119. *Introduction of air.*—But it is not sufficient merely to secure the discharge of the foul air; it is necessary to provide for the admission of an equal amount of fresh air at a proper temperature.

This air, which in winter should be warmed to a temperature of about 68°, may be admitted through an interjoist in the balcony, which is twenty feet above the floor. It should flow horizontally below the chandeliers, above and away from the occupants, and its horizontal velocity of admission may, without inconvenience, be three feet a second. Its volume being 954,000 cubic feet an hour, or 265 cubic feet a second, the total sectional area of the interjoist and of the conducting passages should be 81 square feet.

The length around the inner edge of the balcony being about 200 feet, it will suffice to give the openings—

$$\frac{81}{200} = 0.4 \text{ foot of clear height,}$$

but on account of the ornaments which break up the passage it will be necessary to make them 10 inches either in height or in developed profile.

These arrangements will insure the renewal of 954,000 cubic feet of air an hour, or 1,590 cubic feet to each person, if there are 600 present, sufficient in all seasons to secure the healthful condition of the room and to moderate its temperature; but it is not necessary that they be isolated and confined to one of the reception-rooms of the palace. It will be equally necessary to adopt similar arrangements for the two adjoining rooms, which often contain many persons, and also for the large gallery, frequently used as a ball room. It may not be unnecessary to add that for evening parties the two large fire-places which are in the grand gallery may, by means of gas-burners placed within them, serve as ventilating-chimneys; and if there is any difficulty in cutting in the side-walls descending flues leading to the basement, ascending flues may be made separate, or communicating with a single ventilator placed in the roof over each room.

The fresh air should enter above the cornice and in a horizontal direction.

Each of the principal saloons in the palace should thus have its own ventilators provided with regulating-valves; they should be independent of the others, and this will prevent the unpleasant currents which would otherwise arise as the guests take their departure.

(To be continued.)

RECENT WONDERS OF ELECTRICITY.*

By W. H. PREECE, F.R.S.

Lecture II.—Delivered on Wednesday evening, January 4, 1882.

LAST week, when we had the pleasure of meeting, I endeavored to disabuse your minds of any such idea as that electricity was a fluid, or, in fact any kind of matter. I pointed out to you that every electric phenomenon really was a form of that curious, mysterious agency that exists throughout nature, that produces all the work done on the face of the earth, that probably is at the foot of life itself, called energy. Nevertheless, we can speak of electricity as though it were a distinct entity, precisely in the same way that we speak of sound, of light, and of heat. We know that sound and heat are not sensible to the touch, or taste, or sight; so electricity is of the same character, and is invisible and insensible in every shape or form. Moreover, we cannot either create or produce energy; there is only a certain fixed quantity of energy in the universe, and all that we can do is simply to transform it into its different shapes, such as I illustrated to you last week. All physical phenomena, without a single exception, may be traced to the mere transformation of this energy. I showed you on the last occasion how, by simply winding a wire round a mass of iron, and sending a current of electricity through the wire, we could produce that form of energy called electro-magnetism. To-night I have to speak of one or two other forms in which this energy does its work, forms in which, when electricity is transferred through matter, it does work in some shape or another. The operation of the electric current, when passed through chemical compounds in solution or liquid, is to tear asunder the constituents of the compound, and to arrange them on different sides. A simple means of illustrating this is a glass jar, like the one before you, containing water and two glass tubes, each fitted with a stop cock. When an electric current is passed through the water, the elements of water, oxygen and hydrogen, are driven asunder, and take refuge, as it were, in the right or left hand tube respectively. To prove that these gases have been collected, if a lighted match be placed over the hydrogen tap, the hydrogen will give evidence of its presence by its inflammability; but if the match be blown out and immediately presented to the tap of the tube containing the oxygen, that gas will make its presence evident by relighting the match. [Experiment shown.] The effect of the passage of electricity through water is something like the effect which would be produced by a storm, or other agency, in this room, which caused all the boys of this audience to go to one side, and all the girls to go to the other—excepting that in water there are always two parts of hydrogen to one part or volume of oxygen. Not only does the current tear asunder the oxygen and hydrogen of water, but it also breaks up the constituents of most of the chemical compounds, and the weight of material decomposed per second is the exact measure of the work done and of the current flowing. For instance, if we take a solution of sulphate of copper and pass electricity through it, the solution is broken up into copper and sulphuric acid, and if a bunch of keys were put into the solution while the electricity was passing through it the keys would receive a deposit of copper. If nitrate of silver solution were used instead of the sulphate of copper solution, silver would be deposited upon the keys or piece of metal inserted. Through the kindness of Mr. Bolas, I am able to show you an experiment of this kind, which will enable me to give you a record of this evening's entertainment. I have here a large glass dish containing a liquid, which no doubt appears to you like water, but which is really a solution of the double salt of cyanide of silver and potassium. In this solution I now place a piece of sheet copper, which you see has the usual appearance of copper all over it. Now, while that plate of copper is inserted to one-half its extent in water, we will pass electric currents through the liquid from the hand dynamo-machine on the table [experiment proceeding], which cause the cyanide of silver to break up into cyanogen on one side and silver on the other, and if I take out the

plate of copper, you see there has been deposited upon its immersed surface a coating of silver. Silver spoons and all the various kinds of electro-plate wares receive their silver deposit in the manner I have just shown you. Now, we will set this small dynamo-machine in action by turning its handle, thus converting the energy of the human body into electric energy; and we will immerse a quantity of brass buttons in the liquid, which, when they have received their coating of silver, will be laid aside, ready for distribution as a memento at the close of the lecture. Through the kindness of Messrs. Elkington, I am able to show you the handsome specimens of electro-plating which hang on the walls of the room, and which were plated at their works at Birmingham, by a process exactly similar in character to that I have described, excepting that steam power is substituted for the manual labor you just saw for producing the electric currents.

We next come to the work performed by electricity in passing through solids. The result of that work is simply the production of heat. Before me you will notice two brass stands, and between them I will suspend a piece of fine platinum wire. I now join up one of my battery wires (the same that I used last week) to one of the brass stands, and touch the other brass stand with the other battery wire; the effect appears as a red glow in the platinum wire. If I bring one of my battery wires from the bottom of the brass stand to the end of the platinum wire, the color of the glow becomes brighter; and as I move my battery wire along the platinum wire the glow or light produced by the high temperature in the platinum becomes more and more intense, until finally, when it reaches a certain temperature (about 3,000° Fahr.) the wire is ruptured and falls to the ground. That is evidence that the passage of electricity, through solid conductors, produces heat, and the amount of heat produced is proportioned to the work done in the battery. Energy expended in one part of a circuit must be given out at another. If zinc is consumed in a battery, it generates a certain amount of energy; that energy must be evident in some other part of the circuit, and the heat you saw in the platinum was really the heat that would have appeared in the battery itself if we had not caused the current to flow through a solid conductor which offered a considerable amount of resistance to its progress, as compared with the resistance in the battery itself. This power of producing heat has been utilized in various ways, such as for firing fuses. [An Abel fuse was exploded.] At many places throughout the country, time guns are fired by such an electric fuse to announce the Greenwich-time current at a certain hour. Mines and torpedoes are exploded in a similar manner; quarries are blasted, and many other results are brought about by passing electricity through platinum wire placed in explosive substances, or by special fuses. I do not intend to frighten or alarm you, but for your amusement, and through the kindness of Professor Abel, I have had fuses fixed out of harm's way at various points round the room, and when a small current is passed through them you will hear the explosion produced. [Experiment carried out.] Those fuses might have been fixed miles away, and the same effect would have been produced, and from it you will understand how a number of charges can be fired, or a number of guns can be discharged simultaneously on board our large men-of-war.

The next branch of the subject is the work done by electricity in its passage through air and gases. I have shown you that, in its passage through liquids, it tears the constituents of the solution asunder; in its passage through solids heat is produced; and in its passage through air, it not only produces heat, but violent projection of material particles as well, which it renders incandescent, producing sparks, heat, and other disruptive effects. To illustrate this I have provided an Appa's induction coil, to which can be joined up vacuum tubes of various kinds, and through which the currents produced by the hand dynamo-machine will be passed. [A beautiful collection of vacuum tubes, fitted with various rarefied gases, was then shown, while the lights were turned down.] In those effects we have the result of electricity passing through air, and gases of extreme tenuity, and also an indication of the way in which electricity produces heat—and, therefore, light—in gaseous matter. All instances of artificial lighting or heating are simply due to the fact that we are able to produce heat, and heat of a very high temperature. It is a curious fact that all matter, whether metal or porcelain, carbon or lime, begins to emit light at precisely the same temperature, which closely approaches 1,000° Fahr., or, to be accurate, I believe it is 980° Fahr., so that whenever it is possible by any means to raise any material to that temperature, light is emitted, and the intensity of light increases, until, in the case of carbon, when about 4,000° Fahr. is reached, the material is destroyed. In platinum a lower figure (3,082°) represents the point of fusion. To obtain this very high temperature by electric currents, we must utilize higher means of producing the electricity than I have hitherto shown you. In the battery I have just used, the electric current was produced by the combustion of zinc, but now I want to explain to you how, as I said, muscular power was converted into electric energy. The reason is simply due to the fact discovered by Faraday, that whenever a wire or conductor moved through the sphere or field of a magnet it became electrified. I take up the brass rod before me and move it rapidly, and by doing so have to a certain extent electrified it by causing it to pass through the magnetic field of the earth. The earth is an enormous magnet, a fact which we know, because our compasses guide the mariners across the deep. The air in this room is under the influence of the earth's magnetism, and if I move a wire or rod within that influence, at right angles to the lines of magnetic force, I cause it to be electrified, but only to an excessively small extent. The strength of the current produced depends upon the strength of the magnetic field, and upon the velocity with which the conductor moves across the field. Instead of having only one rod or one wire, we have in this hand-machine an arrangement of a thousand turns of wire; instead of having the weak magnetism of the earth, we have the powerful field of permanent magnet; and instead of causing it to move through the air by the velocity of my arm, we apply multiplying gear, which, as you see, imparts velocity to it of great rapidity. Thus motion, through a magnetic field, produces an electromotive force. There never can be a continuous electromotive force without some source of energy. Here we have mechanical energy expended, and all the conditions for the production and maintenance of a current. Energy expended in one point must be found in some form in another point. If it is not utilized it is wasted. Some of it must always be wasted, and the true economist will try and waste the least possible quantity. If I place a piece of platinum wire between the two wires connected with the hand dynamo-machine, you see that the muscular energy of my assistant, by turning the

handle, generates currents of electricity, which give a red heat to the platinum wire. The energy of the body is thrown into the machine, the machine converts it into electricity, the electricity passes through the wire, which, by having work done upon it, is rendered incandescent, and in consequence becomes luminous. I have here a lamp containing a piece of platinum wire, and if I connect it to the wires of the dynamo-machine [this was done], the platinum glows and gives us light. It is a machine precisely similar in principle to the one now before you, fixed under the arches on the Thames Embankment, and worked by a steam-engine (lent for the purpose by Messrs. Robey), that is supplying currents of electricity to the lamps now lighting this room. There is an occasional throb in the light; this is produced by the unsteadiness of the engine, which was not specially prepared for the purpose, but was the best available. It is in fact an agricultural machine. There are two kinds of electric machines of this class. One is called the magneto-machine, like the one before you, because the magnetic field is produced by the presence of a powerful permanent magnet which I think is visible to most of you, and which consists of several pieces of steel that have been magnetized. The other kind of machine is called the dynamo-machine, in which the magnetic field is produced by an electro-magnet, which is itself excited by the currents it generates, so that there is a kind of accumulative action; one current piles up the agony on the other current, and all of them together, acting on the electro-magnet, increase the total effects until the iron is saturated with magnetism. So much as regards the production of currents for electric lighting purposes. The motion of the conductor through the magnetic field may be caused by the energy of coal which is consumed to generate heat and steam for working a steam-engine; or, as at Godalming, by the energy of water on a water-wheel; and it is very probable that where water is available, it will be the most economical source of energy for electric lighting purposes. Sir William Armstrong, at his seat at Craigside, near Newcastle-on-Tyne, has illuminated his house for some time by currents of electricity, produced by a waterfall in his grounds, so that, he says, his library and his drawing-room are lit by the river flowing through his grounds. As regards the light itself, there are two kinds of lamps. I have already explained and illustrated to you the fact that electricity in its passage through air produces sparks. I have here what is called an arc lamp; in it two rods of carbon are held by two brass clips (not in metallic connection with each other), and the ends of the carbon are, when in action, a short distance apart. On joining up the wires to the brass clips the current flows, a bright light is instantly set up in the air between the carbon points, and the arc is formed. This light is due to the passage of an infinitely rapid succession of particles of carbon, which are projected across the air space, which, in their high state of incandescence, produce light, and which in brilliancy would not compare unfavorably with that of the sun. The light from a larger arc lamp would be far more brilliant than this, but I do not want to damage your eyes or my own. I have experimented on the electric light so much, that I have suffered great tortures from the irritating and exciting influence of its bright rays upon the retina of the eyes, and I advise all people who have an opportunity of examining the arc light, not to look at it too much, or the eyesight may be unfavorably affected. The arc light is used principally for lighting large areas, for instance, Charing Cross station is lit by one form of arc light, called the Brush; Cannon Street station is lit by what is known as the Brockie lamp; the space in front of the Royal Exchange is lit up by the Siemens arc lamp; King's Cross station is lit up by the Crompton plan; and so on. A very brilliant arc lamp at Paris, which attracted a great deal of attention, was called the Jasper light. But all arc lamps play upon one string, similar to the plan I have just shown, viz., that when two pieces of carbon are maintained at a certain distance from each other, and electricity passed between them, great heat and brilliant light is the result. There are certain difficulties in arc lamps which militate against their employment for domestic and internal use generally. The light is very intense; the effect is irritating; the ladies do not like it (and they are a powerful influence in this country), because it does not suit their complexion nor the style of costume for evening wear; they have set their faces against it for internal illumination, and that being so, it is all up with it. Now, the light that is going to supplant the arc light for domestic purposes is the incandescent light. The principle of the incandescent lamp is exactly the same as that I showed you in Mr. Becker's lamp, viz., that a suitable substance is inclosed in a glass bulb from which the air has been extracted, and is brought to a high state of temperature by the passage through it of currents of electricity. The lamps illuminating this room are Mr. Edison's incandescent lamps, whose representative, Mr. Johnson, has been most indefatigable in his assistance for these lectures. The Edison lamp consists of a single curl, or loop, of a fine carbon filament (instead of platinum wire) placed in an exhausted glass bulb. The carbon is extremely thin—as thin as a human hair—but, in spite of its extreme tenuity, you see [knocking a lamp on the table] that concussion or shaking does not cause it to break, but it possesses great resilience, and vibrates like a steel spring; and it is so refractory that it will stand electric currents of enormous strength. As I have said, the lamps before you are worked by electric currents generated by an Edison dynamo-machine on the Thames Embankment, but each lamp is self-regulating and (you see) can be turned on and off by turning a tap very like those used on gas brackets. The stronger the current supplied to the lamp, the greater its heat and brilliancy, and when, by turning a handle in the instrument I have for the purpose, the strength of the current is increased, it forms a brilliant light in the glass tube, until the amount of current is greater than the carbon can stand, when it radiates a beautiful blue haze, which indicates that its end is near, and then it is broken (as you see) and the lamp goes out. I can easily replace the broken lamp by unscrewing it out of its socket, and placing a fresh one in its place, when at once all is in good order, and the light resumed. These lamps are water-tight as well as air-tight, and to prove this, I will insert a lighted lamp into the little aquarium on the table, when you see that the globe is brilliantly lit up, and that the fish it contains show rather a sign of curiosity than discomfiture, and seem rather proud of their colors, which are so distinctly brought out by the brilliancy of the light. Here I have a globe of colored water, to show what brilliant effects can be produced. A good deal has been said about the dangers of electric lighting, and how careful we ought to be in its use, and there is no doubt that electricity is a very dangerous agent if you do not know how to use it. We have heard of the danger from fire through its use in theaters and houses, but I want to show you that, when I place a cambric pocket handkerchief round a lump, which I then break while electricity is going through it, no

* Two lectures delivered before the Society of Arts, London. Lecture I, in SUPPLEMENT, No. 327.

spark or fire of any kind occurs, but the lamp instantly goes out. [Experiment shown.] There is also danger from wires coming in contact with each other, and in that case they short circuit the machine; they cause an increased strength of current to flow, producing heat, and in that manner setting fire to houses. To obviate this danger "safety catches" have been introduced by Mr. Edison. These safety catches consist in the insertion of a very small piece of lead wire in the circuit, which is readily fusible, so that if the current becomes unnecessarily powerful, it passes through the lead wire, heats it to fusing point, and so breaks down the section on which the "safety catch" is placed, eliminating at once all danger. [Illustrated.] It does not affect any other lamps, as you see. When the fused safety-catch is replaced by a good one, the lamps which were broken down by its rupture become lighted up again. We have the means of regulating the lights now burning in the room. Here is an apparatus in connection with the machine at the engine station, and by moving the handle and inserting in the circuit a certain amount of resistance, I am able so to reduce the current flowing from the machine that a considerable lowering of the light takes place. On turning the handle back again, the former brilliancy returns. That shows the electric light in the latest stage of its perfection. We have a bright light now in this room, but no impure gases are given off by the electric light, and the air is not vitiated by it. The room is warm, but that warmth is due to the number of people present, and not to the heat produced by the electric light; though the electric light does, as I have said, generate heat to produce its effulgence. Many people talk of the electric light as being "cold" and cheerless. The light produced by the arc lamp does look cold and cheerless; but the soft, delicious, incandescent lamp before you has just as soothing an effect upon the eye as the prettiest lamps or the pleasantest candle; and it has certainly removed all the objections that were previously raised to the electric light for internal illuminating purposes.

The next and last branch of my subject is the transmission of motive power to a distance. I have shown you how currents of electricity are produced; also how they do work; how they produce electro-magnetism; how they generate heat; how they produce light; and now I want to show you that the whole thing is reversible. If, by the exertion of mechanical power, currents of electricity can be produced, those very same currents of electricity can in their turn produce mechanical power. If instead of receiving currents of electricity from the dynamo machine on the Thames Embankment, we transmitted currents of electricity to it, we should cause it to rotate, but in the reverse direction. I have here a small machine for the purpose of illustrating this to you; it is the invention of Mr. Griscom, who has supplied it to a large extent in America for turning sewing machines. The wires from the hand dynamo-machine are now attached to the Griscom motor, and when currents of electricity are generated by turning the handle of the dynamo, they are conveyed to the motor, and cause it to revolve with the high rapidity which you see. It is surprising that such a tremendous momentum should be produced by so small a strength of electric current. The wires connecting the two machines in this instance are short, but the effect would have been practically the same had the machines been miles apart. By changing the wires, the direction in which the motor rotates is reversed, so that I not only get power transmitted, but can reverse its direction. In this case, as the electricity is generated by hand, its power is small; and, therefore, with my strength (which is only about one-twelfth of a horse power) I can stop the rotation of the motor; but if steam power were employed to generate the electricity, the power transmitted would be beyond my control, in that sense. This motive-power was illustrated in many different forms, at the Paris Exhibition; for instance, from the commencement of the Champs Elysées to the Exhibition Building, a tramcar was propelled (sometimes at the rate of 25 miles an hour) upon rails laid down for the purpose, and during the time that the Exhibition was open, that car carried 75,000 to 80,000 people, who were conveyed to or from the building by motive power, generated by steam in the Exhibition, and conveyed by wires to the farther extremity of the track. An electric railway will form part of the Electric Exhibition at the Crystal Palace, and among the proposals to be laid before parliament next session is a project for constructing an electric railway between Northumberland Avenue and Waterloo Station. Again, at the Paris Exhibition, an enterprising firm of agriculturists showed land-plowing by electricity, and in fact, the application of electricity to innumerable useful purposes was illustrated; rock boring, newspaper printing, driving of sewing-machines, embroidery, leather work, glass cutting, wood carving, lifts raised, ventilation assisted, etc. I am looking forward to the Crystal Palace Exhibition with great interest, to see how far these exhibits will be repeated. The exhibition will be well worth a visit; in fact, all exhibitions are worth visiting, for they excite interest, they induce every one, more or less, by generating curiosity, to add to his knowledge; they honestly stimulate national as well as individual competition; and they always result in the enlargement of the useful application of a power like that of electricity, because a man of one trade who sees electricity used in another trade cannot resist thinking out whether it cannot also be usefully applied to his own purposes. We sometimes hear electricity spoken of as a mysterious agency, and sometimes as a wild, untamed beast. It is only mysterious to the ignorant, and it is only untamed to the unskilled. I hope that the promise I made to you at first starting, that you would leave this room with a fair knowledge of how the electric light is produced, has been fulfilled, and I can only add that electricity will always prove an obedient slave to those who take the trouble to understand it; but it may, as it has, proved a very dangerous ally to the ignorant and the unskilled.

A hearty vote of thanks was accorded to Mr. Preece for his two lectures.

NEW TREATMENT OF DISTILLERY REFUSE.

THE weak liquors which escape from the distilleries injure the water of streams and springs, and in some cases become a medium of infection for the whole neighborhood. MM. Gaillet and Huet add to the liquors perchloride of iron in suitable proportion, mixing the ingredients thoroughly. After the first reaction is completed milk of lime is stirred in, which precipitates the sesquioxide of iron, carrying with it almost all the organic matter. The remaining liquid is perfectly clear, colorless, harmless, not liable to fermentation, and offering no inconvenience to the public health. The precipitate forms a manure, very rich in nitrogen and in phosphoric acid. The sale of the manure not only frees the refuse from being a burden upon the industry, but also makes it a source of profit.—*Les Mondes*.

THE RECTIFICATION AND DISINFECTION OF IMPURE ALCOHOLS ACCORDING TO THE METHODS OF L. NAUDIN, R. PICTET, AND EISENMANN.*

Report of M. A. SCHLUMBERGER.

I HAVE the honor to submit to you the report which you intrusted me to make on the rectification of badly tasting alcohols by the methods which have been submitted to you by L. Naudin, Raoul Pictet, and Eisenmann.

The extreme importance of this problem of the rectification of alcohols in general has caused me to divide in two distinct parts the essay which I lay before you; I shall especially insist on the hygienic side of the question, for I believe that it is necessary, above all, to consider this subject from the standpoint of the public health.

We should, without hesitation, join those innovators who by all and every means succeed in ameliorating, or rendering wholesome, the substances necessary to life.

It is evident that if alcohol did not exist we should not experience the abuses made of this liquid, but since our mission is not to prevent the consumption of alcoholic liquids, it is our duty to encourage the use of those means by which we succeed in purifying these kinds of beverages, and in rendering them more wholesome, so that the consumers may make use of them with more guarantee against the effect that a prolonged usage might exercise on their health.

The highly interesting experiments of Messrs. Dujardin-Beaumetz and Audigé, Rabiteau, Is. Pierre, Albertoni, and Lussana, called attention to the causes of the insalubrity attributable to the majority of those alcohols of which the rectification has been imperfect.

As long as our noble vineyards of the South and of Charentes prospered, the reputation of the brandies of France was such that it was not necessary to make use of alcohols made from beets, grains, or potatoes; the impure alcohols served almost exclusively for the uses of industry; for the fabrication of aniline, for dyeing, the extraction of alkaloids, etc., etc.

To-day, unfortunately, the situation, if not reversed, is at least considerably modified; the phylloxera depriving us of a great part of our vintage products, industry has been obliged to supplement the deficit. The North is destined to give us what the South has no longer; the alcohols of grains, of beets, and of potatoes, have become very important objects of consumption.

The foreign importation amounts to about 200,000 hectoliters (a hectoliter=100 liters) of alcohol made from Russian grains and German potatoes.

We have an especial interest in France to promote the production of beet alcohol, because the soil of France particularly in the North and West is very favorable to this root.

When one considers the enormous quantities of alcohol which arrive at Montpellier directly from Berlin, and the shiploads of maize which come to us from the United States to be turned into alcohol (so called cognac), one should, it seems to me, make every effort to put an end to such an abnormal state of things, and to facilitate in France the production of pure tasting alcohol by means of a product of native culture, viz., the beet.

The silage of the beet which is limited for the fabrication of sugar (because at a certain period the crystallizable sugar becomes decomposed) exerts no influence on the yield in alcohol.

All these favorable circumstances cause us to hope that in a near future the petty farmers of the North and West may become small distillers, and that they will accomplish in that part of France what the distillers of the raw material have done in the South.

But it is evident that the production of beet alcohol will only be of importance when rational methods of disinfection and rectification of the flegmes have become vulgarized.*

The causes of the bad taste of alcohols are the numerous spirits and organic acids of the fatty series; ethylic aldehyd, butylic aldehyd, amylic alcohol, isopropylic alcohol, etc., etc., which one finds equally in the alcohols of inferior quality, constituting above all the base of the toxic elements which render the use of alcoholic drinks of that nature so extremely harmful to health.

The effects of alcohol, so frightful to record, would certainly not be so terrible if one only made use of absolutely pure alcohol, such as that of the grape. (It is understood that the absolute purity of alcohol does not exclude the addition of water, without which it would be impossible to drink.)

The separation of impurities from alcohol is extremely difficult; on examination of the fermentations of beets one finds that they are literally infected, and one asks one's self how one can succeed by rectification in making pure alcohol, without bad flavor.

It is impossible by the ordinary methods to separate, even by fractional distillation, ethylic alcohol of a decided taste—when it contains butylic aldehyd, because the boiling points of these two liquids differ only by two or three degrees.

In general, the alcoholic flegmes are a very complex mixture of substances, boiling at different temperatures, and separable only by mechanical means, or in following the physical law that, in rising in a column of rectification, the vapors of a heterogeneous alcohol separate more or less thoroughly, according as they are in a more or less elevated temperature.

The lightest parts continue their upward march of distillation, while those more dense fall in the still.

Animal charcoal, which has been much employed for the disinfection of flegmes, had to be abandoned because it is costly to keep in order, and does more harm than good to the flegmes in this sense, that it generally retains, mechanically, the appreciable parts of badly burnt organic substances which communicate to the flegmes a persistent taste of animal matter in decomposition.

Wood charcoal does not present the grave inconveniences imputable to animal charcoal, but it does not possess a sufficiently decided disinfecting power.

Olive oil, which has been used to disinfect flegmes, dissolves certain bad tasting, volatile principles which have arisen during fermentation, but the results leave much to be desired, since oil beaten with the flegmes ends by becoming rancid at the contact of air and steam, and communicates a bad taste to the products which it was destined to disinfect.

* Translated from the *Journal d'Hygiène*, by Charles Howard Young, Membre de la Société Française d'Hygiène de Paris.

† Watery products of the first distillation of the juice of grains, beets, etc. They mark about 40° by the alcoholometer, and contain besides alcohol, the essential oils of ether, etc. It is in rectifying the flegmes that one obtains alcohols at 95°.

These different modes of disinfection to which I have called your attention, after having conscientiously studied the work of Mr. L. Naudin, are only, properly speaking, mechanical or empirical.

Recourse has been had to chemical means, and one has, so to speak, exhausted the series of oxygenizing substances, chosen because it was believed that one attained the object in burning, or better still in dishydrogenizing the empyreumatical parts; this is an error.

It would take too long to describe here all the methods which have been tried or utilized with the object of obtaining a more or less thorough disinfection of the flegmes. The limited nature of this essay obliges me to discuss only the three methods which I have been charged to examine: that by electrolyzation, that by cold, and that by ozone. In examining, from the standpoint of priority, each of these processes, I arrive at the following classification:

- 1st. Method of L. Naudin, by electrolyzation.*
- 2d. Method of Raoul Pictet, by cold and by vacuum.†
- 3d. Method by Eisenmann, by ozone.‡

I cannot dwell as I should have wished upon a description of the apparatus of the first two patents, because, unfortunately, a fire destroyed, on the 9th of last December, the manufactory of Gaston Boulet, at Bapeanne les Rouen, where 300 hectoliters of alcohol were rectified daily by the electrolyzation method.

This accident prevented me from accepting the proprietor's offer to study the operation on the spot.

Nevertheless, I have taken my information from the best sources, especially from Mr. Paul Shutzenberger, Professor of Chemistry at the College de France, where Naudin made his first experiments; then from Messrs. Benner and Gros Renaud, who were designated by the Industrial Society of Rouen to investigate the value of the Naudin method.

I have also examined the flegmes of maize and beets before and after the action of electrolyzation, and I am convinced of the excellence of the method of this excellent chemist.

The samples which were sent to me from Rouen bore the stamp of the French government which oversees the operations of the establishment of Mr. Boulet; I submit to your examination some of the samples, and you will see that the alcohols obtained from beets by the Naudin method are of absolutely pure taste.

The aldehyds, which are only alcohols dishydrogenated, have been reconstituted in their corresponding alcohols by fresh hydrogen resulting from electrolyzing action, and have by this lost their poisonous properties.

The phenomena of hydrogenation are explained by the following equation:

It was an important point to succeed in reconstituting, by physico-chemical means, the fractions of alcohol which had lost a part of their hydrogen as a consequence of the different operations of the fermentation, and the concentration of the flegmes. Thus far, it does not appear that any process of disinfection of the flegmes has reunited better than that of Mr. Naudin all the conditions desirable to attain a sufficient purity. The practical yield for the flegmes of beets at 55° is alcohol at 80°, equal in quality to that of alcohols from grain. It is of a pure taste from the first jet.

Permit me here to quote some lines from the excellent notice that Mr. De Parville published in the *Journal des Débats* of Dec. 4, 1881, in a description of the Exhibition of Electricity at Paris. He says:

"Mr. Naudin, having set the electric battery in movement, follows the first operation by a second much more energetic. He passes the flegmes successively in large tubes of glass, in the midst of which are plunged two plates of platina in communication with a Gramme or Siemens dynamic electric battery. The energetic current which traverses the platina plates and flegmes decomposes the water in abundance. The oxygen concentrates on the evil-tasting products and burns them. Probably one thus disposes of those substances which require for transformation an excess of oxygen. Afterwards, a new hydrogenation takes place of those products which require to be saturated with hydrogen. All bad taste is removed, and the beet alcohol becomes equal in quality to the best alcohols made from grain."§

As to the Raoul Pictet method, it appears to deserve especial attention from the standpoint of mechanical division. His method of distillation in a vacuum, and absorption and condensation of vapors by cold, is assuredly very ingenious and merits recommendation. I do not know, however, that this method has been applied on so large a scale as that of Mr. Naudin, and, in any case, the division by cold of liquids of different degrees of density does not accomplish exactly that which the Naudin method does, which possesses, above all, the advantage of transforming the aldehyds into corresponding alcohols; it is evident that one cannot succeed by cold in modifying the chemical conditions of the decomposed fractions in the alcoholic liquid under its influence, and it is desirable, according to my mind, that Mr. R. Pictet should complete the ingenious arrangement of his apparatus by means of a chemical reaction capable of reestablishing the broken equilibrium in the constitution of the elements which form the alcohol.

Mr. R. Pictet has graciously invited me to visit the new establishment which he is constructing to replace that which he established temporarily in the Rue des Immeubles Industriels; I shall, therefore, later, be able to give a more definite decision on the merits of the cold method; I shall also be able to judge better on visiting, after reconstruction, the establishment of Mr. G. Boulet, at Bapeanne.

Before closing, I will merely refer to the ozone method of Mr. Eisenmann. From documents which I have, and which have served me in studying the question from his standpoint, I find that the Eisenmann patent presents absolutely nothing new.

The expired patents of Loew, of July 4, 1881; of Widemann, of Aug. 3, 1872 (especially the last), treated of ozone long before that of Mr. Eisenmann of Berlin.

The conclusion of the Widemann patent indicates this clearly:

"The results of my invention are the application of ozone: "1st. To the treatment of alcohols to remove their empyreumatical taste.

* Patent of Aug. 30, 1879, additions of Nov. 17, 1880, and Jan. 27, 1881.

† Patent of July 24, 1880, and April 15, 1881.

‡ Patent of July 26, 1881.

§ Mr. Naudin has published on this subject a very complete and interesting pamphlet well worthy of consultation. It is entitled "Disinfection of Impure Alcohols by Electrolyzation." Paris: Publisher, Gauthier Villars, 55 quai des Augustins. See the *Journal la Lumière Electrique*, Sept., 1881, article of Mr. Guérout.