SIMPLIFIED HOLTZ ELECTRICAL MACHINE.

BY GEO M. HOPKINS.

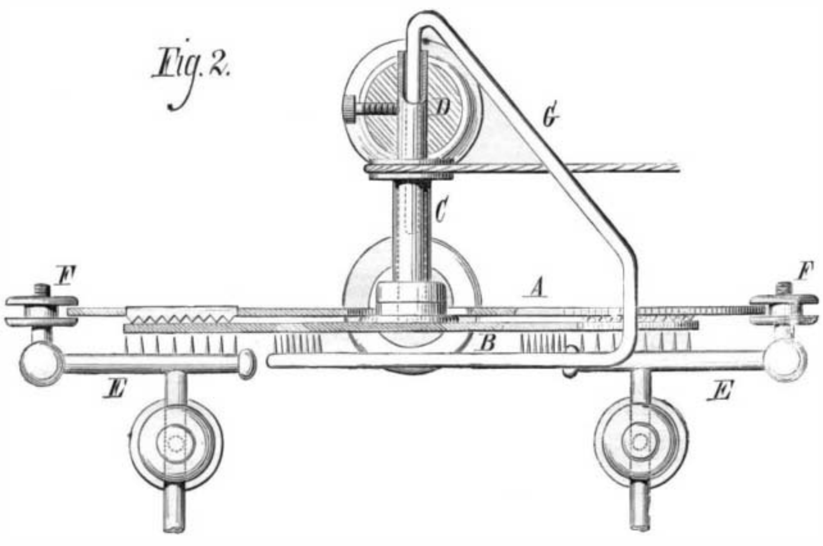
In the domain of physical science there is nothing capable of being illustrated by more brilliant and pleasing experiments than frictional electricity; the means of studying it experimentally are in every one's hand, and if it were better known, doubtless many who are now comparatively uninformed on this subject would begin to make it a matter of study and experiment.

Many will recall the time in school days when the professor, with great exertion, trundled the ponderous frictional machine from behind the glass doors of the laboratory cabinet, and after no end of wipings, adjustments, and applications of amalgam, and after exerting an enormous amount of muscular force, succeeded in discovering that the atmospheric conditions were unfavorable to the generation of electricity, and the students, after being shocked by a quarter inch spark, were further shocked, and in another way, when informed that the philosophical machine must be reconsigned to its glass housings until a more propitious day.

Such was the general experience of the student of science a few years since, and such it is to-day in some of our educational institutions; but many of our schools—to their credit it may be said—have kept pace with the times and have provided modern apparatus capable of being used successfully under all conditions. The more recent forms of Holtz electrical machine are vastly better than the earlier ones, and the earlier ones were far superior to any of the forms of frictional machine. The makers of the improved Holtz machine in New York, Boston, and Philadelphia furnish them at reasonable prices, but there are numbers of our experimenters and students who would hardly feel warranted in purchasing one of them, who would construct one but for a few difficulties which at first sight seem almost insurmountable to the tyro. The questions that beset the inquirer are: (1) What kind of glass shall be used? (2) How shall the glasses be apertured? (3) How shall the parts be adjusted and manipulated to secure the wonderful results attained by this machine?

It is the object of this article to fully answer these queries and to give such details of construction as to enable any one having even a moderate mechanical ability to make, in a very simple manner, a machine fully as efficient as the best in market; and that, too, without any considerable outlay for materials. Without describing in detail the principle upon which the machine operates—these matters being fully treated in all works on physics—I will describe a machine which was made in odd moments as a matter of recreation, and which is as efficient as could be desired, yielding a spark fully six inches in length, equivalent to one half of the diameter of the rotating disk.

This machine is shown in perspective in Fig. 1, and in plan in Fig. 2. Different forms of apertured disk are shown in Figs. 3, 4, and 5. The glass for the disks is selected from common window glass. It should be as thin as possible, of uniform thickness, and flat. It is not essential that the glass be absolutely free from imperfections, although this is desirable. The rotating disk is twelve inches in diameter, the fixed disk is fourteen inches in diameter. I begin with the glass disks, as it is here that most of the difficulty in making the machine is supposed to lie; the especial trouble being in making the aperture in the revolving glass for receiving its hollow shaft, and in making the three large apertures in the fixed glass. I dispense with the hole in the revolving disk and secure it to a vulcanite collar by means of a cement composed of pitch, gutta percha, and shellac equal parts, melted together. The method of applying the cement for this purpose is to warm the vulcanite collar, then cover it with a thin layer of the cement; then, after making the glass rather warm, lay it on a paper on which are described two concentric circles, one the size of the glass disk, the other the size of the collar, and while the glass is still hot press the collar down upon it. The vulcanite collar is screwed on the end of a wooden sleeve, C (Fig. 2), having at one end a shoulder to receive the collar and at the other end a small pulley to receive the driving belt. The sleeve, C, turns upon a piece of three-eighths inch brass tubing which extends through the vertical post, D, ten inches high and two inches in diameter. The end of the sleeve, C, next the glass disk, B, is countersunk to receive a screw which enters the end of the brass tube holding the sleeve in place. This screw is covered by the glass when the revolving disk is in its place in the machine. The glass for the stationary or apertured plate, A, is first cut in circular form and then divided diametrically, and the apertures are formed by cutting half from each plate, a very simple matter as compared with cutting the three holes from an entire disk. The lateral holes are two and three-quarter inches long, and one and three-quarter inches wide at the larger end, and their sides are nearly on radial lines extending from the center of the disk. The central opening through which the sleeve, C, extends is approximately circular, but is slightly elongated at *e e*, to facilitate the removal of the portion cut out. Of course the simplest way to get the glass into the desired shape is to have a glazier cut it with his diamond, but any one may do it with one of the twenty-five cent steel roller glass cutters sold everywhere. The disks of the machine represented were cut in this way, and the notches in the semicircles of the fixed disk were cut with one of these inexpensive yet useful tools. The only precaution necessary in cutting the notches is to make them rather flaring to permit of the removal of the piece after it is cut.



PARTIAL PLAN OF SIMPLIFIED HOLTZ MACHINE.

The two halves of the fixed disk are fastened together by two elliptical pieces of glass cemented to the two halves, between the central and lateral openings. The cement used is the same as that above described, and it is applied in a similar manner. The cement known as "stratena" answers very well for this purpose, but it must have several days to dry before the machine can be used.

The edges of the glass around the apertures and along the seams should be varnished with the best quality of alcoholic shellac varnish to prevent the accumulation of moisture.

Paper inductors, *c*, are attached to opposite sides of the apertured glass by means of starch paste made by cooking starch until it begins to thicken, and cooling it before it becomes clear, *i. e.*, while it is still of milky whiteness. These inductors are made of filter paper or of single thick drawing paper, and extend from the lateral openings or windows about one-third the distance between the two windows in a circular direction. The outer edges of the inductors are arranged on a circle a little smaller than the revolving disk. At the end of each inductor and upon the opposite sides of the glass are pasted pieces, *d*, of gilt paper, which project into the window, and when dry are serrated, the points of the teeth being on the center line of the windows.

APERTURED DISKS.

In front of the revolving plate, B, two combs or collectors, E, are supported upon glass columns having wooden bases and tops. These combs are made of three-eighths inch brass tubing, the two pieces being fitted together and fastened with soft solder. The points, which are simply bank pins, are driven into holes in the brass tube three-eighths inch apart. The inner ends of the tubes forming the combs are soldered to brass ball buttons; the outer ends are inserted in wooden balls, from which wooden screws extend backward to receive the deeply grooved wooden nuts, F, which hold the edges of the apertured disk, A. The points of the combs each cover a space 2½ inches long, or about equal to the width of the paper inductors. Care should be taken to avoid bringing the inner ends of the combs nearer together than is absolutely necessary, and the outer point should be at least one-eighth inch from the periphery of the revolving plate. The points should be as near the face of the revolving glass as possible without touching. The combs are clamped in place by wooden screws in the wooden tops of the glass standards.

The outer ends of the tubes supporting the combs are fitted to tubes soldered in the large hollow balls. Through these balls the discharging rods slide with a gentle friction. The inner ends of the discharging rods are provided with spherical knobs, and their outer ends are fitted with wooden handles well varnished.

The cross arm, G, instead of being supported from the center, as usual with the apertured revolving plate, is elongated and bent so as to enter the rear end of the tube which forms the bearing for the sleeve, C. It is split to create friction in the tubes to retain it in position, and in addition to this the screw which holds the tube in the post, D, passes through a hole in the tube and bears against the extension of the cross arm.

The free end of the cross arm is carefully rounded, and the pins correspond in number and position to those of the combs, E. The cross arm, when the machine is in use, is placed opposite the ends of the paper inductors, as shown in the illustration.

The lower edge of the apertured plate, A, rests in an adjustable support on the table.

The base of the machine is 13 inches wide by 14 inches long, with an extension 9 inches long for receiving the standard of the

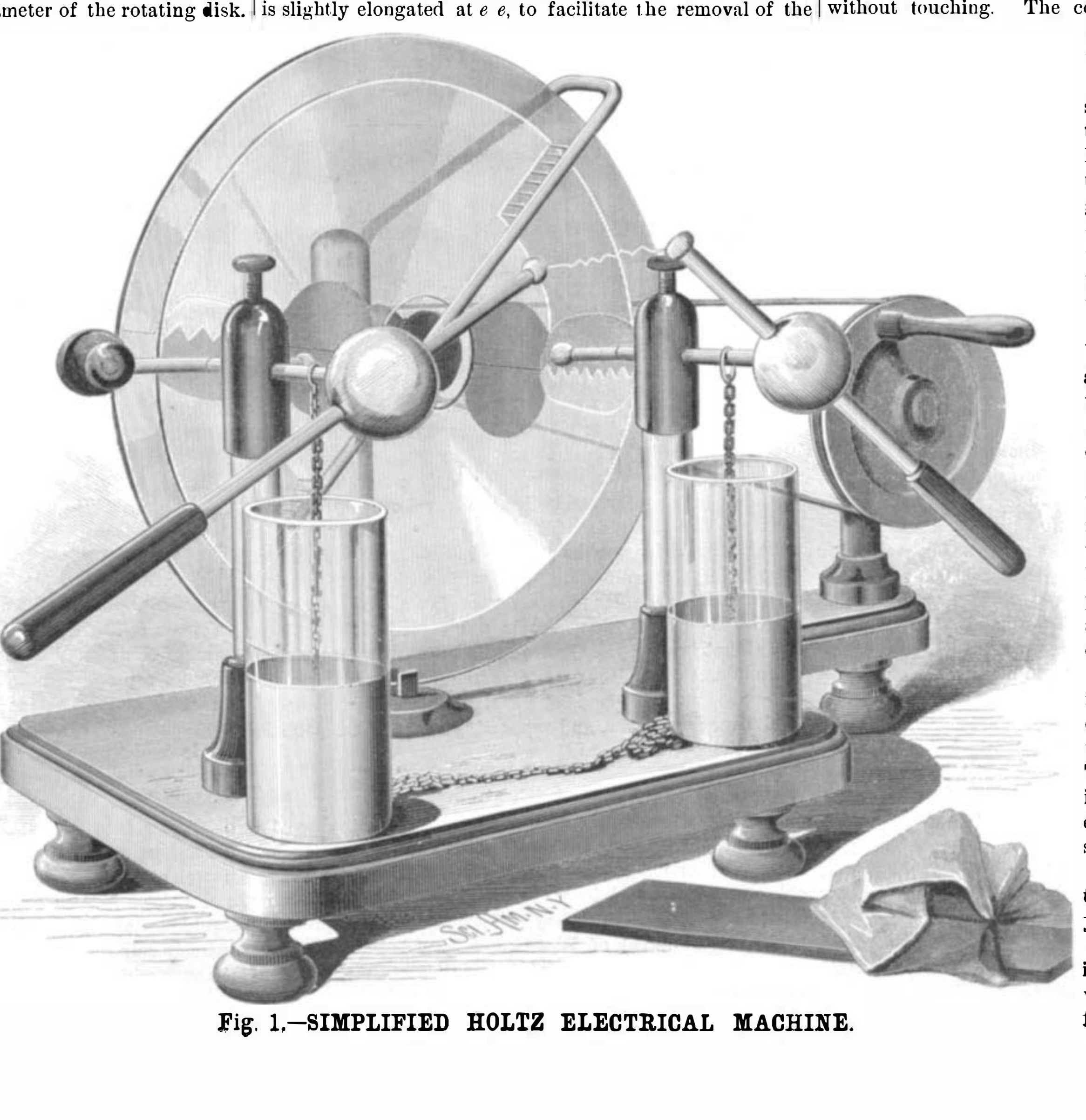


Fig. 1.—SIMPLIFIED HOLTZ ELECTRICAL MACHINE.

driving pulley, which is made adjustable on the table to tighten the belt, the table being slotted to receive the screw projecting from the standard, and the foot of the table answering as a nut to clamp the standard in any desired position. The pulley on the sleeve in 1½ inch in diameter, and the driving pulley is 6 inches in diameter. Almost any kind of belting will answer, but a gut string is preferable.

To complete the machine two condensers or small Leyden jars are required. These may vary in size; in the machine shown they are 2½ inches in diameter and 6 inches high, and are covered on the inner and outer side with tin foil to within 3 inches of the top, the starch paste before mentioned being used to fasten the foil. The uncovered portion of the jar is varnished with shellac. If jars of the desired form and proportion are not obtainable, bottles may be readily cut by means of a hot curved rod of iron about one quarter inch in diameter.

The condensers are placed outside the glass columns under the tubes that support the combs, and a small chain hanging on each tube touches the tin foil lining of the jar.

The outer coatings of the jars are connected by a small brass chain lying on the table. The plate, A, should be placed about three-sixteenths of an inch from the plate, B, and it must be turned so that the edge of the windows to which the gilt paper is attached is exactly opposite the teeth of the combs, E.

To charge the machine the ends of the discharge rods are brought into actual contact, and a piece of vulcanite, a quarter of an inch thick, 4 inches wide, and 10 or 12 inches long, is rubbed with a catskin, a piece of flannel, or a piece of silk, and applied to one of the paper inductors. At the same moment the machine is turned toward the gilt paper points. A strong smell of ozone and an increased resistance to turning are the first indications of the successful charging of the machine. Now, by slowly separating the discharge rods the spark will pass over an increased distance until it is fully 6 inches long. To produce the silent discharge all that is required is to remove the chain on the table from one of the jars. No special directions are required as to the management of the machine. A dry atmosphere is favorable to its action, and it must be kept free from dust. Air currents interfere with its operation; therefore it should be used in a room with the doors and windows shut.

I have so far described only one form of apertured plate. In Fig. 3 is shown a form in which the disk has a central portion, 1⅝ inches wide, removed and the two parts are connected by glass strips, *a a* and *b b*, cemented in the manner already described. When this form of plate is used the combs must be inclined to correspond to the direction of the edges to which the gilt paper is attached. fig. 5 shows the usual form of plate which requires the aid of the glass cutter, as the holes cannot be readily made by one unused to operations of this kind.*

* What has been said will enable the reader to make a very satisfactory machine, but for want of space the matter of experiment with it has not been touched upon. Supplement No. 278 will contain further details in regard to the construction of the machine and of apparatus to accompany it.

The Panama Ship Canal.

The rapidity with which the subscriptions for the construction of the Panama Ship Canal were taken up by the public has been followed by an almost equally surprising celerity in the commencement of the works, ground having been broken on the first of February last. A report by M. de Lesseps, recently presented to a general meeting of shareholders, contained this announcement, together with much interesting information as to the mode by which he proposes to carry out the work that is to separate the continents of South and North America. Justifiably sanguine as to the triumphant termination of this great project, M. de Lesseps points out that the problem is not complicated with a number of the difficulties which beset the construction of the Suez Canal, that no ports will have to be formed, that the materials to be dealt with are of a nature far more tractable than the sands of Suez, that the difference in level of the two oceans will present no difficulty, and that extensive work-shops and workmen's dwellings will not have to be set up in the midst of a waterless desert. The total length of the canal itself will be about forty-one miles. the remainder of the navigable channel being formed by widening, deepening, and straightening the River Chagres. After the Panama Canal Congress of 1879, when an approximate route was decided upon, an international commission was dispatched to Panama, and commenced a detailed examination at the beginning of last year. The result of the labors of this commission showed that a considerable reduction might be made in the amount of excavation necessary for the canal works, the originally estimated quantity of nearly 100,000,000 cubic yards being diminished by more than 2,500,000 yards, the total amount consisting of 59,381,000 yards of earth and soft and broken rock, and of 37,933,000 yards of hard rock. The total estimated cost of the whole work is £20,180,000, of which £17,200,000 will be absorbed in making the canal, the protecting banks for it, and for the Chagres and Rio Grande, and for the transport of material to the site of the great Chagres River dam, a supplementary work decided upon in consequence of some exceptional floods which occurred upon the Chagres last year. Nearly £2,000,000 will be expended in the construction of this dam, in protection works, along portions of the canal, and in making a pier in the Bay of Colon. The improvement of the ports, the formation of docks, and the establishment of lighthouses, etc., will absorb £1,400,000. The present year will be occupied in the final location of the route, and the establishment of preliminary works, which will necessarily be of an extensive and very costly nature, but it is expected that by the end of the season workmen's dwellings, repairing shops, and machinery will be erected, the temporary rail ways laid down, the system of transport organized, and a large proportion of the contractors' plant on the ground; and it is confidently anticipated that excavations will have seriously commenced.

That MM. Hersent and Couvreux have undertaken the completion of this enormous undertaking is a sufficient guarantee that the highest amount of energy, intelligence, and skill will be concentrated upon it; the large and somewhat similar works successfully carried out by these contractors have given them an experience peculiarly valuable in this new undertaking. The methods they have already employed in dealing with vast quantities of earthwork will be substantially employed at Panama, including excavators similar to those they used on the Suez Canal, in making the Gand and Terneuzen Canal, and in the improvement of the Danube, and the dredging plant also employed in the latter work. As for the rock cutting, MM. Hersent and Couvreux have learnt how to deal with it at Brest and Cherbourg. M. de Lesseps confidently anticipates that the canal will be opened for traffic in 1888, assuming that about 66,000 cubic yards of materials of all kinds can be excavated and dealt with during each working day of the coming six years, and that a force of 10,000 men can be kept employed continuously. An interesting feature of the works will be the utilization of water power from the Chagres, which will be required especially for the rock cutting. It is proposed to obtain this by forming the dam, already mentioned, as a necessary part of the work, and actuating by its fall the air compressors required for working the rock drills.

Such is a very general outline of the scheme for carrying out what will be, when completed, one of the greatest engineering undertakings that the world will have seen. That it will be carried to a successful issue there is no room for doubt, since the physical obstacles are great only from the magnitude of the materials to be dealt with, so that the contractors have but to repeat what they have done many times before on a smaller scale. The problem of raising the necessary capital has been solved by the 100,000 subscribers, and all the political and international difficulties appear to have been removed by the energy and diplomacy of M. de Lesseps. In every sense, conditions and opinions have changed since this indefatigable worker astonished the world with his proposal to divide two continents by the Suez Canal. In this country especially that proposal was met with ridicule, and received but little support. It was regarded as impracticable from an engineering point of view, and ridiculous as a financial undertaking. Objections like these have not been urged against the Panama Canal, for the successful completion of the Suez Canal, and, later, of such tremendous undertakings as the Mont Cenis and St. Gothard Tunnels, have silenced all disbelievers in the possibility of great engineering works; while the vast change wrought by the opening of the short road to the East must convince every one that this new gate to the Pacific will develop (and possibly divert) trade to an incalculable extent, and the army of large and small capitalists who have so readily contributed their money to effect this development, will be benefactors of the world at large, even if they should not themselves reap a sufficient reward for their enterprise.—*Engineering.*

Where Stanley Is.

The Philadelphia *Press* prints a letter from Yuseph H. Reading, of the Gaboon and Corisco Mission, dated December 17, 1880, in which the following tidings are given of Stanley's expedition up the Congo. The missionary says: "Count de Braya, an Italian explorer, arrived here yesterday from the Congo River. He went up the Ogowe River as far as he could get in a canoe, thence overland, six days' journey, to the Congo, down the Congo to the sea, and so here by steamer, thus making complete circuit. The point at which he reached the Congo was five days' journey inland from Stanley Pool. Coming down the river he met Stanley and his party 25 miles inland from a place called Avedi. He stayed with them one day. Stanley's party were in a mountainous country and obliged to travel overland, for the river was full of rapids. Their progress was slow. There were no provisions to be had where they were. The men were eating rice and the donkeys corn and hay, all brought out from Europe. He reports one of the missionaries of the English Baptist Mission shot in the groin by the natives. The Count goes up the Ogowe again to-morrow to continue his explorations. He represents the country far up the Ogowe to be a table-land 2,400 feet above the sea, comparatively free from fever, and supporting a large and peaceful population."

The English Skylark.

Another attempt is about to be made to introduce the English skylark to our fields and skies. Last summer Mr. Isaac W. England imported two hundred birds, a considerable number of which have survived the winter and are now in excellent condition. They will soon be set free, probably in the neighborhood of Ridgewood, New Jersey; and it is to be hoped that the people of that region will make it hazardous for small bird hunters to be seen thereabout during the next four or five years.

An Improved Soap.

We copy the following formula from the *Moniteur des Produits Chimiques:* Vegetable oil, 1,980 pounds; animal fat, 660 pounds; soda lye at 33¾° Tw., 4,400 pounds.

As soon as the whole of the lye has been absorbed the mass is kept at a gentle boil until completely liquefied, and there is then added, still keeping up the boiling: Silicate of soda, at 62° Tw., 440 pounds.

This is thrown in by degrees, while the mass is being continually stirred up. When all the silicate has been added the fire is slackened so as to stop the boiling, but still keep up a gentle heat, and the whole is left till it takes the appearance of an oily liquid, transparent, and of a pale amber color, showing that the silicate (which is only used here to clarify the soap) has been completely deposited.

The liquid part is then drawn off into a special boiler, fitted with:

1. A lid, fitting airtight.
2. A slide opening, through which liquids may be introduced.
3. A cock below for drawing off.
4. A screw agitator.

When the soap has been run into this boiler wait till the mass begins to grow pasty. The lid is then closed and the following liquids, previously mixed, are introduced by the side opening in successive portions: Ammonia, 286 pounds; purified oil of turpentine, 91 pounds.

The whole is then worked up for ten minutes with the mechanical agitator, and after settling for an hour it is run into forms.

The soap is said to be very firm, of a fine pinkish white, dissolves well with an abundant lather, and does not injure tissues.

[The yield from the above proportions is not stated.—*Chemical Review.*]

Extreme Sensitiveness of the Telephone.

Mr. W. H. Ash, writing from Penzance, in a recent note to the editor of the *Electrician*, says: "There are two cables landing here, one from Vigo and the other from Lisbon, both of which were, unfortunately for us, broken at the same time, the former in Vigo Bay, the other about 735 miles from here. Generally one or the other is always occupied, so that any experiments of this description are not possible, but being both idle, as well as our land line, I joined the two cables together here through a telephone. The other two ends being so far away I was curious to know what I should hear, and was very much surprised to hear Morse signals. After listening some time I found it was on the Brest cable of the new French Atlantic Company, their line running from Penzance to Brest (the cable lands about three-quarters of a mile from here), and their land line going to Penzance by a different route from this company's. So that with no earth connection here, and none on the other line except at Penzance and Brest, I could read the signals distinctly. No doubt it was by the induced current, but that it can be perceived at such a distance may suggest to some still further uses for this very delicate instrument."

Trichinosis.

According to a recent report to the Sanitary Committee of Massachusetts, it appears that of 2,701 pigs examined during five months no less than 154, or nearly 6 per cent, contained trichinæ. The animals came from different and distant regions, but the majority were from the Western States. The same report affirms that rats are affected with trichinosis at Boston to a much larger extent than in Germany. Of fifty-one rats caught in a Boston slaughter house thirty presented trichinæ. On the other hand, twenty-eight fowls fed in the establishment were found to be healthy. Forty rats taken in another large slaughter house all contained trichinæ, but of sixty found in different stables only six were thus affected.

In France little consideration has, until lately, been given to the danger of trichinæ in imported pork. At Lyons, however, inspection has been commenced, and has quickly borne fruit. An enormous consignment of lard, amounting, it is said, to 120 tons, was lately received at Lyons from New York. Of fifty specimens examined immediately after arrival three were found to be infested with trichinæ. At Barcelona six cases of death from trichinosis have occurred in three months.

Protoplasm—A Complicated Substance.

H. J. Reinke (*Botan. Zeitung*, 38, No. 48) has examined protoplasm obtained from *Æthalium septicum*, and discovered in it the following proximate constituents: Plastin (an insoluble albuminoid resembling the fibrins), vitellin, myosin, pepton, peptonoid, pepsin, nuclein, lecithin, guanin, sarcin, xanthin, ammonium carbonate, paracholesterin, traces of cholesterin, Æthalium resin, a yellow pigment, glycogen, sugar (non-reductive), oleic, stearic, palmitic, and traces of butyric acids, calcium carbonic acid, fatty glycerides and paracholesterides, calcium stearate, palmitate, oleate, lactate, oxalate, acetate, formiate, phosphate, carbonate, sulphate (traces), magnesium (probably phosphate), potassium phosphate, sodium chloride, iron (compound not determined), and water. Plastin can be separated by pressure from the liquid portions of protoplasm. The albuminoids collectively scarcely amount to 30 per cent of the dry substance. Hence the supposition that protoplasm consists of albumen must be abandoned, and we must cease to compare a plasma cell with a particle of white of egg.