DISTILLATION OF ALCOHOL.

and is easily transported from the distillery to the neighboring farms. There is no spent liquor to throw out of the establishment.

Rectified Beet Spirit.

Like all spirits obtained from roots, that from the beet, it matters not what process has been used for obtaining it, contains an essential oil which communicates to it a peculiar harshness and indicating its origin, unless it is carefully rectified according to the principles we shall explain further on. But, on the other hand, when freed from this essential oil, beet spirit constitutes a liquid which is suitable for replacing spirits of wine entirely and without exception in all the uses to which the latter may be applied.

Grain Spirit.

The cereals have been long used in England, Belgium, Holland, Prussia, in the whole of Germany and America, for the manufacture of alcohol, known in the market as grain spirit. This trade, so useful to agriculture, and which has been forbidden by a royal decree in France for four years, has unfortunately never received that extension among us of which it is susceptible, for if the farmers were fully alive to the advantageous results which are to be derived from adding a distillery to their agricultural operations there would be no farm without one or more of stills. But blind and stupid routine is ever blocking the progress of the arts, even those of prime necessity, and in spite of the efforts of enlightened men, who sacrifice their time, and often part of their fortune, in propagating the results of scientific discovery, it requires ages to effect favorable changes. Mathieu de Bombasle is one of those who have sought with ardor to encourage the distillation of grains and potatoes, which he, with reason, considers one of the "Columns of Agriculture."

"There is not a farmer," says he, "who does not know that he should always cause a part of the crop to be consumed on his land by his cattle." In this man-
oats, buckwheat, and Indian corn are also employed under some circumstances with advantage.

Barley being the grain which is used exclusively for the preparation of malt, because it germinates more readily, and develops a larger proportion of diastase, should hold the first place. It should be selected with large fine grains of bright color, well filled, healthy, and firm, without any foreign substance, free from chaff, and as fresh as possible.

Wheat, although of all the cereals that which has the most body, and furnishes the greatest proportion of the alcoholic principle, is but little used in distillation, because its market value is always above that of other grains, and the alcoholic product is not always in proportion to this. In selecting wheat for the still, that should be preferred which is farinaceous, compact, and heavy, and very dry, without being blasted; that in which the gluten is so abundant as to give a vitreous appearance to the fracture.

Oats should be heavy, bright, long, and well filled. It is but little employed on account of its high price.

Of all grains rice is the most proper for the use of the distiller. Its proportion of alcohol is considerable, and the product has a very good flavor. It should be a dull-white, slightly transparent, angular, elongated, without odor, and of a fresh farinaceous taste. The East Indies, Piedmont, and the United States furnish considerable quantities to commerce.

Rye produces also a very considerable quantity of alcohol, in proportion to its cost, but it is inferior in taste to that resulting from rice, wheat, or barley.

As for buckwheat and Indian corn, they are usually sold at a low price, and the distiller may, under favorable circumstances, and in some localities, employ them with advantage.

Chemical Composition of Grain.—Grain (of cereals) is composed of an envelope in the form of bran, and of a portion which when reduced to a powder under the mill takes the name of farina or flour. The flour of the different kinds of grain of which we have just spoken, contains in itself various principles, the proportions of which vary not only for each of them, but for all according to climate, variety, soil, or other accidental causes. These principles are starch (amidon), which constitutes the greater part, gluten in variable quantity, albumen, mucilage, a small portion of saccharine matter, and in some, phosphate of lime and other salts.

By a recent analysis the proportions of these proximate principles may be stated as follows:

| GRAINS | Starch | Gluten and other nitrogenized substances | Decrude, gluten, and diastase substances | Fat matter | Cellulose | Silicon, phosphorus of lime, and small salt of phosphate
|--------|--------|----------------------------------------|----------------------------------------|------------|----------|----------------------------------------
| Wheat—average of five varieties | 65.99 | 18.03 | 7.63 | 2.16 | 3.50 | 2.69 |
| Rye | 65.65 | 15.50 | 12.00 | 2.15 | 4.10 | 2.60 |
| Barley | 65.43 | 13.95 | 10.00 | 2.76 | 4.75 | 3.10 |
| Oats | 60.59 | 14.39 | 9.25 | 5.50 | 7.06 | 3.25 |
| Indian corn | 67.55 | 12.50 | 4.00 | 8.80 | 5.90 | 1.25 |
| Rice | 89.15 | 7.05 | 1.00 | 6.80 | 1.10 | 0.90 |

Among these proximate principles it is the starch which has the property of being convertible into sugar, and giving rise to the alcoholic fermentation and the production of spirit. The gluten and vegetable albumen have the property of transforming starch into saccharine matter. This change is, however, better effected by means of sulphuric or hydrochloric acid, germinated barley (malt), and diastase.

It should be remarked that those grains or seeds which are richest in gluten always contain the largest proportion of azotized substances, and, in general, more fatty matters, inorganic salts, and cellulose, but less starch. As this last principle is that which furnishes the saccharine matter, that is to say, alcohol, preference should

* The proportion of azotized substance has been deduced from the elementary analysis by multiplying the weight of the nitrogen obtained, by 6.5.
be given, for purposes of distillation, to those seeds which contain it in the greatest quantity.

Dextrine.—Starch which has been subjected to the action of hot water, and which is entirely dissolved, has acquired new properties, and then constitutes a new isomeric principle called dextrine.

The very feeble acids, aided by heat and diastase, have the property of converting starch into soluble dextrine, and they produce this curious effect in a very simple manner. Dextrine is obtained by turning into a boiler, containing 100 or 200 litres of water, at 25 or 30 degrees, from five to ten parts of sprouted barley (malt), raising the heat to 60 degrees; then add 50 kilogrammes of flour, stirring the mixture, which is kept at a temperature of 70 degrees, for twenty minutes. The liquid which was opaque and viscous becomes as fluid as water. The temperature is now rapidly raised to 100 degrees; it is then permitted to cool, the clear liquid drawn off, filtered, and evaporated to the consistency of thick syrup.

On cooling the dextrine becomes an opaque jelly, which, when dried, is hard and brittle like gum Arabic. Dextrine is transformed into glucose by the action of acids, or malt added in larger quantity.

Diastase.—This substance is a proximate principle which is developed during the germination of cereals, potatoes, &c., and which has the remarkable property of reacting on flour or starch so as to render all the starchy particles very soluble, forming first a gummy substance (dextrine), which is gradually transformed into glucose. It is a remarkable fact that diastase does not exist in grain before germination. This principle is produced in proportion as vegetation is established, and its office is to react on the starch so as to render it soluble, in order that it may contribute to the nutrition of the incipient plant.

In its pure state diastase is white, solid, uncrystallizable, insoluble in alcohol, soluble in water and dilute alcohol; its aqueous solution is neutral, and without any decided taste; left to itself, it is more or less rapidly altered, according to the temperature, and becomes acid. This alteration, which is important in that it deprives diastase of its most remarkable property, takes place, although slowly, even in dried substances. For this reason it is not proper to prepare malt too long in advance of the time for using it. It is especially improper to keep it from one season to another.

The action of pure diastase on starch or flour made into a paste is most powerful. Fifty grammes of diastase are sufficient to convert 100 kilogrammes of amylaceous matter into dextrine and sugar; this transformation is effected more or less completely, according as the quantity of water employed and the degree of heat are more or less adapted to the operation.

Generally diastase is extracted from barley malt, which does not contain more than two or three one-thousandths; a greater proportion is obtained when the germination has been regularly conducted in all the grains, and when the gemmule or plumule has not been pushed too far in its development. This last is very important to be observed, for when the germination has been too much prolonged, it causes an absolute loss by diminishing the amount of saccharifiable principle. It is on this special reaction of diastase that is founded the art of manufacturing beer, syrup of dextrine, or dextrine.

The Alcoholic Product of Grain.—As with all substances subjected to distillation, the amount of alcohol produced from grains will always be dependent on their nature, their state of preservation, and the manner in which the various operations have been conducted. As a general rule, when the operation has been managed under favorable circumstances, the average result should be as follows, viz.:

<table>
<thead>
<tr>
<th>100 kilogrammes of grain</th>
<th>yield 39 litres of pure alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>wheat</td>
<td>28</td>
</tr>
<tr>
<td>rye</td>
<td>25</td>
</tr>
<tr>
<td>barley</td>
<td>25</td>
</tr>
<tr>
<td>oats</td>
<td>23</td>
</tr>
<tr>
<td>buckwheat</td>
<td>25</td>
</tr>
<tr>
<td>Indian corn</td>
<td>25</td>
</tr>
<tr>
<td>rice</td>
<td>36</td>
</tr>
</tbody>
</table>
The result given above is apparently very different from that obtained when the several grains are taken by measure, since they differ considerably in their specific gravities; wheat, for example, weighs much more for a given measure than barley or oats.

Preparatory Operations which are Necessary before Submitting Grain to the Alcoholic Fermentation.

There are six preliminary operations which are indispensable in order to fit grain for the process of fermentation, viz: 1st, Steeping; 2d, Germination (malting); 3d, Drying the Sprouted Grain; 4th, Grinding; 5th, Mashing; 6th, Infusion.

We shall proceed to each operation in turn, taking barley for an example.

Steeping.—The object of this operation is to introduce into the grain a sufficient quantity of water to determine the germination; it serves, too, to separate all the blasted or withered grains which float on the surface of the water, and also removes the various foreign substances which may be attached to the surface of the barley.

For this purpose the grain is allowed to macerate in river or well water for thirty or forty hours, according to the temperature of the atmosphere, the quality or dryness of the grain, and the character of the water; in other words, the barley is placed in a vat of wood or a stone tank lined with hydraulic cement. A quantity of fresh and limpid water is poured on the grain, so that it may be covered to the depth of ten or twelve centimeters; the mass is left alone for the requisite period of time.

This water, during the high heat of summer, ought to be changed every four or six hours, in order to avoid the establishment of fermentation during the steeping; in order to avoid disturbing the grain, an opening is made in the lower portion of the vat, through which the water may be drawn off at will, as fresh water is added above.

It is known that the grain is sufficiently steeped and softened when it is swollen, and yields readily when pressed between the fingers, when it may be completely crushed without leaving a hard lump or when it is divided easily by the nail. When it is in this condition the water is drawn off, care being taken that none of the grain is drawn off with it. To prevent such an accident the vat is provided with a double bottom, or a layer of straw is placed over the orifice of the vent.

The operation of steeping requires the most careful attention, for if the grain is steeped for too long a time, it will lose a portion of its saccharine matter.

Germination.—Barley which has not been subjected to germination will not answer alone for making spirituous liquors, but when converted into malt it can effect the conversion of a large quantity of flour into saccharine matter. It is therefore important, to indicate precisely the most advantageous method for preparing this malt, which plays so important a part in the distillation of grain.

After drawing off the water which covered the grain as described above, it is allowed to drain for four or six hours, and is then conveyed to the malt-house. This apartment is situated usually on the ground floor, or, better still, in a cellar, in order that the temperature, which should be regulated at $12^\circ$ C., may not be subject to variations. It is always paved with tile or stone.

In the malt-house the barley is arranged in couches or beds of 50 or 70 centimeters high until it becomes sensibly heated. This heat, which is favored in winter by covering the beds with sacking or blankets, is produced by a commencement of vital movement in the grain, and is generally manifest in from twelve to twenty-four hours after the couches have been prepared. At this stage the grain gradually absorbs oxygen from the air, and exhales carbonic acid at first slowly, but afterwards with more rapidity. The temperature of the mass sensibly rises, and at the end of a certain time it has attained a temperature exceeding that of the atmosphere by six or seven degrees; the barley which had become dry on the surface then acquires so much moisture as to wet the hand when thrust into it; it exhales an agreeable odor somewhat similar to that of apples;
when this moisture is observed the grain is said to sweat. It is not proper to permit the grain to become too warm, because it will sprout too rapidly, and the saccharine matter will be destroyed. It is proper, also, to turn the grain over every six or eight hours, placing that which was on the top at the bottom, and that in the middle on top of the pile, taking care always to keep the floor very clean, to prevent the formation of mould and putrid odors.

As soon as the germ appears, which happens when the barley sweats, and when a small white prominence is seen at the end of each grain, which is soon separated into three little roots, which increase in length very rapidly, the barley should be turned every three, four, or five hours, according to the temperature, by which this operation should be regulated. As the process proceeds the beds should be made thicker or thinner, so as to maintain a temperature of 15° or 16°. When the germ is long enough the grain ought to be turned twelve or fifteen times a day, according to the season. When the germination has been checked, and the little roots begin to dry, the thickness of the beds must be reduced so as not to exceed eight or ten centimeters; they must be stirred and changed frequently in order to prevent the rootlets from resuming their growth, to avoid moulding and to prevent the grain from sprouting, that is to say, giving issue to the seminal leaves at the extremity of the seed opposite the roots, for this would deprive the barley of a great part of the substance which yields alcohol.

It is difficult to indicate the exact period for the germination; it varies from eight to fifteen days, according to the season. We know generally that the process is terminated when the rootlets have attained a length equal to about two-thirds of that of the grain.

Germination causes the production of the diastase which is necessary to transform the starch into glucose; it has then for its object to convert a small quantity of the fecula of the grain into sugar, at the same time that it predisposes the rest to a more complete and prompt saccharification by giving to the gluten the property of being more readily dissolved.

Drying the Malt.—We have shown how important it is to arrest the germination promptly, for without this precaution the saccharine matter which has been developed by this operation in the grain at the expense of the starch, which is, as we have said, saccharified by the action of the diastase, will be destroyed, and the grain will pass rapidly to a state of putrefaction after having run through the acid fermentation. These accidents, then, must be forestalled by drying the grain by a gentle and well-regulated temperature in order to arrest the germination.

The drying is effected in an apartment called a kiln. The grain is spread on the floor in beds of twenty or thirty centimeters thick, then subjected to a temperature which, at first, should not exceed thirty-five degrees; but should be gradually increased to fifty-five or sixty degrees at most, until the grain is almost entirely dried. This temperature is most favorable to producing a good quality of malt. If too great a heat is employed at the beginning while the grain is yet very moist from being filled with water, the starch will expand, become hydrated and form a stiff paste, and then acquire so much hardness and cohesion as to be very difficult of solution. When the grain is almost dry, the heat may be raised to 80 and even 100 degrees without risk, the diastase being alterable at this temperature only when water is present. Nevertheless if the grain is dried at a temperature sufficiently high to convert the sugar into caramel, the diastase will be destroyed, there will be a loss of sugar, and the malt will have a less agreeable flavor.

Barley sprouted and dried is called malt. When the heat has not been sufficient to change the color it is pale malt; when the heat has caused a decided color it is brown malt.

When the malt is well dried, it is drawn from the kiln and spread out to cool in a well-ventilated room and stored in piles. It may be preserved for a long time if protected from moisture. The freshest is however the best.
Various means are employed for kiln-drying malt; plates of sheet iron or tiles perforated with small holes are used, metallic cloth of iron or brass is also in use in some establishments, and is to be preferred to the sheet iron or tiles. We would especially recommend the process by heated air. The method of heating by gas jets, recently patented in Great Britain by Hademu of Leeds, is as a combination of the various systems an improvement. Certainly if the results obtained by him are fairly stated, there is great profit both in the improved quality of the product and economy of fuel.

The choice of fuel for kiln-drying malt according to the old method, is by no means a matter of indifference; if wood, for example, be used the grain will acquire the taste of the smoke which will be transmitted to the beer in the fermenting vats, and consequently to the spirit resulting therefrom. Coke either specially prepared or that from the gas-works is the best, the next is wood charcoal.

When the malt is sufficiently dried and while it is yet warm it is passed through a winnowing machine, which will completely separate all the radicles, which are very brittle. There is no real loss from the separation of the radicles, as they contain neither diastase, starch, nor sugar. They yield by infusion a reddish water of disagreeable taste, and if some time is allowed to elapse before the separation, the radicles will, under the influence of a little moisture, resume their elasticity, which will render them difficult to break off from the grains. They are only fit for manure.

Barley converted into malt, loses about an average of 20 per cent. of its original weight, but this 20 per cent. is to be diminished by 12, for the water evaporated during the drying, therefore the real loss is 8 per cent., which may be stated as follows, viz:—

| Substances removed by the water during steeping | 1.5 |
| Matters lost during the sprouting, &c. | 3.5 |
| Radicles | 3.0 |
| | 8.0 |

Malt is known to be of good quality when the grain is round and full of farina, the skin very thin, odor agreeable and taste saccharine, or better still, by the energy of its action on starch, 100 parts of which may be dissolved by 5 parts of good malt in 400 parts of water, if the mixture is placed in a water-bath maintained at a temperature between 65 and 80 degrees and continually stirred. In conclusion, pale dry malt is the heaviest and best for distillation.

Grinding.—It is necessary that malt should be ground to facilitate the action of the water on the farinaceous matter which, without this operation, would be prevented by the skin. Every grain should be crushed, but not reduced to flour; for those which escape the action of the mill, will be lost to the fermentation. It must not be supposed, however, that malt reduced to a flour cannot be fermented, it is only crushed to save labor, and because experience has shown that malt coarsely ground will yield all its fermentisible principles.

Fine grinding is preferable for raw grain, that is to say, for unmalted grain; and in fact this cannot be too finely ground. Thus crude rye, wheat, buckwheat, rice, Indian corn, and barley ought to be ground in the same manner as if intended for making bread. In this condition the material will be more promptly penetrated by the water, and will thus facilitate the action of the diastase on the starch, to effect its conversion into sugar.

It is known that musty grain, whether unground or in flour, appreciably loses its fermentisible properties. To avoid this inconvenience distillers should grind their grain as it is needed. It should also be observed that malt after being ground attracts more moisture from the air than when whole. That which has been on hand for some time, or has absorbed moisture, ought to be mashed with warmer water than freshly prepared malt.

Mashing.—The object of this operation is to wet and soften, with a certain quantity of warm water, the substances of the crushed malt as well as the flour of the various grains that may be mixed with it; it prepares these substances for receiving a larger quantity of water at a...
higher temperature, and appears too to prevent the agglutination of the mass by the formation of lumps and balls which might prove an obstacle to the water penetrating all parts of the mass.

The malt and grain either crushed or ground into flour are shot into a vat; warm water in the proportion of a litre to the kilogramme is turned on in small quantities at a time, in such manner that the temperature shall not exceed 45 or 38 degrees. While the water is being poured in, a workman must stir the mass continually, beating it in every direction so as to prevent the formation of lumps and cause every portion of the flour to receive a thorough wetting; after which the vat is to be closely covered and permitted to rest for twenty or thirty minutes or more.

We should observe during this operation to pour in the water gradually and in small quantities at a time and not to raise the temperature higher than that indicated above, for a greater heat will coagulate the albumen of the grain, will cook the starch, and in a great measure prevent the action which the gluten and diastase ought to exercise on it.

Infusion.—The object of the infusion is to cause the diastase of the grain to react on the starch, which has been thoroughly divided by the mashing, in order to convert it into saccharine matter and to predispose it to a fermentation, which it would be impossible to undergo without it.

This very important operation is effected by pouring boiling water into the vat until we have obtained a temperature of 60 or 70 degrees Cent., while a workman stirs the mixture energetically for ten minutes at least. When the requisite degree of heat has been attained, the vat is covered closely and allowed to macerate for four hours. It is proper during this time that the temperature of the vat should not fall below 50 or 55 degrees, and it is even preferable that it should be maintained at 60 degrees.

We would remark that it is proper to employ a little more heat for the maceration of a small vat than a large one; and also that in winter the heat should be much greater than in summer. In any event if the temperature should happen to fall to 40 or 45 degrees, it will be better to set the malt to ferment at once rather than prolong the maceration, because there must be a loss of a certain quantity of alcohol in consequence of the acidity which will infallibly be produced at this low degree.

The temperature of 60 degrees is the most proper for this maceration, as being that at which the saccharification is effected most rapidly. Not that it cannot be effected at a lower temperature, at 40 degrees for example, but it is then more tardy, and we are exposed to the risk of seeing the whole mass become acid if it is exposed for some hours to this temperature, and this would be an irreparable loss. If, on the other hand, we exceed the temperature of 60 degrees, there will be no inconvenience up to 68 or even 72 degrees; but at 75 degrees mischief begins to be manifest, and above 75 degrees the fermentation is exposed to serious injury; it will fall altogether if the temperature is raised to the neighborhood of 100 degrees. It appears that the gluten, which is, in this operation, the vehicle of saccharification, only possesses this property when it has not been exposed to too high a temperature. Heat contributes very much to its action and renders it much more intense; but the maximum of utility of this heat is from 60 to 72 degrees.

The proportion of water also plays a remarkable part during the maceration. The greater it is, the more prompt and complete will be the saccharification, all other circumstances being the same. Let us take an example: generally when we wish to treat 100 kilogrammes of flour we mash with one hectolitre of water and add two and a half hectolitres of water for the maceration. This then is completed in the space of four hours; but if the dose of water is doubled, that is, if we use three hectolitres for mashing and four for the maceration, the operation will be as perfect as the preceding in the space of two or two hours and a half. So much for the influence of water upon saccharification.
Now that we have set forth the principles of the operations to which the grain must be subjected before submitting it to the alcoholic fermentation, we shall proceed to occupy ourselves with this last.

**Alcoholic Fermentation of Grain.**

When the operations which we have described above are completed, that is, when the maceration is finished, the barley is submitted to the vinous fermentation; for this purpose, as it contains a sufficient quantity of saccharine matter, it suffices to mix it properly with cold water so that the temperature may be at from 20 to 26 degrees, according to the volume of the mass operated on. Liquid beer yeast is then added in the proportion of one litre of yeast to 100 kilogrammes of grain (or 250 grammes of dry yeast), the vat is then covered and the fermentation is soon established.

The mash ought to be cooled promptly in order to prevent acidification during the operation. Never make a mash unless it can be set to ferment immediately.

The chemical analysis of a must thus obtained gives for its results: 1st. A saccharine substance, which constitutes the most abundant portion of it; 2d. Starch, which it is easy to recognize by the blue color obtained with tincture of iodine; 3d. A combination of starch and gluten; 4th. Mucilage, which is precipitated in flocks when the must is poured into alcohol.

As a general thing where the various operations have been well managed, the fermentation progresses with perfect regularity and lasts from two to three days; but it is only twenty-four hours after it is finished that we proceed to the distillation in a continued apparatus for pasty materials.

We have taken barley for our illustration in all the preparations and arrangements we have described, because malted barley is the very essence of the distillation of grain and potatoes, not that this grain has properties which are peculiar to it, but because it possesses them in a much higher degree than any other.

There are many methods of distilling grain. We shall examine those which are most in use in the farm and agricultural distilleries of Europe.

**Method of Dombaste.** — "Suppose," says he, in his valuable Treatise on the Manufacture of Spirits from Grain and Potatoes, "that it is desired to ferment 100 kilogrammes of flour (80 kilogrammes of rye and 20 kilogrammes of malted barley), the fermenting vat should contain six or seven hectolitres, not counting the space which ought to remain empty. The water must be heated to the boiling point and maintained at that degree for some minutes; a portion is then to be cooled down to 50 degrees for making the paste. For this purpose we use a vat which is much wider than deep, and which contains three or four hectolitres; this is the mash tun. The flour is turned in and the water at 50 degrees is gradually added with continual stirring in such manner that the flour may be thoroughly moistened throughout, without the formation of lumps. We should continue to add the same water until the temperature of the mass is reduced to 31 or 33 degrees. This must then be covered and allowed to stand for half an hour. We should then take some of the water which is still boiling, and pour it into the mash tun in small quantities at a time, stirring the mass continually so that no part of the flour may be exposed to too great an excess of heat until the mass has attained about 62 degrees. The vat must then be covered and allowed to rest for two hours. It may be permitted to rest even three or four hours if the mass is large, or if the temperature of the apartment in which the operation is conducted be sufficient to prevent the heat from diminishing too rapidly. At the end of this time the vat should be uncovered and the liquid stirred so as to cool it as rapidly as possible. A method which has been very successful in accomplishing this cooling, consists in filling a copper..."
or tin flask of a capacity of 25 or 30 litres and having a long neck, with cold water, which is plunged into the liquid and gently moved about therein. When the water becomes warm it is changed and the operation continued until the liquid has acquired the proper degree of temperature. This degree ought to be calculated so that when the mass is conveyed to the fermenting vat and enough cold water is added to fill the vat to the desired point, the liquid shall have the proper temperature for adding the yeast. As soon as the mass is sufficiently cooled it is transferred to the fermenting vat and the last of the cold water added; it should then have the proper temperature for adding the yeast, as has been explained before. This varies from 20 to 25 degrees according to the season, the size of the vats, the nature of the grain used, &c. By the assistance of the thermometer we shall soon ascertain the proper degree for each distillery and every circumstance that may require attention. If the yeast is added when too hot, the fermentation will take place promptly, will be very active, and the liquid will become acid on the second or third day. If, on the contrary, the yeast is added too cold, it will be easily discovered, because the fermentation will take place slowly and will have but little activity; then too, the acid fermentation will commence before the vinous fermentation has sufficiently advanced. As a general rule, when the yeast has been properly added and in sufficient quantity, the fermentation has already begun two hours after the addition of the yeast, and in twelve hours is very active, and so continues until the third day. Thus a vat which has been set to ferment on Monday, will present during the whole of Tuesday an active fermentation with an elevated foam and very strong odor; if a lighted candle is plunged into the empty part of the vat it will be very promptly extinguished. On being tasted, the liquid should still be sweetish without any acidity. On Wednesday, the foam will have very much diminished, and the liquid be no longer sweet but vinous, although not yet acid. On Thursday the foam will have completely fallen and settled to the bottom of the vat; the liquid is almost clear and slightly acid, and there is generally found on the surface a whitish pellicle. This is the proper condition in which to subject it to the action of the still.

"I have advised that the mashing should be performed in a separate vessel; nevertheless it is the common usage of distillers to make the mash in the fermenting vat directly. I prefer the former method, because it is easier to cool the mass in a large vat of little depth than in the fermenting vat, which is much deeper than broad. Besides, in transferring the mass to the fermenting vat, which is cool, it will lose two or three degrees, which is so much time gained in the cooling, and it is very important that this should be accomplished as promptly as possible. By making the mash in the fermenting vat, it is necessary to add a very much greater quantity of cold water to reduce the mass to the degree of heat proper for adding the yeast, and we have in consequence a very weak wine.

"I have indicated 62° Cent. as the most favorable temperature for making the mash. It is in fact that which is best under the greatest variety of circumstances, and we shall never fail in a fermentation from having made the mash at this degree; nevertheless, there are circumstances in which we obtain a greater quantity of spirits by making the mash some degrees above or below 62°. These circumstances are so numerous that it is impossible to give precise rules for each. We should always be governed by experience, with the thermometer in hand that it may direct us. We may say, however, that, in general, the mash should be much warmer in winter than in summer; for small vats than large, and as much warmer as the proportion of malt is increased."

This process, by reason of its simplicity, like that spoken of by us before, may be practised in farm distilleries of the least importance; both require but little hand labor, a small number of vessels, and consequently not much capital.

Another French Method.—Suppose that we intend to operate on one hundred kilogrammes of grain:—
DISTILLATION OF ALCOHOL.

According to Dubrunfaut, the grain being mixed in the proportion of 80 parts of rye and 20 of malt, is reduced to coarse flour, then deposited with two or three kilogrammes of chaff, in a fermenting vat of a capacity of 12 hectolitres. These materials are then moistened with three hectolitres of water at about 45°, and then made into a mash with four hectolitres of cold and boiling water, mixed in such proportions that when the mashing is completed, the mixture shall have a temperature of 62° or 68°. The vat is then covered and left to itself for three or four hours; after this time has elapsed, the vat is to be filled to within six or eight inches of the top with cold and hot water, mixed in such proportions that the whole mass shall have a temperature of about 25°. It is set to ferment with a litre of good liquid beer yeast.

After a few hours, the fermentation commences, and runs through all of its stages in the space of about thirty hours. It is then in a proper state to go into the still.

"If the grain is of good quality and the operation properly conducted, the result ought to be from 45 to 50 litres of proof spirit (50° centesimal)."

Many distillers only obtain from 30 to 35 litres by this process. There are many circumstances which may concur in causing this result; the principal and most influential is the proportion of water employed; instead of using about 11 hectolitres of water to 100 kilogrammes, they only employ about six.

"In a continuous operation the spent liquor (or swill), which is drawn from the still, ought to be stored in hogheads or in a cistern constructed for the purpose. There the solid matter is deposited, and the clear liquor floats above. This liquor may be profitably employed in succeeding operations to dilute the mash. It is found that this practice has the advantage of bringing to the fermentation a liquor which still contains fermentable matters which have escaped in the previous operation. This course may be continued through many successive operations, three, four, or even five; and we may obtain by this means as much as 60 litres of proof spirit from a metrical quintal of grain, a result which cannot be obtained by any other process. We should cease to use the clear portion of the spent liquor, when, after many operations, it has become so acid as to injure rather than support the vinous fermentation.

"If we operate with a smaller proportion of water, we cannot follow the same course, or at least it cannot be pushed so far, because in that case the fermentation, requiring three or four days instead of thirty hours, yields a strongly acid spent liquor."

This method, like those spoken of before, necessitates the distillation of pasty or semifluid materials, which, as we know, always furnish an alcoholic product of inferior quality; first, on account of certain principles contained in the envelope of the grain; second, because the mash, when distilled over the open fire, readily attaches itself to the bottom of the still, burns and gives to the product a burnt or empyreumatic flavor which detracts very much from its value. These objections disappear when steam is used, or, better still, with the following, known as the:—

**Old English Method**—Which consists in treating the grain in a vat with a double bottom, so as to make an extract just as is done in the manufacture of beer.

The grain, consisting of malt and raw rye, being mixed and crushed as for mashing by the French process, a layer of short straw, about two centimeters deep, say about ten kilogrammes, is arranged on the false bottom of the vat; on it are placed about 200 kilogrammes of the crushed and mixed grain.

Then, by a lateral pipe communicating with the vacant space between the two bottoms, 200 litres of water at 35° or 40° Cent. are turned on, while one or two men stir the mass vigorously with a beater for eight or ten minutes. The mass is then left to itself for about a
quarter or half an hour, in order that it may be well saturated with water. This operation is identical with and has the same result as the steeping, which precedes the mashing in the last method described, the only difference being in the apparatus used.

Immediately after this steeping, the workmen resume their beaters, and recommence the stirring, while a new supply of boiling water, 800 litres, is turned on by the lateral pipe. This stirring is kept up about a quarter of an hour, then it is left to stand about an hour. At the end of this time any grain which may have been floating on the surface ought to have fallen to the bottom of the vat, and the whole be covered by a stratum of tolerably clear liquid. A cock, which communicates with the space between the two bottoms, is now opened, and as the upper or false bottom, by its conical perforations and layer of straw, forms a species of filter, all the liquid (wort) runs off and is conveyed to the fermenting vats.

The first extract being completed, 600 litres of boiling water are turned in by the lateral pipe, and the mass is again stirred for fifteen minutes; the mass allowed to stand an hour, the wort is drawn off, as before, and set to ferment. The grain which remains on the false bottom, after these two operations, is sufficiently exhausted of fermentable matters which have been borne off by the water in saccharine form.

This operation, which is a true mashing when well understood and properly managed, proves to a demonstration the effect of this mashing on the grain; it proves, as we have said, that it is a true saccharification.

The liquid which we have obtained, and which has been conveyed to the fermenting vats, is leavened when the temperature has fallen sufficiently, say to 20° or 30° Cent., according to the capacity of the vat; and we thus obtain a liquid free from deposit, which may be subjected to distillation in any kind of apparatus.

If it is found that the grain remaining on the double bottom is not sufficiently exhausted, it may be submitted to the operation a third time.

The Germans follow the same method for the distil-
water warmed by this particular arrangement may be transferred to the boiler which furnishes water to the mash tub.

When the temperature of the must has attained the proper degree (18° or 20°), it is set to ferment in immense vats containing from 180,000 to 200,000 litres, by adding five or six litres of fluid yeast, or two and a half to three kilogrammes of dry yeast to the 100 kilogrammes of material employed; the fermentation is developed very slowly at first, then progressively, and is finished at the end of four or five days.

When the operation has been conducted under favorable conditions, the result is about 25 litres of pure alcohol (29.4 litres at 95 per cent.) to 100 kilogrammes of the farinaceous substances employed.

Generally the English distillatory apparatus is of colossal dimensions; there are many which distil 5000 gallons (22,700 litres) per hour, or 120,000 gallons (340,800 litres) in twenty-four hours. The superiority of the English proof spirit is due entirely to the use of such stills; the greater the capacity of the apparatus, the better the quality of the product. We are well convinced of the truth of this proposition, and indicate the reasons therefor in the various circumstances of the process of rectification.

It is to be remarked that in England, as in France, it has been observed that broken barley allows the filtration of the must, and oats favor it; while, on the other hand, the flour of rye hinders it, and compels us to decant the liquid after a sufficient rest.

Belgian Process.—Since Holland was separated from Belgium, the legislation of the latter country, on the subject of distilleries, has entirely changed the processes in use up to that time, and created a system used in no other country of Europe.

Thus, says M. Lacambre, while, before the Belgian law of July 18, 1852, it usually required 36 or 40 hours to complete the operation of mashing and fermentation; since this date, the greater number of distillers in Belgium complete the operation in 22 or 24 hours, and

there are some who finish in 18 or 20 hours. This is certainly not for the best, because the product is manifestly diminished by it. This practice is followed because of the heavy tax levied on the mash tuns (one franc to the hectolitre for each 24 hours).

The new law of 1852 increases this tax to one and a half francs, imposing an additional impost on those who complete the mashing and fermentation in less than 24 hours, consequently there are no longer any distillers who finish the fermentation in less than 24 hours, which is really a useful and beneficial result of the last change in the Belgian law.

Almost all of the changes which have been made in the old Dutch process, and which legislators and workmen have commonly called improvements, have had the effect, or at least for their object, to reduce the taxes by either accelerating the operations of mashing and fermentation, or reducing the capacity of all the vessels and apparatus on which taxes were laid. From this it will be easy to comprehend how most of the products of the Belgian distilleries in general, and of the farm stills especially, had diminished in quantity and lost in quality before the law of 1852, which has in some measure improved this deplorable state of things.

In fact, prior to 1852, most of the Belgian distillers conducted their work as follows: They had reduced the quantity of mixed flours used to from 11 to 12 kilogrammes to the hectolitre in the mash tun, mixing with water at 50° or 60° Cent., after which they added enough boiling water to fill the vat to about three-fifths of its capacity, and stirred constantly until the mixture was as perfect as possible. When this second addition of water was well mixed in, the vat was covered and allowed to rest for half an hour; frequently, at the end of twenty minutes, the mixture was stirred anew in order to cool it, and the cooling was hastened by the addition of cold water, or cold spent liquor, resulting from a previous operation, to lower the temperature and the density to the required degree. It was then set to ferment at a temperature so high that the first two periods of the