large wineries are equipped with special coils in the vats which may be used. In any case, the manufacture of white wine, on account of its lower acid and tannin content, and on account of its slower fermentation requires greater care than does the manufacture of red wine.

Aging and Racking.—In these processes again, greater precautions are necessary for white wine than for red, and the racking must be performed a greater number of times and at shorter intervals to ensure health in the delicate constitution of the white wines. Similarly pasteurization is almost obligatory for the lighter white wines prior to bottling.

Correction of Wines.—From the time the grapes are crushed until the wine is bottled any number of inherent deficiencies may appear or new troubles and diseases may develop. It is the object of the correction of wines to so alter the deficient or diseased character that a normal wine results. Very many treatments have naturally been developed as part of the wine-makers' technique, for this purpose. Most of them are of limited or occasional application, but there are four or five which are very generally required. These include the correction of deficient sugar, acidity, and tannin, and the fining of wine.

When the grapes are crushed a portion of juice is tested for its sugar and acid content. A proper sugar content should be between 20 and 28% and a deficiency requires only a simple calculation and the addition of the calculated amount of ordinary cane sugar.

The normal acidity of the juice should be 0.5-1.5% expressed as tartaric. It was formerly the practice to correct low acidity by the addition of calcium sulphate, Plaster of Paris. Hence the operation is called "plastering the wine." This treatment has the advantage of ease since an excess of plaster may be added and comparatively small amounts as required will react. The reaction takes place as follows:

\[
\text{Potassium}
\]
\[
\begin{align*}
\text{Calcium Sulphate} & \quad \text{Cream of Tartar} \\
\text{(Insoluble)} & \quad \text{(Insoluble)} \\
\text{CaSO}_4 & \quad \text{KH(C}_4\text{H}_4\text{O}_6) \\
\text{Calcium Tartrate} & \quad \text{Acid Sulphate} \\
\text{(Insoluble)} & \quad \text{(Soluble)} \\
\text{Ca(C}_4\text{H}_4\text{O}_6) & \quad \text{KHSO}_4
\end{align*}
\]
The effect, therefore, is to increase the amount of acid in solution. On the other hand, the practice is undesirable since the dosage cannot be measured readily and also because it may result in the presence of sulphates in excess of the legal limits in the wine (corresponding to 2 grams of potassium sulphate per liter 0.2%). It is easier to correct deficient acidity by blending with a juice of excess acidity or by the addition of a properly determined and calculated dose of tartaric acid.

Excess acidity within reasonable limits is not important since on aging the excess will precipitate as cream of tartar. However, a new wine with excess acidity is harsh and matures slowly. There are two procedures which may be employed to correct excess acidity. These are called respectively "gallizing" and "chaptalizing." Gallizing consists in diluting the must with water and adding either grape or cane sugar to correct the deficiency in sugar which results. Within narrow limits it is a harmless practice, but naturally, the other essentials of the wine are equally diluted and a more watery wine results. Chaptalizing consists in partly neutralizing the acid with chalk and adding sugar. This is usually done with grapes that are insufficiently mature. Like gallizing it is not objectionable if practiced in great moderation.

Few red wines need treatment for insufficient tannin since they ferment over the seeds and skins and possibly some stems so that they have ample opportunity to acquire the tannin they need. White wines, on the other hand, are almost invariably deficient in tannin as the pressing immediately after the crushing offers no opportunity for extraction. The amount of tannin required in the finished wine is very slight, most of the excess being consumed in precipitating the albuminoids of the freshly fermented wine. However, the presence of tannin helps ensure a sound fermentation and to clarify the wine afterward, so that a slight addition of tannin, say one part to 20,000 of white wine must is unobjectionable and almost invariably beneficial.

Fining.—One of the qualities especially desired of wine is clarity in the highest degree. The various suspended solids which interfere with this clarity may settle out during aging and be removed in racking. Indeed, it has been stated that frequent
racking of wine is practically the equivalent of both filtration and sterilization. However, it often happens that the solids are so finely divided that they do not flocculate or clump together in sufficient mass to settle out. When this happens the wine remains cloudy unless an agent is added which will assist the flocculation and settling. This operation is called "fining." There are a number of materials which are adapted for this purpose all of them being gelatinous in nature. That is, they first dissolve in the wine, then gradually they combine with the tannin, to form insoluble tannates which entrap the other solids dispersed in the liquid and cause the whole to settle to the bottom. Milk is used for this purpose, especially for wines deficient in tannin as the milk casein requires only acidity to cause it to change from a dissolved to an insoluble state. More commonly gelatin, egg white, and isinglass are used. Mechanical filtration, refrigeration, and centrifuging are all coming into use to effect clarification of the wine.

Bogue, The Chemistry and Technology of Gelatin and Glue, (1922, p. 355) discusses as follows the use of isinglass for fining:

"The efficacy of the isinglass for this service lies in the purely mechanical property it possesses of maintaining a fibrous structure in the solution, and as this settles slowly to the bottom it entangles in its netlike meshes the colloidal bodies that produce the undesirable turbidity. For clarifying wine the isinglass is first swollen in water and then in the wine until it is completely swollen and transparent. It is then thoroughly beaten into a small amount of the wine, strained through a linen cloth, and stirred into the rest of the wine. The temperature is kept low and the isinglass does not go into solution, but only into a very finely divided suspension. Thus the original fibrous structure of the sounds has at no time since it came from the fish been lost. In this lies the difference in the action of isinglass and gelatin for fining. If isinglass were heated and made into a true gelatin it would then have lost the properties which make it so valuable for this service."

A single ounce of isinglass will clarify, under the optimum conditions, 500 gallons of wine in 10 days. One ounce of gelatin will clarify 50-120 gallons of red wine. The white of an egg will fine about 10 gallons of red wine. This last material is chiefly used with only the highest quality of wine.
Finings may be prepared as follows:

**Gelatin**

Cover with wine and soak a few hours or overnight. Dissolve by gentle heating, cool and dilute with more wine. Mix thoroughly and add with stirring to the wine in the cask.

**Egg White**

Beat to a foam. Allow to settle and filter through heavy linen. Stir up with a small amount of wine and add with stirring to the wine in the cask.

**Champagne**

*General Statement.*—Champagne is a sparkling wine of fine flavor and fragrant bouquet. Its effect upon the human system is the production of rapid, but transient, intoxication. Medical authorities have stated that fine, dry champagnes are among the safest wines that can be consumed. Champagne is said to have valuable medicinal properties and to be of definite benefit in the treatment of neuralgia, influenza and a run-down condition.

About the time of the Civil War pink or rose-colored champagnes were fashionable; the color being obtained by tinting with a small amount of a dark red wine. Today, a straw color is favored and that is the color of all current commercial champagnes. Occasionally, a pinkish wine is met, which owes its color to partial extraction from the grape skins and is the result of accident rather than design.

Champagnes are made dry or sweet, light or strong according to the markets for which they are designed. A dry champagne, of good quality and fragrant bouquet, free from added spirit, is made from the best vinbrut, to which a very small amount of liqueur has been added. Sweet champagne receives a heavier dosage of liqueur, which hides its original character and flavor, and therefore can be made from wine of less delicate flavor.
The dosage of champagne with syrup (liqueur) materially contributes to its sparkle, effervescence and explosiveness. It is not true, however, that the heavier the dosage the better the wine. Too heavy dosage causes an accumulation of carbon dioxide in the space between the wine and the cork and such a champagne explodes loudly and effervesces turbulently when the cork is withdrawn, but soon becomes flat and loses the characteristics one looks for in a good wine. On the other hand, a fine dry wine does not explode so violently, nor effervesce so turbulently, because it acquires its sparkle to a large extent from the natural sugar of the grape. This holds the carbon dioxide somewhat more firmly within the wine and so it continues to sparkle for a much longer time. While this helps it to hold the characteristics of a good wine for a longer period, it is only fair to say that a good champagne should retain its fine flavor even after the carbon dioxide is exhausted.

Russia and Germany prefer sweet champagnes and twenty or more per cent of liqueur in the wine is not unusual for the latter country. England buys very dry, sparkling wines, having about one-fourth the amount of dosage given wines intended for Germany. France, herself, prefers light and moderately sweet wines. The United States used to buy a wine of intermediate character before prohibition. Australia and South Africa like their champagne strong, while India and China and all hot countries favor light dry wines.

Champagne is made in Germany and the United States, but France is commonly considered the home of this king among wines. The heart of the industry is in the Department of the Marne and centers around the cities of Reims, Epernay, Ay, Mareuil, Pierry, Avise, and to a lesser extent, Chalons.

The best American sparkling wines come from the Finger Lake district of New York, and the Ohio region around Cincinnati. Very little sparkling wine was made in California before prohibition, but the industry is now being developed there.

Apart from incessant labor, skill, care and precaution the fine quality of French champagnes is attributed to the climate (which imparts a delicate sweetness and aroma, combined with finesse and
lightness to the wine) and to careful selection of the vines, of which four types are cultivated, three of them yielding black and one white grapes. The soil is also said to impart a special quality which it has been found impossible to imitate in any other part of the earth. Claims are made that to the wine of Ay it imparts a peach flavor, to that of Avenay a strawberry flavor, to that of Hautvillers a nutty flavor, and to that of Pierry a flint taste known as the “pierre à fusil” flavor.

**Manufacturing Process.**—Figure 40 is a graphical presentation of the process of champagne manufacture. It will be noted that the early stages of the process are similar to those of white wine manufacture excepting that the juice of the first pressing is kept apart for first quality wines. Second and third pressings...
are given, but the wine made from second or third juices is inferior.

Following pressing the must is drawn into large vats and allowed to rest for 24 hours so that some settling of the sediment can take place.

It is then transferred to sterilized casks of about 40 gallons capacity. The cask is filled to about nine-tenths of its capacity, and the bunghole is generally covered with a vine leaf held in place by a small stone.

The must is then taken to one of the large underground caverns or cellars where a temperature of 60° to 70° F. usually prevails. The cask is bunged up, primary fermentation sets in and is almost completed in about two weeks to a month depending on whether the wine is high or low in sugar. At the proper point, as explained under red wine manufacture, primary fermentation is arrested by filling the cask up to the top, bunging it, and transferring it to a cooler cellar. Here a secondary and slower fermentation sets in. The object of this treatment is to preserve some of the sugar unsplit in order to insure to the wine its future effervescent properties.

About the third week in December the wine is racked and fined and then blended (cuvée) in large vats of about 12,000 gallons capacity. An agitating device worked by hand insures proper mixing of the wines. The proportions of the blend are never irrevocably standardized but about 80 per cent by volume of black grape wine to 20 per cent of white grape wine is average practice. The vintages of Bouzy and Verzenay are supposed to impart body and vinosity; those of Ay and Dizy softness and roundness; and those of Avize and Cramont lightness, delicacy and effervescence. Some blenders prefer a one-third mixture of vintages of Sillery, Verzenay and Bouzy, one-third of Mareuil, Ay and Dizy, and one-third Pierry, Cramont and Avize. Others advocate an equal mixture of Ay, Pierry and Cramont.

At this stage the important question arises of how much present and potential carbonic acid gas the wine contains. If it is too high in sugar and gas, there will be trouble because many will be lost after the bottling by explosive shattering of the
Fig. 41.—The vintage in the champagne: a wine press at work. (From Vizetelly. The History of Champagne, Henry Sotheby & Co., London.)
bottles and the cellars will be flooded. On the other hand, if sugar and gas are low the wine will not sparkle properly and the corks will refuse to pop.

The cuvée is, therefore, tested by means of a glucometer for sugar and if it registers low the addition is made up by sugar-candy. If it is high it is necessary to re-ferment it in a cask until it reaches the right condition.

The cuvée is now fined with isinglass and some tannin is added to offset ropiness and other defects. It is casked and allowed to rest for a month. If by that time it has not become clear and limpid, it is racked off, re-fined and allowed another month to settle. In some of the largest establishments, mechanical fining or filtration is now used.

The cuvée is put into new bottles (tirage). These are usually new, very strong, and weigh about 2 lbs. apiece. The pressure developed by the wine is such that the bottle is always weakened. It is, therefore, made of special glass which cannot liberate any alkali to act upon the wine and spoil it.

The tirage is accomplished by running the wine into vats from which it flows into oblong tanks provided with a row of syphon taps, at which the bottles are filled. The taps automatically close and stop the flow as soon as the bottle is full.

Next, a culture of selected pure yeast is often added and the bottles are corked, the corks secured by an iron clip (agrafe) and the pressure within the bottle determined by an instrument consisting of a sort of pressure gauge fitted with a hollow screw at the base. The screw is driven through the cork and the pressure in atmospheres registers on the gauge. A "grand mousseaux" represents a satisfactory wine. It has a pressure of 5 3/4 atmospheres and can safely be stored away in one of the cold subterranean caverns. If the pressure is about 4 atmospheres it is advisable to store the wine above ground until fermentation raises its pressure. If the pressure is less than 4 atmospheres it is advisable to put the wine back in a cask, add cane sugar and ferment further.

The temperature of the cavern is about 50° F., and must be kept as constant as possible to avoid too great changes in
Fig. 42.—The tuage or bottling of champagne. (From Vizetelly, The History of Champagne, Henry Sootheran & Co., London.)