less than one-half per cent." Such a label complies with the law, but it is permissible to give any additional facts which it is desired that consumers should know, and the maker who is putting forth every effort to produce a standardized product of high grade should give some additional information. For example, the variety from which the juice is made may be named, or the fact may be stated that the juice is a blend of several varieties, which are named. If the juice is filtered, carbonated, or if other special treatment is given, this fact may also appear, while a statement that strictly sound apples were used, if true, is an advantage.

An artistically designed, attractive label has a very considerable value in catching the eye of the buyer. The juice put up by a given maker may be quite distinctive in quality and flavor, but unless it bears a label which arrests attention or a name which is easily remembered the consumer has no clue by which he can find that particular product in the market again. Consequently, the producer who feels a pride in his cider should guard against the use of a stock label which does not differentiate his package from those of other makers. If the expenditure of a little thought and money will devise a label which will attract attention at first sight and make the product easily remembered and found again, the investment will be a paying one. The maker of high-grade cider should insist upon putting out his product under his own name and should not use stock labels bearing the name of a jobber, as the identity of his juice is thereby lost.

PRESERVATION BY METHOD II.

While the method outlined in the preceding pages gives very satisfactory results, it is time-consuming and laborious. The juice must be twice pasteurized; it must have storage space where the temperature is under some degree of control during the period of clarification, which necessitates keeping on hand a large number of containers; and there is a considerable proportion of loss due to fermentation and to repeated handling and consequent breakage. For these reasons considerable effort has been devoted to devising methods of treatment of unfermented fruit juices which will eliminate as much of the labor of preparation as possible without sacrificing the quality or palatability of the product. A method developed in the laboratories of the Bureau of Plant Industry is regarded as combining several highly desirable features. It makes the entire process of preparation of a juice, from pressing the fruit to the pasteurization of the juice in the final containers, a practically continuous process, eliminates the necessity of pasteurizing the juice and holding it in storage containers for clearing, lessens the loss from breakage and the cost of production by reducing the handling necessary, and enables the maker to put the finished product on the market within a few days after pressing begins. At the same time it produces a clear sediment-free product without the use of costly special equipment and without the loss of the characteristic flavor and beverage quality of the juice.

The steps in the treatment of the juice by the new method are as follows: The juice is pressed, allowed to stand for 12 hours or overnight to settle, decanted from the sediment, and blended if necessary. It is then mixed with diatomaceous earth (also called infusorial earth, kieselguhr, and diatomite) at the rate of 6 to 8 pounds per hundred gallons, thoroughly stirred, and immediately filtered through a thin layer of diatomaceous earth supported by a closely woven cloth. The clear juice is placed in the final containers as it comes from the filter, sealed, and pasteurized, which completes the work. The details of the process will now be stated.

MIXING THE JUICE WITH DIATOMACEOUS EARTH.

In pressing, sedimenting, siphoning off, and blending, the juice is handled precisely as in Method I. Instead of placing the blended juice in storage containers for pasteurization and storage, as in that method, the juice in the blending tank or other good-sized open tank is treated with diatomaceous earth. The dry earth, previously prepared for use by the method outlined in a subsequent paragraph, is weighed out and slowly shaken into the juice, which is vigorously stirred meanwhile. It is essential that the earth be added to the juice in a finely divided condition, avoiding lumps, in order that it be equally distributed through the tank. An ordinary flour sifter is

an excellent device from which to add the earth. If the plant is equipped with power, a small power stirrer may advantageously be used to agitate the liquid; if power is not available, the liquid should be very thoroughly stirred by hand, and the stirring should be repeated two or three times before filtration begins. As the efficiency of this treatment depends upon bringing the particles of the earth into contact with the floating matter of the juice, which becomes attached to the surfaces of the earth particles, repeated and vigorous stirring of the mixture is not a process to be omitted or carelessly performed. From 10 to 15 minutes should be allowed for this stage of the work, after which the juice is ready for filtration.

FILTERING THE TREATED JUICE.

The treated juice now has suspended in it innumerable fine particles of the earth, each more or less completely covered with a layer of gummy or slimy material derived from the juice. These particles are, for the most part, extremely thin, slightly curved, saucer-shaped or boat-shaped bits of silica, with a small percentage of smaller irregularly shaped fragments produced by the crushing of the larger pieces. The next step in the process is to pass the juice through a filter capable of holding back these fine particles, which will retain all the suspended matter and give a perfectly clear liquid.

Suction or gravity pulp filters of the usual type, such as were described in connection with Method I, do not give satisfactory results with juices which have been treated with earth. The reason is that the finer particles of earth at first pass through the pulp, giving a cloudy filtrate. They then gradually choke up the openings in the pulp and build up on the surface a slimy, gummy layer which almost entirely stops the passage of liquid; consequently, the filtration is extremely slow and soon stops entirely.

The most effective method of filtration for such juices is to pass them through a thin layer of earth supported on rather closely woven cloth. The particles of earth form a meshwork having excessively fine openings through which the juice must pass, and any floating particles which enter these passages become attached to the surface of the earth particles and are held there.

The plate and frame type of filter press is ideally adapted to filtering by this method, as the filter cloths can be coated with a thin layer of earth by pumping a suspension of earth in water through the press before the treated juice is turned in. Deposition of earth from the juice constantly builds up a fresh surface, so that filtration goes on at a fairly rapid rate until the chambers of the press are completely filled with the cake. Where large volumes of juice are to be handled a wood-frame press of this type should be installed, as the rather high initial cost will be offset by the rapidity of filtration. Such a filter

press should be so constructed as to permit cleaning by back flushing, that is, by forcing water through the press in the reverse direction, as much time is thereby saved.

A pulp filter of the suction type can be so modified as to do very satisfactory work by replacing the layer of pulp with a closely woven cloth. A piece of heavy nickel or bronze wire screen should be fastened permanently in place in the bottom of the filter tub, to serve as a support for the filter cloth. The cloth, which should be a moderately heavy, closely woven denim, is laid upon the screen and fastened by placing the aluminum ring supplied with the filter upon it and packing the space between the ring and the wall with filter pulp. Then pour a suspension of prepared diatomaceous earth in water upon the cloth, start the suction, and wash with water until the water comes through free of earth. The flow of juice is then started.

Care must be taken to agitate the juice in the supply tank from time to time in order that constant deposition of earth from the liquid over the surface of the filter may occur. If this is not done, the larger particles of earth will settle in the supply tank, leaving in suspension very fine fragments which tend to form a slimy layer over the top of the filter, causing clogging. It is also a good plan to scrape the surface of the filter slightly from time to time, to remove a portion of the deposited earth, but care must be taken not to cut through the cake and expose the cloth.

Some types of the multiple-disk pulp filters discussed under Method I are so constructed that it is a simple matter to replace pulp disks with cloths and to coat the cloths with earth by running a suspension in water through the press. In a filter of this type very good capacity is obtained by placing the supply tank 15 to 20 feet above the filter so as to obtain a gravity pressure of 7 to 9 pounds per square inch. Greater capacity is, of course, obtained by employing a force pump capable of giving 15 to 20 pounds pressure. By cutting off the juice supply when the filter becomes clogged and connecting a hose from a water faucet with the juice outlet of the filter, it is possible to clean the cloths by back flushing in much less time than would be required to open the press and to wash and replace the cloths.

When only small quantities are to be handled very satisfactory results can be obtained with a bag filter. The bag filter should be made of closely woven denim or flannel and should have the form of a rather tall cone. The seam should be double, to guard against leakage. To make it ready for use, the bag is thoroughly wetted, suspended by the top from supports, and filled with a fairly thick suspension of diatomaceous earth in water. As the water drains through, it leaves the inner wall of the bag covered by a thin layer of the earth. Water is run through until any particles of earth

which may have found a way through the cloth are washed off. The filtering of the juice may then be begun. As the only force driving the liquid through the filter is the weight of the juice in the bag, filtration is, of course, rather slow, and it is well to make the bag a tall narrow cone and to keep it full of liquid in order to hasten the filtration as much as possible.

The juice which passes through a properly prepared diatomaceous-earth filter is perfectly transparent and without murkiness or cloudiness, and it remains so after bottling and pasteurizing. Samples prepared in this way have been kept for more than two years without developing haziness or throwing a sediment. When a freshly prepared filter is started up, the first liquid coming through usually is not clear, as fine particles wash through the cloth. The filtrate should, therefore, be returned to the filter until it comes through entirely clear. The color of the filtered juice is not affected by the treatment, as properly prepared diatomaceous earth does not remove the dissolved coloring matters. The color consequently depends upon the varieties of apples used and the length of exposure of the juice to the air.

The juice should be bottled, sealed, and pasteurized as rapidly as it is filtered. The details of these processes have already been discussed and need not be repeated here.

HEATING THE JUICE TO AID FILTRATION.

Heating the juice before filtering and passing it through the filter while hot has the advantage that the filtration is much more rapid than with cold juices. In the case of small quantities the juice may be heated in enameled vessels over a stove after the addition of the earth, stirring occasionally to keep the earth in suspension and make the heating uniform. If the filter is being fed from a supply tank, a small steam coil placed in the tank will serve the purpose. In whatever way the heating is accomplished it is extremely important that the temperature be known and under control, as the juice can not be raised to a temperature much greater than 140° F. in open vessels without undergoing some alteration in flavor, probably owing to the driving off of some volatile flavoring constituents by the heat. In experiments with a large number of apple juices no such change was found to occur when the temperature was held below 135° F. unless the juice was kept at this temperature in an open vessel for several hours. Consequently, the operator who heats the juice should control the process closely with the aid of a good thermometer and should also guard against keeping a tank of juice hot for a long period while filtration is stopped.

PREPARATION OF DIATOMACEOUS EARTH FOR USE.

Diatomaceous or siliceous earth consists of the cell walls of microscopic 1-celled plants, diatoms, which exist in a great variety of forms in both fresh and salt water and in damp soils. The wall about each individual consists of two parts, which fit together like the top and the bottom of a pill box, and is made of silica. Extensive deposits of this earth are found in various parts of the United States. A number of these deposits are being worked, as the earth has many industrial uses, the principal ones being as an abrasive and metal polisher, as an insulating and sound-deadening material, as an absorbent for nitroglycerin in the manufacture of dynamite, and as a clarifying agent in the manufacture of cane sugar.

The earth comes upon the market under various names; among these may be mentioned kieselguhr, infusorial earth, infusorial silica, fossil flour, diatomite, tripolite, and tripoli powder. The material as found on the market has been subjected to grinding and screening, hence can be obtained in various grades of fineness from the manufacturers and from chemical and agricultural supply houses. In experiments conducted in the Bureau of Plant Industry it has been found that the grades of fineness known as 150 mesh and 200 mesh, which means material which has passed through screens having, respectively, 150 and 200 openings to the inch, are most suitable. Most companies manufacturing diatomaceous earths make special grades intended for use in filtration. These should be employed rather than the coarser grades intended for use as abrasive or insulating materials.

Some of the earths on the market instead of consisting of silica contain varying quantities of calcium carbonate. Such earths are unfit for use with apple juice, as the lime salt reacts with the acids of the apple juice so as to neutralize it partially. Therefore it is well to test a sample of earth for the presence of lime carbonate by putting a few drops of dilute hydrochloric acid upon it. Pure silica is wetted by the acid just as it would be by water, without reaction, while the presence of carbonates of lime is shown by the release of carbon dioxid. Any earth which fails to pass this test should be rejected.

As obtained from manufacturers and dealers, diatomaceous earths contain some organic matter which will give a disagreeable foreign or "earthy" flavor to the juices unless it is removed. The usual method recommended by manufacturers is to place the earth in a large wooden or other vessel, pour boiling water over it, stir, allow it to settle, pour off the water, and repeat the treatment once or twice, after which the earth must be allowed to dry before it is used. This method is not only troublesome and time-consuming but fails to remove wholly the substances which give the foreign flavor, even when six to twelve changes of water are used.

The most satisfactory method of purifying the earth is by heating it to redness for a short time. An ordinary heavy-walled steel kettle with a lid or a piece of iron pipe capped at one end and provided with a loosely fitting plug at the other end makes a satisfactory container. Fill the dry earth into the vessel, put on the cover, and partially bury the vessel in the coals in the fire box of the boiler or house-heating plant, allowing it to remain for an hour or until the vessel and contents have been at low red heat for 10 or 15 minutes. Remove and allow to cool; then break up any lumps which may have formed by rubbing the earth through a sieve.

REPEATED USE OF THE EARTH.

Diatomaceous earth which has been used until it has become clogged with material derived from the juice can be used repeatedly merely by heating it after each use for the same time and in the same way as at first. Heating to redness destroys all organic matter and leaves behind in the earth only small amounts of carbon. As the earth is used again and again the carbon continues to accumulate, and as it has very marked decolorizing powers the proportion present in the earth may finally become large enough to cause a noticeable reduction of color in juices treated with it. This point is usually reached, however, only after the earth has been used and burned 12 to 15 times.

SUMMARY OF METHODS I AND II.

This detailed discussion of the various steps in each of the processes of preparation, with a description of the apparatus employed and with practical suggestions as to its use which may be of service to the inexperienced, has necessarily resulted in making both methods appear very much more complicated than is really the case. For this reason the following outline summary of the two processes is appended. The procedure is divided into steps; it will be noted that steps 1 to 6 and 10 to 13 are identical for the two methods.

SUMMARY OF THE PROCESSES FOR PREPARING UNFERMENTED APPLE JUICES.

STEPS COMMON TO BOTH METHODS.

(1) Select sound, well-matured, properly ripened fruit.

(2) If different varieties are available at the same time, blend them in proper quantity to give a well-balanced cider of good flavor.

(3) Wash and sort the fruit, trimming or discarding all specked or partially decayed apples.

(4) Grind and press, subsequently re-pressing the pomace.

(5) Place the juice in deep containers in a cool room over night, to allow the settling out of the pomace.

(6) Siphon off the juice from the sediment.

STEPS USED WITH METHOD I.

(7) Place the juice in suitable sterilized containers, seal with sterilized tops, and submerge in cold water in the pasteurizer. Bring the temperature up to 175° F. and keep it at that point for the prescribed time. Or (second method) pasteurize at 175° F. by passing the juice through a continuous pasteurizer, placing it in sterilized containers, and sealing immediately.

(8) Store the juice in a cool, dark room until settling is completed (two weeks to four months). For home use juice may be left without further treatment until used, if preferred.

(9) *a.* Siphon off from the storage containers.

b. Blend, if juices pressed at different periods are being used.

c. Clarify further by passing through a pulp filter, milk separator, centrifuge, or flannel filter bag.

STEPS USED WITH METHOD II.

(7) Transfer the juice to a suitable vessel or tank, slowly add properly prepared diatomaceous earth at the rate of 6 to 8 pounds per 100 gallons, and stir very thoroughly. If the juice is very cold, heat it to 130° F. to aid in filtering.

(8) Prepare the filter by passing a suspension of diatomaceous earth in water through a filter press or bag filter so as to form a thin layer of earth on the filter cloths.

(9) Filter the juice, stirring the supply tank occasionally in order to prevent the sliming and clogging of the filter.

STEPS COMMON TO BOTH METHODS.

(10) Place the juice as filtered in previously sterilized final containers, seal and submerge the containers in cold water in the pasteurizing tank.

(11) Pasteurize for the prescribed period at 170° F.

(12) Remove from pasteurizer and store in a cool room for 10 days or more.

(13) Label and pack.

FEDERAL REGULATIONS GOVERNING THE MANUFACTURE AND SALE OF CIDER AND UNFERMENTED FRUIT JUICES.

As considerable confusion and uncertainty exist in the minds of many persons as to the meaning and scope of the laws relating to the manufacture and sale of apple juice or cider, the following extracts from instructions issued by the office of the Federal Prohibition Commissioner of the Bureau of Internal Revenue to prohibition enforcement officers are added in the hope of making the matter clear to those interested. These extracts give the essentials of the regulations in effect at the time this bulletin is issued. These regulations are subject to modification, and any person planning to manufacture fruit juices for sale should inform himself as to the current regulations by making inquiry of the Federal prohibition director of his State.

Pro. Mim. 84, issued June 3, 1920. Manufacture of nonintoxicating cider and fruit juices exclusively for use in the home.

To Federal Prohibition Directors, Supervising Agents, and Others Interested:

Section 29 of Title II of the national prohibition act provides that the penalties imposed in the act against the manufacture of liquor without a permit shall not apply to a person for manufacturing nonintoxicating cider and fruit juices exclusively for use in his home, but such cider and fruit juices shall not be sold or delivered except to persons having permits to manufacture vinegar.

The bureau's interpretation of the foregoing provision is as follows: Any person may without permit and without giving bond manufacture nonintoxicating cider and fruit juices, and in so doing he may take his apples or fruits to a custom mill and have them made into cider and fruit juices. After such nonintoxicating cider and fruit juices are made they must be used exclusively in the home, and when so used the phrase "nonintoxicating" means nonintoxicating in fact and not necessarily less than one-half of 1 per cent of alcohol, as provided in section 1 of Title II of the said act.

Or if the person making such cider and fruit juices desires to do so, he may (1) sell such cider and fruit juices at any time to persons having permits to make vinegar; this he may do under the provisions of said section 29. (2) If he preserves such cider and fruit juices at the time they are made, he may sell same to the public in general; this he may do under the provisions of section 4 of Title II of said act. (3) Or he may sell such cider and fruit juices so long as they contain less than one-half of 1 per cent of alcohol, but the purchasers thereof can not use or possess the same after they contain more than one-half of 1 per cent of alcohol; this he may do under the provisions of sections 1 and 3 of Title II of said act.

The cider in the home may be allowed to turn to vinegar if the owner so desires, provided he adds no sugar or other fermentable substance to the cider or fruit juices to increase the alcoholic content thereof, inasmuch as such practice is held to constitute the making of a mash fit for distillation within the provisions of section 3282, Revised Statutes; he may sell said vinegar to anyone who may desire to purchase it; this he may do under the provisions of section 4 of Title II of said act.

This regulation is not intended to cover the commercial use of cider and fruit juices, but merely the use of the same as applied to the home and as provision is made in section 29 of Title II of said act.

These instructions were further supplemented and explained by the following:

Pro. Mim. Coll. No. 2608, Pro. No. 135, issued October 14, 1920. Manufacture of nonintoxicating cider and nonintoxicating fruit juices exclusively for use in the home.

To Collectors of Internal Revenue, Federal Prohibition Directors, Supervising Federal Prohibition Agents, and Others Concerned:

Questions have arisen concerning the application of Pro. Mim. 84, relating to the manufacture of nonintoxicating cider and nonintoxicating fruit juices exclusively for use in the home, to the internal revenue laws. It is hoped that the following statement will make the situation clear:

Cider made and used in the home is not subject to tax under the internal revenue laws, but grape and other fruit juices, not including cider, if fermented to the point where they contain one-half of 1 per cent or more of alcohol by volume, even though not intoxicating, and regardless of section 29, Title II, of the national prohibition act, are subject to tax under the revenue act of 1918 as wine. All persons producing fruit juice other than cider containing one-half of 1 per cent or more of alcohol by volume are required to register in accordance with regulations No. 28, supplement No. 2, and Treasury Decision 2765. Subject to the limitations indicated by Treasury Decision 2765, the head of a family who has properly registered may make 200 gallons exclusively for family use without payment of tax thereon. If he makes more than 200 gallons, he must give a bond and pay tax on the excess. If such excess amount is intoxicating, double the ordinary tax is due as provided by section 35 of Title II of the national prohibition act.

Pro. Mim. 127, issued October 7, 1920. Instructions relative to manufacture of cider, cider vinegar, and nonintoxicating cider.

To Federal Prohibition Directors and Others Concerned:

Numerous inquiries are being received in this office relative to the manufacture, sale, and use of cider and the manufacture and sale of cider vinegar.

For the benefit of all concerned the following instructions are issued:

HARD OR FERMENTED CIDER.

Section 1 of Title II of the national prohibition act defines "intoxicating liquor," and the definition is held to include hard or fermented cider containing one-half of 1 per cent or more of alcohol by volume.

Any person desiring to manufacture such hard or fermented cider for conversion into vinegar or for any other legal nonbeverage purpose is required to qualify by giving bond and procuring a permit. (See reg. 60, arts. 3 and 5, and T. D. 3035.) Such hard or fermented cider may be sold only in quantities of 5 wine gallons or more by one qualified permittee to another permittee pursuant to permit to purchase, Form 1410. Full instructions for the procurement and shipment of such intoxicating liquor under permit to purchase, Form 1410, will be found in article 8 of Regulations 60.

It is illegal to possess, except in the home, cider containing one-half of 1 per cent or more of alcohol by volume without a permit. If a person purchases cider for commercial use containing less than one-half of 1 per cent of alcohol by volume and such cider later develops a greater alcoholic content than permitted by law, the person so possessing such cider in good faith may apply for a permit to dispose of the same to another permittee as above provided.

SWEET CIDER CONTAINING LESS THAN ONE-HALF OF 1 PER CENT OF ALCOHOL BY VOLUME.

Where the alcoholic content of sweet cider is kept at all times below one-half of 1 per cent by volume the manufacturer or vendor is not required to give bond or secure a permit either to ship or sell.

Such sweet cider, however, should be sterilized or preserved, and be put up in sterilized glass bottles or other similar closed containers, to insure the alcoholic content remaining less than one-half of 1 per cent by volume until consumption. Cider containing less than one-half of 1 per cent of alcohol by volume put up in closed containers by the manufacturer for sale as a soft drink is subject to a sales tax of 10 per cent of the sales price under section 628 of the revenue act of 1918.

Manufacturers who sell sweet cider in bulk containers, such as barrels, for use as a soft drink must pay the tax thereon and are held responsible for preserving and marketing it in such manner as will insure the alcoholic content remaining less than one-half of 1 per cent by volume until consumed. If such cider is found upon the market containing one-half of 1 per cent or more of alcohol by volume, the burden of proof is upon the manufacturer to show that such liquid contained less than one-half of 1 per cent of alcohol by volume at the time it was manufactured or sold by him or withdrawn from the place manufactured.

Sweet apple cider containing less than one-half of 1 per cent of alcohol by volume may be sold in bulk containers, such as barrels, for use in the manufacture of vinegar or apple butter without payment of tax thereon, but the vendee must furnish a written order showing the kind and quantity to be furnished and that the alcoholic content is to be less than one-half of 1 per cent by volume, and the names and addresses of the vendee and vendor, respectively. These orders must be permanently filed by the vendor in alphabetical order and be open to inspection by internal revenue and prohibition officers. A label showing the same data as the order must be affixed to each container. The entries covering such sales on the records required to be kept and the returns to be made, if any, by regulations 52 and 53, respectively, pertaining to soft drinks, should be in red ink.

Sweet cider direct from the press may be sold to customers by the glass or in other open containers without payment of sales tax, provided that it is not mixed or compounded with any other ingredient and is sold for consumption at the place of business or in proximity to such place of business.

Farmers or other persons, without obtaining permit or giving bond, may take fresh apples or other fresh fruit to a commercial mill for the purpose of having the juice expressed therefrom, and such fresh juice of the fruit containing less than one-half per cent of alcohol by volume may be removed for use in the home exclusively.

Dried fruits, such as raisins, may not legally be used in the manufacture of such nonintoxicating fruit juices exclusively for use in the home.

Full information on these subjects may be obtained from the Federal prohibition directors of the various States.

Treasury Decision 3077. Approved October 7, 1920. Commercial cider—National prohibition act of October 28, 1919. The burden of proof as to alcoholic content at the time of manufacture or sale is on the manufacturer.

To Supervising Federal Prohibition Agents, Federal Prohibition Directors, and Others Concerned:

Section 36 of article 5 of regulations 60 is hereby amended to read as follows:

SEC. 36. Sweet cider containing less than one-half of 1 per cent of alcohol by volume may be manufactured and sold without the necessity of obtaining permit, provided such product is put up and marketed in sterile closed containers or is treated by the addition of benzoate of soda, or other substance which will prevent fermentation, in such proportion as to insure the alcoholic content remaining below one-half of 1 per cent of alcohol by volume. The responsibility for keeping the alcoholic content below such percentage rests upon the manufacturer, and in any case where cider is found upon the market containing alcohol in excess of the allowed percentage the burden of proof rests upon the manufacturer to show that such liquid contained less than one-half of 1 per cent of alcohol by volume at the time it was manufactured or sold by him or withdrawn.

In instructions (Pro. Mim. 5) issued on November 3, 1919, there is a paragraph regarding the manufacture of vinegar which reads as follows: "The manufacture of cider for conversion into vinegar is permissible, but sugar or other fermentable substance should not be added to the apple juice for the purpose of increasing the alcoholic content under any circumstances, since this is held to be the manufacture of 'a mash fit for distillation' and is prohibited by section 3282, Revised Statutes, as amended." Also the statement "the home manufacture of vinegar from cider or fruit juices will not require a permit unless such vinegar is made for sale."

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