the diffusion vessel instead of fresh water. Cattle do as well on the spent slices as on the pressed cake.

Purification of the Syrup

The great object in the purification of beet root sugar, is the getting rid of the potash and salt, and other saline matters. In the first instance this was done by repeated strainings through bone charcoal, but that being very troublesome, and expensive, several other plans have been tried, and are generally now adopted.

The first of these plans is the "Osmose" process which is founded on the fact that certain substances, and mediums allow readily the passage of salt through them, while the medium prevents the passage of the sugar, except in a very small degree. The principle is an extended one, and is known under the name of "dialysis," but as we only want to show how the process is used in the manufacture of beet sugar, we shall not go into the general question

The usual machinery adopted for the Osmose process is the "Osmogene," and is thus described by Crookes, in his admirable work on beet sugar :—

"The apparatus consists of about fifty cells, "separated by sheets of parchment paper, laid flat, "and connected at the edges all round, the space be- "tween each pair of sheets being fully half an inch. "Each sheet is supported by a cross piece of wood, "and a network of twine. The whole arrangement "is about four feet long, and three feet high. By "a peculiar arrangement of connection the syrup "admitted from below passes through every second "division, while water admitted from above also "passes through every second space, and at last flows "off from below, at a strength from 1° to 2° B, or "say 1° to 2½° Twaddle (this strength is caused by "the salts taken out of the sugar) Owing to the "high diffusive power of the salts, as compared "with that of sugar, the former readily pass through, "together with only a comparatively small portion of "the sugar, which may be saved as before, by fer- "mentation—whilst the potash, and salts are saved "by evaporation, and burning This will no doubt "appear to many too delicate a process to work on "a large scale, but experience proves that it works "well, and that six such machines are sufficient for "a manufactory working daily about 250 tons of "beets."

Modification of the Osmose Process.

The following modification of the Osmose arrangement originates with the author, and has been highly approved of by one of the best sugar engineers in France, who says he shall adopt it in his works in future, as it admits of being cleaned, and renewed better than the ordinary system. It takes more room, but that is a small matter compared with its other advantages. The new system is as follows : Construct a long trough, about 30 inches wide, and 12 feet long. The width must be made to suit the parchment paper, and the length must be made to suit the premises. If you want greater length, make two or more troughs. Let the sides and ends of this trough be about two inches deep, and it must be made water-tight with paint, or with pitch run into the angles. Good paint, or any good cement, is better than pitch, but the latter will answer. This is to hold the water. Then construct another trough of a smaller size, so as to fit easily into the first, but the bottom of this inner trough must be made with very narrow slats, or a network of twine, or wire, the meshes of which must be about an inch square ; the wire should be brass, as it will oxidize less than iron. This is to bear the weight of the thin stratum of syrup. The net-work must be covered with the parchment paper, which must be fastened down so as to be water tight. This may be done with thin strips of wood, nailed down over the edges of the paper, and through to the bottom, or sides of the frame of the inner trough. Water is put in the outer trough, and the inner trough is made to float on the water. You will thus have water on one side of the parchment paper, and syrup on the other side. The water is let into one end of the outer trough, and is made to flow towards the other end, where it is drawn off. The syrup is made to flow on to one end of the parchment paper bottom of the inner trough, and to cover the whole of the parchment paper in a thin stream, and to flow off at the other end, so that the water *very gradually* flows one way and the syrup flows the other way. The current of both liquids, however, is extremely slow. During the passage of the syrup, it parts with the potash and salts through the parchment paper, and into the water, whilst a little water comes through the parchment paper into the syrup. The salts can be recovered from the water by evaporation, where it is worth while, which it will not be on a small scale. After a time, the paper will refuse to pass the salts. It can then be cleaned and renewed by a slight scrubbing with water weekly acidulated with sulphuric acid. Use a corn broom for the scrubbing, but you must, of course, be very careful not to tear the paper.

This is the osmose principle, and when once well understood, the operator can make his "osmogene," as the troughs are called, in any way which will best suit him, or his premises or means allow.

The following is a new method of removing the salts from the syrup. The writer has not yet tried it, but as it forms the subject of an English patent, taken out by Mr. Duncan, of London, England—the great sugar refiner, who has large beet sugar works at Lavenham, Sussex, England- there is no doubt of its being well adapted to the end proposed.

The following is the description taken from the English magazine, "The Sugar Cane."

New Method of Removing Potash from Saccharine Solutions.

"The plan now under consideration consists in adding to the cold syrup sulphate of alumina, so as to form an alum with the whole of the potash present. The solution is then well stirred, and after a few hours standing, the alum separates out in the form of small crystals, technically known as "alum meal." The clear liquor is then run off, and immediately neutralized with milk of lime, finishing up with a little chalk, so as to prevent the necessity of removing any excess of lime by carbonatation. It is possible to use chalk only, but the amount of effervescence is then very great, and the chalk should therefore be added little by little.

"In working this alum process, the solutions should be quite cold. It is also advisable to operate as quickly as possible, consistently with a due separation of the alum, as otherwise more or less sugar would become inverted (that is, not crystallizable)

"Every one part of potash in the syrup requires for conversion into alum about 9½ parts of sulphate of alumina, out of which 2½ parts are required to convert the potash into sulphate, and the remaining 7 to combine with the sulphate of potash, so as to form alum. If the liquor contains any sulphuric acid, either free or combined, the 2½ parts of sulphate of alumina required to convert the potash into sulphate, may be partly or entirely dispensed with.

"When once the liquor has been neutralized (with the lime and chalk), it is heated and filtered in the usual way.

"The precipitated alum (or alum meal) is washed free from syrup with three consecutive washings, using one-third of its weight of cold water each time These washings, after neutralizing with lime and chalk, are used to dissolve up a fresh quantity of the raw beet sugar."

The alum meal is easily dried in a centrifugal machine, or by pressure, or other suitable means.

The sulphate of alumina has the following composition :—

Alumina, ...	15.41
Sulphuric acid, .. .	35.99
Water, ..	48.60
	100.00

It should be as free as possible from iron, and should not contain more acid than given in the analysis.

The solution of sulphate of alumina generally used contains one third of its weight of sulphate of alumina, and has a density of about 24° Baume.

Instead of using a solution, the dry sulphate of alumina, in a finely ground state, may be added to a syrup, and when alum separates under these circumstances, the liquor is actually concentrated to some extent. This, of course, saves evaporation.

The rapidity of settlement of the alum is accelerated by throwing into the mixture a quantity of "alum meal."

Experiments made with beet syrup at Mr. Duncan's sugar works, at Lavenham, have conclusively shown that by means of sulphate of alumina, potash may be almost entirely separated from syrups, not more than 0.2 per cent. (that is two-tenths of one per cent.) being left in solution. By again concentrating the mother liquor, and repeating the process, the whole of the potash may be practically removed.

The advantages of the process are—

1st. The removal of the potash, and ammonia from syrups, without much dilution.

2nd. The removal of a great deal of the coloring, and albuminous matters, and a considerable improvement both in taste and odor.

3rd. The alum produced is equal in value to the sulphate of alumina used, so that the process is comparatively costless.

4th. The plant (or utensils) required is of the simplest description, the cost of labor small, and the entire process is of a continuous, and rapid character.

It will naturally be asked by unscientific practical persons, "What is sulphate of alumina, and what does it cost?" In reply, sulphate of alumina is a natural production in the ground, and occurs in many places like sulphate of lime, or plaster. It is caused by a natural combination of sulphuric acid, and clay, and this substance is found in large quantities wherever alum works are established. Alum is a triple salt, and it requires the presence of the three elements, sulphuric acid, alumina, and potash, to make it. Where these three elements meet they rush together and form alum. In the alum manufactories they introduce the potash to the sulphate of alumina. In the before described process, the sulphate of alumina is made use of to draw the potash out of the beet syrup, and thus get rid of it from where it is not wanted, and is mischievous. There is also alum made with soda, and also ammonia alum, and as all the three alkalies, potash, soda, and ammonia are present in beet syrup, the foregoing process attacks, and removes the soda and ammonia, as well as the potash. There is no doubt that this will prove a most valuable discovery, and tend greatly to the success of the manufacture of beet root sugar.

Another portion of Mr Duncan's process consists in using tartaric acid instead of sulphate of alumina. This is added to the expressed liquor, and the admixture of it with the potash in the juice, when the admixture is made in the cold, forms tartrate of potash, or cream of tartar, which is all but insoluble in cold liquor. It sinks in the juice, and is removed as before described with the turbine, &c. The tartrate of potash so obtained, can by well-known means, which every manufacturing chemist understands, be again converted into tartaric acid, and so used over and over again *ad infinitum* at very moderate expense.

The Turbine on Centrifugal Machine.

The next operation after crystalization, to render the sugar useable, is to free the crystallized sugar from the molasses, which are very badly flavored. For this purpose, the mass into which the boiled juice forms is first mixed with a *little* water, just enough to render it somewhat fluid, and it is then put into the turbine and whirled rapidly round. The outside of the "basket" of the turbine is made of fine wire cloth, or in large concerns of very finely perforated copper ; and the rapid circular motion throws the molasses through the small perforations, leaving the sugar behind; this is, after a short time, (and when no more molasses comes from it) sprinkled with water, and again put in motion, when the water cleanses the crystals of sugar, and again flows out with the molasses, leaving the sugar clear in the basket. On the large scale a jet of steam is used instead of the water. The sugar is then taken out and dried, either by stove heat or otherwise, and the work is finished. This sugar is quite useable, although it flavors somewhat of the beet, but when properly centrifugalled with water or steam, the beety taste is scarcely perceptible, and it is quite good enough for all ordinary household purposes. All the salts, and most of the beety flavor, passes off with the molasses, which are then further purified, either with the osmose process, the sulphate of alumina, or tartaric acid as before mentioned, or with phosphate of ammonia, and then set by in a warm place ; this at a considerable interval, often many weeks, but sometimes less, produces a second crop of crystals, and afterwards a third crop. The remaining molasses is, by the great manufacturers, fermented and distilled into spirit, and the wash or slop which results from the still is evaporated and burned into potash ; but, on a small scale, the farmer will not do anything more than take the first crop of crystals, or possibly the second as well, and the remaining molasses he will feed to his cattle and pigs. It is a most fattening thing when used *in very small quantities*, and mixed with other food. In this case, the potash and salts at once passes to the manure heap, and adds greatly to the fertility of the farm.

For farmers or small manufacturers, the turbine is thus made : A wire cage, with an iron frame constructed on an iron spindle, stands upright. The lower journal is a pointed steel toe ; the upper a well turned journal. The cage is open at top, but the bottom and sides are covered with the fine wire gauze, on a small scale, or with finely perforated copper, on a large scale. This spindle and cage, set in a proper frame, is made to revolve very rapidly with a multiplying power, either by cog wheels or drums, and its speed is urged until the required effect is produced, and the molasses are ejected from the sugar ; the speed required is very great.

Below is a cut of such a machine as might be made by an ordinary mechanic and used, by the farmer or small manufacturer; but on a large scale, the turbine must be obtained from a machine shop. They can be obtained ready to erect from Europe, or from H. I. Booth & Co., Union Iron Works, San Francisco, California, which enterprising firm have constructed several Beet Sugar works in California, which are meeting with great success ; they make all the