(No Model.) 3 Sheets—Sheet 1.

# W. H. CLAUSEN.

## PROTECTOR FOR USE IN ELECTRIC CIRCUITS.

No. 454,926. Patented June 30, 1891.

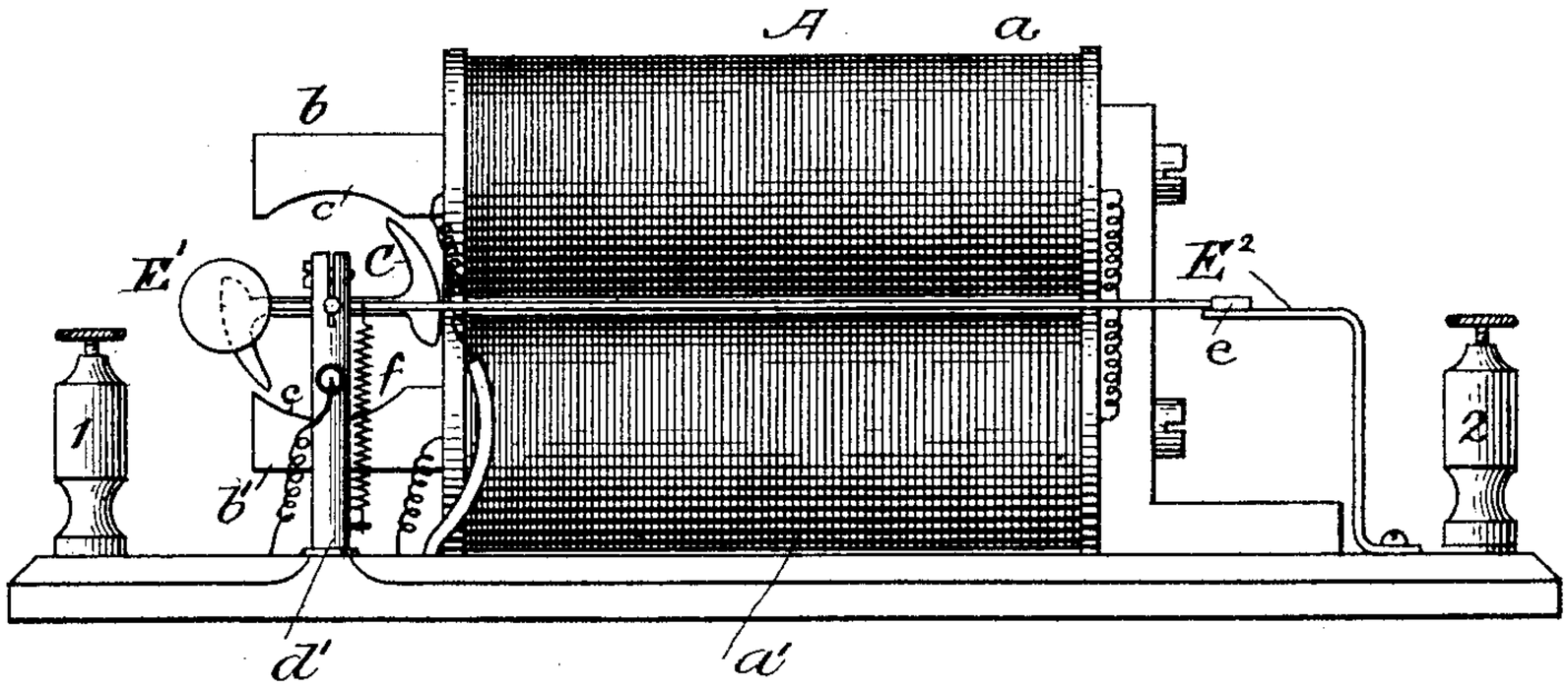


Fig. 1.

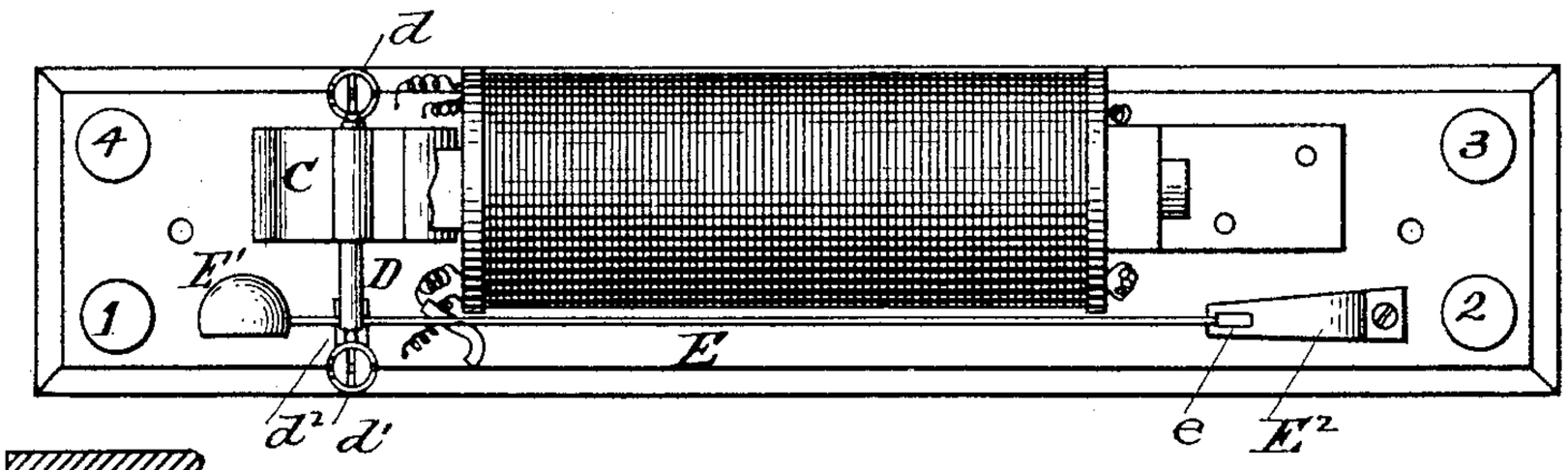


Fig. 2.

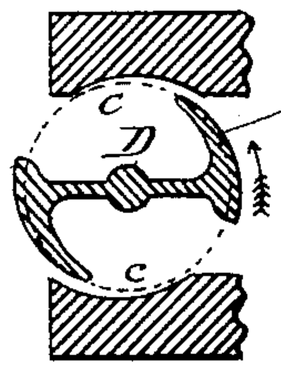


Fig. 3.

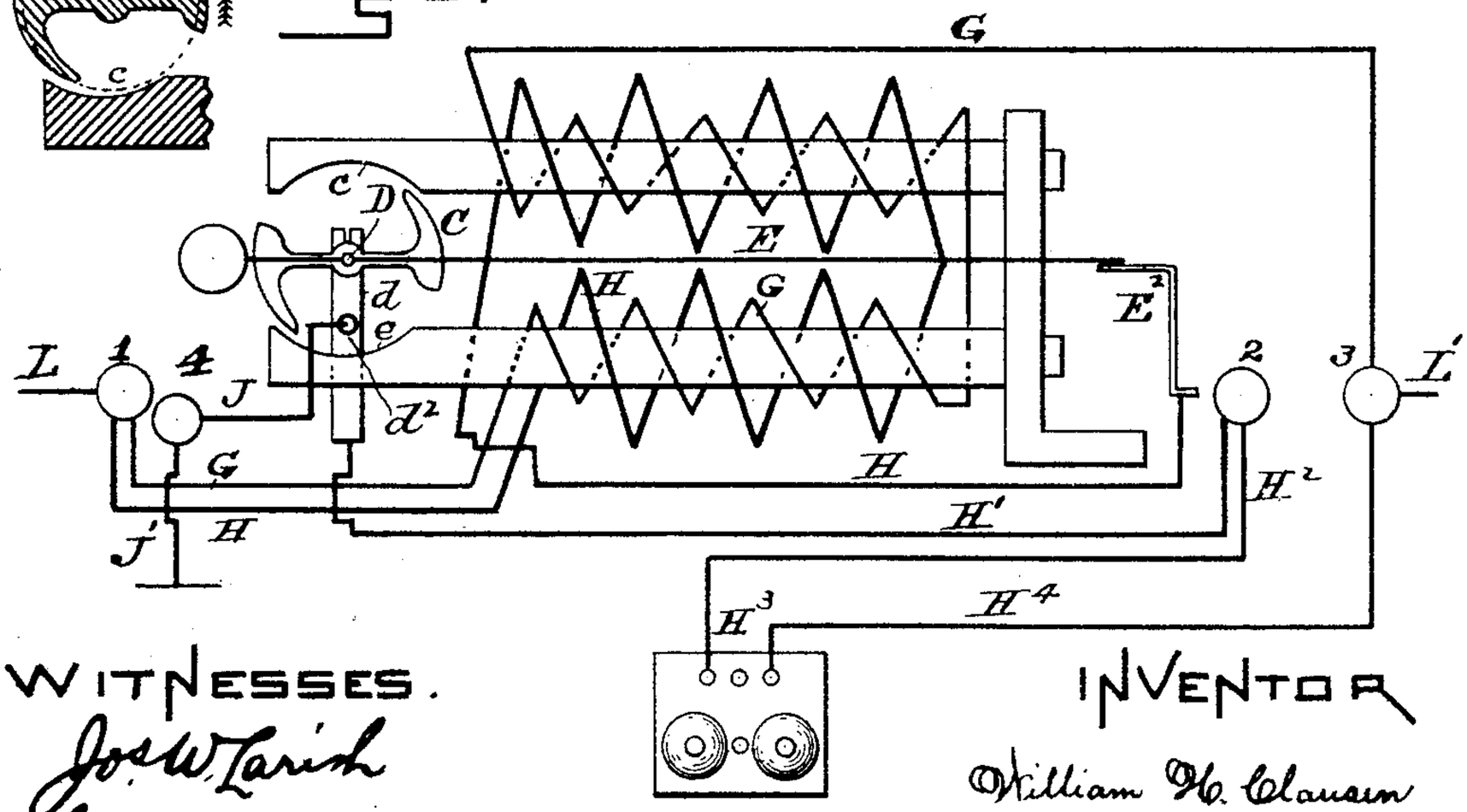


Fig. 4.

WITNESSES.

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(No Model.) 3 Sheets—Sheet 2.

# W. H. CLAUSEN.

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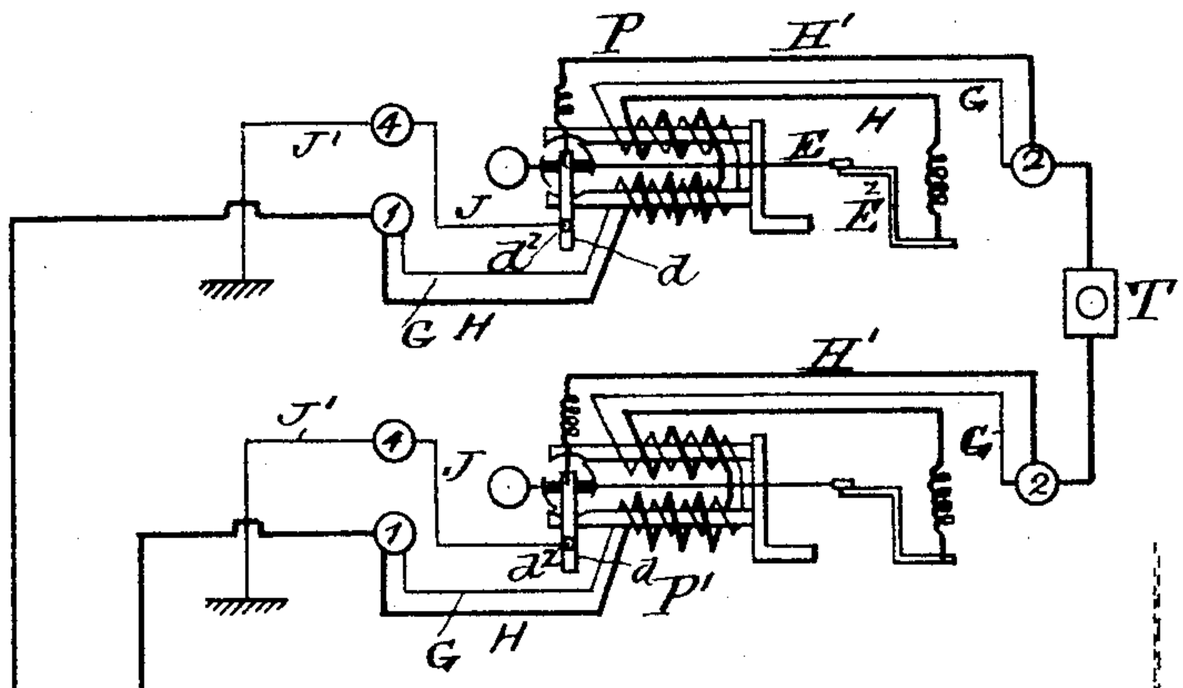



Fig. 6.

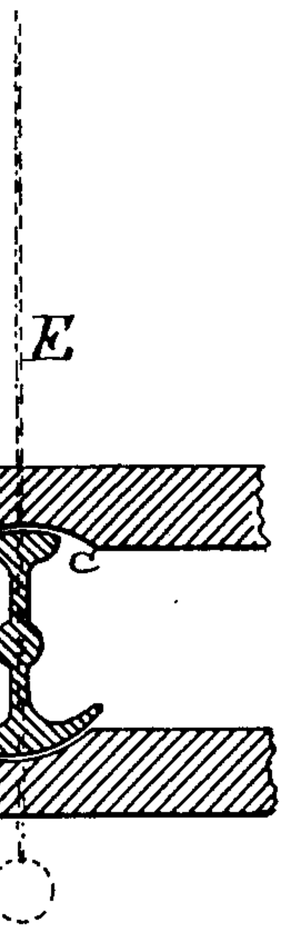
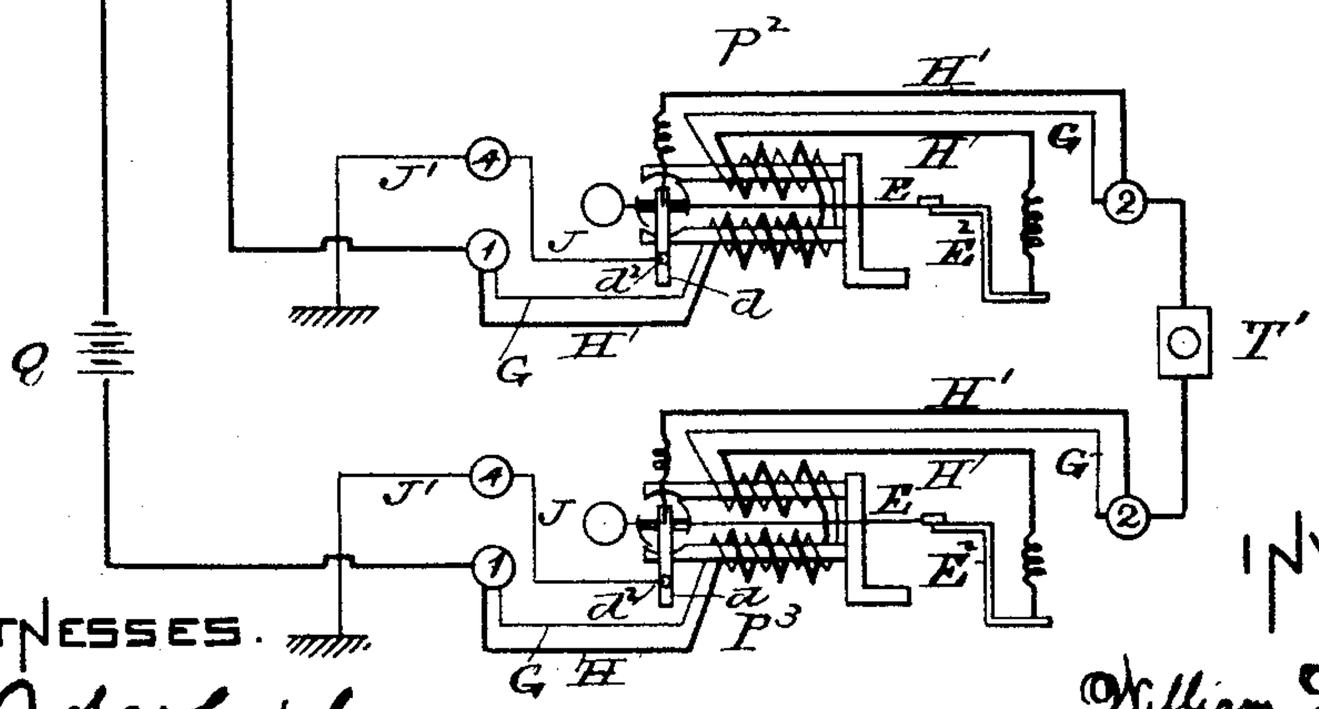



Fig. 5.




Witnesses.
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(No Model.) 3 Sheets—Sheet 3.

# W. H. CLAUSEN.

## PROTECTOR FOR USE IN ELECTRIC CIRCUITS.

No. 454,926. Patented June 30, 1891.

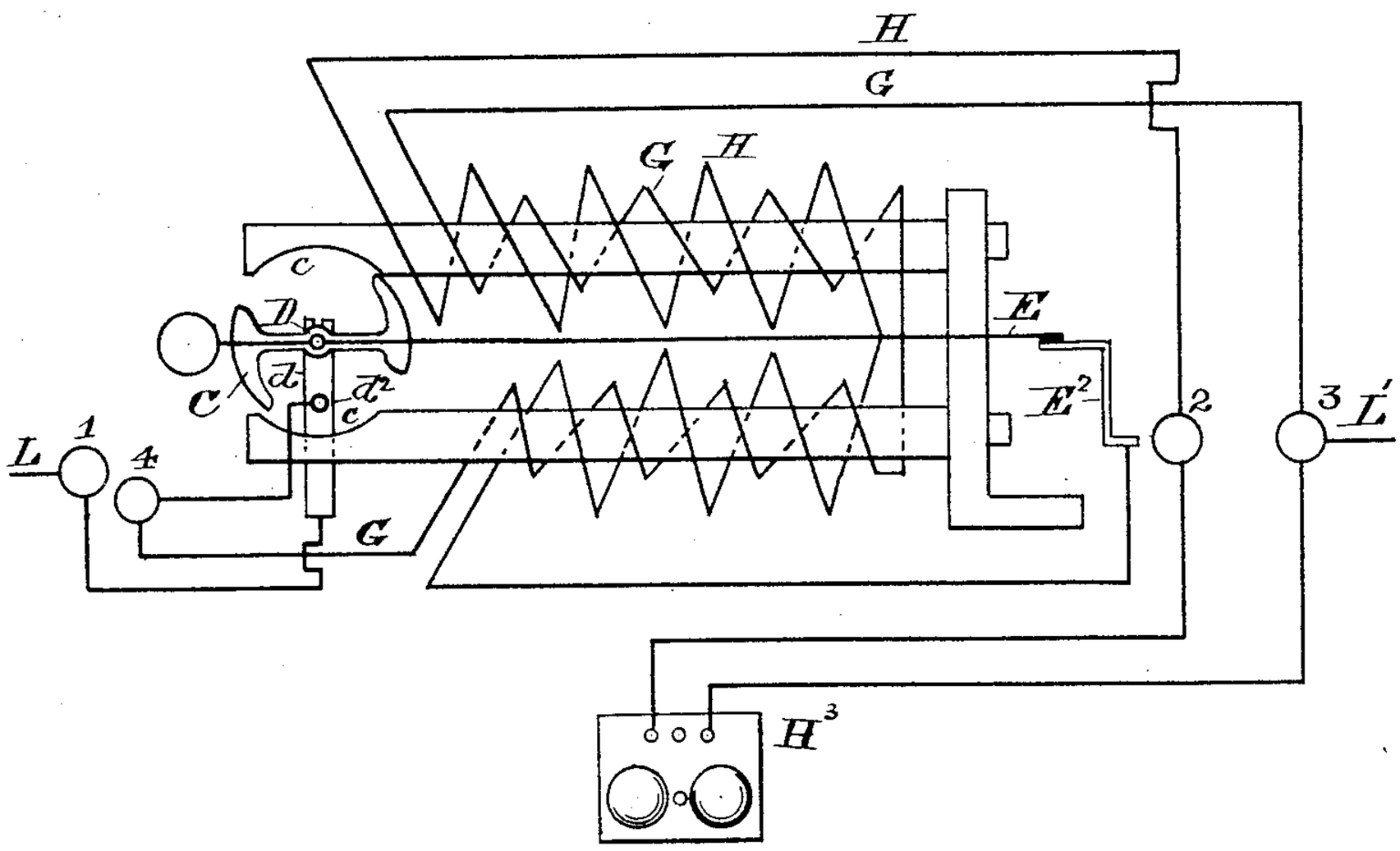


Fig. 7.

WITNESSES
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his atty.

# UNITED STATES PATENT OFFICE.

WILLIAM H. CLAUSEN, OF MELROSE, ASSIGNOR TO JOSEPH W. LARISH, TRUSTEE, OF BOSTON, MASSACHUSETTS.

## PROTECTOR FOR USE IN ELECTRIC CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 454,926, dated June 30, 1891.

Application filed December 22, 1890. Serial No. 375,407. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM H. CLAUSEN, of Melrose, in the county of Middlesex and State of Massachusetts, have invented a new and useful Improvement in Protectors for Use in Electric Circuits, of which the following is a specification.

The danger from a sudden very large increase of current on a wire designed to carry an ordinary current is well known. It is frequently the case, for example, that an electric-lamp wire will come in contact with a telephone-wire, with the result of destroying the telephone as well as endangering the building in which it is located from fire.

My invention relates to an automatic device for breaking the low-resistance circuit when it is crossed by a wire carrying a dangerous current and diverting the current through a high-resistance coil and automatically re-establishing the low-resistance circuit when the danger is passed; and it consists in an automatic circuit breaker and closer so constructed that when a current of dangerous strength is about to pass through the instrument to be protected it will be diverted through a coil of comparatively high resistance, and hence its dangerous effects will be practically killed, and when the normal condition of the line is re-established the protected circuit will be closed again, all as described below.

In the drawings is shown the best form of my invention now known to me, although certain of its features may be embodied in a different form to accomplish the same result.

Figure 1 is a side elevation. Fig. 2 is a plan. Figs. 3 and 5 are vertical sections to illustrate the relation of the oscillating armature to the poles of the electro-magnet in the form of my invention shown in the preceding figures. Fig. 4 is a diagram showing the way in which one form of my protector may be located with respect to the instrument to be protected and the main circuit, this form of my invention being particularly useful under the circumstances indicated in diagram Fig. 6; and Fig. 6 shows an application of my invention to a metallic circuit for the purpose of reducing the dangerous effect of the current while maintaining a complete circuit through the ground for all the apparatus on the main line. Fig. 7 shows an apparatus embodying my invention and like the apparatus shown in Fig. 4 in every respect, except that the various coils are differently connected, as will be hereinafter described.

A is a horseshoe electro-magnet mounted on a stand of insulating material, having two coils *a a'* and two poles *b b'*.

C is the armature, which, in the instrument shown in the drawings, oscillates—that is to say, it is so constructed that normally it will stand in the position shown in Fig. 3, but when attracted by the magnet it will take position shown in Fig. 5. I prefer to cause the armature to oscillate by cutting away the sides of the poles of the magnet, as at *c*, in curved lines, and making the active parts of the armature of a general wedge-shaped form, the end nearest each pole being thin and pointed and the rear edge being heavy and wide. This armature is mounted upon the shaft D, pivoted in supports *d d'*, one of which *d'* is insulated and provided with stop-pin $d^2$, electrically connected with the screw-cup 4. This stop regulates the movement of the arm E, as below described. The shaft D is located eccentrically with reference to the centers from which the curved portions *c* of the poles of the magnet are struck, so that as the armature is attracted by the poles of the magnet each end of the armature will approach nearer and nearer to its attracting-pole, and the nearer it gets the greater the metallic mass exposed to the direct action of the magnet. I prefer, also, to make the peripheral surface of the armature cam-like, as shown—that is to say, curved on an increasing radius in distinction from cylindrical—and also to curve the surfaces of the poles of the electro-magnet in a similar manner; but the desired result may be attained by mounting an armature having a cylindrical surface with its axis eccentric to the concaved surfaces of the poles.

On the shaft D is also mounted an arm E, having a counter-weight attached to its short end E' and an expanding spring *f* arranged to hold it normally horizontal. This arm E

is provided with a platinum point at its outer end *e*, which point is normally held upon the support $E^2$ by the spring *f*, this construction (heretofore described) being such that when a sufficiently heavy current passes through the coils of the electro-magnet A the ends of the armature C will be attracted by the poles of the electro-magnet, thus causing the shaft D to rotate in the direction of the arrow and the arm E to move in the same direction through an arc of, say, ninety degrees, or until its shorter end E′ strikes the stop $d^2$, thereby separating its point *e* from the support $E^2$ for the purpose to be described. When the current through the protector becomes so slight in amount that the armature C is no longer attracted, the arm E drops again into the position shown in Fig. 1, the movement of the armature back to the position shown in Fig. 1 being assisted by the spring *f* which may be adjnstable. The electro-magnet coil in all cases is to be so constructed and connected with reference to the other parts of the instrument as to prevent a normal current from so magnetizing the cores as to operate the armature against the force of the spring *f*, and also to practically kill the effect of any current of dangerous potential which may accidentally strike the line. Its armature is so constructed and connected that when it is oscillated from its normal position it will cause the current which has been passing through the low-resistance circuit—viz., that part of the circuit containing the circuit-breaker—to be diverted through the high-resistance coil, which up to that instant may or may not be in multiple therewith.

It is evident that for the purpose of killing the dangerous effect of the current it is immaterial, as has been intimated above, whether the high-resistance coil or circuit be in multiple with the low-resistance circuit or not; but it must be so located and arranged with relation to some convenient form of circuit-breaker that when the dangerous current reaches the line and the circuit-breaker in the low-resistance circuit is moved a circuit will be established through the high-resistance circuit. The result will be that the abnormal strength of the current will be reduced to substantially the normal strength which so much of the line as remains in circuit can safely carry. Such a method is extremely simple and must be effective for the desired purpose. Moreover, the terms "high resistance" and "low resistance" are used herein relatively.

One method of using such a device as this for the purpose of protecting a telephone or other instrument is to connect the coil of the electro-magnet so as to form a shunt around the telephone or be in multiple with it, the arm E and support $E^2$ being in series with the telephone. If a current sufficiently heavy to damage the instrument to be protected strikes the line, the electro-magnet *b b′* will be sufficiently magnetized to attract the armature instantly and move the arm E, so as to break the protected circuit between E $E^2$, thereby causing all the current to pass through the electro-magnet A until such a time as it has lost its unusual strength, when, the electro-magnet becoming sufficiently demagnetized again, the armature will resume its former position and the arm E fall again upon the support $E^2$, thus making again the protected circuit. In case of considerable external resistance, however, it is desirable to rely not only upon the current in the shunt-coil, but also upon a portion of the current on the protected circuit, in the first instance to operate the armature C, and I show in Fig. 4 a diagram of my protector arranged for such a purpose. In such case I wind my electro-magnet, as before, with a large number of turns of a wire of comparatively high resistance, which I have represented in my diagram by the line marked G, and over it I wrap a number of turns of wire of comparatively low resistance, which is represented by the line marked H, this second wire being in series with the instrument to be protected and in circuit with the arm E and support $E^2$. In this arrangement the current enters the instrument, for example, by the line L, passing to the screw-cup marked 1. Here it divides, a portion passing through the wire H, support $E^2$, arm E and its shaft, post *d*, and from thence through the wire H′ to screw-cup 2, wire $H^2$, instrument $H^3$, wire $H^4$, to screw-cup marked 3, and out by the line L′. The other portion of the current passes from screw-cup 1, through the wire G, around the coil to the screw-cup marked 3, and out by the line L′.

The operation of this device is as follows: The ordinary current passing through both coils of the protector does not magnetize the cores of the electro-magnet sufficiently to operate the armature, and consequently contact is maintained between E $E^2$ and a circuit maintained through the telephone or other instrument to be protected. Whenever a sufficiently heavy current strikes the line L, the current, dividing as before, reaches the electro-magnet, and instantly so magnetizes it as to attract the armature and move the arm E, so as to break the protected circuit, thus leaving sufficient current upon the protecting circuit G to keep the arm E up and cutting out the telephone or other instrument to be protected. The parts remain in this position until the current decreases sufficiently to pass with safety through the telephone, when the armature is released and the arm E drops into the position shown in Fig. 4. When the armature and arm are in the position indicated in Fig. 5, a metallic contact is established with the pin $d^2$, which may be connected by a wire J to the screw-cup 4, from which a wire J′ may run to the ground, if desired, for purposes hereinafter described. For example I have shown in Fig. 6 an application of four of my protectors to a line in which the instruments to be

protected lie outside of the divided circuit, the protectors in this case being marked P, P′, $P^2$, and $P^3$, the instruments to be protected T T′, the battery Q, and the line M N. In this case two protectors are placed at a station, one on each side of the instrument to be protected, and they are so connected with the instrument T or T′ that if a dangerous current strikes the line connecting two stations the arms E in the two protectors directly connected by said line will be thrown up, so as to ground the instruments in those stations and leave the dangerous current upon the line, which will thus contain at each end a coil of high resistance. Thus the dangerous effect of the increased current will be killed by the introduction of the high-resistance coils into its path, and the instruments T T′ will be grounded, so that they may be operated by a ground-circuit until the source of danger is removed. To illustrate such a case more especially, suppose an abnormal current from an electric machine should become located on any part of the line N, Fig. 6. The instant effect would be that the arms E in protectors P′ and $P^2$ would be operated by the sudden increase in the magnetism of their electro-magnets and their rear ends would make a ground, so that the battery-circuit would be maintained through line M, protector P, instrument T, and the following parts of protector P′—viz., wire H′, post *d*, shaft D, short end E′ of arm E, pin $d^2$, wire J, screw-cup 4, and wire J′—to the ground, the connections being the same on the other side of the battery Q through protector $P^3$, instrument T′ and the corresponding portion of protector $P^2$ being in the circuit, forming a ground connection, which leaves the instruments T T′ in a circuit of substantially normal strength to be operated by the battery.

It is obvious that other arrangements of these instruments may be made whereby similar results may be attained whether the circuit be entirely metallic or partly through the ground. Moreover, an instrument like that shown in Figs. 1 and 2 may be connected up in a variety of ways. Fig. 7, for example, shows another method of connecting, in which the screw-cup 1 is electrically connected with the post *d*, the pin $d^2$ is electrically connected with the screw-cup 4, to which is also connected one end of high-resistance coil G, the other end of said coil being connected to screw-cup 3, and the support $E^2$ is electrically connected with the low-resistance coil, which runs about the electro-magnet to screw-cup 2, the said cups 2 and 3 being also electrically connected either through the instruments to be protected or not, as most convenient. By connecting screw-cup 1 with the main line and screw-cup 3 also with the line the normal current will pass in at screw-cup 1 to post *d*, from thence through the flip, support $E^2$, and low-resistance coil to screw-cup 2, thence to screw-cup 3, through the instruments or not, according to the way in which the protector is used, and out by the main line. Any sudden accession of current will so far increase the magnetism of the electro-magnet as to attract the armature, breaking the contact between E and $E^2$, and if the impetus given it be sufficient the tail of the flip will come in contact with $d^2$, thus establishing a circuit from screw-cup 1 to *d*, as before, thence through the tail of the flip-pin $d^2$ and high-resistance coil G to screw-cup 3 and out on the line again, the current being sufficiently reduced by the high-resistance coil to be perfectly harmless to any instruments in the line and yet sufficiently strong in the electro-magnet to hold the armature so long as the contact exists with the power-wire. When this contact is broken, the original circuit is re-established. It will be seen that by thus automatically throwing into the circuit an abnormal resistance I can so reduce an abnormal current as to render it perfectly harmless without permanently affecting the circuit. Moreover, the construction of the protector may be modified in many ways. It is not necessary, for example, that what has been called the "series-coil" H, which assists in magnetizing the electro-magnet, should be used, or, if used, that it should be in the divided circuit, the essential features of this mechanism being an arm and support, which are operated by an electro-magnet of comparatively high resistance, either to divert a current of dangerous potential through a safe channel or kill its dangerous effect in the coils of the electro-magnet, and when the source of danger is removed automatically are returned to their original position.

The armature above described I believe to be new with me. Its purpose is not to form part of a motor, but to move suddenly for the purpose of suddenly breaking an electrical contact and moving the electrodes against the force of a spring of possibly increasing tension. While both it and the attracting-surface of the poles of the magnet are curved, they are cam-like, as shown, and the armature is hung eccentrically to the centers of the various curves, so that the armature will approach nearer and nearer to the poles of the magnet by which it is being attracted and no part of it will move out of the magnetic field. Moreover, it is evident that instead of an arm attached to the armature and a support of exactly the kind above described other well-known means of making and breaking the circuit may be adopted to be actuated by the armature, which may itself form one of the electrodes.

I have used the term "diverted" to describe the course which the abnormal current takes when my invention is used. I mean by this term that the current is turned aside from its normal path, which is practically the normal circuit, and is driven through the high-resistance coil, which is so located as to be

available for that purpose. This of course cannot take place so long as the normal circuit in the protector remains closed.

What I claim as my invention is—

1. The protector above described, consisting of an electro-magnet having a coil of high resistance, with its armature and a movable arm and support, said arm and support being normally in electrical contact and in multiple with said electro-magnet, and said arm being connected to said armature, all as set forth.

2. The protector above described, consisting of an electro-magnet having a coil of high resistance, an armature carrying an arm, and a support, said arm and support being normally in electrical contact and in multiple with said electro-magnet, all as set forth.

3. In combination with an electric circuit containing a movable arm and a support normally in electrical contact, a circuit of comparatively high resistance in multiple therewith containing an electro-magnet provided with an armature adapted to operate said arm, all as set forth.

4. In combination with an electric circuit to be protected containing a movable arm and a support normally in electrical contact, a protecting circuit of comparatively high resistance in multiple therewith containing an electro-magnet provided with an armature adapted to operate said arm, a portion of the protected circuit being located to increase the efficiency of said electro-magnet during such time as said arm and support are in contact, all as set forth.

5. In a protector for reducing abnormal currents, in combination with a low-resistance circuit normally closed, an electro-magnet provided with an armature normally unattracted thereby, and a high-resistance coil arranged to receive the diverted current on energization of the magnet by an abnormal current.

6. In combination with an electro-magnet the poles of which are extended, an oscillating armature located between the extensions of said poles, the opposite surface of said extensions being curved eccentrically to the axis of the armature, and the general peripheral surface of the extremity of each radial arm of said armature being also curved eccentrically to said axis, as set forth.

7. In combination with an electric circuit, two circuit-breakers, each normally in electrical contact, in series therewith, and two coils of comparatively high resistance, each located in multiple with one of said circuit-breakers, and mechanism of substantially the kind described operated by said coils, whereby said circuit-breakers are caused to break and make said circuit, as described, all as set forth.

8. In a protector, an electro-magnet having a coil of low resistance, provided with an armature and a circuit breaker and closer normally closed and operated thereby, in combination with a secondary coil of high resistance located and electrically connected as described, whereby when the circuit through said circuit-breaker is closed said secondary coil is practically out of magnetic circuit with said armature and when the circuit through said circuit-breaker is open the secondary coil is thrown into magnetic circuit with said armature, as set forth.

In testimony whereof I have hereunto subscribed my name this 19th day of December, A. D. 1890.

WILLIAM H. CLAUSEN.

Witnesses:

JOS. W. LARISH,

GEORGE O. G. COALE.