HEAT is the principal agent of distillation. The general laws regulating its action on material substances constitute an interesting study, for which the reader is referred to any of the scientific books on the subject.* It is sufficient to say here that it is capable of being transmitted by conduction through the substance of bodies which are called good or bad conductors according to the facility of the transit, and that it passes from one body to another either by contact or through the surrounding atmosphere by radiation. There is a tendency among all bodies to acquire an equilibrium of heat by giving it off, or by absorbing it, as the case may be.

By its power of penetration it overcomes the cohesive force which exists between the atoms of matter. By its accumulation in the body of a substance these effects are shown by the dilatation, which progresses until the solid becomes a liquid, and the liquid is finally converted into gas or vapor.

By the abstraction of heat contrary effects are produced. This may be seen in the example of water, which is so readily presented under the three forms of ice, water, and steam, as increase or diminution of this imponderable force may determine.

The following table will exhibit the boiling point of different liquids in degrees of the centigrade thermometer:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Boiling Point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphuric ether</td>
<td>350.5</td>
</tr>
<tr>
<td>Pure alcohol</td>
<td>780.4</td>
</tr>
<tr>
<td>Alcohol of 90% strength</td>
<td>800.1</td>
</tr>
<tr>
<td>&quot; 85% &quot;</td>
<td>850</td>
</tr>
<tr>
<td>&quot; 80% &quot;</td>
<td>850.3</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>305</td>
</tr>
<tr>
<td>Linseed oil</td>
<td>315</td>
</tr>
<tr>
<td>Pure water</td>
<td>100</td>
</tr>
</tbody>
</table>


We have already said that bodies have a tendency to acquire an equilibrium of heat, and that the transfer from one body to another is made by contact. The greater the number of points of contact the more rapid will it be effected.

It is, therefore, easy to conceive that in subjecting a liquid to the action of caloric in a still, it will be heated more rapidly in proportion to the number of points of contact presented to the source of heat and to the conducting power of the material of which this vessel is made. For this reason a still should be broad and shallow if it is destined to evaporate its contents rapidly.

Heat for practical purposes is derived from the combustion of various kinds of fuel. Much of the useful effect to be derived from the combustion depends on the construction of the furnace where it is effected, and in which the heat is applied to the different bodies to be heated.

The heat for reducing liquids to the form of vapor is applied directly over the open or naked fire, or indirectly, that is, by steam and the water or sand bath.

Heating by the naked fire.

Distillation over the open or naked fire consists in effecting the combustion directly underneath the still. This method of heating is most usually employed in operations on a small scale.

The management of heat with the open fire requires much skill on the part of the distiller, especially when semi-liquid substances are to be distilled—as the marc of grapes, cherries, &c. The degree of heat is quite difficult to fix and to be equally kept up, for, when a small addition of fuel is made to the fire, the heat may pass all at once from the condition of being too low to that of being too high, and the distillate may contract an empyreumatic flavor.

An unequal distribution of heat with the open fire often presents the inconvenience of altering the product more or less. The liquid dries, and burns the upper
parts of the still, or, rather, some of the solid matters submitted to distillation attach themselves to the sides, and, by opposing an obstacle to the passage of the heat, favor its accumulation at such points; the product, under such circumstances, will inevitably contract a burnt flavor.

Heating by Steam.

The inconveniences which have just been pointed out in the use of the naked fire disappear entirely where steam heat is applied for purposes of distillation. There is, too, great advantage in its use.

These advantages may be summed up as follows:—
1. Economy of fuel—since it permits all the operations of the distiller to be conducted by the use of a single furnace, when otherwise each one would require a separate fire.
2. Economy of labor, and consequently greater facility of personal supervision.
3. Perfect regularity in the temperature necessary for the work.
4. And as a consequence of this regularity of temperature a superiority in the quality of the product.

It is admitted that most liquid bodies may be transformed into vapor. This change is called in general evaporation; it is silent when the vapors are formed at the surface of the liquid without any movement therein. When the vapors escape tumultuously the phenomenon is called ebullition or boiling. The latter only concerns us.

Ebullition, is the tumultuous evolution of steam which is formed in the body of a liquid and escapes in bubbles at the surface.

When any liquid contained in a vessel is submitted to the action of heat, a certain time elapses before the ebullition begins; this time is necessary for the vapor to acquire, by increase of temperature, a sufficient elastic force to overcome the pressure of the atmosphere; the boiling point depends on this pressure; in proportion

as it is diminished the temperature necessary to cause ebullition is also diminished. In a vacuum ebullition is independent of the temperature. It begins instantly, and continues until the vacuum is filled, and then ceases.

The heating of liquids, or materials to be distilled, is effected by several methods. When, without inconvenience, they can be mixed with water, the steam is admitted directly or by injection. This is used for semi-fluid substances, or for the distillation of substances in the large Belgian or column stills. But generally with the simple or continuous stills, arranged by Derosne, Egrot, etc., rectifying stills, etc., the liquids are heated by conduction from the steam, that is to say, by causing a current of steam to circulate in it through a tube usually arranged in a coil. Or the steam may be admitted into a jacket (or envelope) surrounding the still, or into a double bottom; these last are used only by the spirit distiller.

We would recommend that the greatest caution should be observed, in admitting steam into any apparatus, to open the steam-cocks slowly, so as to avoid too great and sudden condensation in the pipes, which will occasion detonations and shocks which injure the joints of the pipe and cause leaks.

Those who are desirous of acquainting themselves with the calculations for the force of steam boilers for heating purposes, are referred to the catalogue of H. C. Baird for several valuable books on the subject of the steam-engine and its applications.

Note.—The use of the water and sand-baths being confined to another branch of the art, the consideration of them is deferred until we treat of distilled waters, etc.
CHAPTER V.

SOME CONSIDERATIONS UPON DISTILLATION AS APPLIED TO ALCOHOL.

A distilling apparatus to be profitable should be so constructed as to be able to heat the liquid rapidly, and to evaporate and condense it with facility. We may now add, as a sequel to these principles, that it is necessary, 1st, to heat at the same time, and equally, all parts of the mass subjected to distillation; 2d, to remove any obstacles that may interfere with the ascent of the alcoholic vapors; 3d, to effect the condensation promptly in order to prevent a portion of these vapors from escaping in the gaseous state.

In order to obtain the first of these conditions it is necessary, in the first place, that the mass of liquid should be of little depth, and should present a large surface; that the heating, whether by the naked fire or by steam, should be conducted with intelligence and care, so as to maintain the stream of the distillate of regular size, and in order to avoid shocks.

The ascent of the alcoholic vapors always goes on satisfactorily when the first condition is fulfilled, but care must be taken in a continuous distillation not to turn the wine or fermented must into the apparatus before it has acquired a temperature of at least 80° Cent., for if the wine be cold or only tepid the operation will be interrupted.

The alcoholic vapors are always promptly condensed when the liquid contained in the cooler is sufficiently cold, that is to say, does not exceed a temperature of 18°; nevertheless the vapors should not come over in such great abundance that the condensed liquid will be warm.

ACCIDENTS OF DISTILLATION.

The following accidents may occur during the course of an operation:—
1. Leaks in the apparatus.
2. Insufficient exhaustion of the spent liquor.
3. Imperfect condensation of the alcoholic vapors.
4. Fires.

Leaks in the Apparatus.—When the joints of the apparatus are not well made, or when the screw taps or bolts are not tight enough, there will be an escape of alcoholic vapor, which will occasion more or less loss, and may be the cause of fire. The accident may be easily prevented by being careful to apply between the joints a cement of white and red lead mixed with oil, and to examine the taps and bolts occasionally to see if they are tight enough.

Some loss of liquid or vapor may occur when there are cracks in the soldered joints necessary to the adjustment of the coils, wine-heater, and cooler; but in this case the liquid which flows into the proof bottle will be sensibly lowered in strength, and will at once indicate what is going on in the apparatus.

Insufficient Exhaustion of the Spent Liquor.—The liquid which has been subjected to distillation, that is to say, the residuum which results from this operation, is called spent liquor.

The insufficient exhaustion of the spent liquor can only occur when we distil too quickly the quantity of liquid which should be distilled in a given time, or when the apparatus used is defective. This last danger of loss will disappear by using the apparatus we have described.

Testing the Spent Liquor.—We ascertain whether the liquid submitted to distillation contains any more alcohol, as follows:—

We open the air-cock, placed on the top of the still, containing the liquid to be examined; a small quantity of vapor escapes, to which a lighted match is applied; if it takes fire it is evident that the spent liquor still contains a certain quantity of alcohol.
If, however, there should be any doubt about this test, it may be better to use the following:—

Connect the air-cocK, by means of an India-rubber tube, with a small cooler similar to that of a test-still; open the cock half way, and the vapor will be condensed into liquid within the coil. This product when collected is tested in two ways: first, by throwing a small quantity on the top of the still, and applying a lighted match; if it burns, the exhaustion is not complete; second, by plunging into the liquid an alcoholmeter; if it marks two or three degrees, it is proof that the liquid contains more alcohol, and distillation must be continued until the liquid marks zero, then we may be certain that it is despoiled of its alcohol.

Imperfect Condensation of the Alcoholic Vapors.—This accident may happen when the liquid of the cooler is not sufficiently cold, or rather when, in consequence of a shock, there is disengaged so great a quantity of alcoholic vapor that a part will escape in a gaseous state, while the other part flows into the proof bottle in the form of a hot liquid. The first cause readily disappears by taking care that the cooling liquid, as has already been said, does not exceed 18° in temperature, or by replacing the wine in the cooler by water; in this case the wine passes directly into the wine heating condenser. The second takes place only when the fire or steam is pushed too actively. By regulating the heat this accident is prevented.

Fires.—A distillery should be so arranged as to avoid all chances of conflagration. With this view the alcoholic products of the distillation ought to be received in reservoirs of iron, or tanks of oak lined with tinned copper, hermetically closed, and if possible in a separate place. The spirits that are rectified, or are ready for consumption, ought also to be placed in a special store. Leaks of the apparatus, and the imperfect condensation of the alcoholic vapors, may frequently become the cause of fire, these vapors being exceedingly inflammable. The smallest flame is sufficient to set them on fire, and when a room or building is filled with this vapor the explosion which follows is truly terrific.

The same accident may occur from the escape of the ethereal vapors, which are produced at the beginning of a distillation, or during rectification.

All danger of fire is avoided by being careful not to enter, with a candle, a place where distilling is carried on, or where spirits are stored, without using a lantern—the use of Davy's safety lamp is to be preferred. The lamps necessary for lighting the establishment should be inclosed by glass or mica, and finally, if it is possible, to distil only during the day, the risk will disappear almost entirely.

CHAPTER VI.

DISTILLATION OF ALCOHOL.

Now that we have explained the theory of the general principles of the distillation of alcohol, it becomes our province to set forth the rules for their practical application; for the connection between theory and practice is indispensable, and it is vain to separate them. The operator who is not guided by theory is like a blind man who walks without seeing his way. Practice is action; theory explains the why and wherefore it is done; it indicates the means to be employed to insure success, as well as those to which we must have recourse to surmount obstacles which might prevent its attainment.

We set up no claim, in order to arrive at the end we have in view, to fix limits to the progress of distillation. We believe, on the contrary, that there is much yet to be learned. We have made, since we have practised the art, some interesting and valuable observations, founded on science and work, which have proven to us that the actual state of our knowledge in regard to distillation
90 DISTILLATION OF ALCOHOL.

is far from being perfect. Moreover, every day brings new discoveries to enlarge the circle of our knowledge! Be this as it may, we shall explain in simple terms all the operations which are practised in our day for the production of the different kinds of ardent spirits which are found in the market. We shall add to these the results of our own experience, which, we are persuaded, ought to be taken under consideration.

Spirits of Wine (Alcohol from Wine).

The distillation of wines is one of the most fruitful sources of prosperity to France, and its development in the United States may yet lay the foundation for a branch of trade which will render great aid in restoring to its originally prosperous condition a portion of our beloved country, so lately prostrated by intestinal strife.

The manufacture of all kinds of liquids, capable of yielding alcohol, being of necessity the province of the distiller, we shall devote some space to the mode of preparing wine from grapes. The limits of this work do not permit us to enter into all the details of this interesting subject, and for more extensive information our readers are referred to special treatises, of which there are many.

WINE.

Wine.

Among the fruits which contain the elements necessary for the vinous fermentation the grape occupies the first rank. It has within itself the sugar, the water, and the ferment in the most suitable proportions. These substances are, however, variable according to the climate and changes of seasons; nevertheless it is these, added to a bouquet or peculiar aroma, which constitute that valuable liquor, known as wine, and its infinite varieties.

France, situated almost in the centre of Europe, is, by its topographical position, and by the nature of its soil, the richest country in vines, and that in which they best succeed. In the plains and on the mountains, here in the sand, there among the rocks, and everywhere vineyards, old or new, yield their choicest products. That which especially distinguishes the French wines is their bouquet, their delicate flavor, and that valuable lightness which renders them inoffensive and superior to all foreign wines.

In many parts of the world wines are made, of uncontestable merit, but which, nevertheless, generally fatigue the organ of taste, and which impress on the nervous system a state of excitability often dangerous; sometimes it is from their extreme tarmness; sometimes a flat and unsavory flavor, which is caused by an excess of sugar and the ropiness of the liquid; and sometimes from the harshness resulting from an excess of alcohol. In France there are innumerable varieties which answer to all the fancies of the most capricious taste, of a good color, a generally irreproachable limpidity, strength, fineness, mellowness, bouquet, delicate and light aroma, and a gracious perfume, which flatters, charms, and soothes the nerves, but rarely injures, except when abuse is mingled with their enjoyment.

Vintage.—The name applied to the season of the grape harvest, and the various labors necessary to the manufacture of wine.

The vintage calls for the preparation of many details. We should be careful to provide the number of puncheons or hogsheads for which we may judge that we shall have need, to have them gauged and in good order, to make the necessary repairs to the press and vats, to have ready wooden shovels, iron forks, tubs and buckets of wood, funnels, panniers, and baskets.

We ought to await the perfect maturity of the grapes before gathering, otherwise the wine will be sour, and keep badly. The true period of this maturity is when the berry begins to soften and falls at the slightest touch, when the stem becomes brown, and the expressed juice is sweet and sticky. The ripeness of the white grape is recognized by the transparency of the berry, its sweet taste, and by its brown spots.

Grapes should be gathered as soon as possible after the dew has disappeared, using for the purpose the scis-
sors or shears. The knife jars the bunches, and causes the best berries to fall off. It is proper to handle them with care, so as not to bruise them, and to transport them to the place where the wine is to be made without jolting them.

Crushing.—In order that it may yield a vinous liquor it is necessary that the grape should be crushed, to the end that its proximate elements may be brought into more intimate contact; for there would not be any alcohol in the berry if left to itself; unless it be torn it will wither, dry up, and be decomposed without undergoing a regular and complete vinous fermentation.

There are many ways of crushing the grape—each country has its own. The following appears to us to be the best:

We use a square box, open at the top, the bottom pierced with holes; it is placed on two pieces of wood, which rest on the edges of the vat; within this box a vintager places himself, and tramples the fruit with his great sabots; the expressed juice flows into the vat; then, by a sliding side-gate, he causes the marc to fall into the vat; this is thrown into another vessel, if the must is to be fermented alone. The crushing goes on as described until the vat is full.

The crushing in the fermenting vat, directly, as is done in some countries, is highly objectionable; a great part of the berries not being mashed, it follows that the sugar and ferment contained in them, although floating in the liquid in full course of fermentation, will remain untouched because still inclosed in their cells, and when the grapes are pressed these berries yield a juice which will ferment in the hogshead.

It is a question among wine makers whether it is proper to stem the grapes, but all doubt ceases when it is fairly examined. The stems containing, in fact, neither aroma nor saccharine matter, contribute nothing to the strength or the bouquet of the wine. Then, if the grape is not in a state of complete maturity, either from want of heat, or because the vintage has been hastened by frosts, or from any cause whatsoever, the stems can only contribute, by their acidity, to increase that produced by the grape in this condition.

But, on the other hand, there are feeble and almost insipid wines, such, for the most part, as come from humid climates, in which the slightly acid taste of the stems relieves the natural flatness of this drink. It was so in Orleans, that, after having commenced to stem the grapes, they were forced to abandon it, because it was observed that the grapes which were stripped from the stems furnished a wine which very easily became ropy.

It has been also observed that the stems of the grape increase and regulate the fermentation of the must; that they give to the cap a degree of permeability necessary to the escape of the carbonic acid, in such a manner that the stems may be considered as an advantageous ferment in all cases in which it may be feared that the fermentation will be slow or incomplete. They contain, too, an astringent principle which contributes to the preservation of wines containing a small quantity of alcohol.

At all events stemming is but little practised, except in two-fifths of our wine-growing departments, or by some large proprietors, who take the greatest pains to obtain wines of the best quality.

Vetting.—The grapes, after being crushed, are to be turned into the vat; a vacant space of 20 or 25 centimeters is left, because of the increase of volume which occurs in the mass in consequence of the heat developed during fermentation and the escape of carbonic acid gas. The vat is then covered, and fermentation suffered to go on.

The vats for the vintage are of oak, and are round; they are brought together and strengthened by wooden hoops, but iron hoops are better, as they are more solid. The contents vary from 20 to 25 hectolitres; they should be larger at the bottom than at the top; they rest ontrustles, and are furnished with a stopcock for racking. Vats of masonry are preferable for the proprietors of large vineyards, especially when the wine is intended for distillation. They may be heated before being filled.
The plastered lining of these vats has a sensible action on the wine only the first year.

Chemical Composition of Must.—The recently expressed juice of the grape is called must. It is a sweet liquor, agreeable to the taste, which contains no alcohol, but only those elements which are proper for its development and the formation of wine.

In order to explain the phenomena which take place within the vat during the fermentation, it is necessary to make known the composition of the must or juice of the grape. We find in it cellulose, water, glucose or grape sugar, pectic acid, malic acid, tannin, vegetable albumen, an azotized substance called albumen or gladi dine, and which appears to produce the ferment, an essential oil, a violet-colored substance situated under the skin of the grape, fatty matter, acid tartrates of potash, lime, and alumina, sulphate of lime, and chloride of sodium. Of all the substances which are found dissolved or suspended in the must, the most important is the glucose or grape sugar; the other substances are but accessories.

Fermentation.—The grapes having been disposed as described above, the fermentation will in a few days have established itself, the mass becomes heated, bubbles of carbonic acid are disengaged so abundantly as to present the appearance of ebullition; they raise the solid debris of the fruit, and a thick scum consisting especially of altered ferment, in such a manner as to form by degrees on the surface of the liquor a hemispherical crust which is called the cap. But very soon the effervescence is calmed down, and the cap subsides. The vat is now stirred so as to mix all the materials and revive the fermentation. When the liquor ceases to effervesc, when it has acquired a vinous taste, and has become clear, it is drawn off into hogsheads. It now bears the name of wine.

The fermentation is feeble when the temperature is cold at the season of the vintage; heat being, as we know, one of the primary conditions of the vinous fermentation, it is necessary in order that it may go on properly that the cellar in which the wine is made should have a constant temperature of 15° Cent., and of course that the fruits should be at the same degree. This result is attained by heating the cellars with stoves and allowing the fruit to remain uncrushed until it has acquired the temperature of the place. We can, too, produce the proper temperature by drawing off a portion of the must, and heating it nearly to the boiling point and returning it to the vat.

When the progress of the fermentation is not diminished, it is unnecessary to stir or plunge the cap into the wine. In any event, instead of sending naked men into the vat (which is both nasty and dangerous, asphyxia often resulting from the carbonic acid gas generated during the process), it is better to depress the cap by a wooden plunger with a long handle.

A majority of wine growers prefer the open vats; this was the method of our fathers. Although the loss which takes place in open vats has been greatly over-estimated (since Gay-Lussac has shown that it does not exceed the half of one per cent. of alcohol), it is better to cover them. Indeed, in the open vats, if the atmosphere is dry and warm, the cap becomes dry and the air penetrates it; and if the fermentation is prolonged, acetic acid will be formed, and when the cap is mixed with the mass by stirring, it will communicate to the wine a disposition to assume the acid fermentation. If the air is cold and moist, the upper surface of the cap will absorb water which will dilute the grapes, and cause the development of the acid or putrid fermentation and incipient mouldiness.

Fermentation in closed vats combines the following advantages. The interior temperature is maintained, and the must before beginning to ferment ripens. The green fruit thus attains a degree of maturity similar to that which would have occurred on the vine if the season had been favorable. The air has no influence, the evolution of carbonic acid is retarded, and the wine may be left for a longer time in contact with the marc without...
out any other inconvenience than the solution of the elements of the stem.

Improvement of Must.—When the season has been cold or rainy, or the grape has been grown on moist lands, the must contains too much water of vegetation, and too little sugar. In this case, in order that the fermentation may not be irregular, slow, and often incomplete, and that the product which results may not be deficient in alcohol, it is proper to restore the proportion of the elements by diminishing the water by artificial evaporation.

This operation not only restores the normal proportions of the elements of the must, but facilitates the clarification of the wine if it is not pushed too far. It must be remarked, however, that must which remains too long over the fire loses its fermenting properties. This phenomenon is to be attributed to the coagulation of a part of the albuminous, glutinous, and extractive molecules contained in the must.

The most natural means and those most in accordance with the principles of wine-making, in order to counteract the excess of water in the juice of grapes or other fruit, are to add some saccharine substance to the must; at the same time that we supply this defect in the work of nature, correcting the imperfect composition of the must, we supply to that liquid the quantity of sugar which would have been developed if the season had been more propitious: we do more; we produce at will the must of the south or of the north.

"Generally," says Chaptal, "when the grape ripens, the sugar and vegeto-animal principle (ferment) exist in proper proportions to undergo a perfect and regular fermentation, but when the season is moist or cold, the sugar is deficient, the mucilage is in excess, and the product of the fermentation is wanting in alcohol. In this case the small quantity of alcohol developed is not sufficient to preserve the wine from spontaneous decomposition, and on the return of warm weather a second fermentation is set up which decomposes the liquor and converts it into vinegar.

"This unprofitable result may be obviated by correcting artificially the imperfect composition of the must. It is only necessary to add the amount of sugar that is wanting and which nature has failed to produce.

"In order to determine the quantity of sugar to be added to must derived from unripe grapes, the following indication will suffice:

"In the South of France the grape ordinarily ripens perfectly, and in this case it is only necessary to manage the fermentation properly; the wine will keep without alteration, but in the north, even in a favorable season, this fruit never ripens completely. I have constantly observed that, in the south, wine which has been well fermented marks on the areometer some fractions of a degree below the specific gravity of water, while in the North of France, the new wines rarely allow the instrument to descend to the same degree.

"Another important observation which may serve as a guide to the quantity of sugar which it is proper to employ each year, is to determine the degree of concentration of the must, which varies with every gathering. The areometer has often shown a difference of from two to four degrees of concentration in must resulting from the same vintage, as the maturity of the grape has been more or less advanced; the must from very ripe grapes weighs the most.

"Thus, when we have once determined the specific gravity of must derived from grapes which have attained the greatest maturity, it is sufficient to bring it to this degree by the addition of sugar in seasons when the ripening is less perfect.

"In 1817 the grapes of Touraine had not ripened; the must of my vintage, which marked 11° in a good season, was only at 9°; I brought it up to 11° by adding sugar. I covered the vat with boards and woolen cloths, and allowed it to ferment. The wine was found to be very clear when drawn from the vat; it was almost as strong as that from the south, while that which had been vatted without the addition of sugar was flat and thick, as the thick red wines of the wine-
growers constantly are. The latter sold for fifty francs the barrel. I refused eighty-four francs for mine, preferring to keep it for my table. The wine, as it was drawn from the vat, was as clear as that made from the same vineyard, and which had been four years in barrels, and it was much more generous and agreeable to the taste. Twenty barrels of wine prepared in this manner required fifty kilogrammes of sugar.

"As the grapes are crushed and the vat filled, some of the must is put in a boiler over the fire and heated sufficiently to dissolve the sugar. When dissolved, the solution is poured into the vat and the mass carefully stirred. This operation is to be repeated until all the sugar has been disposed of. When the operation is finished the vat is covered and the fermentation suffered to proceed."

The habit of sweetening must to improve wines is at present general in Burgundy, Champagne, Orleans, and many other wine-growing countries, only glucose is preferred as offering more analogy to the sugar of the grape than cane sugar. Yet it would be, in our opinion, more advisable to use white refined cane or beet sugar for table wines even of a low price, and to use glucose for common wines; by this means we should avoid increasing in the wines the formation of amylic alcohol, which the fermentation of the glucose of starch always produces in a variable quantity, and independently of the alcohol resulting from the decomposition of the saccharine matter.

Drawing off. (Racking.)—The quality of the wine depends in a great measure on this operation; but, all-important as it is, the wine-growers, even in our day, depend only on equivocal signs. They have imagined a number of signs and circumstances by the assistance of which they pretend to ascertain the propitious moment; but it is easy to understand that this period cannot be fixed, because the phenomena vary in energy and duration according to climate and season, or, rather, according to the temperature at the time of the vintage, and also according to the quality of the must. We may, there-

fore, affirm that all methods, the object of which is to fix the period of racking in a general or precise manner, are necessarily fallacious. The only one that will furnish a sure guide consists in observing, during the fermentation, the progress of the decomposition of the saccharine principle, that is to say, the complete vinification of the liquor. The areometer may, under certain circumstances, aid in determining the stage of fermentation in the must.

Expressing.—The whole of the wine is not obtained by the operation of drawing off; there remains a very considerable quantity with the marc which forms the cap, which sinks down as the wine is drawn off, until it forms a single mass at the bottom of the vat. The marc is expressed by means of a wine-press. This has various forms, which are more or less perfect.

This expressed wine is frequently mixed with that drawn off without pressure; but this is wrong; it should be kept separate, because it is harsher, less ripe, and more tart than the latter.

Chemical Composition of Wine.—We shall omit the details of racking, sizing, sulphuring, and storing wines, as well as some other operations in regard to this subject, as not being within the limits of a treatise like the present. We cannot speak of the distillation of wine without pausing a moment, as was done for must, to consider its chemical composition, from which it differs but little.

Wine contains a large proportion of water, a little undecomposed glucose, traces of soluble azotized matter or ferment, alcohol in variable proportions (from 7 to 24 per cent.), pectine and mucilage, some tannin, free malic and tartaric acids; a coloring matter, yellow in white wine, and red in the dark wines; acetic and oenanthic acids; an aromatic principle or bouquet, and oenanthic ether, an essential oil of vinous odor; and, finally, all the vegetable and mineral salts contained in the must.
The wines of Bordeaux contain, in addition, a sapid principle called enanthine, and the champagnes an appreciable quantity of carbonic acid gas. The numerous varieties of wines have very nearly the same composition, although the constituent elements are not always in the same relative proportions. These substances pre-exist in the marc of the grape beside some which are generated during the act of fermentation. The alcohol, acetic and enanthic acids, the bouquet, enanthic ether, and enanthine, are the products of the fermentation of the must. The alcohol is derived evidently from the sugar. The acetic acid is formed at the expense of the alcohol, and is almost always the result of a too active or too prolonged fermentation. The enanthic acid analogous to the fat acids results from the oxidation of the fatty substances contained in the must; its action as an acid is but little appreciable to the taste, but it is observed in proportion as it is transformed into enanthic ether by its reaction on the alcohol; this enanthic ether is a sort of essential oil, which appears to be the principle which communicates, not the bouquet peculiar to each locality, but that characteristic vinous odor more or less common to all wines. As to the bouquet of wine so much prized by gourmets, it is a substance which, by reason of the minute proportion in each kind of wine, has hitherto escaped all the researches of the chemist.

Wines are generous and strong in proportion to the amount of alcohol they contain. It is this principle to which they owe their intoxicating properties. The tannin gives them roughness and the acetic and malic acids, and cream of tartar, their taintness. As the tartar is deposited by degrees in the casks and bottles, it may be well understood how wines improve by age. They lose, too, by keeping, a large proportion of their coloring matter, and acquire a tint which has received the name of onion peel.

Choice of Wines for Distillation.

In the choice of wines the distiller is principally decided, first, by the alcoholic richness, and then by the quality of the product he can obtain. The alcoholic richness of wines is easy to determine by means of the test-still of Gay-Lussac or Salleron (see determination of the strength of alcoholic liquide). It is sufficient to distil off one-third of the wine to be examined, and then add to the distillate two volumes of water, and plunge an alcoholmeter into the mixture. This instrument, with the aid of a thermometer, will at once indicate the degree of spirituosity, or, in other words, the alcoholic strength of the wine tested.

The proportion of alcohol in the different kinds of wines varies very much; it depends on the nature of the climate and soil on which the wines are grown. The strength of wines may be deduced, as we have seen, from the proportion of alcohol which they contain, but their value, in reference to the quality of the product they will yield, is not so easily determined. This value depends on numerous circumstances which cannot be ascertained by the taste alone. In general wines that are rich in alcohol have neither the mellowness nor the perfume, which characterize the light wines; but, on the other hand, it is certain that they contain less malic acid. It is also to be remarked that generous wines yield the best rectified spirits (trois six). The distillation of alcohol from wines (spirits, trois six), having for its object to procure a perfectly pure product, that is to say, free from taste, neither the bouquet, fineness, taste, nor the age of the wines is indispensable to the success of the operation. In brandies, however, as we shall see hereafter, all these qualities are to be sought for. Besides, in the choice of wines, we should be guided by the experience acquired in regard to each particular locality. They should be examined simultaneously by the taste and the small test-still referred to above; these will not only make known the quantity of alcohol, but will also throw some light on the quality of the product.
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DISTILLATION OF ALCOHOL.

Distillation.—This operation is generally conducted in the continuous apparatus, the use and management of which we have described (apparatus of Derosne & Egrot). By means of this method of distillation we obtain at once the desired degree (86 or 88 degrees), we exhaust the liquid completely, and economize a large quantity of fuel. It is, however, possible to distill wines with the simple apparatus; but, in this case, it is necessary to redistil the product several times to procure the degree of concentration required by the trade; this will necessarily lead to a great loss of time and considerable expenditure of fuel, without yielding a product equal in quality to that obtained by the continuous apparatus.

TroisSix or Spirits of Wine (Rectified Spirits).

In this trade these names are applied to the alcohol of wine, marking 85 degrees Centigrade, or 33 degrees of Cartier. The denomination trois six is very old, and constitutes with the following, viz., \( \frac{2}{3}, \frac{4}{3}, \frac{5}{3}, \frac{5}{4}, \frac{6}{5}, \frac{7}{6}, \frac{8}{7}, \frac{9}{8}, \) \( \frac{10}{9}, \) the ancient fractional denominations which are used in the South of France, at the present day, to designate spirits of different degrees of proof, and which correspond to 23, 24, 29, 30, 31, 32, 35, 37, and 41 degrees of Cartier's areometer, the temperature being at ten degrees of the thermometer of Reaumur. These numbers are not arbitrary; they indicate the weight, and not the volume, as some theorists have contended, of the quantity of water which it is necessary to add to any spirituous liquor to bring it to proof (Prueba de Hollande), or 19 degrees Cartier (50 degrees Centigrade).

Thus the three-fifths is spirits at 29½ degrees, which mixed in the proportion of three parts of spirits with two parts of water, will give five parts in weight of brandy at 19 degrees.

The trois-six is alcohol at 33 degrees, of which, if these parts are mixed with an equal weight of water, will produce six parts of brandy of the same degree, or 19 degrees Cartier.

The trois-six of wine is at present used exclusively in the manufacture of liqueurs, and for improving common brandies; the great advance in price for many years, has caused manufacturers to have recourse to the spirits of beets and grain for these purposes.

Fine or well-flavored trois-six should be perfectly pure, without aroma, and besides should be absolutely limpid. Badly flavored trois-six is detected by its empyreumatic taste, resulting from careless distillation, or the flavor of the still, caused by too hurried a rectification, or the taste of the marc, of the beet, or produced by an admixture of the spirit manufactured from these substances.

In examining it, trois-six should never be tasted, unless it is diluted with at least half its weight of water; this is necessary to develop the aroma that may exist in the spirit; besides it would be very difficult to taste it pure, as the power of taste would be blunted by the strength of the spirits. Yet there are some dealers who have no difficulty in tasting trois-six by dipping in the point of the little finger and carrying it at once to the mouth. We may also, in order to recognize the odor of badly flavored trois-six, pour a few drops into the palm of the hand, and then after striking the hands together, let them approach the nose.

The engraving exhibits the general arrangement of a first class brandy distillery.

Alcohol from Molasses.

Molasses is the uncrystallizable syrup which is produced during the manufacture of cane and beet sugar. It is the residuum of the manufacture and refining. Molasses is a brown, viscous, and very dense liquid, marking generally from 41 to 45 degrees on Baumé's areometer, and rarely above. Its color varies from a clear yellow to almost black, according to its origin.

Variety and Selection of Molasses.—The selection of molasses is a matter of very great importance to the distiller, as much in respect to the quantity as the quality of the alcohol it will yield. The best is that
which is of a beautiful amber tint, without any burnt taste, and in which are still found particles of crystallizable sugar.

Frequently, we confound the molasses of the refineries with that from the colonies, from which tafia and rum are made. The taste is of excellent quality, and sometimes contains as much as 60 per cent. of sugar.

The molasses from the refinery is made from (1) cane sugar, or (2) beet sugar.

The first is to be preferred as containing much more sugar, but it is scarce and always high priced in France. The molasses from the refineries of beet sugar, in its turn, should be preferred to that from the factories. It furnishes a larger quantity and better quality of spirit than the last. The molasses from the beet sugar factories lacks that fresh, agreeable, and honey-like taste which characterizes the product of the cane factories and refineries. It retains a bitter and acrid taste derived from the root. It is strongly alkaline, because of the salts of potash which it contains in considerable quantity, and has an unpleasant odor. Because of its bad taste, this molasses cannot be employed for any other purpose than distillation.

Fermentation.—The following is the process of fermenting it, whatever be the kind of molasses selected. Dissolve the molasses in four or five times its weight of water, or in seven or eight times its volume, at pleasure, of which a certain portion should be heated to 30° C., in order that the mixture may be complete; the cold water is then to be added so as to reduce the temperature of the mass to 20° in summer, and 25° in winter. The proportions indicated will yield a must, the density of which will vary from seven to eight degrees of Baumé's areometer.

As the liquid is often strongly alkaline, especially when operating with molasses from the beet sugar factories, it becomes necessary to remedy this inconvenience which would otherwise prove an obstacle to the regular development of the fermentation, and consequently, the production of alcohol. The alkalies are neutralized by the addition of a slight excess of sulphuric acid. This is determined by the use of litmus, which reddens instantaneously by contact with an acid.

The exact quantity of acid to be used cannot be fixed, because the quantity of alkaline salts varies with the quality of the molasses. It may be stated as between three and four kilogrammes for each one hundred kilogrammes of molasses. The acid should be diluted in seven or eight volumes of cold water to prevent altering the saccharine principle in the molasses.

When the mixture is prepared, it is drawn into one or more vats according to the quantity, and the fermentation is established by adding 250 grammes of good fresh yeast, previously dissolved in a little tepid water, to each 100 litres of must at 7° or 8° Baumé. After introducing the yeast, the liquid is to be well rummaged for some minutes, the vat carefully covered and left for the fermentation to proceed. In a very short time under the influence of the yeast and heat the fermentation will begin to be apparent; the surface of the liquid will be covered by a light white scum which begins at the sides of the vat and gradually extends over the whole surface. This scum consists almost entirely of yeast; it is caused to disappear entirely by throwing on the surface of the liquid a little oil or grease, mixed with a small quantity of boiling water. In the absence of grease a little soft soap dissolved as above will produce the same effect.

When the scum has disappeared we perceive lively undulations of the surface of the liquid, at the same time that it exahes the very characteristic odor of the carbonic acid gas, a manifest sign of the conversion of the saccharine principle into alcohol. To this tumultuous movement of the liquid succeeds another phase. As the undulations become less active, and in proportion as the fermentation diminishes, the evolution of carbonic acid