covered upon the parts to be wound by adhesive tape or by cotton cloth attached by means of shellac varnish.

The direction of winding is clearly shown in Fig. 9. Five layers of No. 16 magnet wire are wound upon each section of the magnet, the winding of sections 1 and 2 being oppositely arranged with respect to each other. In like manner the winding sections 3 and 4 are oppositely arranged. The winding of section 1 is also opposite to that of 3, and that of 2 is opposite to that of 4. The winding begins at the outer end of the magnet, and ends at the inner end of the section. When the winding is completed, the temporary binding is removed. The outer ends of 1 and 2 are connected together, and the outer ends of 3 and 4 are connected. The inner ends of 2 and 4 are connected. The inner end of 3 is to be connected with the commutator brush, *f*. The inner end of 1 is to be connected with the binding post *g'*, and the binding post, *g*, is to be connected with the commutator brush, *f'*.

The field magnet is now placed upon a base having blocks of suitable height to support it in a horizontal position. A block is placed between the coils to prevent the top of the magnet from drawing down upon the armature, and the magnet is secured in place by brass straps, as shown in Fig. 1.

The armature is wrapped with three or four thicknesses of heavy paper, and inserted in the wider part of the field magnet, the paper serving to center the armature in the magnet. The armature shaft is leveled, and arranged at right angles with the field magnet. The posts in which the armature shaft is journaled are bored transversely larger than the shaft, and a hole is bored from the top downward, so as to communicate with the transverse hole. To prevent the binding of the journal boxes, the exposed ends of armature shaft are covered with a thin wash of pure clay and allowed to dry. The posts are secured to the base, with the ends of the armature shaft received in the transverse holes. Washers of pasteboard are placed upon the shaft on opposite sides of the posts, to confine the melted metal, which is to form the journal boxes. Babbitt metal, or, in its absence, type metal, is melted and poured into the space around the shaft through the vertical hole in the post. The journal boxes thus formed are each provided with an oil hole, extending from the top of the post downward. If, after cleaning

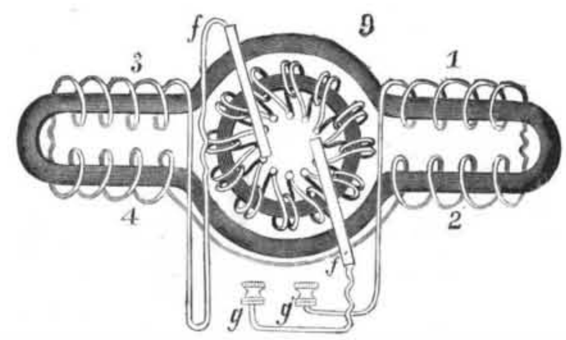

Fig. 9.—CIRCUIT OF SIMPLE ELECTRIC MOTOR.

and oiling the boxes, the shaft does not turn freely, the boxes should be reamed or scraped until the desired freedom is secured.

All that is now required to complete the motor is the commutator brushes, *f f*. They each consist of three or four strips of thin hard rolled copper curved as shown in Fig. 4, to cause them to bear upon the screws in the end of the hub, G. The brushes are secured by small bolts to a disk of vulcanized fiber, or vulcanite, at diametrically opposite points, as shown in dotted lines in Fig. 5, and the brushes are arranged in the direction of the rotation of the armature. In the brush-carrying disk is formed a curved slot for receiving a screw, shown in Fig. 6, which passes through the slot into the post and serves to bind the disk in any position. The disk is mounted on a boss projecting from the inner side of the post concentric with the armature shaft. The brushes are connected up by means of flexible cord as shown in Figs. 1 and 9. The most favorable position for the brushes may soon be found after applying the current to the motor. The ends of both brushes will lie approximately in the same horizontal plane. When the motor is in operation the direction of the current in the conductor of the field magnet is such as to produce consequent poles above and below the armature.

Eight cells of plunging bichromate battery, each having one zinc plate 5 × 7 inches, and two carbon plates of the same size, will develop sufficient power in the motor to run an ordinary foot lathe or two or three sewing machines.

The dimensions of the parts of the motor are tabulated below:

Length of field magnet (inside)	10½ in.
Internal diameter of polar section of magnet	3⅝ "
Width of magnet core	2½ "
No. of layers of wire to each coil of magnet	5
No. of convolutions in each layer	34
Length of wire in each coil (approximate)	95 feet.
Size of wire, Am. W. G.	No. 16
Outside diameter of armature	3½ in.
Inside diameter of armature core	2 3/16 "
Thickness " " "	⅜ "
Width " " "	2 "
" " " wound	2½ "
No. of coils on armature	12
No. of layers in each coil	4
No. of convolutions in each layer	8
Length of wire in each armature coil (approximate)	30 feet.
Size of wire on armature, Am. W. G	No. 16
Length of armature shaft	7¼ in.
Diameter of armature shaft	9/32 "
" " wooden hub	1¾ "
Distance between standards	5⅝ "
Total weight of wire in armature and field magnet	6 lb.

THE LOCKS OF THE PANAMA CANAL.

We illustrate herewith the new system of locks devised by Mr. Eiffel for use on the Panama canal.

The gates (Figs. 1 and 2) consist essentially of a hollow, balanced, movable caisson, capable of sliding above at right angles with the axis of the canal, on a track carried above the canal by a revolving bridge. This track is prolonged above the lateral chamber. The motion is analogous to that of the doors which slide at the top that are generally used in locomotive shops. When the flood gate is placed in the chamber,

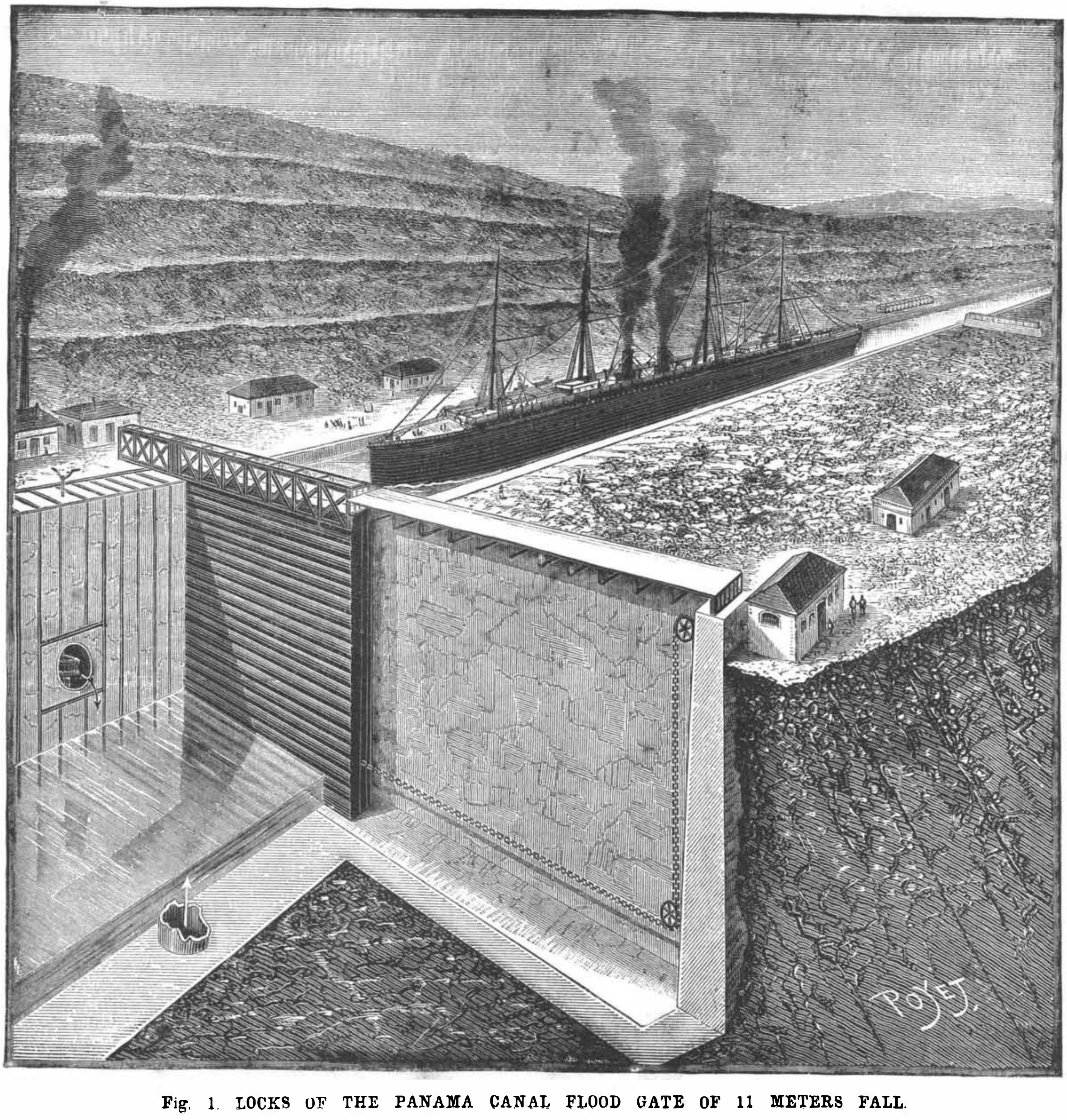

Fig. 1. LOCKS OF THE PANAMA CANAL FLOOD GATE OF 11 METERS FALL.

it is only necessary to revolve the bridge 90° to free the passage and allow boats to go through.

The diagram in Fig. 3 shows the maneuver. A vessel, S, is about to pass from lock, B B', to the reach, C. To this effect, at N the gate, P', taken from its chamber, R, bars the canal, and the bridge, A', is closed above it. At M the gate, P, has slid into its chamber, R'. The revolving bridge has pivoted 90°, and opened the passage.

The gate or movable caisson, the sides of which are stiffened from meter to meter by strong, horizontal, T shaped iron beams, which carry all the stress of the water pressure over to the side walls, is arranged beneath like the working chambers of the caissons used in constructing bridge piers. Moreover, above the working chamber, it is divided into nine compartments by three horizontal and three vertical partitions. All these compartments, as well as the bottom chamber, communicate with the external air through chimneys starting from air locks, so that either water or compressed air may be allowed to enter them at will. Owing to this arrangement, it is easy to balance and ballast the gate, and, besides, on exhausting its different parts in succession, to inspect and repair them. The gate is suspended from a carriage provided with rollers, which, on rolling over the track carried partly by the bridge and partly by a framework, carries along the gate.

The suspension rods of the gate are not fixed in an invariable manner to the carriage. They carry rollers at their upper extremities which are capable of revolving to a certain distance upon transverse rails fixed to the carriage. The object of this arrangement is to start the gate before sliding it forward and to prevent its rubbing against the walls of the chamber and its bearing points. The gate remains constantly suspended by parts situated outside of the water, and which can be repaired and kept in order with the utmost ease. This mode of suspension offers the advantage that it assures the complete stability of the gate, even under the influence of winds that might be capable of overturning it. For a lock of 11 meters fall the dimensions are as follows:

TAIL GATE.

Height	21	meters.
Width	4	"
Length	21·6	"

HEAD GATE.

Height	10	meters.
Width	3	"
Length	21·6	"

For the lock of 8 meters fall, the height alone varies. The section of the canal left free by the opening of the gate is 18·6 meters at the lower part and 20·6 at the leveling of the talus and works of access. The location for the locks will have to be so selected that they can be excavated in compact rock. The side walls of the intermediate locks will then consist of the rock itself, with a thin lining in places where there are cracks. As for the side walls of the heads, they will be formed of T-iron caissons lined with cast iron and filled in with beton. Their dimensions vary with those of the locks. For a lock of 11 meters fall they are as follows:

Thickness	5·5	meters.
Height	24·25	"
Length	30	"

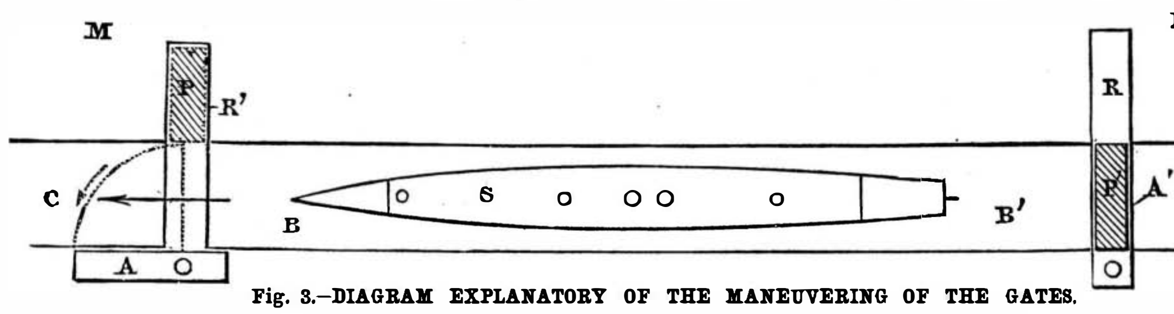

Fig. 3.—DIAGRAM EXPLANATORY OF THE MANEUVERING OF THE GATES.

The revolving bridges are of iron or steel, and are 5·5 meters in width by 34·2 in length. This length is divided into two sections of 23·8 and 10·4 meters on each side of the axis of revolution.

The gate chambers are 7 meters in width by 30 in length. The maneuvering of the bridges and gates is effected through chains winding around capstans actuated by hydraulic power, through turbines moved by the fall of water occasioned by the reaches.

In order to introduce so great a mass of water in so short a time (40,000 cubic meters in 15 minutes), it has been necessary to adopt peculiar arrangements. The method adopted consists in making the water flow through the entire length of the lock and in vertical jets, so as to prevent the strong eddies and tumultuous motions that would necessarily be produced in this arrangement. To this effect, for the entire length of the lock, and laterally, in channels beneath the flow of the canal, there run two large cast iron pipes, 2·8 meters in diameter, provided at every 2 meters distance with 0·40 meter apertures. These pipes pass beneath the sill of the gates, at each extremity, and are prolonged about 15 meters down stream and about 12 up stream in the reach that follows the lock (Fig. 4). Here they curve, and, at 9·75 meters above the floor, terminate in a valve contained in a chamber formed in the side wall. There are, then, two valves of this kind to each reach. These valves, due to Engineer Fontaine, are cylindrical, and without lateral pressure, thus rendering the maneuvering of them extremely easy. With this system the emptying and filling of the locks will take but a quarter of an hour.

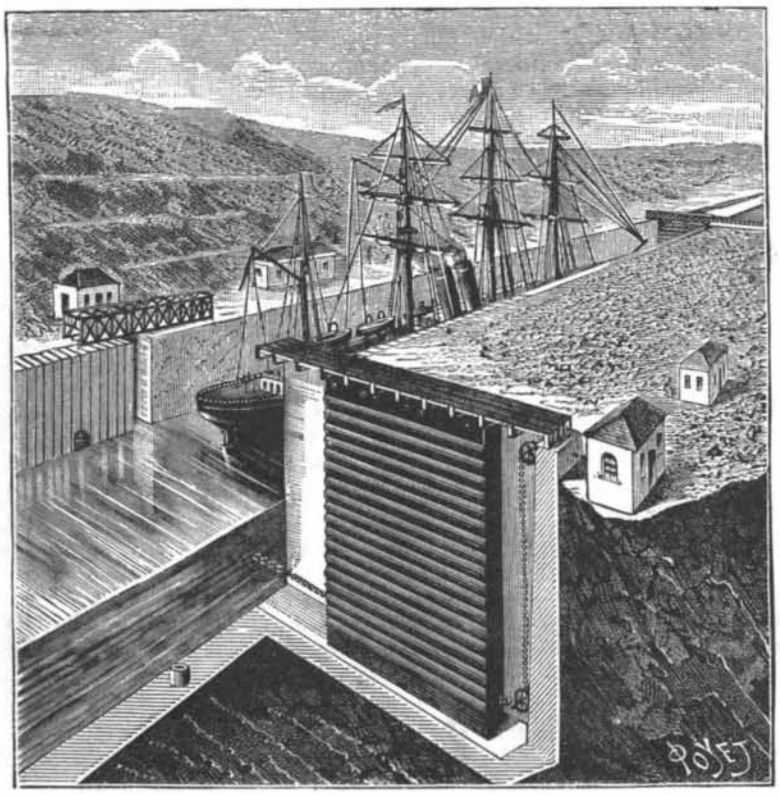
Fig. 2.—THE GATE OPEN.

For the illustrations and description of these gates, we are indebted to *Le Genie Civil.*

New Photo-Stereotype Printing Process.

A new process of so-called autostereotypic printing, especially adapted for the reproduction of books and engravings, has lately been invented in Switzerland, and is already used with advantage at the establishment of Orell, Fussli & Co., at Zurich, a printing office of European fame. The process will cheapen the reprinting of the works of foreign authors. By this method the type setting and the copying of engravings is saved and an accurate stereotyped plate is obtained directly from the original. It is a transfer process, and for the reproduction two newly printed copies of the publication to be reproduced are necessary to insure complete sucess. It is done in the following manner: Plaster of Paris, best quality, is mixed with water to make it a thin putty without lumps, and to this a little alum or salt is added to make it set quickly. To every 5 lb. of the plaster are then added: Silicate of potash or silicate of soda, 3 oz.; phosphate of lime, 2 oz. The mixture thus obtained is then put upon a perfectly level piece of plate glass of the desired size, around which iron rods are placed, and left to get hard. The plaster cast ought to be at least type high, to prevent breakage. While the mass is setting, the back ought to be scraped level, and should remain undisturbed until it is perfectly dry and hard. After that it may be taken off, and it will be found to be as smooth as the glass itself.

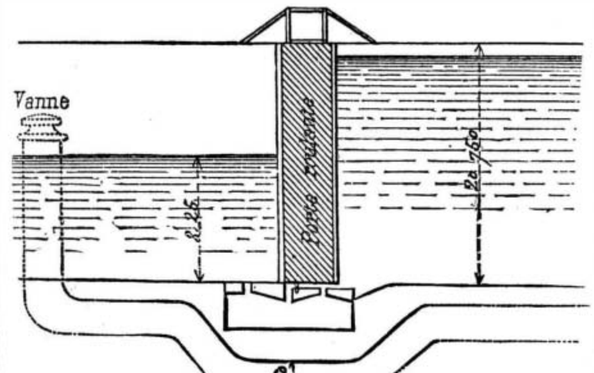

Fig. 4.—POSITION OF THE PIPES FOR FILLING THE LOCKS.

The paper to be reproduced is next placed, with the side to be copied down, in a dish which contains the following transferring solution: Distilled water, 16 oz.; alcohol, 90°, 5 oz.; acetic acid, ¼ oz.; phosphate of soda, ¼ oz. Care should be taken not to get the solution on the back of the paper, which is not to be transferred, as it is then liable to print through when it is drawn through the transferring press. Should the print to be copied have been printed for some time, it is desirable to warm the solution and float the paper longer on it. The sheets should be left on the solution for at least two hours to insure perfect action. In the mean time, the plaster of Paris plate, which was completely dried before, is prepared in a dark room. A solution of 5 oz. of gelatine in 12 oz. of water is prepared by letting the former soak for half an hour and then heating it to about 190°. Care must be taken to prevent the boiling of the solution. To this six drachms of citrate of iron and ammonia and 2 oz. of alcohol are added and well filtered. This is when still warm. Put into a flat dish covered to a depth of about ¼ in. It is well to put this dish upon a hot metal plate, as it gets hard quickly when getting cold. The plaster of Paris plate, which itself is warmed first, is dipped in the solution on the smooth side for a moment, thus letting it take up some of it, whereupon it is taken out and dried in the dark. When dry, the copy is transferred upon it in the usual way, the plaster having been placed between rubber sheets to prevent it from breaking. Of course, also, this has to be done in the dark room, that is, at lamp or gas light. The plate is then dried once more and exposed to direct sunlight for fifteen minutes. When taken out, the places where the light has acted will be found to be quite hard, while at the other places the plaster is soft, and will fall off as fine powder as deep as the solution has penetrated, if brushed with a hard brush. After that the plate is ready to be stereotyped.

The Condition of Sulphur in Vegetation.

The conditions under which sulphur appears in coal are to some extent elucidated by recent experiments of MM. Berthelot and Andre upon the forms in which sulphur may be found in plants. These experimentalists state, in a communication to the *Comptes Rendus*, that sulphur occurs in plants as sulphates. In the form of ethereal compounds comparable to the ethyl-sulphates and glyceri-sulphates capable of being split up by hydration under the prolonged action of dilute acids or alkalies, or by oxidation. In the form of mineral compounds, such as sulphides, sulphites, hypo-sulphites, etc., convertible by the moist way into sulphates by the prolonged action of oxidizing agents. In the shape of organic compounds, such as taurine, cystine, the sulpho-conjugated acid and albumen compounds, the sulphur in which is not convertible into sulphuric acid in the moist way. The sulphur of plants has been determined by the authors, with absolute accuracy, by burning the sample (previously dried at 100° C.) in a column of oxygen, passing the resultant vapors through a long column of pure anhydrous sodium carbonate. The tube is of hard glass, and the temperature is near redness.

When the organic product is entirely burnt, the current of oxygen is still maintained for some time, so as to complete the conversion of any sulphureted salts into sulphates. After this is effected, the tube is allowed to cool, the contents are dissolved in water acidulated with hydrochloric acid; then boiled; and the sulphuric acid precipitated in the ordinary manner. MM. Berthelot and Andre do not appear to have experimented on fossil plants.

Sheep Bugs.

There are many breeders and sheep raisers in Delaware County, N. Y., and in years past they have had to cope with a variety of diseases among their flocks. At the present time sheep are suffering from the ravages of bugs, and there seems to be no potent remedy at hand to kill them. The pests measure from one-half to three-quarters of an inch in length, and look more like the ordinary snapping bug than anything else. The pests burrow their way into the heads and brains of the sheep, and the loss in the aggregate incurred thereby is quite large.