DISTILLATION OF ALCOHOL.

to cool to 36° C., work in the flour. The glue is to be dissolved in the remaining 16 litres of water at a boiling heat, and the solution mixed with the flour dough. The mass is then allowed to cool down to 24° C., and the yeast is added. The mass will very soon begin to ferment, and, at the end of twenty-four hours, will have been converted into a very good leaven fit for immediate use.

If a small quantity of this leaven is prepared at the beginning it will serve for preparing more, and by this means it may always be procured in such quantity as may be needed. It may be kept for eight days in a cool place without alteration.

The following may also be employed successfully:

- Common honey: 5 kilogrammes.
- Malt: 3 kilogr. and 500 grammes.
- Cream of tartar: 500 grammes.
- Water: 10 litres.

Heat the water to 50° C., then add the cream of tartar, honey, and malt; stir the whole well together and leave it for some hours. As soon as the temperature has fallen to 24° C. cover the leaven until the fermentation is established.

The following process for the distillation of the juice of the beet, for which a patent was issued in France in 1838, may with some modifications be highly useful.

Phenomena of the Vinous Fermentation.

Now that we have explained the rôle of the five indispensable agents of the vinous fermentation, their combination and use, we shall describe the phenomena of the operation itself.

The vinous fermentation, as we have already said, is the result of the decomposition of sugar, the products being alcohol and carbonic acid.

These results may be easily established by dissolving some sugar in four times its weight of water, or more, according to the idea of the distiller, without, however, using too great a quantity of water, for then the fermenting mass will heat with difficulty, because it will be too watery. When the liquid marks 10° of the saccharometer its temperature should be raised, as has already been said, in proportion to the mass, that is to say, between 15° and 30° C. Take 24 per cent. of dry and fresh yeast, and dilute it with a small quantity of the liquid which is to be fermented; beat the mixture strongly with a small whip; cover the vessel, and if the yeast is good, the fermentation will be established at the end of a quarter or half of an hour at most; if not we shall be compelled to add yeast until fermentation shall be active and tumultuous. This preparation finished, the leaven is poured into the fermenting vats, the mixture thoroughly stirred, and the vessel closed. The temperature of the mass must be kept up, and under these conditions the fermentation will not delay in establishing itself, and will run through its various periods.

Let us suppose that this experiment is performed in a flask furnished with a bent tube, which is plunged into a cistern filled with water, in order to give issue to the gas, and at the same time prevent its dissipation in the air. With the apparatus so arranged it will be easy to observe what passes.

First stage.—The liquid is disturbed, its volume in-
creases, and its temperature rises; for the heat applied to the vat to inaugurate the fermentation is not all that will act; the fermentation produces it spontaneously in proportion to the rapidity of its development, that is to say, in accordance with the more or less prompt decomposition of the sugar, and, consequently, with the quantity of carbonic acid formed. Certainly it is easy to comprehend that it is to this heat, produced by the internal movement in the vat, that is due the elevation, or, at least, the preservation of the temperature of the mass in fermentation. It is evident that without this new heat the vat would soon lose a part of its caloric, and acquire the general temperature of the place wherein the fermentation is conducted. It is, too, on this principle that we raise the temperature of the place and of the mass in proportion as the quantity is small, and the must weak.

The symptoms of fermentation then are: 1st, increase of volume; 2d, elevation of temperature; 3d, formation and discharge of carbonic acid gas.

This gas escapes from all points of the liquid in innumerable small bubbles, which rise to the surface and break, bringing with them particles of the ferment, and produce, according to the nature of the materials acted on, a scum (or foam), more or less thick, called the cap.

Second stage.—The vat attains its highest degree of temperature, the fermentation is in the greatest activity, the gas escapes abundantly, and the cap thickens; then the tumultuous movement subsides, the heat of the vat decreases, and this last resumes its original temperature.

Third stage.—Almost the whole of the sugar being converted into alcohol and carbonic acid gas, the fermentation is finished, the liquid acquires the temperature of the place in which the fermentation is conducted, the cap, no longer supported by the carbonic acid, falls to the bottom of the vat, the liquid becomes clear, and should, if the operation has been well conducted, that is to say, if the sugar is decomposed, be reduced to the term zero of the saccharometre. In this condition, if the liquid is examined, it will be found to have lost its saccharine taste, and to have acquired one that is more or less strong and warm, as well as a peculiar vinous odor.

From this point it loses the name of must to receive that of wine, whatsoever may be the character of the materials that have produced it.

The vinous fermentation having run through its different stages, if we have collected the whole of the carbonic acid gas evolved on the one hand, and, on the other, distilled the fermented must to extract the alcohol, leaving out of the calculation the foreign substances furnished by the ferment, we arrive at this result of our experiment, viz., that 100 parts of sugar will furnish 51.455 parts of pure alcohol and 48.545 of carbonic acid.

Now by establishing the quantity, in volumes, of the elements of sugar and of alcohol, we can easily account for this transformation of sugar into alcohol as indicated by Gay-Lussac:

<table>
<thead>
<tr>
<th>Composition of sugar in volumes.</th>
<th>Composition of alcohol in volumes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapor of carbon . . . . . . . . .</td>
<td>Vapor of carbon . . . . . . . . .</td>
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<tr>
<td>Hydrogen . . . . . . . . . . . . .</td>
<td>Hydrogen . . . . . . . . . . . . .</td>
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<tr>
<td>Oxygen . . . . . . . . . . . . .</td>
<td>Oxygen . . . . . . . . . . . . .</td>
</tr>
<tr>
<td>3 vols.</td>
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<tr>
<td>3 &quot;</td>
<td>3 &quot;</td>
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<tr>
<td>15 &quot;</td>
<td>½ vol.</td>
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</table>

From which it is seen that alcohol differs from sugar only in this, that it contains one volume less of the vapor of carbon and one of oxygen, proportions which are exactly those in which these two bodies combine to form carbonic acid. Wine is only sugar, less a certain quantity of oxygen and carbon.

As to the decomposed ferment, it is deposited in the form of white flocculi; but it no longer contains nitrogen as one of its elements, and, as we do not find it in any of the products, we are ignorant of what has become of it.

It may often happen that a vinous fermentation is entirely completed, although the saccharometre indicates one or more degrees, as in the fermentation of common molasses and of beet-juice. This indicates that the fermented liquid contains some salt of potash, or other substance, and that the saccharometre does not really indicate the quantity of sugar contained in the liquid, but only the specific gravity of this liquid.
So many circumstances may influence the more or less prompt decomposition of the sugar, that it is impossible to indicate precisely the time necessary for the fermentation to run through all its stages. This decomposition is dependent, first, on the saccharine richness of the must; second, on its volume; third, on the local temperature and that of the mass to be fermented; fourth, on the energy of the ferment and the quantity employed; in fact on a number of unforeseen causes.

The phenomena which we have just described are produced in all saccharine liquids which enter into a state of fermentation, whatever be their origin. If we examine all the phenomena of fermentation as a whole, we arrive at a confirmation of the principle long ago laid down by Laplace and Berthollet, viz: "That an atom set in motion by any force whatsoever, may communicate its own motion to another atom which may be in contact with it. This is a general law of dynamics which embraces every case in which the resistance (vital force, affinity, electric force, force of cohesion) which opposes a motion is sufficient to arrest it." (LIEBIG.)

Accidents of Fermentation.

The vinous fermentation requires much precaution; if it may be disturbed by many known causes, there are others which it is sometimes impossible to foresee or explain. It is necessary, then, to bring to this operation the most absolute care.

Acid Fermentation.—The most to be avoided of all the accidents of fermentation is, without doubt, the acid fermentation, which results in the formation of acetic acid. This is always the sequence of the vinous fermentation; it takes place when the fermented liquid is exposed to the air, under a temperature of from 20° to 35° cent. A portion of the oxygen of the air is absorbed, and aids in the formation of carbonic acid gas, the volume of which is equal to that of the oxygen which has disappeared.

The liquid becomes heated, and by degrees is rendered turbid by a long stringy substance, which after a time is precipitated, thus restoring the transparency of the liquid. At this stage all the alcohol it contained is decomposed, and in its place is found a quantity of acetic acid which is proportional to it; from which circumstance it is concluded that the acid is formed at the expense of the alcohol.

Although chemistry cannot as yet explain in a satisfactory manner how these reactions are effected, it is known, 1st, that pure alcohol mixed with water never acidifies when exposed to the air; that it is necessary in order to convert it into vinegar that it should be in contact with a ferment or some other nitrogenous substance that will fulfil the office of one; 2d, that the presence of air and a temperature of from 20° to 35° cent. are indispensable to the fermentation of liquids containing alcohol. Hence we conclude that the ferment is in this case a cause of decomposition in the conversion of alcohol into acetic acid or vinegar.

From this statement it may be understood how important it is to prevent the access of the air to vats during the course of the vinous fermentation, and to avoid too high a temperature in the place where these vats are situated, as well as in the must when set for fermentation. The same remark is to be made in regard to the use of the ferment; while a proper quantity favors the development of the vinous fermentation, too great a dose will excite the acetic fermentation.

In order to prevent every cause that may favor the acidification of the vats, the greatest cleanliness should be observed in the distillery, and care taken to wash the empty vats as well as all the utensils with lime-water, which neutralizes the acid. It is, in fact, proven that the smallest portion of acid is a leaven which will accelerate the oxygenation of the alcohol.

The acid fermentation may also be developed under a number of exceptional circumstances. Great perturbations of the atmosphere, stormy weather, thunder, the use of fetid or stagnant water, and the foul odors which
exhale from the fermenting-rooms, are so many causes that may induce the souring of the vats.

Putrid Fermentation.—This is produced when the decomposition of the liquid passes beyond the acetic stage. The liquid then becomes viscos and turbid, disengages ammonia and deposits an earthy sediment. The rest of the liquid is nothing more than water, whose fetid and repulsive odor infects all parts of the place where this fermentation is developed.

Viscous Fermentation.—This is a spontaneous alteration which sometimes takes place in white wines of inferior quality, in common beer, beet-juice, and generally in saccharine liquids, which have been kept too long before being set to ferment. It results in rendering these liquids thick and slimy, and the transformation of the sugar and starchy matters into a kind of gummy substance.

The peculiarity of this fermentation, when developed actively, is to form in the mass of the liquid mucilaginous flocks which disturb its transparency and disengage during the chemical reaction a small quantity of carbonic acid and hydrogen gases. The light and partial foam which is formed at the surface confirms this discharge of gas, which, although small, is yet sufficient to be observed.

According to M. Payen this vitiation of fermentable liquids is attributable to the alteration of the caseine and other nitrogenous substances which they may contain. One quite serious cause also to which this viscous change may be attributed, is the much too feeble action of the leaven, which does not possess sufficient strength to disorganize the saccharine principle entirely.

It is to be observed that the viscous fermentation once produced in a must may be reproduced in any other saccharine liquid to which the altered must may be added; it fulfils in this case the office of a ferment.

The viscous fermentation may be easily avoided: 1st, by keeping the vats very clean, taking care to wash them with water acidulated with 5 per cent. of sulphuric acid of 66°; 2d, by only using good fresh yeast (the cap); 3d, by adding to certain must three or four thousandths of tannin or one-half of one per cent. of sulphuric acid.

Lactic Fermentation.—This accident of fermentation results in the conversion of saccharine or amylaceous substances into lactic acid. It originates like the viscous fermentation in certain albuminous or nitrogenous liquids, the fermentation of which progresses too slowly, either in consequence of using an altered ferment or in too small quantity, or by the delay in setting the vats to work.

The lactic may take place simultaneously with the vinous fermentation, and even sometimes overcomes it, but most frequently it succeeds or accompanies the viscous fermentation. It is recognized by the odor and the acrid and disagreeable taste which result from it.

This accident may be prevented by the same care and precautions indicated for the viscous fermentation.

Frothing.—The evolution of carbonic acid always produces, during the fermentation of liquids, a great quantity of foam, which frequently runs over the top of the vats on to the floor of the apartment where it may occasion putrid exhalations. This accident may be prevented by sprinkling the batch from time to time by means of a broom with a solution of soft soap (500 grammes in 4 litres of water), or by a small quantity of very thick oil beaten up with water.

Sweat-House and Fermenting Vats.

After having spoken of the conditions, the phenomena and accidents of fermentation, it yet remains for us to say something in regard to the fermenting-houses and vats (vessels) destined for this operation.

Since the vinous or alcoholic fermentation may be produced during the whole year without regard to the seasons, it is necessary to have a place specially devoted to it.

The apartments in which this operation is conducted
is called by some a cellar, and by others a shop, but the proper term is sweat-house.

The size of the sweat-house should be in proportion to the importance of the distillery as well as to the number and capacity of the indispensable vats; it should receive as much as possible its light from the east or west, should have but little height of ceiling, and be surrounded by thick walls in order to preserve its heat. The number and size of the windows and doors should be restricted to what may be absolutely necessary, and care should be taken to cut off all air currents.

A uniform temperature being one of the first conditions of a good fermentation, a thermometer should be placed in the sweat-house to indicate the degree of heat. If the heat is not sufficiently high, it may be supplied by means of large stoves placed in the middle of the room. Distillers frequently have no sweat-house, but place their fermenting vats in the distillery itself, so as to avail themselves of the heat of the distillery or other apparatus. This method, which at first sight appears to be very economical, is highly objectionable, because it is impossible to regulate the fermentation properly. Supposing that this heat is sufficient in winter, it is incontestable that it will be too great in summer, and even sometimes in the bright days of spring and autumn. There is a loss in alcohol, which is converted into acid, which is much greater than the cost of the fuel necessary for heating the sweat-house.

As has already been said there are evolved during the vinous fermentation, considerable quantities of carbonic acid gas. This gas, the composition of which is well known, is also one of the products of combustion, and of the respiration of men and animals. It is also a constituent of many minerals, being most abundant in the natural limestones, as chalk, etc.; readily absorbed by water, it reddens litmus paper slightly, the color being restored by a gentle heat. It is heavier than atmospheric air, nearly double the weight bulk for bulk, and may be poured from one vessel to another, extinguishes flame, and is destructive to the life of animals compelled to breathe in an atmosphere contaminated by its presence in sufficient quantity.

We cannot recommend too great precautions against the deleterious action of this gas. On entering the vats, its presence may be readily detected by taking a lighted candle in the hand, and holding it near the bottom. The gas in consequence of its weight will occupy the lower stratum of air; if the light becomes dim, it is no longer safe to remain, and it becomes necessary to withdraw from the vessel at once, and gain free access to fresh air.

In order to keep the air of the sweat-house healthy, we should place several buckets filled with lime-water or, better still, chlorine gas. These remedies are often successful in cases of asphyxia from carbonic acid, yet it is better to send for a physician at once and in all cases.

The greatest cleanliness should prevail in the sweat-house; the floor should be swept every day, and, if possible, well washed with a large quantity of water. It is proper that it should be paved with bricks or tiles that will resist the action of the organic acids which form when the froth or fermented liquids (or destined for this operation) are spilled on the floor. It is heavier than atmospheric air, will flow off at these vents.

If a person should meet with an accident from breathing carbonic acid, he should at once be taken into the open air and caused to breathe a small quantity of ammonia (hartshorn), or, better still, chlorine gas. These remedies are often successful in cases of asphyxia from carbonic acid, yet it is better to send for a physician at once and in all cases.

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Occasionally the air of the sweat-house should be removed, but without varying too suddenly the temperature which is necessary for the success of the work.

The fermenting vats are generally made of oak or pine encircled by thick iron bands; their dimensions and capacity vary according to the quantity and nature of the
DISTILLATION OF ALCOHOL.

materials to be fermented. They should be deeper than wide, and the bottom diameter should be some inches greater than that of the top, in order to present the least surface to the action of the air, and consequently diminish the chances of acidification.

The solidity of the vats should be in proportion to their size, since the thickness of the wood has the advantage of preserving the heat and protecting the liquid from variations in the temperature of the external air. A thickness of 4 centimeters is sufficient for a vat of 25 or 30 hectolitres, and 5 centimeters for a vat of 60 or 70 hectolitres. For vats of greater capacity, the thickness should be increased in proportion.

The form of the vats is by no means a matter of indifference. Circular vats, although occupying more space than those that are square, are infinitely preferable, because they are so much better adapted to preserve the heat of their liquid contents. It is moreover readily understood that the angles of square vats will very much favor this loss of heat.

In order to avoid cooling and the loss or acidification of the alcohol, the fermenting vats ought to be hermetically closed by a cover of which two thirds may be raised at pleasure.

It is also a matter of the greatest importance to clean the fermenting vats as soon as they are emptied, and rinse them out either with slightly acidulated water (1 litre of sulphuric acid at 60° in 20 litres of water) or with lime-water. The former is used when the liquid which is drawn from the vats has not been fermented with sufficient energy, or when it contains a small proportion of sugar; the latter when the fermentation has been tumultuous or slightly acid. For this purpose, the vats should be furnished with a tap 5 centimetres from the bottom, for drawing off the liquid, and a bung in the bottom for cleaning out entirely the deposit formed during the fermentation.

An arrangement used in some distilleries under the care of the author, and which has been found very ser-

viceable, may be used with advantage for the manufacture of alcohol. (Fig. 1., Pl. VI.)

This apparatus consists of a copper coil, the diameter of which varies according to the size of the vat, placed at the bottom of the latter. This coil is connected to a pipe with two branches furnished with stopcocks; one of these conducts steam and the other cold water, according as the batch has need of being heated or cooled.

By this simple means the operation is under the control of the distiller.

CHAPTER III.

DISTILLATION.

The object of the process of distillation is to separate liquids from each other, which are converted into vapor at different temperatures, or to isolate a volatile liquid from a fixed substance by converting it into vapor by the aid of heat, and by means of its contact with a cold body cause it to resume its liquid form by being deprived of its heat, and thus to be collected in proper receivers. It requires much care and skill.

There are many methods of applying heat in the process of distillation, and to favor the ascent of vapor according to the liquid distilled, viz., the naked fire, the water bath, sand bath, and by steam, so that the degree of heat and its manner of application may be varied with the substance to be distilled. These operations will be treated of more particularly hereafter.

Distillation is effected in apparatus, the form and arrangement of which are appropriate to the liquids or substances to be treated. Everything the earth produces may be its object and aim, but it is chiefly for the distiller of spirits and the liquorist, for flowers, plants, fruits, seeds, roots, and in fact every substance that contains an aromatic, saccharine, or amylaceous principle.
DISTILLATION.

1. The boiler or still (Fig. 1, Pl. I.) is made of tinned copper, and enters the furnace; its size varies according to its capacity. At about three-fourths of its height this piece is project ed or bulged, and forms a border or flange which rests on the furnace. An opening having a socket a, with a screw plug b, is placed on this projection, and serves for the introduction of liquid to replace that which is evaporated, without arresting the distillation. The opening of the boiler is strengthened externally by a circular flange c, of rolled copper to support the water bath; it has two handles d, to facilitate the handling. A round grate (Fig. 2, Pl. I.) of tinned copper perforated with small holes rests near the bottom, supported by many feet b, two or three inches from the bottom. This grate is formed of two pieces united by hinges, and is furnished with a handle a, to facilitate its removal from the still.

2. The water bath (Fig. 3, Pl. I.) is a vessel of copper tinned inside only. It is supported by the still into which it enters. At its mouth are also two flanges, a and b, of rolled copper which fit exactly, one with the still and the other with the head. The water bath is also furnished with two handles, c, and a cover with a handle (Fig. 4, Pl. I.) which closes it hermetically. This cover is only used when the water bath is used for making infusions.

3. The head or cap is of copper, tinned inside only. It has the form of an inverted funnel. Its two openings are each finished with a flange of rolled copper a and b. One fitting either the water bath or still and the other the goose-neck. A hole c, similar to that on the still, and for the same purpose, is made at about two-thirds of the height of the cap.

4. The goose-neck (Fig. 6, Pl. I.) is a long copper tube bent into a semicircle, and reinforced at each end by a flange a and b, which serves to connect the still with the coil or worm. The coupling (Fig. 7, Pl. I.) is made of tin or copper with small flanges of copper or brass for connecting the goose-neck with the worm when the water bath is in use for distilling.
5. The cooler or worm (Fig. 8, Pl. I.) is a long pipe of block tin or tinned copper bent into a spiral, the branches of which are supported by the perpendicular strips of tin or copper, which are soldered to it. The upper extremity of the worm, which is connected with the goose-neck by a flange, has the form of a flattened sphere, and is called lentil. The whole is surrounded by a slack-tub of copper, at the bottom of which there is a tap. The hot water of the cooler runs off by a level pipe, which is placed at the top of this vessel. A long copper funnel (Fig. 9, Pl. I.), extending a little above the top, and descending to the bottom of the slack-tub, serves to keep up the supply of cold water. It is called the cooling pipe. The beak (Fig. 10, Pl. I.) is attached to the lower extremity of the worm to connect it with the receiver. (The receiver is the vessel which receives the distillate, that used by the liquorist is glass, copper, or stoneware.) The cooler is firmly supported on a mass of bricks or oaken trestles.

The apparatus with the goose-neck is generally used for the preparation or rectification of perfumed spirits. The still with moor's head is composed of pieces like the last, with the exception of the cap, in which it differs completely. This cap (Fig. 11, Pl. I.) is made of tin or copper, and rests on the still or water bath. A long lateral pipe or neck, serves to conduct the vapors into the worm. An opening with a neck of copper, closed by a screw plug, of the same metal, is placed at the top of the cap; two flanges, and complete the apparatus.

The moor's head is preferred for the distillation of volatile oils and aromatic waters, as well as for Swiss absinthe.

For the distillation of aromatic waters, the perforated water bath (Fig. 12, Pl. I.) is used with advantage. This vessel is used to contain substances which it is desirable to subject to a higher degree of heat than can be attained by the ordinary water bath. The perforated water bath is not plunged into the boiling water, and the substances which it contains are subjected to the action of the steam only, thus preventing contact with the walls of the still and the fear of having them burn and attach themselves to the sides, which sometimes happens when the contents of the still are large.

M. Soubeiran has invented the following very simple apparatus for the preparation of distilled waters by steam:

A movable copper pipe a (Fig. 13, Pl. I.), in the form of a handle with a stopcock b, serves to conduct the steam from the still into the water-bath; a second copper pipe c is connected with it, and descending within, along the walls is bent inwards and opens near the middle of the bottom of the water bath. A perforated diaphragm d, supported by several feet which sustain it above the orifice of the steam-pipe, and furnished with two handles by which to introduce or remove it at will, serves to hold the plants or flowers which are to be distilled. By this system we may replace the perforated water-bath, and at the same time effect a distillation by steam, since the substances are not in direct contact with the water of the still.

The still with column, like the preceding, consists of a still, a cap, goose-neck, and a cooler. The column (Fig. 14, Pl. I.) is the only point of difference; its height varies with the capacity of the apparatus. The extremity, which rests on the still, is closed by a fixed diaphragm b, pierced with a great number of holes; this supports four or five other diaphragms, c, fitted with handles, which rest on the other, being each charged with a layer of plants or flowers.

A very important improvement has been added to the column still by Egrot, a skillful manufacturer in Paris, which consists in placing between the still and the column an intermediate piece which he calls a separator. (Vase extractif appliqué à la distillation.) By his process are obtained separately, but not at the same time, both the good and bad products without the latter mixing with the former.

Thus, if in the ordinary apparatus we place a separator (so called because it rejects all the fixed and non-
distillable products); between the still and column for flowers, it is certain, that of the steam arising from the still to pass through the flowers in the column, to exhaust them of their aroma, a small quantity will condense therein and carrying with it the color and active viscous parts of the plant (often very injurious to the operation), which instead of falling as before into the still, will now fall into the separator and be rejected from the apparatus.

It is these viscous colored products that first fall into the still, and, under the action of repeated distillation, sometimes for an hour or two, are volatilized. They give a taste of phlegm injurious to the flavor of the distillate, or rather this turbid liquid attaches itself to the walls of the still, and detaches the tin or burns the bottom. Finally, if a distiller or perfumer finds himself pressed with his work, as happens at the period of the flower harvest, he will have the advantage with the extractor of not being compelled to change the water in his still, thereby gaining much time; since he may distil with the same liquid during the whole day, taking care only when he renews the charge to add a quantity of water equal to that drawn off during the operation.

Fig. 1.

The Extractor.

The use of the cap being to contain a certain quantity of vapor, it would be more simple to conduct it at once into the worm, towards which it is attracted by the coolness of the condenser. This remark is so true that all distillers of alcohol have suppressed the cap.

Simple stills to which steam is to be applied as a means of heating should receive it in a double bottom, and not by an interior coil, as is done in stills for a continuous operation, because by this arrangement the substances to be treated may attach themselves to the surface of the
coil, and, by interfering with the transmission of heat to the liquid, retard the operation.

By the application of steam the water bath is superseded.

Continued Apparatus.

This term is applied to a form of apparatus in which the distillation progresses without intermission and without interruption, and which possesses the advantage of producing with great economy of time and fuel a large quantity of alcohol of infinitely higher degree than that obtained from the simple still. The wine is introduced in a constant stream, is deprived during its course of all its alcohol, and passes off at the other extremity in such a manner that if the liquid subjected to distillation was not susceptible of befouling the apparatus, the operation might go on indefinitely.

There are two forms of continuous apparatus, one for liquids and the other for semifluid or pasty materials.

Derosne's Apparatus.

Among the continuous apparatus, one of the most remarkable is, without contradiction, that of Cellier-Blumenthal as improved by M. Derosne, whose name it now bears. It is in use in the larger portion of the distilleries of France.

The following is a description (Figs. 1 and 2, Pl. II.)—

A. Reservoir into which are raised the materials to be distilled. A hogshead or a barrel of any size may be substituted for the reservoir.

A'. Bucket for regulating the flow of the liquid into the apparatus.

B. Wine-heater and condenser.

C. Distilling column. This column is built in two different modes, according to the uses for which it is intended. If for common distillation the subdivisions are made of wire gauze (or cloth); if it is intended more especially for the rectification, or the production of spirits of a high degree, the plates should be of solid sheet metal.

D. Upper boiler or still.

E. Lower boiler or still.

F. Furnace for heating the two boilers D and E.

G. Rectifying column.

H. Cooler or slack-tub.

a. Tube for introducing the liquid to be distilled into the slack-tub H.

a' a'. Tube by which this liquid passes from the cooler H to the wine-heater and condenser B.

a'. A small gutter pierced with holes placed within the wine-heater for distributing uniformly the wine passing through the tubes a' a'.

b b. Tube through which the liquid to be distilled leaves the wine-heater B to pass into the distilling column C.

b'. Tube and stopcock connecting the lower part of the wine-heater with the tube b b, and serving to empty the wine-heater when the distillation is terminated.

c. Handle of a copper rod which traverses the tube a' a' and the cooler H, bearing at its lower extremity a dasher, by means of which the contents of the cooler may be agitated, and any deposit which may have formed at the bottom of this piece, or may obstruct the different orifices of the apparatus, can be detached.

d. Tube connecting the rectifier G with the coil in the wine-heater B.

e. Tube connecting the condensing coil of the wine-heater B with the coil of the cooler H.

f. Indicator of glass, marking the level of the liquid in the upper plate of the rectifier G.

f'. Indicator of glass, for detecting the engorgement or choking of the distilling column C.

k. Stopcock for emptying the cooler H.

j. Proof bottle or jar, for testing the distillate as it flows from the coil of the cooler.

k. Opening closed by a plug and intended for removing any semifluid deposit collected in the cooler H.

l. Screw plug on the boiler D, through which if necessary liquor may be introduced when the apparatus is used for rectification.
DISTILLATION OF ALCOHOL.

1. Screw plug on the boiler E for the same purpose.

m m. Cover of the wine-heater B in which are two small open tubes for admitting air when necessary into the wine-heater, and to indicate the formation of steam therein. The cover is fitted with a water-joint.

n n1 n2. Three stopcocks for returning the low wines from the coil in B to the plates of the rectifier G. These cocks correspond to different turns of the coil B.

o. Cock and ball-float placed in the reservoir A. The float opens or closes the cock according to the height of the liquid in A.

p. Stopcock to A by means of which is regulated the quantity of liquid which should flow in a given time according to the briskness of the operation.

q q1. Goose-neck connecting the two stills D and E.

r. Glass indicator showing the level in the still D.

s s1. Two cocks connected with the indicator, to be closed in case of its being broken.

t. Stopcock and pipe connecting the two stills D and E.

u. Glass indicator showing the level in E.

v. Two cocks attached to the indicator u, which are to be closed in case of its being broken.

x. Stopcock for emptying the boiler E.

y. Valve for admitting air to the boiler E if necessary. There is a similar valve on the boiler D not shown in the drawing.

B. Horizontal pipe for returning the low wines condensed in the coil B. This horizontal pipe connects with a number of small vertical pipes, each of which corresponds to a turn of the coil in the condenser B.

The numbers from one to sixteen indicate all the flange-joints of the apparatus; they are brought together by screw bolts.

To Commence the Operation.—Before kindling the fire under the still E, the different parts of the apparatus which should contain it must be filled with wine. For this purpose, the reservoir A being full, we open the cock o, then the cock p of the regulator A. The wine then flows through a' a' into the cooler H, fills it, and through a' a' flows into and entirely fills the wine-heater B, in which it is distributed by the perforated gutter a'.

From B the wine escapes by the tube b b to pour on to the upper plate of the distilling column C; from this column it descends into the first still D, and through the cock t, which is open, it passes into the still E.

The wine is allowed to flow from p until the still E is filled to three-fourths of its height, as may be seen by the indicator u; the cock t is then closed, the still D is allowed to fill in the same manner when the cock p is closed.

The fire is now to be started under the still E; the flame, after acting on this, passes under the other still D, and thence into the chimney.

The still E soon begins to boil; the steam which escapes from it passes through the curved pipe (goose-neck) q q to escape at the bottom of the still D. The liquid contained in this still D is also very soon set to boiling, the steam rises into C, traversing the plates, mounts into the rectifier G, and from this is conducted by d into the condensing coil of the wine-heater B; the steam which reaches this coil, surrounded by a cold liquid, is entirely condensed. The condensed product fills the return pipe B B, and by the tube e (it is supposed that the return cocks n n1 n2 are all closed), it passes into the coil of the cooler from which it is received in the test jar j.

When the brandy flows through j, and that part of the wine-heater B which is above G is too hot to bear the hand, we may consider the operation as started, and should open the cock p of the bucket A to allow a continuous flow of wine into the apparatus.

To Conduct the Operation.—The apparatus being under way, the continuous stream from p should be regulated according to the quantity of liquid which can be distilled in an hour, and this depends on the size of the apparatus. As for o of A it will not require any attention; the ball-float which is fixed to the key of the cock will cause it to move, as the level of the liquid in
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A rises or falls, in such a manner as to close it before A can overflow. If it is desired to obtain brandy at 50° centigrade (proof spirit), the three return cocks n, n1, and n2 are ordinarily closed; when, on the contrary, a spirit of higher degree is wanted, they are opened.

In the latter event all the products of a lower degree, which are collected in coil of B, return upon the plates of the rectifier G; that only passes into the coil of H which has continued in the form of vapor to the extremity of the coil of B, and which is consequently of a decided alcoholic strength. The product which passes into J should be cold; if it comes over warm, or is accompanied by steam, it will be an indication that the fire under E is too active, if the flow from p is regulated according to the quantity of wine to be distilled in an hour.

When the flow of wine from the cock p is properly regulated it should not be disturbed so long as the operation lasts. The whole attention should be directed to the conduct of the fire, which should be increased or reduced according to the jet of brandy or spirits which flows from the proof jar J. If this jet is warm, it indicates too much activity of the fire; it is the same if the strength is lowered, which is caused by too much water vapor that cannot be condensed by the quantity of cold liquid that passes into the apparatus, it is then necessary to moderate the fire.

To Empty the Stills.—At certain periods it is necessary to empty the stills D and E; this should be done without interrupting the distillation, and after being assured that the liquid is deprived of its alcohol.

When the liquid appears to be sufficiently exhausted (which is ascertained by the test for spent liquor, as will be explained hereafter) the wastecock z of the lower still is opened, and the spent liquor drawn off until what remains in the still is five or six inches deep. The cock z is then closed, and this still is refilled as before to three-fourths of its height, from the liquor in the upper still D, by opening the cock t. When filled to the pro-

per depth the cock t is closed, and the boiler D suffered to refill from the stream of wine which continues to flow from A.

This emptying causes no interruption to the distilling, the stills having kept up a constant supply of vapor. The operation is therefore continuous.

To Terminate the Operation.—When it is desired to terminate the operation, that is to say, when there is no more wine to be distilled except what remains in the different parts of the apparatus, and consequently A and A1 are empty, it is necessary to suspend the fire for a while to empty the stills D and E, supposing that their contents are exhausted of alcohol, then to refill the stills with the contents of B by opening the cock b; at the same time H is emptied by means of the cock h, and the contents passed into the stills D and E by the plug t and l. The pieces B and H being empty are now to be filled with water, introduced from A and A1. To prevent this water from passing into the stills D and E by the tube b b, that portion of it between the joints 5 and 6 is detached; the open end at 5 is closed by a plug, and to the end at 6 is adjusted a pipe for conveying off the waste water which flows off at this point during the operation.

The apparatus being thus prepared the heat is raised under the stills D and E, and the water is allowed to flow from A through p; the water which now circulates in the two pieces B and H produces the same effect as the wine, rectifying and condensing the vapors which enter the coil B. At the end of half an hour, and when the contents of the still E appear to be sufficiently exhausted, it is emptied; and the contents of D transferred to E, the former being replenished by any wine that may remain from the contents of other parts, B and H, of the apparatus. The distillation is started anew, and so on until the whole stock of wine is disposed of.

If towards the end of the operation we do not wish too great a quantity of weak brandy and low wines, the flow of cold water should be increased, and the cock n1 and n2 should be opened. The low wines are then com-