(No Model.) 3 Sheets—Sheet 1.

D. MONNIER.

AUTOMATIC METHANOMETER.

No. 263,939. Patented Sept. 5, 1882.

FIG. 1.

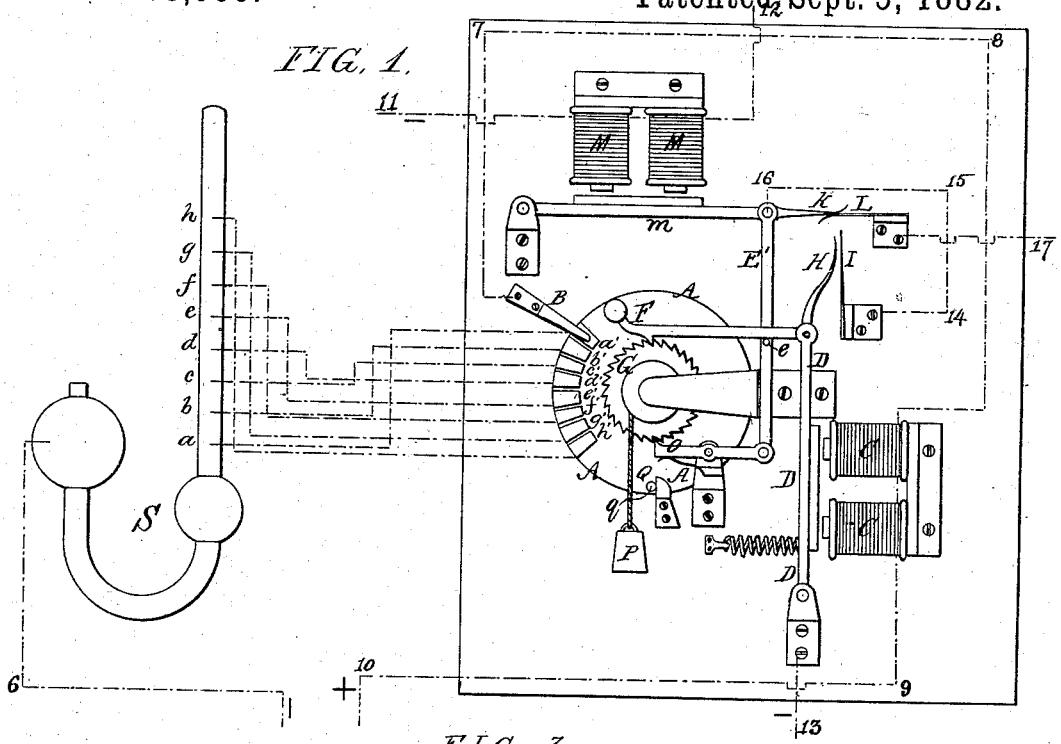
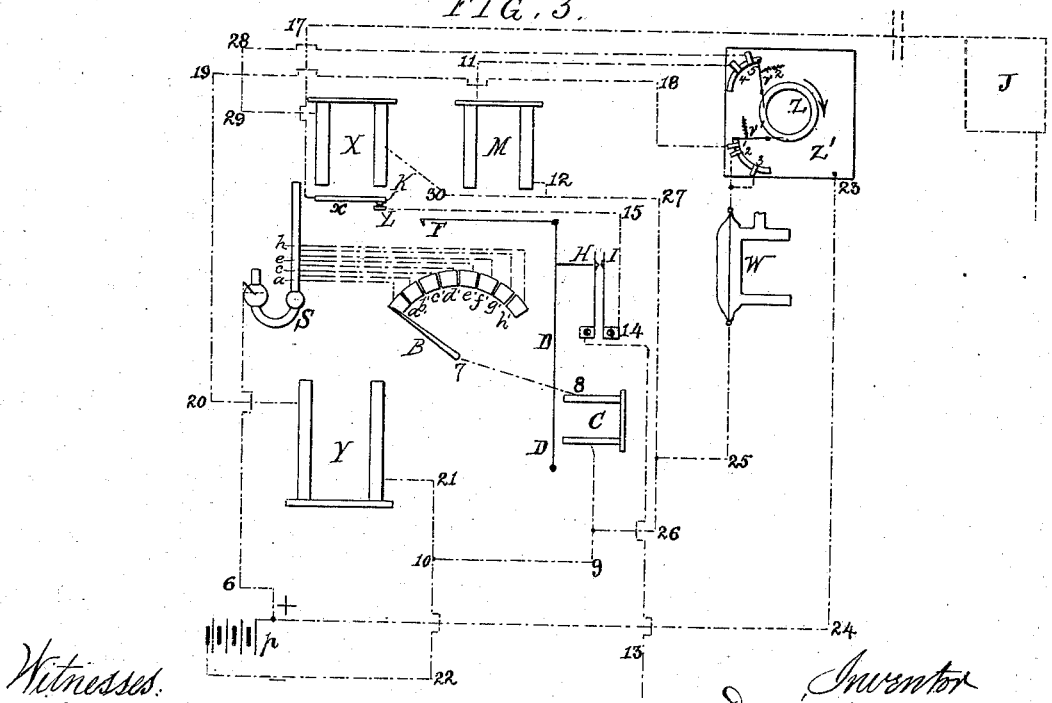


FIG. 3.



Witnesses.
James F. Tobin
H. L. Tulenwider

Inventor
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by his Attorneys
Howson and Son

(No Model.) 3 Sheets—Sheet 2.

D. MONNIER.

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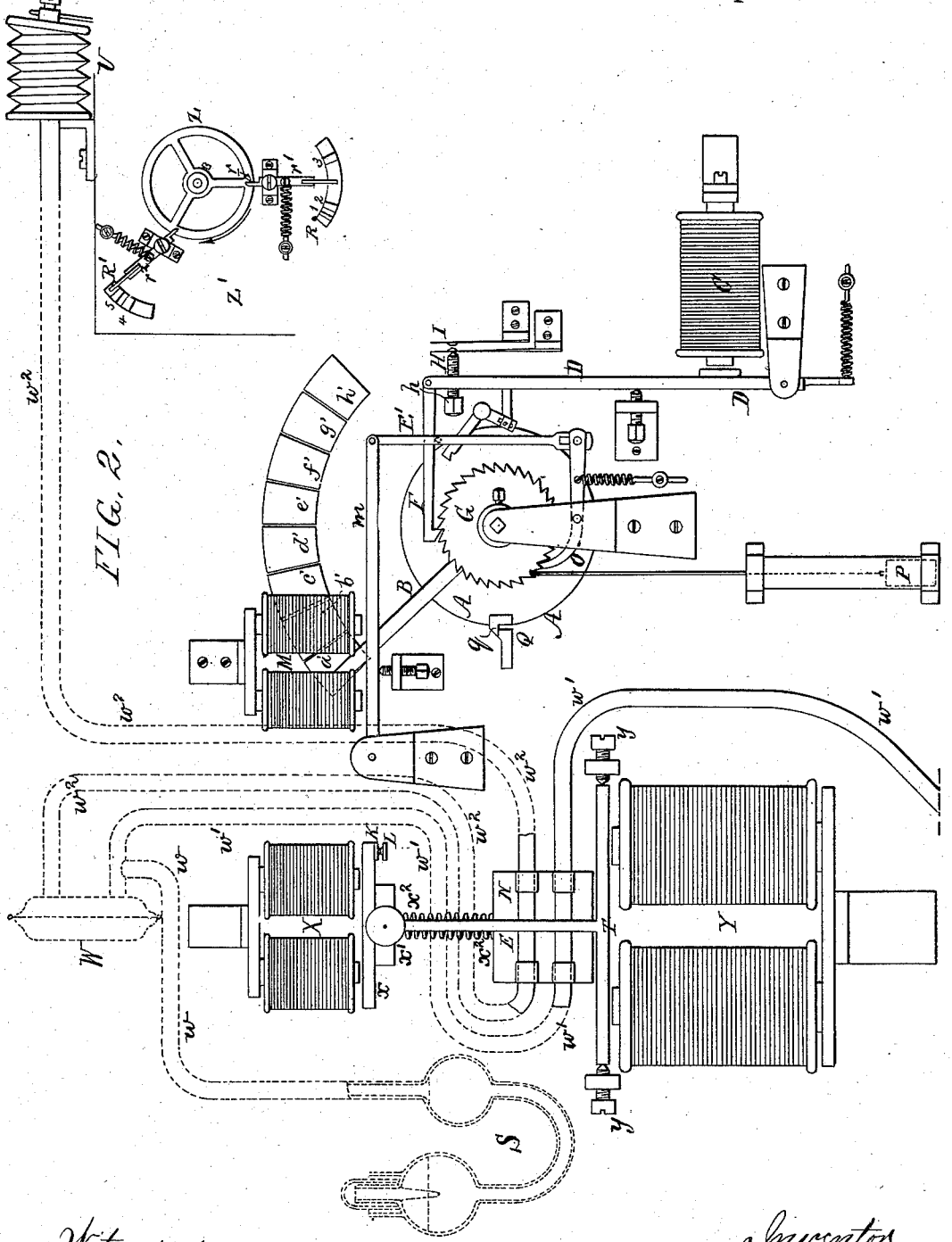

FIG. 2.

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(No Model.)

3 Sheets—Sheet 3.

D. MONNIER.

AUTOMATIC METHANOMETER.

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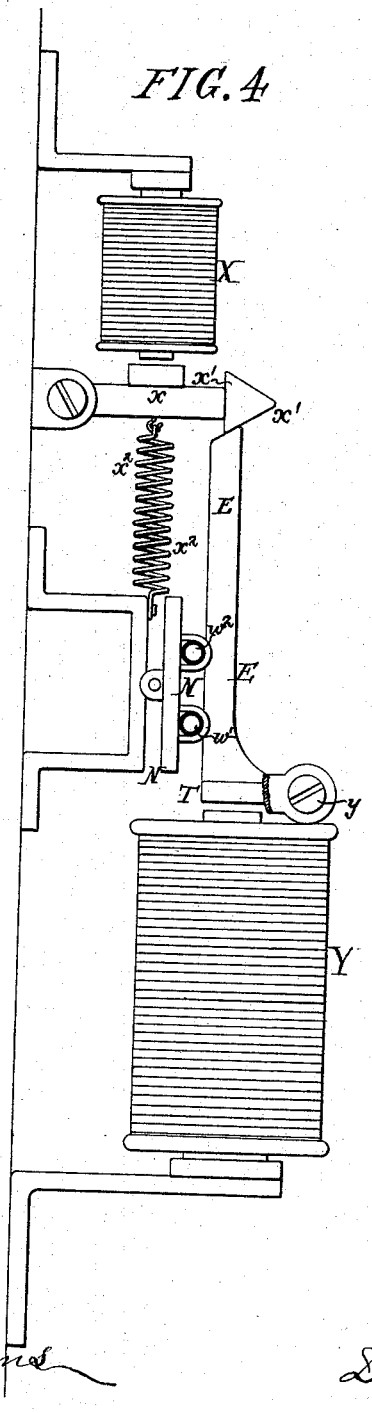
FIG. 4



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Inventor:
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UNITED STATES PATENT OFFICE.

DENIS MONNIER, OF GENEVA, SWITZERLAND.

AUTOMATIC METHANOMETER.

SPECIFICATION forming part of Letters Patent No. 263,939, dated September 5, 1882.

Application filed March 19, 1881. (No model.) Patented in France January 14, 1881, No. 140,617; in Belgium January 20, 1881, No. 53,634; in England January 24, 1881, No. 312, and in Germany February 5, 1881, No. 15,679.

To all whom it may concern:

Be it known that I, DENIS MONNIER, a citizen of the Republic of France, and a resident of Geneva, Switzerland, have invented certain Improvements in Apparatus for Testing Mine-Gases, of which the following is a specification.

The object of my invention is to construct an apparatus for automatically testing the gases of mines and indicating at a distance their density and explosive nature and the presence of fire-damp; and this object I attain by means of the apparatus fully described hereinafter, and which I term a "methanometer"—that is, an apparatus for testing or measuring "methan" or marsh-gas.

In the accompanying drawings, Figure 1, Sheet 1, is a view of one form of my apparatus for detecting fire-damp; Fig. 2, Sheet 2, a view of a slightly-modified form of the complete apparatus for testing the gases and indicating their nature; Fig. 3, Sheet 1, a diagram illustrating an arrangement of electric circuits in carrying out my invention; and Fig. 4, Sheet 3, a side view, drawn to a larger scale, of the automatic locking and releasing devices shown at the left-hand side of Fig. 2.

Methan or mine-gas in the presence of an excess of atmospheric air will explode when subjected to the influence of a spark from an induction-coil or of a platinum wire heated to redness or other means. I avail myself of the condensation or rarefaction which follows such explosion or decomposition within a confined chamber to cause such condensation to act on a column of mercury in a manometer or a flexible diaphragm, piston, or float of a similar apparatus to close electric circuits, and so indicate at a distance the density and explosive nature of the gases, the character of the signal transmitted by the indicating apparatus varying with the degree to which the column of mercury or equivalent device fluctuates.

My automatic methanometer, as illustrated in the accompanying drawings, consists of the following principal elements: a chamber, W, means for drawing the gases to be tested from the mines into said chamber, and automatic devices for trapping the gases therein and exploding them, a mercury manometer, S, communicating with said chamber W, and an electrical indicating apparatus or signal-transmitter having a series of circuits closed by the rise of the column of mercury in the manometer and giving signals at any desired distance—say in the office of the mine engineer.

I will first proceed to describe the testing or combustion chamber and means for supplying the gases thereto and the manometer in communication with said chamber, and for this purpose will refer to Fig. 2, illustrating these devices.

The combustion or testing chamber W, Fig. 2, consists of a small glass vessel, through which passes a fine platinum wire, forming part of an electrical circuit, which is automatically closed at a certain time, as hereinafter set forth. The interior of this chamber is in communication, through a tube, w, with a glass manometer, S, containing a column of mercury, and closed at its outer end, so that the pressure of the gases cannot force the mercury out of the manometer. The chamber W has also inlet and outlet nozzles, the former of which communicates, through rubber tubing w', with the mine or source whence the air to be tested is to be drawn, while the outlet-nozzle communicates, through rubber tubing w^2, with a bellows or other exhaust mechanism, U, for drawing the air, when required, from the mines into the chamber W. The two flexible tubes w' w^2 at a suitable point pass between a cut-off or locking lever, E, and a clamping-plate, N, to which latter they are secured, so that when the lever E is pressed up toward the plate the flexible tubes will be clamped between the lever and plate and the passages through the tubes closed, so as to practically trap the gases in the chamber W.

The locking-lever E is carried by an armature, T, at right angles thereto, acted on by an electro-magnet, Y. This armature is so mounted on the conical points of screws y y that when a current is passed through the coils of the magnet to cause the attraction of the armature the cut-off lever E will be forced down onto the tubes w' w^2, so as to clamp them against the plate N and close them. The plate N is mounted so as to be free to oscillate to a certain extent to accommodate itself to the movements of the cut-off lever E and maintain its face parallel with the latter. The rubber tubes act as springs to throw the lever and armature back when released.

With the cut-off lever E, I combine an automatic catch for retaining the lever in the closed position until released at the proper time by

the closing of another electric circuit. This catch x', Fig. 4, is in the form of a cone carried by the pivoted armature x of the electro-magnet X. A spring, x^2, tends to retract the armature from the magnet and pull the conical catch toward the lever E. The end of this lever is beveled, and when the armature T is not attracted this beveled end of the lever rests against the tapering side of the cone, the spring x^2 pulling down the armature x, so as to push the end of the lever toward the apex of the cone x'. When the armature T is attracted the lever E raises the cone and armature x until it passes and is caught under the base of the cone. The lever is thus retained in the closed position until the armature x is raised by the attraction of the magnet due to the passing of a current through its coils.

The construction of the signal-transmitting apparatus will be more readily understood on reference to Fig. 1, from which the parts already described, with the exception of the manometer S, are omitted for the sake of clearness; but before describing this it will be well to explain that the rise of the mercury in the manometer is in proportion to the quantity of explosive gas contained in the volume of air drawn from the mines—that is to say, the greater the proportion of gas exploded in the chamber W by the heated platinum wire the greater the condensation, and consequently the higher will the mercury rise in the small vertical tube of the manometer. I have proved by practical tests that these manometrical indications give uniform results when obtained under similar conditions—that is, when the length of time during which the platinum wire is maintained at a bright-red heat, the temperature of the surrounding air and the barometrical pressure correspond in every case. The barometrical pressure exercises but little influence on the result. The temperature, however, affects them more, but within limits wide enough to allow of the apparatus being adjusted before use in the galleries of mines, where the temperature is not subject to great variations.

Supposing that the apparatus is to be used in a gallery of a mine where the temperature varies from 30° to 40° centigrade, it is adjusted in that case for a mean temperature of 35° centigrade. For this purpose the chamber W and its manometer are placed in a stove at a temperature of 35° centigrade, and the height of a column of mercury which will indicate a mixture of five volumes of methan or fire-damp and ninety-five volumes of air is determined. This height divided by five will give the height corresponding to one per cent. of methan. The experiment is repeated with two, four, six, eight per cent. of gas to check the first result, and the height corresponding to one per cent. is thus exactly fixed. Let it be assumed that this height is 8 mm. Starting from 0° on the index of the manometer, and from 0° at intervals of 8 mm. the tube is pierced by a wire of platinum heated to redness, and in these holes wires of platinum, which penetrate to the interior of the column of the manometer, are inserted and hermetically secured. I have shown eight of these wires, *a b c d e f g h*, thus inserted in the manometer S, Fig. 1. The manometer thus prepared is ready for use in connection with its corresponding test-chamber, W. Each such chamber should be carefully gaged and corrected, as it is impossible to produce with the simple blow-pipe chambers of exactly the same capacity. The wires *a b c*, &c., inserted in the side of the manometer above the mercury level, are respectively connected to metallic plates a' b' c', &c., arranged radially on an ebonite or other non-conducting disk, A, mounted on an axis adapted to turn in suitable bearings in the frame of the apparatus. To the same axis is secured a ratchet-wheel, G, and round the said axis is coiled a cord carrying a weight, P, which tends to turn the disk so as to keep the pin *q* on the face of the disk in contact with a fixed stop, Q, on the frame. The ratchet-wheel G is acted on by a gravity-pawl, F, pivoted to the end of the armature-lever D of the electro-magnet C, whose coils are in the circuit 7 8 9 10, leading from the spring contact-finger B, (bearing on one or other of the plates a' b' c', &c.,) to the positive element of the battery, the circuit being completed through the wires *a b c*, &c., and manometer S. Into the ratchet-wheel G also takes a spring-pawl, O, pivoted to the frame, and having its outer end connected by a rod, E′, to the end of the armature-lever *m* of the electro-magnet M, whose coils are in another electric circuit, 11 12, controlled by automatic clock-work, as hereinafter set forth. On the connecting-rod E′ is a pin, *e*, which bears on the under side of the pawl F, so that when the armature-lever *m* is raised to release the pawl O from the ratchet G the pin *e* will at the same time raise and release the pawl F from the ratchet. On the end of the armature-lever D or on the pawl F is a tail-piece or contact-point, H, which, when the said armature-lever is attracted by the electro-magnet C, comes into contact with a tongue, I, and so closes the line-circuit 13 D H I 14 15 16, points K L, hereinafter referred to, and 17, so as to operate a suitable signal instrument or receiver, J, Fig. 3, at a distant point—say in the engineer's office.

The transmitting-instrument illustrated in Fig. 2 does not differ materially from that shown in Fig. 1. In this case, instead of having the spring-contact B fixed and the plates a' b' c', &c., movable, the latter are fixed, and the contact B is mounted on the rotary disk A. The spring-contact H, instead of being carried by the armature-lever D or pawl F, is secured to the frame or base, and has its spring end acted on by a set-screw, *h*, carried by the armature-lever D, so that when the latter is attracted by the electro-magnet C the point H will be brought into contact with the point I to close the line-circuit, as above described. The points K L are in Fig. 2 shown as in con-

nection with the armature-lever x instead of the armature-lever m, as in Fig. 1. In other respects the transmitter shown in Fig. 2 substantially resembles that shown in Fig. 1.

The automatic mechanism for closing the several circuits consists of a wheel, Z, Fig. 2, mounted on a suitable plate, Z′, and slowly rotated in the direction of the arrow by means of suitable clock-work. This wheel Z carries a knife-edge pin, r, and two pivoted contact-levers, r' r^2, are mounted on the plate Z′, so as to have their tails in the line of movement of the pin r. These levers r' r^2 are so acted on by springs as to be normally held up in contact with corresponding stops, R R′, as shown in the drawings, until the pin r on the revolving wheel comes into contact with them one after the other, first moving the lever r' over metallic plates 1, 2, and 3, mounted on a non-conducting quadrant-shaped piece, and connected to circuit-wires, as hereinafter described. Then, after the pin has slipped over the end of this lever, which is immediately drawn back to the stop R, the pin r comes into contact with the lever r^2 and moves its outer end over metallic plates 5 4 (also mounted on a non-conducting quadrant) to close certain other circuits successively.

The arrangement of circuits is shown in the drawings, Fig. 3, the several circuits, except the line-circuit, being shown connected up to the same battery, p.

The operation is as follows, the several parts of the transmitter being in the positions indicated in Figs. 1 and 2: The exhaust-pump U is first operated about half a dozen times, so as to withdraw all atmospheric air from the chamber W and entirely replace it by the air to be tested from the mine. The pin r on the rotating wheel Z, Fig. 2, about a minute later strikes the end of the lever r' and causes it to come into contact with the metallic plate 1, and so close the circuit through the plate Z′, wire 23 24, battery p, wires 22 10 21, coils of the electro-magnet Y, wires 20, 19, and 18, and plate 1. The passing of the current through the coils of the magnet Y causes the latter to attract its armature T, so that the lever E closes the flexible tubes w' w^2 and traps the mine-gas in the chamber W and adjoining portions of the tubes, the lever E being retained by the conical catch x' on the armature x. Then as the wheel Z continues its revolution the pin r causes the lever r' to come into contact with the metallic plate 2, and closes the circuit for about fifteen seconds through the plate Z′, wire 23 24, battery p, wires 22 10 9 26 25, platinum wire passing through the combustion-chamber W, and plate 2. The platinum wire, being thus heated to redness, causes the explosion of the gases within the chamber W, and the resulting condensation causes the mercury in the manometer S to rise. The lever r', after leaving the plate 2, takes about a minute to reach the contact 3, which again closes the same circuit, only through the plate 3 instead of 2, for about fifteen seconds, the object of this second ignition of the platinum wire in the chamber W being to insure the combustion of any explosive gases which may have escaped combustion at the first ignition. The pin r then releases the lever r', which is immediately pulled back to its normal position against the stop R. The pin r then takes about ten minutes to reach the lever r^2. Meanwhile, if the proportion of explosive gas in the volume of air in the chamber has been such that the resulting condensation has raised the column of mercury as high as the first wire, a, it will have closed the circuit through the manometer, wire 6, battery p, wires 22, 10, and 9, coils of the electro-magnet C, wire 8 7, arm B, plate a', and wire a. The electro-magnet C will then attract the armature-lever D, so as to cause the pawl F to rotate the disk the extent of one tooth of the ratchet G and bring the arm B into contact with the plate b'. If the mercury has risen to the second wire, b, the operation will be repeated and the arm B brought into contact with the third plate, c', and so on, should the mercury have risen higher. Should it have risen only to the first wire, a, then the movement of the arm B to the plate b' will break the circuit and the action will cease, unless the fluctuations of the mercury shall rise to the wire b. The attraction of the armature-lever D brings the point H into contact with the point I and closes the line-circuit 13, H, I, 14, 15, K, L, and 17, so as to cause the receiver at the distant station to give a signal corresponding with the operation of the transmitter, and to indicate in this manner the presence of fire-damp in the air in the mines. About ten minutes later the pin r comes into contact with the tail of the lever r^2 and brings it over the plate 5, so as to close the circuit through the plate Z′, wire 23 24, battery p, wires 22 10 9 26 27 30, coils of the magnet X, wires 29 28, and plate 5. The electro-magnet X is thus caused to attract the armature x, and so release the lever E, which springs back under the action of the rubber tubes, the latter being thus opened for the next operation. When the lever r^2 comes into contact with the plate 4 the circuit is closed through the plate Z′, wire 23 24, battery p, wires 22 10 9 26 27 12, coils of the electro-magnet M and wire 11, and plate 4, so as to cause the attraction of the armature-lever m. This frees the ratchet G from the pawls F and O, and the weight P then returns the disk A to its normal position, with the pin q in contact with the stop Q and the arm B in contact with the first plate, a'. The line-circuit is broken at K L, either while the disk A is returning to its normal position, Fig. 1, or when the lever E, Figs. 2 and 3, is freed to open the tubes w' w^2 and admit fresh air to allow the mercury in the manometer to return to its normal level, and the line being thus broken at K L, fluctuations of the mercury cannot accidentally close the circuit at those times.

The reason why the platinum wire in the combustion-chamber is preferably heated twice

with an interval of a minute is, that the wire, being suddenly brought to a high temperature, causes the gas inclosed in the chamber to expand instantly, and a portion thereof, being driven back into the manometer, escapes combustion. During the time allowed for the cooling of the wire the gas which had previously escaped combustion passes back into the chamber W, where it is consumed at the second ignition. If the rubber tube which connects the chamber W with the manometer were closed, so as to shut off communication during the ignition of the wire, complete combustion might be obtained with one heating of the wire; but in that case the chamber would be liable to burst, and it is to avoid such an accident that communication between the chamber and manometer is always left open.

The various parts of the machine above described are preferably mounted on a strong plate of brass, to one face of which are secured the combustion-chamber, its manometer, and the clock-work of the automatic contacts. On the other side are the transmitter and the devices for locking and releasing the rubber tubes, the whole being incased in a closed box.

The receiving apparatus J is preferably similar in construction to the transmitter, with plates numbered from 1 to 8 to indicate from one to eight per cent. of fire-damp. By doubling the number of plates or by quadrupling them, as well as the platinum wires of the manometer, as high a percentage as twenty-five or fifty may be indicated, if desired. The numbered plates of the receiver are provided with contact-points, in order to sound a continuous alarm when the proportions of the gaseous mixture approach the limit which it is desirable not to exceed. This receiver may be placed in a central office—in the engine-room, for instance—and thence warnings may be issued in as many directions as desirable. Each time the mercury in the manometer reaches a division or wire *a b c*, &c., the needle of the dial of the receiver will give a corresponding indication. Any fluctuations of the mercury below the highest point it may have reached will not be recorded, however, since each wire can only transmit the current once.

Should it be desired to keep in operation several—say four—of these apparatus in different galleries of a mine by means of a single connecting-line, the clocks of the four test apparatus can be each fifteen minutes ahead of the other. Thus, for instance, the first will be set to operate at nine o'clock, the next at a quarter past nine, the third at half past nine, and the fourth at a quarter to ten.

I claim as my invention—

1. The combination of a combustion-chamber, W, with a manometer communicating with the interior of the said chamber, and an electrical signal-instrument operated by the fluctuations of the mercury or other body in the manometer, substantially as set forth.

2. The combination of the combustion-chamber, mechanism for drawing the air to be tested into said combustion-chamber, and devices, substantially as described, for trapping the air therein, with a manometer and an electrical signal-instrument operated by the fluctuations of the mercury or other body in the manometer, substantially as described.

3. The combination of a chamber, W, and a platinum wire therein, forming part of an electric circuit, with a manometer communicating with the interior of said chamber, and an electrical signal operated by the fluctuations of the mercury or other body in the manometer, all substantially as specified.

4. The combination of a combustion-chamber, W, with an electrical signal-instrument, and a mercury manometer having one or more wires introduced through its wall, and forming part of a circuit operating the said signal-instrument, substantially as described.

5. The combination of a combustion-chamber, W, flexible tubes w' w^2, and exhaust apparatus U with a clamping-plate, lever E, electro-magnet, and armature carrying said lever, all substantially as set forth.

6. The combination of a combustion-chamber, W, flexible inlet and outlet tubes, with electro-magnet, and armature carrying a locking-lever for the tubes, and a spring-catch for retaining said lever.

7. The combination of a combustion-chamber, flexible inlet and outlet tubes, with electro-magnet Y, and armature carrying a locking-lever, E, and electro-magnet X, and armature carrying a catch for said locking-lever.

8. The combination of a combustion-chamber, and manometer in communication therewith, with an electrical transmitter operated by the fluctuations of the mercury or other body in the manometer, and a receiver operated by the transmitter, all substantially as specified.

9. The combination of a combustion-chamber, platinum wire therein, and inlet and outlet tubes with electro-magnet Y, locking mechanism operated thereby, circuits, contacts, and mechanism, substantially as described, for automatically and successively closing the circuits.

10. The combination of a combustion-chamber, inlet and outlet tubes, with electro-magnet Y, locking mechanism operated thereby, electro-magnet X, and armature carrying a retaining-catch for said lever, and automatic mechanism, substantially as described, for successively closing the circuits of said magnets.

11. The combination of a revolving wheel having a pin, *r*, with spring-lever *r'*, stop, contact-plates, and circuits, all substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

DENIS MONNIER.

Witnesses:
ERNEST HUMBERT,
EMILE HUMBERT.