of this bacteria jelly that the bacteria in the unfiltered water are removed. The bacteria come down into the pores of the filter, when they are caught by this jelly and they are consumed. And if the rate of movement of the water is slow enough it is possible to begin with water like that of the River Spree, which is a portion of the water supply of Berlin, containing 100,000 of bacteria to the cubic centimeter, and after passing through one of the filter beds the water which comes out will contain but forty or fifty bacteria. This takes place when the rate of filtration is such that 1,000,000 gallons of water pass through those filter beds per acre in twenty-four hours. If the rate is diminished until only 300,000 gallons pass through in that interval, the bacteria can be diminished until there are only five or ten per cubic centimeter. But this rate is too slow to permit of economical use of the filter beds, and the consequence is that the authorities of Berlin require that the water shall pass through the filter beds at the rate of a million gallons per acre in twenty-four hours. The interesting fact is thus brought out that some of the foulest water, most polluted with sewage, is so filtered at the present day in the capital of Germany; the filtered water is submitted to the most searching criticism of Prof. Koch, whose institute of hygiene is there, and to whose labor our knowledge on this subject is mostly due, and that this foulest of water is there taken, filtered, and then becomes the water supply of Berlin. If we can do as well or better than that, we have every reason to be satisfied that we are on the side of safety.

The foreign filter beds, excellent as they are, have never been introduced practically in the United States. Moreover, there is no prospect that they will be. The amount of water filtered per acre is so small that the first cost is a large one. In the second place, the climate of Europe and England is altogether different from the climate of America. Those filter beds freeze up, even at London, and the engineers are sometimes greatly troubled. In the next place, in England, even in that temperate climate, a great quantity of algae develop in the filter beds. In the United States, with our severe winters and the great trouble you have experienced in Hemlock Lake, from the growth of algae, engineers are unwilling to undertake such method of filtration. This being the case, the attention of engineers has been directed to find some way of effecting a result which will satisfy our own needs. And the system that I shall bring to your notice in reference to your immediate wants is this American system.

The filter is simply a case made of boiler iron, of five feet, ten feet, or twenty feet in diameter, made strong enough to stand any pressure to which it is subjected. It contains a bed of sand three and one-half or four feet in depth. The water is passed through the filter under pressure and passes out of the bottom by a series of valves so constructed that they permit the water to pass, but entirely detain the sand. After a time, when the filth accumulates on the surface and through the bed of the sand, the operation is reversed, a current of filtered water under pressure is sent up from below, the sand is washed, and the impurities pass out from a waste pipe, and then filtration is resumed. In practice, after filtering for ten hours, a filter operating on such water as the Genesee River can be purified by washing in ten minutes' time.

That it is possible by such a method to renovate the sand and dirt you will probably have no difficulty in admitting; but what will such a filter do with reference to the bacteria? If it is necessary to pass water at so slow a rate where the pressure is as light as that given by a head of four feet, as is the case in the foreign filter bed, how is it possible to pass the vastly greater quantity through one of these American filters? One of these filters of which I have been speaking, ten feet in diameter, under a pressure of fifteen pounds to the square inch, will filter successfully a quarter of a million of gallons per diem. In order to effect that result it is necessary to have something which will take the place of bacteria jelly that I have described. And the most successful substitute is a jelly made of hydrate alumina. It is obtained in this way: All natural water contains in solution carbonate of lime, to which its hardness is due. When sulphate of alumina is introduced into the water, it is decomposed by the carbonate of lime, and sulphate of alum is formed and hydrate of alumina is set free. It is a perfectly white, translucent jelly. It forms on the surface of the filter bed in contact with the grains of sand, and when the smallest particle of silt or the bacteria come in contact with it they are caught by it and held. It is possible to entirely remove the bacteria from water by use of this jelly. These filters worked in that manner have been repeatedly tested, and that point has been most carefully established.

The water that I have sent around the audience this evening is filtered water. It contains no bacteria. They were removed at the same time that the turbidity and the color were taken out. The question then is, whether the bacteria are to be removed by a bacteria jelly or by means of an alumina jelly. There are some who think that no chemical substitute whatsoever can rightly be employed in the purification of water. It appears to me to adopt such a sentiment is to renounce the advantages which the very elaborate study of this question has given to us. They say that hydrate of alumina, which is one-fourth of alum, is very pernicious to health. If alum ever went into your water supply I would concede the point that it is not a proper thing to use; but it does not go into the filtered water. The alum is so perfectly decomposed that I never have been able to find it in the filtered water. The hydrate of alumina is left behind, and the alumina which goes into your water in a minute amount is also present in natural water itself. If you examine the analysis of the river water you will find that the water contains naturally some alumina. It is the alumina in the soil which makes spring water so bright. It is the alumina in the soil which makes the water of driven wells filtered water. All that is proposed in this method is to take advantage of nature's methods.

In the sample that is before you a quarter of a grain of alum has been used. That is so small an amount that it is difficult to weigh it upon a druggist's balance. Of that quarter of a grain of alum, only one-third is alumina; and one-twelfth of a grain of alumina, or the one-seventh hundred thousandth part of the weight of a gallon of water, is sufficient to remove all the dirt and all

the bacteria by this process of filtration. The quantity is practically infinitesimal.

Unfortunately, the Genesee water, at the time it was sent to me, was in a very favorable condition. I wish it had been at its worst, because the difference is too slight to show what the process is capable of doing. This method is now in use supplying filtered water in much larger quantities than what you desire to have here. The city of Chattanooga, some four years ago, began taking some three million gallons of water from the Tennessee River. It has now gone on increasing its filtering plant, until it takes six million gallons, and it is all treated by the method I have spoken of. I have here a sample of water taken from the Wabash River at Terre Haute. It is not possible that the Genesee River should ever have water of the character that you see here. It is loaded with mud. The water was so bad that I at first thought, when this sample was submitted to me, that it was a hopeless case. I am interested in this question, as a consulting chemist, from the fact that a great many waters are submitted to me by the people that are engaged in doing this work, and I am desirous of seeing this American system introduced generally. I think it will be universal before many years have passed. And here is one of the samples that was submitted. A plant was put in some year and a half ago to filter this Terre Haute water. The impurities were so great that I said that they could not be successfully handled without using as much as four grains of alum to the gallon. They have been filtering, not three, but four and one-half million gallons of water with a three-million-gallon filter plant. And this has been done with two grains of alum to the gallon, and less. The superintendents have been careful not to use more than that, because of the expense. They use less. And this is the largest amount of alum I have ever known to be used practically in the filtration of water.

I will not detain you longer than by saying I have here a working drawing, showing ten of these vertical filters, ten feet in diameter, which are doing this work at Terre Haute. The water is filtered under a pressure of two hundred pounds, and the filtered water is used for fire purposes as well as for general supply.

Here is the working drawing of a plant at a place in Kansas, a smaller plant. It is the same size as that at Bordentown, in New Jersey. Long Branch has for the past three years filtered and treated all its water in that way. It was much more deeply colored with peat than the Genesee River water was that came to me, or it is possible for the Genesee ever to be colored. It came from a cypress swamp. And the filtered water at Long Branch is colorless. And when the health inspector of Providence examined that plant he found that the filtered water contained two bacteria per cubic centimeter, while the unfiltered water contained three hundred.

In conclusion, then, I will say that this method is in use in one hundred of our American towns; that those who are using it are extending their plants to supply the increased demand; that by its use in the filtered samples which I have shown you, the organic nitrogen in the Genesee water was cut down to one-half the amount usually present, and also the water in the Hemlock Lake was cut down by the same amount. The Hemlock water, if filtered by this method, would be 100 per cent. purer than delivered to you as it is, and you consider it, as it is, very excellent water.

At the recent convention of the engineers in Philadelphia the expression of opinion was general that this method of treatment of waters was, in the near future, to be generally adopted. When the city of Liverpool put in its new water supply from Vruwy Lake, the purest water they could obtain in Wales, they put on the descending main a filter plant; and I said to the chief engineer at Liverpool: "Why do you filter this beautiful mountain water?" and he said to me, "The public opinion in England is so strong in this matter that we cannot supply water unless it is filtered." If you have examined one of those filter systems you will find that all of the filtered water is passed through a well, at the bottom of which there is a pavement of white porcelain, and the engineer and the people are not satisfied without, on looking through a depth of five feet of water, the filtered water should always go over that porcelain and be absolutely colorless. I think the time has gone by in this country when people will be satisfied with taking any water supply without they are made certain of its purity. As I said before, I know of no method of guaranteeing the purity of water except by filtration.

Mr. President, I trust I have been not too lengthy. I wish to answer the question which was asked: "If a temporary supply of 3,000,000 gallons of water is taken from the Genesee River can it be made colorless, can it be made pure from a sanitary standpoint?" I have answered that it can be, and that the method is one in large use, and is a method requiring so moderate an outlay that it has become feasible for the water supply of cities demanding a great amount of water. —*The Stevens Indicator.*

REMOVAL OF SUPERFLUOUS HAIR BY ELECTRICITY.*

By PLYM S. HAYES, M.D., Chicago, Ill.

THE removal of superfluous hairs by means of electrolysis was primarily devised as a purely therapeutic measure. It was only after this method had been demonstrated to be a perfect success in the destruction of hairs in entropion that this procedure was diverted from its strictly therapeutic channel and applied to a broader field, and used in what may be called a cosmetic rather than a therapeutic sense. Even if confined to the cosmetic use, there is a decided therapeutic effect produced in the liberation of many ladies from a self-imposed seclusion, if not actual close confinement, akin to prison life. The gloom produced from this seclusion has frequently made life a burden, and been a factor of no small moment in the development of a melancholia.

A correspondent writes that he understands that this operation is largely a mechanical one, and he desires instruction enough to know how, and then he will be able to do as well as any one. This latter statement he does not make, but, from the tenor of his letter, is

* Read at the meeting of the American Electro-Therapeutical Association.

readily inferred. The operation is mechanical, much in the same sense that the repairing of a watch is mechanical; but it is not every watchmaker, to say nothing of the broad class of mechanics, to whom we would intrust our valuable watches.

Those who first demonstrated the possibility of the permanent removal of superfluous hair by means of electrolysis did their work so thoroughly and understood the laws of electrolysis so well that but little has been added to the technique of the operation during the past six years.

Whether the operation is for therapeutic or cosmetic purposes two points are to be kept constantly in the mind, namely, to destroy the hair and then see to it that you do not leave indelible proof in scars that you have not done your work thoroughly.

The statement is frequently made that this operation leaves no scars. The frequent occurrence of scars in positions that tell of the destruction of offending hairs, as well as the form of the scar left, gives the lie to the statement. If this were not sufficient, then the applications that we have for the removal or modification of scars, or the completion of the work that some one else has commenced, but by reason of clumsiness has made the patient seek some more skillful operator, will leave no doubt in the minds of all that scars may result.

Without entering into the detail of the operation so well understood, I will take up the points that have aided me most in making the operation a perfect success, and leaving little to be desired, unless it be that the time consumed in its performance may be abridged.

THE NEEDLE.

The history of the changes and modifications in the needle has shown that we did not have all that was to be desired in this important part of our apparatus.

Theoretically, the needle should be so constructed that it will reach the bottom of the hair follicle, and come in contact with the papilla without doing violence to the tissues, and finally, to be so arranged that the current will exert its electrolytic effects only at the point of contact with the papilla. Practically, this is impossible of accomplishment; but in this direction much more has been accomplished than would at first sight seem possible.

I early discovered that a blunt-pointed needle was much better than a sharp one, and a thin one than a thick one.

After a long series of experiments I came to the conclusion that steel was the only material that would give us a needle of sufficient tenacity and yet have the strength and rigidity to accomplish the desired result.

The best material for the needle is found in the jeweler's broach, an instrument for reaming out the jewels in watches. This is ground to (so as to be of) a diameter varying from $\frac{3}{16}$ to $\frac{3}{32}$ of an inch. From the point to a space of one-sixteenth of an inch back it should be slightly thicker than the shaft; although this bulbous point is of advantage, it is not an absolute necessity. The point of the needle is the main thing, and it should represent as nearly as possible a hemisphere. A conical point should never be used, because of the danger of piercing the walls of the hair follicle.

The temper of the jeweler's broach of necessity renders the steel exceedingly brittle, and it has been found of advantage to draw the temper in order to prevent breakage of the needle. This is best accomplished by taking a glass tube of about one-fourth inch in diameter and closing one end, and introducing the needle into the closed tube. This is then held in the flame of an alcohol lamp or Bunsen burner until the tube begins to become slightly red, when it is put aside to cool with the needle in it. When cold the needle will be found to have had its temper drawn, so that it can be bent at right angles and straightened again without breaking. It is still quite rigid enough for our purpose. Should the attempt be made to heat needles as thin as those described in the naked flame they will take fire and burn, thus completely destroying their usefulness. I present for your consideration, to illustrate these facts, some needles prepared as I have directed and furnished by the McIntosh Battery and Optical Company, of Chicago.

It has been with great difficulty that I have been enabled to have the needles manufactured of the diameter given in this paper. While the shape was easily obtained and the finish of the needle all that could be desired, the size was almost, without exception, from three to five times too great. Before using a needle I invariably examine it with a lens of three-fourths inch focus in order to see that the point is the proper shape. If the shape is not as it should be, another needle is selected. My experience has been that I could ill afford to work with a needle that was not as it should be. I have found that a needle bent at an angle varying from 45 to 90 degrees from two to three-eighths of an inch from its point serves my purpose better than a straight one. All things considered, we accomplish our best results with the thinnest needle.

(Those who have once used a needle prepared in the manner described, and as exemplified by the samples shown, will never use any other form of needle.)

THE CURRENT.

The strength of current required (for this operation) varies from three-fourths of a milliampere to a milliampere and one-half, and, in rare instances, possibly three milliamperes. The strength of the current, however, must of necessity be regulated by the amount of chemical action which takes place around the needle, as well as by the amount of pain produced. In this operation the chemical action produced around the needle (the negative electrode) is a much better index than the milliammeter. In fact, the milliammeter is all but a useless instrument in electrolytic epilation.

As a rule, the less current the longer the time required to destroy the tissue, including the hair papilla. From three to six cells of the diamond carbon battery is usually sufficient.

The question has been frequently asked whether storage cells could be used. The reply is, that if three or four storage cells are connected in series for tension, the current obtained from such a battery can be used. The resistance of the tissues of the thin steel needle of the ordinary electrode and of the cords is so great that our milliammeter will register no greater strength of current than as though we had used the same number of Bunsen cells.

The commercial current from an Edison plant has been successfully used. The pain produced is ordinarily so great as to make its use undesirable. The Edison current has an ordinary pressure of about 110 volts. To reduce this current so that we can use it for epilation, we find that the difficulty to be overcome is that, with our present means of controlling the current, we reduce the amperage much faster than we do the voltage, and, consequently, get a current of tension which is more painful than current obtained from a battery. The results of a number of observations have led me to formulate the following:

Have as little resistance in the circuit outside of the battery as possible.

A battery with large cells and large elements is preferable to one with small elements. Two cells of a storage or galvanic-cautery battery are equal to about three cells of a diamond carbon battery. Where the external resistance is as great as it is in this operation, it will be found that the milliammeter will register about one milliamper for three diamond carbon or two storage or galvanic-cautery cells. It is thus readily seen that the current from the storage or cautery battery has been so reduced by the resistance of the body and the circuit, in which it is included, as to be unable to heat the needle at all. We must count the volts rather than the amperes. In the above statements, relative to the requisite number of cells of the various batteries required, it will be found that the volts in two cautery cells will equal the number in three diamond carbon cells.

THE OPERATION.

I desire to emphasize but one or two facts rather than to give any detailed account of the operation.

Always use care in introducing the needle, and see that it follows the hair closely.

Do not carry the current so long as to produce a lesion that will form a scar on healing.

If the needle is arrested before it has entered much beyond the neck of the follicle, by reason of the size and density of the hair and root sheaths, allow the current to pass until any adhesions that may exist at the point are overcome. It would be well, in this case, to cause the needle to act on the tissues on all sides of the hair. Remove the hair, and the root sheaths will come with it, if the operation has been carefully done. The reintroduction of the needle in the now empty follicle is easily accomplished, and, if care is used, the papilla will be reached without trouble, and destroyed with more certainty and less destruction of tissue than as though this method had not been followed. This method is only to be used in those cases where the needle does not follow the hair to the papilla when first introduced. The reintroduction of the needle insures the destruction of a much greater percentage of hairs than where this is not done.

IN CONCLUSION.

We can state that but little that is new has been added to our methods in electrolytic epilation during the past few years. The advance in this branch has been brought about by improving the apparatus at hand, rather than by the introduction of new apparatus.

In the *needle* we note the exceeding thinness of it, the hemispherical and bulbous shape of the point, and the drawing of the temper. In the *battery*, that cells with comparative large amperage (large surface of plates) are of advantage. In the *circuit*, outside of the battery, that the conductors shall offer but little resistance; the connections be good; the positive electrode large; and that every piece of apparatus, such as a rheostat and milliammeter, that would interpose resistance, be left out of the circuit. In the *operation*, that it is advisable in many instances to remove the hair before the needle has reached, and the current has destroyed, the papilla, and then reintroduce the needle, which now readily glides into the follicle made vacant by the hair and its root sheath.

With the most approved apparatus the ultimate success depends as much upon the man as the means. Every operator leaves his record on the face of his subjects, and success or failure, as well as gratitude or regret (according to the result), is accorded to him who essays this simple yet delicate operation.

RAPID DETERMINATION OF CARBON DIOXIDE IN FURNACE GASES.

The apparatus, as shown in the figure, consists of a vessel *a* having a capacity of 100 c. c. and provided with an inlet and outlet tube. A graduated tube *c*,

APPARATUS FOR DETERMINING CARBONIC DIOXIDE.

divided into c. c., and fitted with a stopcock, is ground into *a* at *b*. The stopper *b* is bored at the side, so that communication between the vessel *a* and its side tubes can be made or closed.

The vessel *a* is filled with the furnace gas to be tested by drawing it through the tube *e* by means of the rubber ball *g* in the usual way. The graduated tube *c* is filled with caustic soda solution of specific gravity 1.25 to the mark *f*. A blank experiment is first made by filling the vessel *a* with air free from carbon dioxide, closing the openings of the side tubes by turning

the stopper *b* and opening the cock communicating with *c*. The liquid in *c* falls to a certain point, which is made the zero of the instrument. Correction for temperature and pressure is neglected, as the instrument is only intended for rough technical purposes.

In making a determination, the vessel *a* having been filled with the gas to be tested, the soda solution is allowed to flow in until absorption of carbon dioxide is complete and no more can enter. The volume of soda solution used then gives at once the percentage of carbon dioxide in the sample.

Determinations made by this instrument agree well with those made by more accurate apparatus.—*Jour. S. Chem. Ind.*

GENERATION OF CHLORINE.

By G. GRUNEWALD.

THE flask *A* contains the manganese dioxide and is provided with a rubber stopper having two holes, through one of which the bent tube *a, b, c, d* passes

FIG. 1.—APPARATUS FOR GENERATION OF CHLORINE.

to the flask *B*, while a tube provided with a stopcock is inserted in the other. By opening or closing this stopcock the acid is drawn into or forced back from the flask *A*, the acid being contained in *B* and *C*. The bent tube *a, b, c, d*, must be capable of being moved up and down. To prevent the stopping up of the bent tube, it is provided with a number of small holes at the bottom, and is surrounded by a wider tube, also containing small holes at the sides, as shown

FIG. 2.

in Fig. 2. The dimensions recommended are as follows: Flask *A*, 300 c. c.; flask *B*, 320 c. c.; bulb *C*, 600 c. c.; *a, b*, 24 cm.; *b, c*, 12 cm.; *c, d*, 12 cm.; *l*, 40 cm. For larger forms of apparatus these proportions should be adhered to. The apparatus can also be employed for the continuous generation of other gases that require heat for their production.—*Ibid.*

IMPROVEMENT IN THE MANUFACTURE OF SODIUM AND POTASSIUM.

By H. Y. CASTNER, London.

FUSED caustic soda or potash at as low a temperature as possible is decomposed by an electric current. When the temperature is high, the power of the bath to absorb both the metal and oxygen becomes very

APPARATUS FOR THE PRODUCTION OF SODIUM AND POTASSIUM.

great, and practically no decomposition takes place. The material therefore should not be heated to a temperature higher than 20° above its melting point, and at the same time facilities should be given for the rapid separation of the liberated metal from the bath. The apparatus consists of an iron vessel *A*, mounted in brickwork *R*, in which the caustic soda is melted by heat supplied by means of the gas burner *G*. The vessel is provided by one or more base pipes or extensions *B*, adapted to receive the negative electrode *H*, which is made of metal, the space *K* being filled with

molten caustic, which becomes set and seals *H* in position. Above this electrode is suspended a tubular iron receptacle *C*, provided with a lid *N*, and with a cylindrical piece of iron wire gauze *M* attached to its lower end. This gauze surrounds *H* and rests between it and *F*, the positive electrode. *P* is an opening for the escape of gas and for the insertion of a thermometer, and *S* is an asbestos or other insulating medium. The current is supplied through *I* and *L*.

The size of the electrodes and their distance apart should be in proportion to the quantity of current. If they be larger than necessary, the elements will be subjected to a greater chance of being absorbed by the bath and recombining with a consequent waste of electrical energy. On the other hand, if they are too small, the resistance will increase and the bath become overheated just at that part where an elevated temperature is most objectionable. When the decomposition takes place, the liberated metal rises and floats on the surface of the caustic in *C*, whence it is removed by a finely perforated spoon which allows the caustic to drain through while retaining the metal. Fresh caustic is added to the bath from time to time, so that the process may be worked continuously.

ON THE NATURE OF SOLUTION.

By J. ALFRED WANKLYN, W. JOHNSTONE, and W. J. COOPER.*

THE venerable Dalton made the great discovery, about the year 1840, that contraction occurs when salts dissolve in water. In some instances the contraction is so great that the volume of the solution of the salt is not greater than that of the water itself—the contraction being as large as the volume of the anhydrous salt existing in the solution. Dalton experimented upon the same salt in its hydrated and in its anhydrous condition, and he also extended his investigation to a great variety of salts, and his results he sums up as follows: "I have tried the carbonates, the sulphates, the nitrates, the muriates or chlorides, the phosphates, the arseniates, the oxalates, the citrates, the tartrates, the acetates, etc., and have been uniformly successful; only the water adds to the bulk, and the solid matter adds to the weight."

Such was the condition in which Dalton left this subject about the year 1840.

Taking up the investigation where Dalton left off, we find that in the majority of cases there is indeed considerable contraction when salts dissolve in water, but that the degree of contraction varies very widely with different salts. In some instances in which mineral matter dissolves in water, the contraction is so great that the volume of the solution is actually less than the volume of the water which forms it. This is strikingly exemplified by lime water, which occupies less space than the water which it contains. On the other hand, there are cases where the volume of the solution of a mineral salt is almost as great as the sum of the volume of the salt plus the volume of the water in the solution. (The solution of nitrate of silver is a case in point.) There are even instances where expansion takes place. This is exemplified by some ammoniacal salts, where the volume of the solution has been found to exceed the sum of the volumes of water and dry salt.

Finally, there is the very important and, we think, very common case where solution takes place without any change of volume whatever. Such a case is afforded by solutions of cane sugar,† which dissolves in water in almost all proportions, and the solutions of which occupy exactly the same volume as the separate water and sugar which enter into them.

A characteristic example of solution is afforded by sugar and water; and we hold that solution is mutual permeation without change of volume, as exemplified by sugar and water.

The changes of volume so frequently observed, in the instance of mineral salts, are due to chemical action, which is often a concomitant of solution.

In order to trace the connection between the specific gravity of solutions and the composition of solutions, the following method may be followed with advantage.

We regard solutions as being generated by the entrance of successive units of weight into a large unit of volume. The unit of weight is one gramme. The unit of volume is 100 cubic centim., or one liter. The unit of volume is taken to be constantly filled with the solvent except in so far as it is occupied by the thing dissolved.

i = the increment coefficient; that is to say, the increment of weight occasioned by the entrance of one gramme of the substance into 100 cubic centim. or one liter of the solution. It is found experimentally by weighing the 100 cubic centim. or the liter of the solution, and subtracting the weight of 100 cubic centim. or a liter of the pure solvent. If the solution contains more or less than one gramme of the substance in the 100 cubic centim. or liter of solution, the number of grammes must be ascertained and used as a divisor.

When one gramme of a substance is inserted into 100 cubic centim. occupied by a solvent, one of three things must happen:

(1) There may be absolutely no change in volume—neither contraction nor expansion. When one gramme of mercury is dropped into 100 cubic centim. of water, there is neither contraction nor expansion, and the gramme of mercury simply displaces its own volume of water, which overflows out of the 100 cubic centim. measure. Sp. gr. being the specific gravity of mercury, the quantity of water which overflows will be

—; and the increment of weight in that case sp. gr.

would be $1 - \frac{1}{\text{sp. gr.}}$

Such a value we represent by *i*.

$$i = 1 - \frac{1}{\text{sp. gr.}}$$

This is the case of sugar, and no doubt of many or-

* Communicated by the authors.

† Henry's "Life of Dalton" (Cavendish Society), p. 193.

‡ *Vide* Chemical News (1891), vol. lxi., p. 27, Wanklyn and Cooper.