becomes less abundant, it is remarked that the sweet
taste of the liquid also diminishes and insensibly dis-
appears; then the vat acquires a very decided odor of
alcohol—a sign which indicates the termination of the
fermentation.

When the operation has been conducted under favor-
able circumstances such as have been indicated above, the
vinous fermentation terminates usually at the end of
thirty-six or forty-eight hours, and if it is not completed
within fifty-five or sixty hours or more, the result will be
a very bad one.

We know that the operation has progressed properly
when the liquid only marks 0° or 1° on the areometer
of Baumé.

When the alcoholic fermentation is terminated, the
acids contained in the fermented liquid are neutralized
by a slight excess of lime, which should be previously
mixed with a sufficient quantity of water. The object
of this addition is not only to neutralize the acids which
exist in the wine, or are produced during the fermenta-
tion, but also to afford a means of arresting or at least
of retarding, and in a great degree diminishing the pro-
gress of the acetic fermentation which, as we know,
always takes place at the expense of the alcohol. After
saturation the vats are closely covered and allowed to
stand twelve or fourteen hours. During this period of
repose the vinous liquid becomes clear, and the lime falls
to the bottom of the vats, combined with the acids
which it has neutralized, when we may proceed to the
distillation by the continuous apparatus.

Admitting that we have operated upon good molasses,
and that we have directed and watched the fermentation
and distillation with the special knowledge which these
operations require, we shall obtain ordinarily an average
of 28 or 30 litres of pure alcohol from 100 kilogrammes
of molasses at 42° (37 or 41 per cent.).

The alcoholic result will be materially increased if we
use for a new fermentation the clear waste liquor which
is derived from the previous distillation, by using it in-
stead of water to dilute the molasses. This method,
practised at present in distilleries of molasses from beet
sugar presents also the peculiar advantage of affording a
more highly concentrated saline liquid from which to
extract the potash it contains. There results from it a
notable economy of labor, and especially of fuel for con-
centrating the waste liquor.

Since the waste liquor resulting from the direct distil-
ation of the wine of beet molasses usually marks from
3° to 4° of the areometer of Baumé; and when used
for a new fermentation we obtain after distillation waste
liquor marking from 7° to 8°, we would call attention
to the fact that in charging the vats we ought not
to estimate at its full value the degree of the waste
liquor used for diluting the molasses. In other words,
if the charge of molasses for fermentation should be at
8°, and the waste liquor used had marked 4°, we should
charge the vats at 12°, since there are 4° resulting from
the waste liquor which count for nothing.

Some chemists advise the fermentation of molasses at
12° or 14°. This would in effect yield a more concen-
trated waste liquor, but experience has proven that by
charging the vats at so high a degree there will be too
much sugar lost in the waste liquor. For many years we
have seen that the use of malt and rye-flour in the fer-
m entation of molasses will produce an excellent effect.
Five hundred grammes of each are to be employed for
each hectolitre of the liquid to be fermented. It is cer-
tain that these substances perceptibly increase the fer-
m entation, and produce a greater quantity of alcohol.

The spirit of molasses has neither the taste nor the
odor of spirits of wine; it is sweeter, and when the
distillation and rectification have been properly con-
ducted, it may be considered as a type of alcohol in its
purity, for it has neither taste nor any peculiar aroma.
In this state it is called fine spirits, and may be employed
in the manufacture of liqueurs, for improving common
brandies, and especially for refining the troix six (recti-
fied spirit) of Montpellier. The spirits of molasses
occurs usually in the market at from 90 to 94 centesimal degrees.

NOTE.—In those districts of France where the beet is largely cultivated for the manufacture of sugar, and the molasses is converted into alcohol, the waste liquor is made a source of no inconsiderable profit by concentrating it and incinerating the residuum, from which is obtained, for the use of the soap boiler, a caustic potash of superior quality. In addition to the alcohol, 100 kilogrammes of good beet molasses will yield 10 or 12 per cent. of commercial, or from 7 to 8 per cent. of refined potash.*

Alcohol from Beets.

The manufacture of alcohol from beets, after having been for many years the object of a special industry, has now a tendency to become entirely agricultural; in fact, for many years only three hundred farmers had set up distilleries for beets, and this year (1867) at least double the number will be set in operation if alcohol still continues to rise in price. The advantages which this manufacture presents to the farmers are considerable. Producing the raw material themselves, they get it at a price to which the trade cannot aspire; they extract the alcohol by maceration at minimum cost. This work furnishes a residuum, which is almost nothing, and which, when fattened them visibly. On the other hand, the food resulting from this work will, in its turn, improve the quality of the land already improved by the cultivation of the beet.

Finally, the distillation of the beet being conducted at a season when field work is interrupted, will afford occupation for the laborers.

From these considerations it follows that the industrial distillation of the beet should give way to the agricultural, and that, after awhile, will do so entirely.

Chemical Analysis of the Beet.—The following is the average of many analyses made at different times by intelligent and skilful chemists:


<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>85 parts</td>
</tr>
<tr>
<td>Sugar</td>
<td>10 parts</td>
</tr>
<tr>
<td>Ligninous fibre</td>
<td>2.5 &quot;</td>
</tr>
<tr>
<td>Albumen and other substances</td>
<td>2.5 &quot;</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
</tr>
</tbody>
</table>

The other substances not named are: malic and pectic acids, an azotized substance, red, yellow, and brown coloring matter, fatty matter, an aromatic principle, an acrid essential oil, chlorophyll, oxalate and phosphate of ammonia; the silicate, sulphate, nitrate, and oxalate of potash, the chlorides of potassium and sodium, sulphur, silica, the oxides of iron and manganese.

When the distiller does not cultivate the beets he wishes to distil, that is to say, when he is obliged to buy them, it is best to make a preliminary examination of them in order to be assured of their saccharine richness, for this varies with the species of beet, the method of cultivation, and the nature of the soil in which they are grown. Atmospheric influences also have their effect.

The most certain test, that which will give the best result, is, without doubt, to ferment the juice and distil the wine resulting from the fermentation; the proportion of sugar which previously existed in the roots is deduced from the quantity of alcohol obtained.

A very simple method of testing beets consists in cutting from the middle of a number of them some thin slices, which, after being carefully weighed in a small balance, are dried either in a hot room, or on a moderately-heated stove.

As soon as the drying is complete, which may be known when the slices have become so hard and brittle that they break in the attempt to bend them, they are again carefully weighed; the difference in weight represents the quantity of water originally contained in the fresh beets. It is indispensable, in order to have the drying perfect, that the slices should be subjected to many successive weighings until they lose no more weight.
In order to determine approximately the quantity of sugar which the dried slices contain, we make the following calculation: Beets of a good variety, cultivated in a proper soil, and in a favorable season, would have 16 to 18 parts of dry matter for 100 parts of the fresh root; we should subtract 7 or 8 parts for the foreign substances, and there will remain 9 or 11 parts representing the proportion of pure sugar, or, in other words, 9 or 11 kilogrammes of sugar from 100 kilogrammes of fresh beets, of which it will be possible, when operating on a large scale, to obtain from 4 to 7 kilogrammes of refined sugar, or from 7 to 11 litres of spirit, at 50° Centigrade (proof), representing 3 to 5 litres of pure alcohol, because the beets only yield about four-fifths of the alcohol, and only one-half or two-thirds of the sugar they contain.

Another method of testing as simple as the preceding, but much more prompt, consists in ascertaining the density of the juice of the beets examined, and is as follows:—

Some beets are rasped in an earthen pan, and the pulp pressed in a cloth, the juice filtered through paper; then plunge an areometer into the liquid, and the degree of density will indicate the saccharine value of the beets with sufficient accuracy. This operation should be conducted quickly, and at a temperature below 15° Cent., in order to prevent the juice becoming thick and beginning to ferment.

The yield of alcohol from beets is dependent on the quantity of sugar they contain; it increases with the density of the juice, but not in proportion to it, on account of the saline matters and vegetable albumen which the roots contain in very variable proportions. Yet it is ascertained, according to a number of experiments, that beets, when they are matured, will generally yield 8 or 9 per cent. of sugar when their filtered (but not defecated) juice marks 6° on the areometer of Baümé, 9 or 10 per cent. when it marks 6½°, and 10 or 11 per cent. when the density is 7°.
DISTILLATION OF ALCOHOL.

thick or slimy, and still retain after this operation a certain quantity of liquid, notwithstanding the force applied. This inconvenience may be avoided by occasionally plunging the sacks into water containing two or three one-thousandths of tannin in solution, or five per cent. of sulphuric acid at 60 degrees.

The extraction of the juice of beets, by rasping and pressure, demands the most constant attention to cleanliness; for the sacks, hurdles, reservoirs, and other implements may produce changes which will react with very great rapidity upon must otherwise of good quality, and cause serious damage. We should, therefore, every day wash the reservoirs, presses, tables, &c., with lime-water. The sacks are to be placed in a large rectangular box, hermetically closed, and into which is introduced a current of steam. When they have been submitted to this operation they are rinsed in lime-water, or acidiolated water (five litres of sulphuric acid, at 60 degrees, to 100 litres of water).

The juice resulting from the rasp and press is then brought together in a boiler, and heated by steam to a temperature of 26 or 28 degrees, then it is conveyed by a pump or elevator to the fermenting vats. Although the beet contains a natural leaven, the fermentation should, nevertheless, at the start be developed by means of beer yeast, in the proportion of 50 or 60 grammes to the hectaritre of juice. This yeast should previously be carefully mixed with a small quantity of water or must, and the temperature of the apartment should be at 18 or 20 degrees Cent.

It is indispensable, in order to regulate and hasten the fermentation, to add to the liquid about two or two and a half kilogrammes of concentrated sulphuric acid for 1000 litres, according to the richness of the must, and more particularly according to the quantity of foreign substances which it may contain. This dose, however, ought never to exceed three kilogrammes; for then the acid would produce a contrary effect, that is to say, would hinder the development of the fermentation. The office of the sulphuric acid, in this case, is to saturate the alkaline salts, and to give the liquid an acid reaction, which will favor the conversion of the starchy elements into sugar, and the transformation of the sugar into glucose, which, as we know, requires no ferment to produce the alcoholic fermentation. This transformation always precedes the conversion of saccharine matter into alcohol and carbonic acid. Sulphuric acid also prevents the development of the viscous fermentation, otherwise so frequent in beet juice obtained by rasping.

According to M. Dubrunfaut, the office of the acids employed in the fermentation of the beet is to destroy the cells of that root, and to facilitate the extraction of the sugar; then to produce, by heat or cold, a sort of defecation which precipitates in a solid state the various azotized substances, especially the glairy ferment. Be this as it may, it is certain that by the employment of the acid, if the beet juice is placed in the condition of a favorable temperature, it will undergo a perfect and very regular alcoholic fermentation without the intervention of beer leaven, and that all the sugar contained in the juice will be converted into alcohol, under the influence of the natural ferment of the root, transformed into an exclusively alcoholic fermentation by the reactions of acids.

The acid may be advantageously added at different stages of the operation—on the rasp* by dissolving it in the water which flows on the drum of this machine during the rasping of the beets, in the trough of the rasp with the pulp after it has passed the machine, or when moistening the sacks already pressed, when they are submitted to the press a second time. In this addition the

* The acidulation of the pulp on the rasp, that is to say, at the moment of its production, preserves it radically from all change, either by oxidation or otherwise. The pulp remains white, the juice is limpid or colorless, the sacks and other utensils are cleansed, and will thus be kept perfectly sweet even without washing. The cells of the pulp not being dissolved, and, if we follow up the work by moistening the pulp with pure water, and pressing a second time, as is done everywhere, we shall obtain a new juice rich in sugar, and at the same time remove from the pulp the small quantity of acid which it would have retained but for this method of treating it
The dose of acid should be calculated upon the weight of the beets as juice, and even above, because the earth on the roots, which may have escaped the washer, will neutralize a portion of it.

It is known that the quantity of acid is sufficient when the pulp is colorless, and the slightly-colored juice is quite clear. A rapid fermentation, that is to say, one which is affected after a delay of less than eighteen hours, with a foam that is white or grayish, light, easy to reduce by the aid of any fatty liquid, is also an evidence of a proper quantity of acid. Blackish foam, or one that becomes so by exposure to the air, indicates the reverse.

It is easy to avoid irregularity in the dose by verifying the state of acidity of the juice, which ought to be, as was said above, from two to three kilogrammes of sulphuric acid, at 66 degrees, for 1000 litres of juice, according to its density, and the nature of the beets from which it is obtained. The dose of acid in the juice is ascertained with sufficient exactness by means of the alkali test solution, graduated test glass, and litmus. As a general thing two kilogrammes of sulphuric acid will be sufficient for a juice marking 103 degrees on the densimeter, or five degrees on the areometer of Baumé.

Hydrochloric acid may be used with advantage to replace sulphuric acid for the acidulation of the juice or pulp of the beet. This acid, which possesses a marked superiority as an agent for changing crystallizable into grape sugar, and for the conversion of amylaceous substances into sugar, enjoys also the same superiority as an agent for the destruction of the cells of vegetables. Besides, hydrochloric acid produces the development of the ferment and the alcoholic fermentation with a greater economy of time and money.

The proportion which the hydrochloric acid should bear to the dose of sulphuric acid is that of their chemical equivalents; that is to say, about two kilogrammes of hydrochloric acid (commercial) for one kilogramme of sulphuric acid at 60°.

The fermentation of a vat, while yet in a state of activity, may serve to produce a new fermentation in another vat without the addition of beer yeast; it is sufficient for this purpose to draw off one-half of the liquor into the second vat, and to fill the two vats with fresh acidulated juice; the fermentation is then developed and progresses without interruption, and may be the means of a new fermentation. The reaction is instantaneous, and takes place with great activity.

During the fermentation of beet juice there is produced quite a large quantity of globular ferment which forms the cap, and which has properties analogous to the yeast of beer, but is possessed of almost double its fermenting power. This ferment is collected in the same manner as that of beer, and may be applied to the same uses. When the fermentation is terminated, which happens generally 18 to 24 hours after the juice is introduced into the vats, the wine is allowed to rest for some hours, and then it is distilled in the continuous still, and in the manner already indicated. It is known that the fermentation is at an end, and the wine ready for the still when it only marks 0° or 1° on the areometer of Baumé, instead of 5° or 6° as at the commencement.

There is formed during the fermentation of juice obtained by rasping and pressure a very great quantity of foam which may overflow the vats and spread on the floor of the sweat-house; this inconvenience is easily prevented by the use of a solution of soft-soap or grease, as has already been said.

The deposit of the vats ought never to be used as a leaven for a succeeding operation; it only contains spent ferment which will do more harm than good. It may be understood from this how necessary it is to clean the vats with care after each operation, and according to the principles indicated above.

The alcoholic result is dependent on the saccharine richness of the beets, and the more or less advanced state of the season. It varies between three and five litres of pure alcohol for 100 kilogrammes of fresh beets.
DISTILLATION OF ALCOHOL.

Distillation of the Beet by Maceration.

Maceration is an operation by the aid of which is extracted by means of water and spent liquor, all the saccharine principle contained in the beet.

The object of extracting the juice by maceration is to suppress the rasp and press, which call for the expenditure of much mechanical force, and carry with them also too great an encumbrance of expense and personnel.

Then, too, we obtain by this process five or six times as much residue as by rasping, which is a great advantage to the farmer; nevertheless, it must be acknowledged that the alcohol produced by maceration preserves a little more of the taste peculiar to beet-spirit than that obtained from rasping and pressure.

There are many methods of applying this process, but we shall confine ourselves to those in general use.

Maceration by Water.—This should by all means be preferred as the industrial process, because it yields an alcohol having a less unpleasant odor than that obtained from maceration with spent liquor. Nevertheless, this process may be resorted to by the farmer, if he will restore to the residue of the beets the salt or salts they have lost in the process.

Maceration by water is effective either hot or cold. The first method, although it furnishes a spirit of inferior flavor, presents the advantage of yielding a much greater quantity of sugar in a very much shorter time. The heat, by bursting the vegetable cells of the beet, facilitates the escape of the saccharine matter, the place of which is occupied by the water. It furnishes also a residuum suitable for feeding cattle. The second is longer, but furnishes a residuum which is better suited for feeding stock, while the alcohol is of better flavor; however it may be, the hot process is in general use, and we shall therefore commence by describing it.

Maceration by Heat.—The beets are to be washed in a special apparatus, and sliced by means of a root-cutter moved by horse or steam power, or if the distillery is of little importance, by the force of two men. In the last case a fly-wheel should be added to give a greater impulse to the machine, and accelerate the cutting. In any event, it is indispensable that the root-cutter should make from 120 to 150 revolutions per minute, in order that the roots may be properly cut.

The knives of the cutter should be so arranged as to divide the beets into ribbons having a width of one centimeter to a thickness of one millimeter, and a variable length. These dimensions being rigorously observed, the maceration will be perfect.

It is best in order to save labor that the beets should fall directly from the washer into the hopper of the root-cutter. The beets being cut as described, are placed in a macerator of wood or iron and covered with boiling water, acidulated in the proportion of two kilogrammes of sulphuric acid at 66° to 1000 kilogrammes of roots. This dose of acid should be increased to five kilogrammes if the beets are damaged.

After macerating for one hour the liquid is drawn off, and at once turned into a second vat charged with beets cut in ribbons, where it remains still another hour; it is then drawn off into a third macerator charged as before, and after standing the same length of time, it is drawn off into the fermenting vat. This juice should have acquired, during the three successive macerations to which it has been subjected, a density which differs but little from that obtained by the rasping process.

While the operation is going on in the second macerator, the first is charged anew with acidulated boiling water, which also remains one hour, and is then turned into the second macerator after its contents are drawn off into the third. Finally the beets are completely exhausted by a third charge of acidulated boiling water, which also remains one hour in the first macerator.

The pulp being exhausted, is removed and replaced by fresh slices; the first macerator is then charged with juice which has already passed through two macerators; it stands one hour on this fresh pulp, and is ready for fermenting.

The starting differs, as we see, from the regular course

DISTILLATION OF THE BEET BY MACERATION.
of the operation, in this, that the first macerator receives three charges of acidulated water at the beginning, while it only receives one when the work is under way; the two other charges are made with juices which already have a certain density, as they are the result of exhausting two other macerators. In conclusion, each macerator, to be completely exhausted, must receive three successive charges of liquid at intervals of one hour.

When the temperature of the air is not too cold, the juice which results from the three macerations ought to be set to ferment without the necessity of being reheated; it is usually at from 22° to 24° of the centigrade thermometer.

The fermentation is started at first only by the assistance of beer yeast in the proportion of 125 to 150 grammes to the hectolitre. This yeast, carefully dissolved in advance in a sufficient quantity of water or juice, is poured into the vat before introducing the liquid, and in proportion as the latter is turned in, it is strongly stirred for some minutes in order to distribute the ferment properly. When the vat is full, that is, when the must rises to within 20 or 25 centimeters of the top, it is carefully covered, and the whole left to ferment in a local temperature of from 18° to 20°.

Since, as was said above, the beet contains a natural ferment, a vat which is fermenting will serve for developing a new fermentation in another vat without the use of any more beer yeast. For this purpose one-third or one-half of the must in the vat, after fermentation has commenced, is turned into a new vat and the two vats are filled during the course of the day with fresh juice.

The fermentation will then proceed without interruption, developing itself and continuing its course to give rise to new fermentations.

Generally the fermentation of juice obtained by hot maceration is completed in the space of twenty-four or thirty hours; it sometimes happens that it is finished within eighteen hours.

It is essential to observe the precautions we have pointed out in regard to preventing the accidents that may occur during the course of the fermentation, either from frothing or from the formation of acids, as well as those prescribed in regard to the cleansing of all the vessels and utensils.

The fermentation having terminated, as is known when the must has acquired an agreeable vinous odor, and when all internal movement has ceased in the vat, the liquid ought to mark 0° or 1° on the areometer of Baume. In this condition it may be distilled at once, but it is better to let it cool for twenty-four hours in order that it may attain the lowest possible temperature as it is used for cooling the coil and condensing the alcoholic vapors.

When the fermented juice is sufficiently cool the distillation is at once commenced in one of the continuous stills described above. The distillate usually marks from 45° to 55°: it must be rectified to deprive it of the disagreeable odor it exhales at this feeble degree, and to obtain it in the concentrated form required in the market (90° or 94°).

The quantity of alcohol obtained from the beet is, as we have said, influenced by the amount of sugar it contains, as well as the season in which the work is carried on. In general 1000 kilogrammes of beets of good quality will produce, by the process just described, an average of 35 litres of pure alcohol, or 37.78 litres of spirit at 94°. This method of maceration, if it is thought proper, may be conducted in every particular, and without change with spent liquor—only substituting this liquid for boiling water.

**New Method of Maceration by Heat.**—We devised, some ten years ago, a system of maceration which is very simple and convenient: exhausting the beet completely, and which permits—1st, the heating of the liquid in the macerators by steam; 2d, the almost instantaneous emptying of the pulp contained in the macerators. This new arrangement has been introduced into a number of farm distilleries in France and Italy.

We shall now proceed to describe the apparatus and
the manner of using it. PI. VI., Figs. 5 and 6, represent
the front and end elevation of the macerators.
1, 2, 3, cylindrical macerators of iron plate of suitable
thickness, each having two perforated diaphragms
within—one fixed at fifteen centimeters from the bottom
by supports and nuts; it serves to support the pulp, while
it prevents it from being drawn off with the juice; it also
facilitates the dripping of the juice. The other diaphragm
has two handles, and is used to press down the pulp and
prevent it from rising and running over; it is supported by
three nuts (near the top of the macerator) which fit in
three grooves in the edges of the diaphragm in such man-
ner that, by giving it one-twentieth of a revolution, it
prevents the pulp from rising.
a. Six bearings or boxes, of which each lower half
is fixed by means of four screws to six posts of oak; the
upper half is fastened down by two screws. In these
boxes rest the trunnions which serve as points of support
for the macerators, rendering it possible to turn them
over in either direction. The pivot on the left is solid,
that on the right consists of a pipe working in a stuffing
box, the outer part attached to the steam-cook b, and the
inner attached to the macerator.
b. Cocks by means of which steam is introduced into
the macerator from the main steam-pipe c, and the branch pipes c.
For this purpose a plunging-pipe d is
placed within the macerator, just above the bottom;
this pipe, being pierced with holes along its whole
length, facilitates the admission of steam, and its distribu-
tion throughout the entire mass. This pipe is indi-
cated by the dotted lines.
d. Posts of oak.
f. Pipe having a diameter of fifty millimeters, and
communicating with the elevator. On this pipe are
three perpendicular tubes, of the same diameter, curved
at the top in such a manner as to pour the liquid into
the macerators. Towards the middle of these tubes are
placed cocks g, to give passage to weak juice, water, or
spent liquor. By means of these three cocks liquid may
be turned into any one of the macerators at the will of
the operator.
h. Main discharge-pipe, fifty millimeters in diameter,
conducting weak juice to the elevator, to be transferred
to the macerators. To this pipe are attached three
other curved pipes, each having a large funnel i. Each
of these funnels has within a grating which prevents the
pulp, which may be drawn off with the liquid, from ob-
structing the pipes, and is placed directly under the dis-
charge-cocks.
k. Main pipe, thirty-five millimeters in diameter, for
conveying the strong juice to the fermenting vats. On
it are three funnels l.
m. Displacement-pipes, one end attached at n by coup-
ling-plate and three bolts under the bottom of the mace-
rators, the other end curved into the funnels l.
o. Pipe in the form of a semi-ellipse, having at its
middle point a perpendicular pipe g, by which water is
conveyed to the macerators. There is a cock at the ex-
tremity of each of these pipes.
p. Another pipe, curved and arranged in the same
manner with cocks g', for conducting weak juice to effect
the displacement of the concentrated juice.
The pipes c and p are in communication with reser-
voirs or vats, situated above the place in which the
maceration is carried on.
o' and p'. Connections with main pipes for water and
weak juice.
The maceration by means of the vessels just described
is started as follows:—
First, fill macerator No. 1 with washed beets, cut in
slices of the size and thickness indicated (p. 117) in the
preceding article. Then wet the mass with sulphuric
acid, at 66 degrees, diluted in twenty times its weight
of cold water, in the proportion of one and a half or two
kilogrammes of acid to 1000 kilogrammes of roots. The
dose of acid may even be increased to two and a half
dose of acid to 1000 kilogrammes of roots. The
season and the condition of the beets. When this is done, place the diaphragm
on the beets, which should be packed carefully and with-

DISTILLATION OF ALCOHOL.

out crowding; then open the cock \( q \) of the pipe \( o \) to admit cold water on the beets until they are covered; then turn on steam from the pipe \( c \) by cock \( b \), opening it gradually and carefully, so as to prevent explosions caused by the steam coming in contact with the cold water, and heat the macerator until the hand cannot be borne on the upper part (60 or 65 degrees Cent.). At this stage close the steam-cock \( b \), and permit the mass to macerate during forty-five minutes. When this time has elapsed, open the cock \( j \) to let the juice be conveyed to the elevator through the funnel \( i \) and the pipe \( k \).

When the liquid in macerator No. 1 has been entirely drawn off, close the cock \( j \), and open \( g \) of the pipe \( o \), in order to fill the vessel again with water; heat to the same degree as in the first charge, and also allow it to macerate during forty-five minutes.

While the second maceration is going on in vessel No. 1, macerator No. 2, which has been previously filled with sliced beets, should be charged, by means of the elevator, with the juice from the first operation, which, on leaving the elevator, passes by the pipe \( j \) and the cock \( g \); then heat to the same degree, by opening the steam-cock \( b \), and leave it to macerate during forty-five minutes.

When this operation is finished, draw off the remaining liquid into macerator No. 3, which has been filled with acidulated beets in slices, and allow it to stand for a few minutes; send, by means of the elevator, the product of the second maceration of vessel No. 1 into the reservoir of weak juice, and open the cock \( q' \) of the pipe \( p \), in order that the strong juice may be displaced. The weak juice pouring into the top of the macerator naturally presses on the liquid contained in it, and forces it to flow out by the pipe \( m \) and the funnel \( l \), to pass through the pipe \( k \) into the fermenting vats.

The displacement of the strong juice should be accomplished in thirty or thirty-five minutes. We know that it is complete when the liquid which flows into the vats has the same density as the feeble juice, which was used to effect the displacement.

DISTILLATION OF THE BEET BY MACERATION.

Generally we obtain one and a quarter or one and a half litres of strong juice for each kilogramme of beets, or from 1200 to 1500 litres for each 1000 kilogrammes of roots treated.

The macerators Nos. 1 and 2 should then receive each another charge of water, which must be heated and suffered to stand for the time indicated above, so that after this maceration No. 1 is completely exhausted, having received three charges of water. No. 2, on the contrary, must receive another charge to be entirely exhausted.

As soon as the third maceration of vessel No. 1 is completed the exhausted pulp is to be emptied. For this purpose the macerator is to be tilted into a horizontal position by tackle or a crank; then, with an iron fork, having two or three curved teeth, the pulp is to be drawn out into a hand-barrow, to be carried from the building. The exhausted pulp being removed, the vessel is again filled with fresh slices of beet, which are sprinkled with acidulated water in the proportions and manner indicated.

The displacement of vessel No. 3 being terminated, the juice which it contains is heated in its turn, as has been said, and, after a sufficient maceration, is transferred to vessel No. 1, in which the slices have been renewed; this juice is then displaced and conveyed to the fermenting vats by the same means employed for vessel No. 3, i.e., by weak juice from the cock \( q' \).

Thus it is seen that by this method the beets are completely exhausted by three washings or successive macerations and displacement. In a regular operation it is always the juice from the second maceration which is poured over the fresh acidulated slices, and which is displaced by the third juice or that from the last washing, to be sent to the fermenting vats. The last charge is made with pure water or spent liquor, according to the process adopted by the distiller.

In this method special attention is to be given to the two distinct operations of maceration and displacement. The former is conducted at the will of the workman;
the latter should be made as gently as possible. To attain this last result, it is necessary that all other operations should be conducted with promptness, which is easy enough, if use is made of the elevator, which adds greatly to the value of this method, by reason of the rapidity with which the transfers of liquid are made, that giving more time for the displacement to be completed.

The strong juice obtained by the process just described, has a proper degree of heat, and is therefore ready for immediate fermentation. This operation and the distillation present no peculiarities of management that have not been described for juice obtained by other processes.

The advantages resulting from this system are:

1. The employment of steam for heating, which is infinitely to be preferred for distilling and rectifying, to the open fire.
2. The distribution of the steam in each of the macerators, which affords time for any method of maceration that may be preferred, and gives a degree of heat as high as may be necessary.
3. The possibility of effecting displacement of the strong juice in a given space of time at the pleasure of the operator.
4. The filtration of the liquid which is effected during the displacement, and which admits of sending to the fermenting vats a much clearer juice than that resulting from other methods of maceration; the juice ferments readily, without producing any great amount of foam, and forms scarcely any deposit in the distilling apparatus, and yields low wines which by rectification will furnish alcohol at 94° of good quality.
5. The ease and celerity with which the macerators may be emptied and filled, being suspended on pivots that may be caused to swing or turn over easily. This last advantage is very important; it dispenses with the use of the awkward fork tongs used by some, which is very heavy work, especially when the macerators are large, for then the workmen are compelled to descend into the vessel, where they will be surrounded by vapors that are more or less injurious to the health, and are certainly a cause of intense discomfort to those who escape other injury. By the employment of swinging macerators, these inconveniences disappear. It is sufficient to tilt the vessels to an inclination of 45° for the workmen to empty and cleanse them in a few minutes.
6. Finally, the regularity with which, all the operations succeed each other, as well as the facility of execution.

As to the pulp resulting from this operation, it is most excellent for cattle, as we may readily understand. The slices, when placed in the macerators, will receive weak juice, water, or spent liquor. These liquids, in consequence of being heated with the beets, form regularly throughout the mass, a precipitate of various salts some of which adheres to each bit of the root; then comes the displacement of the liquid, which, by reason of the slowness with which it is effected, also deposits on the surface of the beets the vegetable albumen, coagulated by the addition of sulphuric acid. All the nutritious principles of the beet, except the sugar, are then preserved after the maceration by this process.

Maceration; the Cold Process.—The beets, after being washed, are divided into very thin slices by the root cutter, and are placed in a wooden macerating vat, then covered with water, acidulated with sulphuric acid at 60°, in the proportion of two or three kilogrammes of acid to 1000 kilogrammes of beets. After a maceration of two hours, the liquid is to be drawn off into a second vat containing fresh material, when it again stands for two hours; drawn off again, it is turned into a third vat containing a similar charge, where it stands the same length of time. This juice has then, during the space of six hours, passed successively through three macerators, and ought to have acquired a density almost equivalent to that of the juice obtained by the rasp and press. This juice is then heated to 22° or 24° C., and set to ferment as described for the hot process.

As in the hot process, each macerating vat receives three charges for the complete exhaustion of the slices,
DISTILLATION OF ALCOHOL.

weak juice replacing water during a part of the operation, thus giving a juice of proper density for fermentation.

The cold maceration is effected much more promptly when the beets are reduced to a pulp by the rasps, than when sliced, but the cost of the mechanical force required for the machinery is more expensive.

Maceration of Beet Chips.*—Beets cut in slices by a root cutter, and dried on frames of wood or wire cloth in the open air, or in a drying room, are called beet chips. The object of thus drying the beets is to preserve and furnish material for the distiller at all seasons, so that he may continue his operations after the stock of fresh beets has been exhausted, or when the advance of the season does not permit him to employ them with profit; and further, it reduces the cost of transportation when it may be desired to send them to a distant market.

The maceration of beet chips is conducted as in the hot process, only it must be understood that it requires more water or spent liquor than the latter, because the chips absorb five or six times their weight of liquid in swelling to their original volume, and assume a condition almost equivalent to fresh slices.

The fermentation and distillation of juice obtained by this process are managed exactly in the same manner as from other processes described—sulphuric acid being employed in the same proportion, allowing for the loss of weight by drying. We should advise the use of boiling water, as indicated above, especially when the farmer has an abundant supply, since it favors the division of the molecules of the root, and produces a better result than spent liquor.

It may be objected that beet chips will be less nutritious for cattle. We would reply that what is lost on one hand is gained on the other. The vat constructed of wood or masonry, with an opening near the bottom, which has an inclination towards the opening, is placed so as to receive the spent liquor as it runs from the still, after it has been filled with enough beet chips for a day’s work. The next morning the spent liquor is drawn off to be poured over the manure pile, the value of which it greatly enhances.

If it is desired, to save the expense of fuel, and to avoid the construction of a special furnace for heating the water, it will be sufficient to construct a hot water tank of sheet iron, with an interior coil through which the spent liquor may pass before reaching the vats; this will heat the water, intended for the maceration, to a sufficient degree. This cistern may, also, if necessary, have beneath it a small furnace in the event of boiling water being required. The fuel consumed by this extra fire will be a trifle.

We have also remarked that there is an economy of time for the maceration, and that one-half of the sulphuric acid ordinarily used will be sufficient; because the boiling water lacking those organic principles which are obnoxious to the fermentation, attacks the cells of the beet more promptly and more energetically.

If, from any cause, this process cannot be employed, we should advise the adoption of the method of Leplny—the direct distillation of the beet in substance.

Maceration by Spent Liquor.—The value of this operation has been greatly over-estimated by some. It has, however, its advantages when the supply of water, as in some localities, is scant. It is sufficient to say, that spent liquor is used instead of water in the different stages of the operations, until it has acquired such a density as to become profitable for the manufacture of potash. The macerating vats should be one meter deep, and one meter in diameter, capable of containing about 400 kilogrammes of beets.

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* No apology can be required for the use of this term, although it is ignored by the lexicographers. Chips are thin transverse slices of fruits dried. Slices are slices cut longitudinally and dried. The two words as given above are in constant use in the great valley of Virginia, where all kinds of fruits are dried for home consumption or for sale.—Trans.
Direct Distillation of Beets.

Process of Leplay.—This operation depends—

1. Upon the direct fermentation of the beets cut in pieces or strips without extracting the juice, and without the addition of beer leaven, the slices being placed in circumstances to favor this reaction.

2. Upon the direct distillation of these strips by a current of steam passing through the mass without direct heat, and in such manner that the pieces preserve their form, and constitute a mass which may be fed directly to cattle.

The beets being properly washed, are cut by means of a root cutter in pieces, having the form of ribbons some centimeters long, two centimeters wide, and two or three millimeters thick; these pieces, when placed one above another, leave interstices for the passage of the steam which is to act on them during the course of the distillation.

When this operation is finished, the beets are put into sacks and placed in a vat having a double bottom, containing juice, which has already passed through a good alcoholic fermentation in such manner that they shall be completely submerged, which is effected by means of a perforated cover, which keeps the sacks down while it gives passage to the liquid and the carbonic acid disengaged during the fermentation. This begins instantaneously, and is usually completed at the end of ten or twelve hours. All the sugar is then transformed into alcohol. It is, however, still retained in the substance of the beet, having taken the place of the sugar.

The fermented slices have not altered in form; the original volume of juice has not apparently changed. The sulphuric acid is poured into this juice, which has already passed through a good alcoholic fermentation in such manner that they shall be completely submerged, which is effected by means of a perforated cover, which keeps the sacks down while it gives passage to the liquid and the carbonic acid disengaged during the fermentation.

This column has a close cover with an opening connecting it with the coil which is cooled by cold water to condense the alcohol. There are a number of movable perforated diaphragms arranged within the column to support the pieces of beet and prevent them from packing. Between the lower one and the bottom of the cylinder, is a vacant space intended to receive the water of condensation which collects during the heating of the mass by the steam injected into this space by means of a cock placed below it. The steam, after penetrating this species of double bottom, escapes through the interstices left between the pieces of beet, heats them to the centre, disengaging the alcoholic vapors which rise into the layers of beets above, to operate upon them in the same manner as the vapor of water has on those below, and to become more and more spirituous as they rise. With a column three or four meters high, we can obtain alcohol of 70 or even 80 degrees. The contents of the several diaphragms are successively and completely exhausted of their alcohol, and yield a cooked pulp which, says M. Leplay, contains all the nutritious elements of the beet, even all the soluble salts, the sugar alone having disappeared. This pulp, which constitutes nearly fifty per cent. of the weight of the beets, keeps without difficulty.