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J. W. HOWELL.

ELECTRIC CURRENT INDICATOR.

No. 356,041. Patented Jan. 11, 1887.

Fig. 1

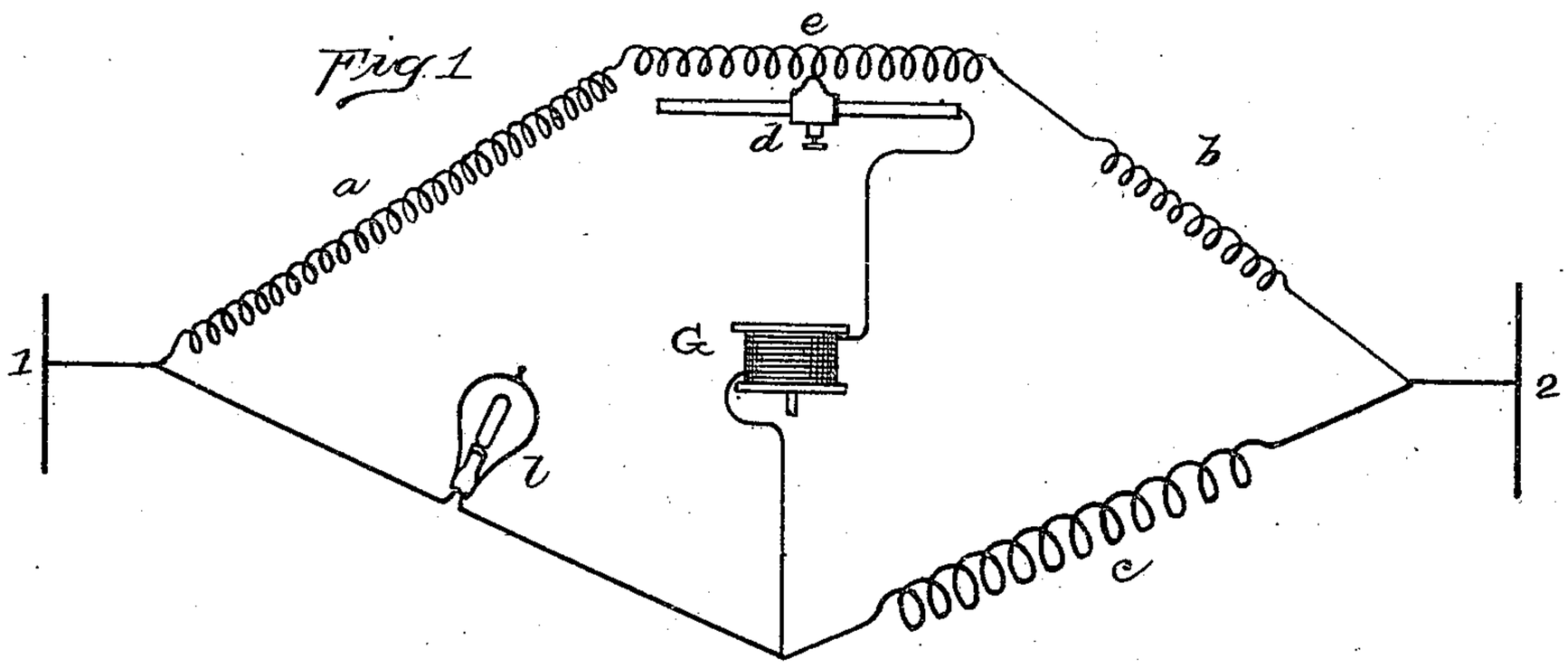


Fig. 2.

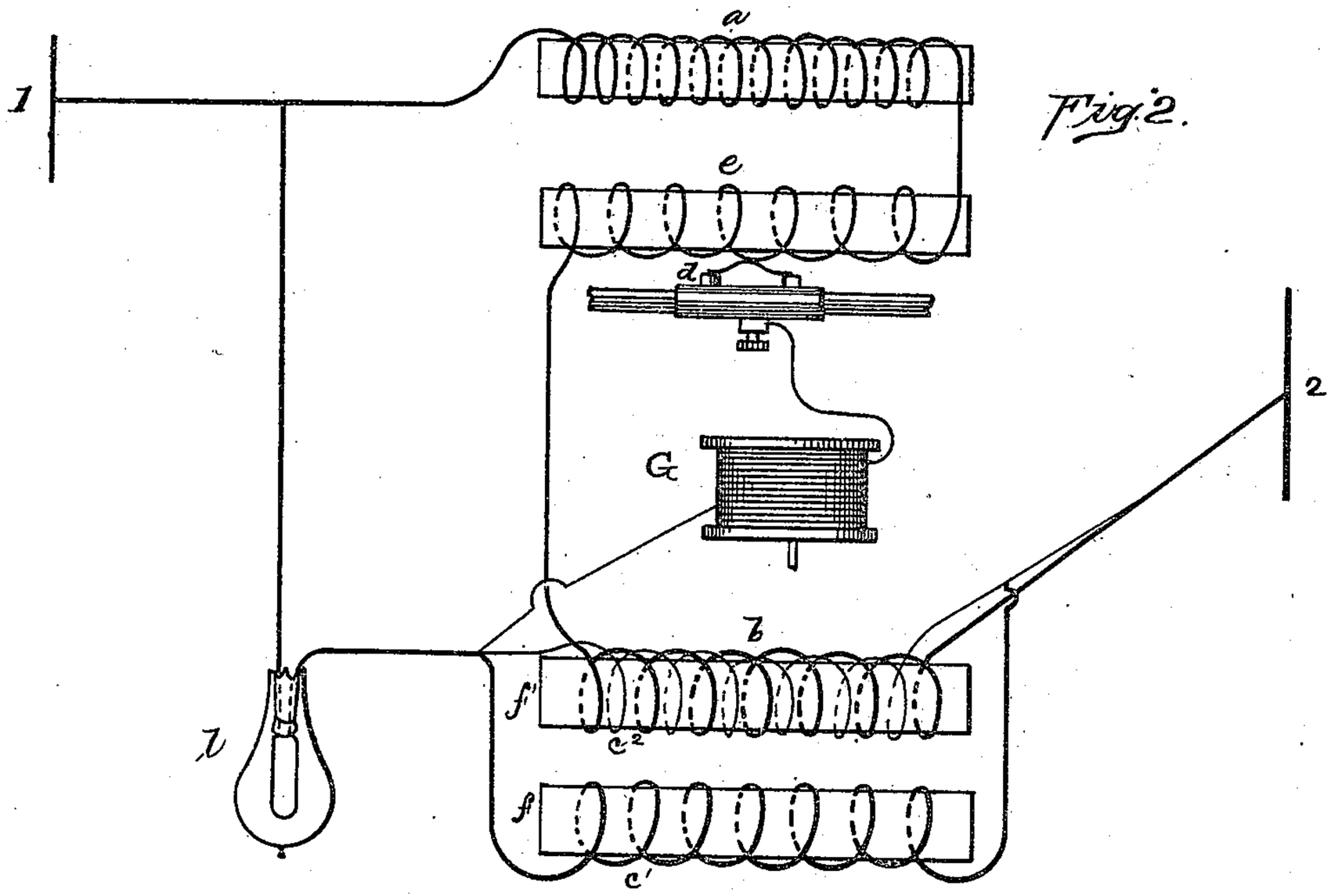


Fig. 3.

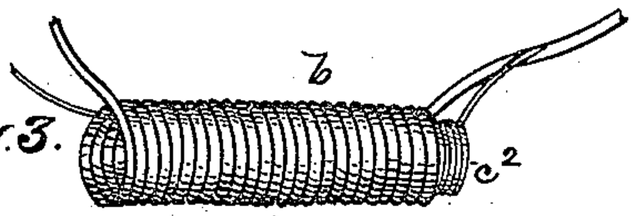
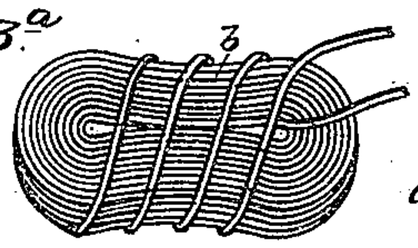


Fig. 3ª



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ELECTRIC CURRENT INDICATOR.

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Fig. 4.

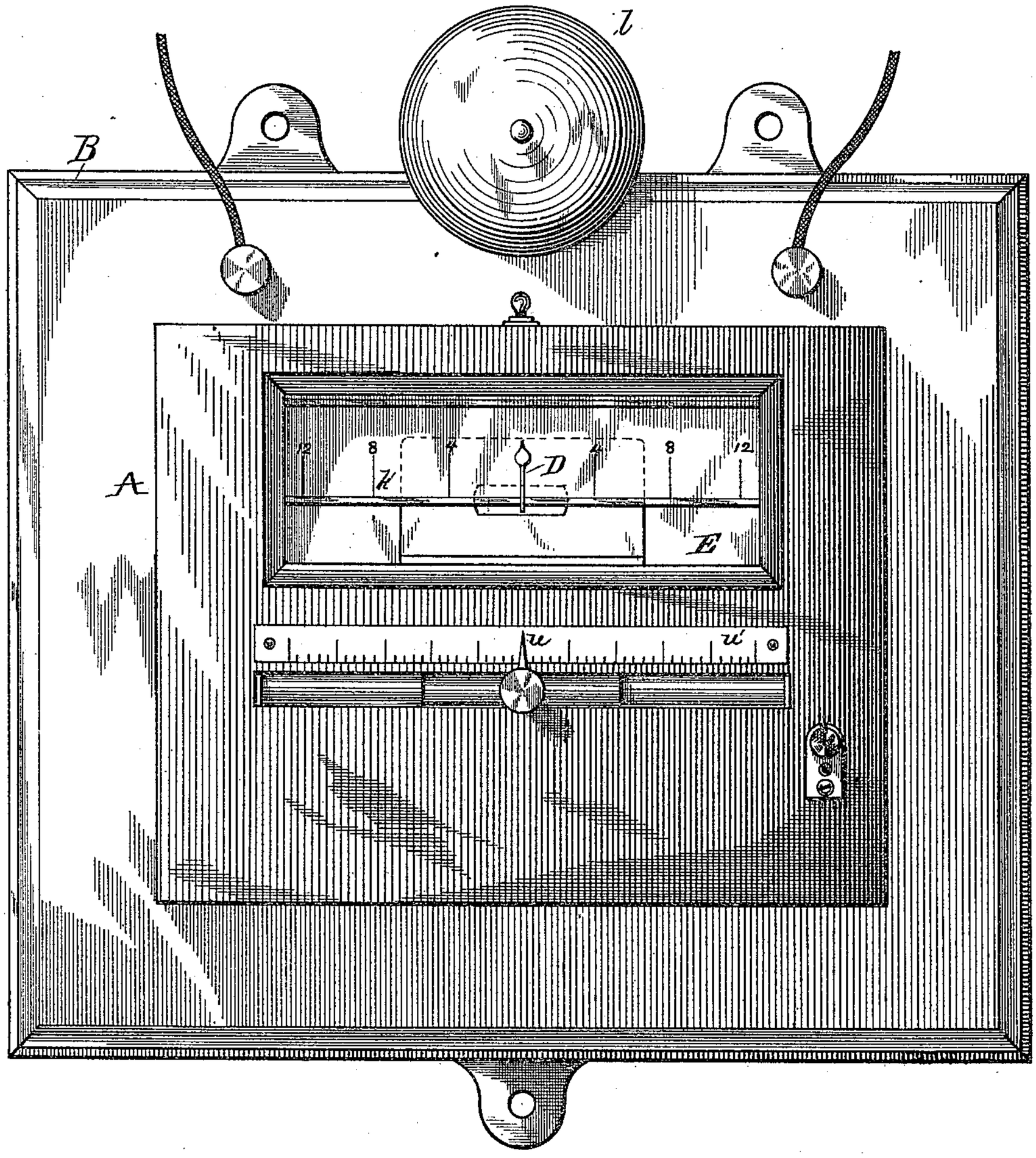

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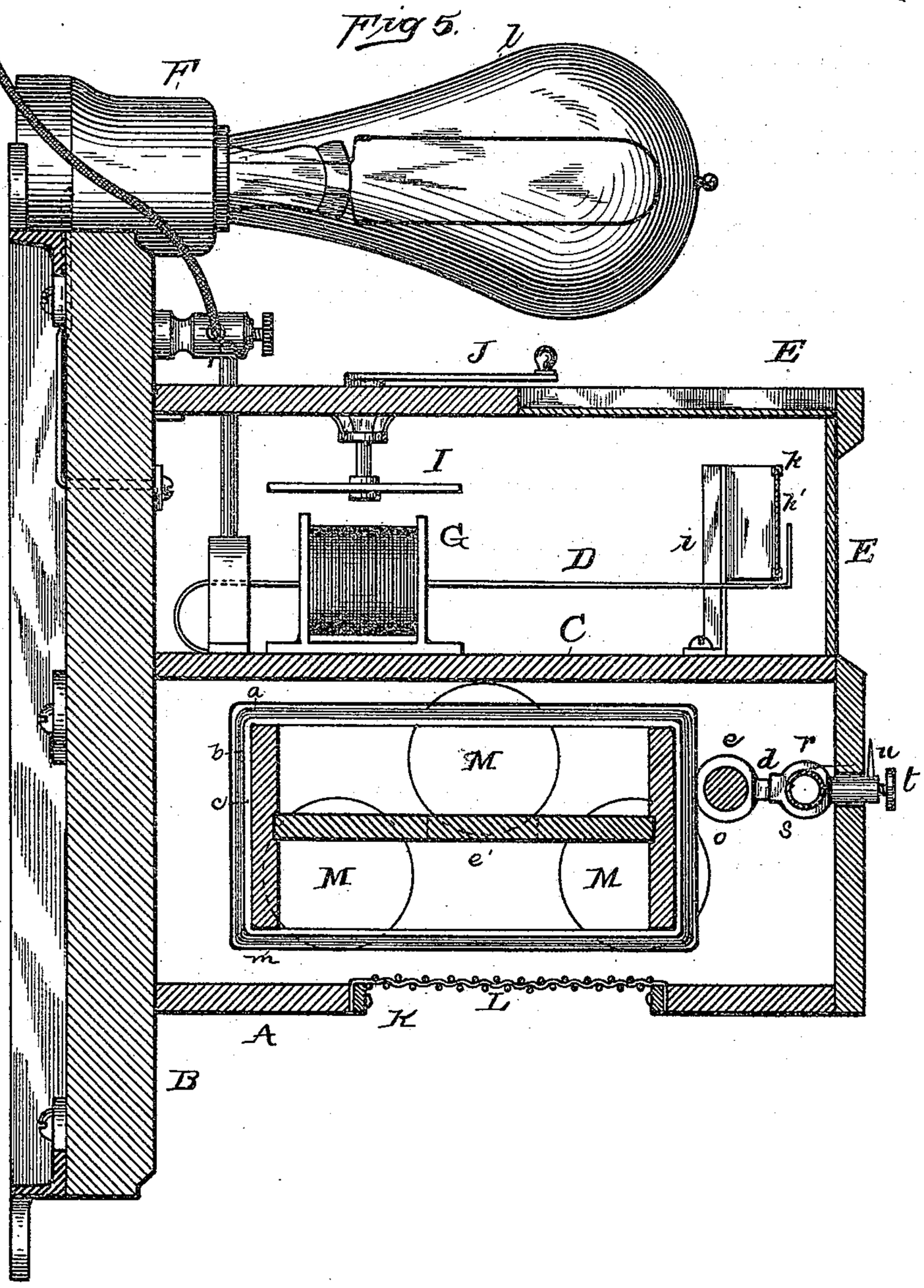
Fig 5.



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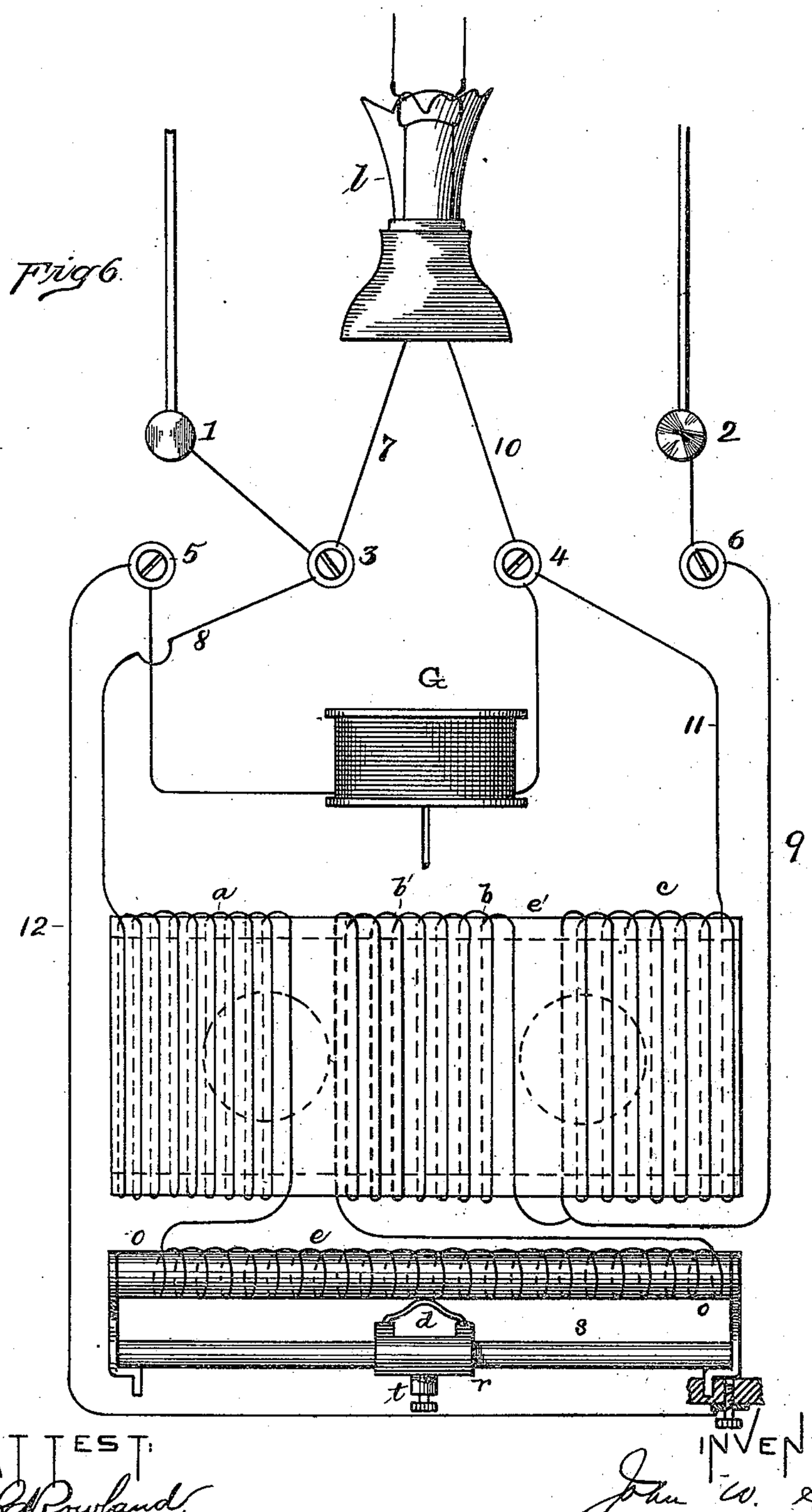
No. 356,041. Patented Jan. 11, 1887.

Fig 6.



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ELECTRIC CURRENT INDICATOR.

No. 356,041. Patented Jan. 11, 1887.

Fig. 7.

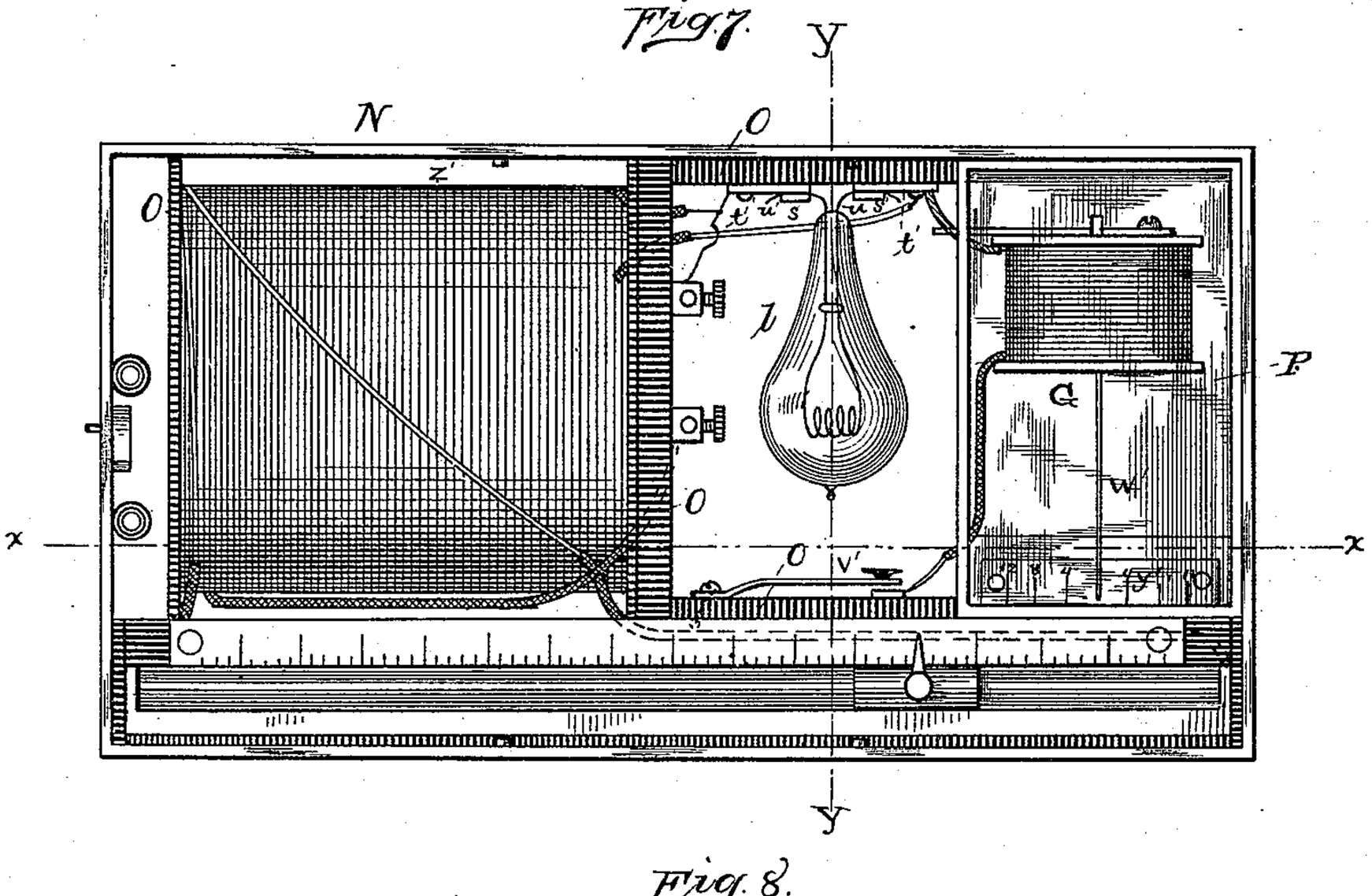


Fig. 8.

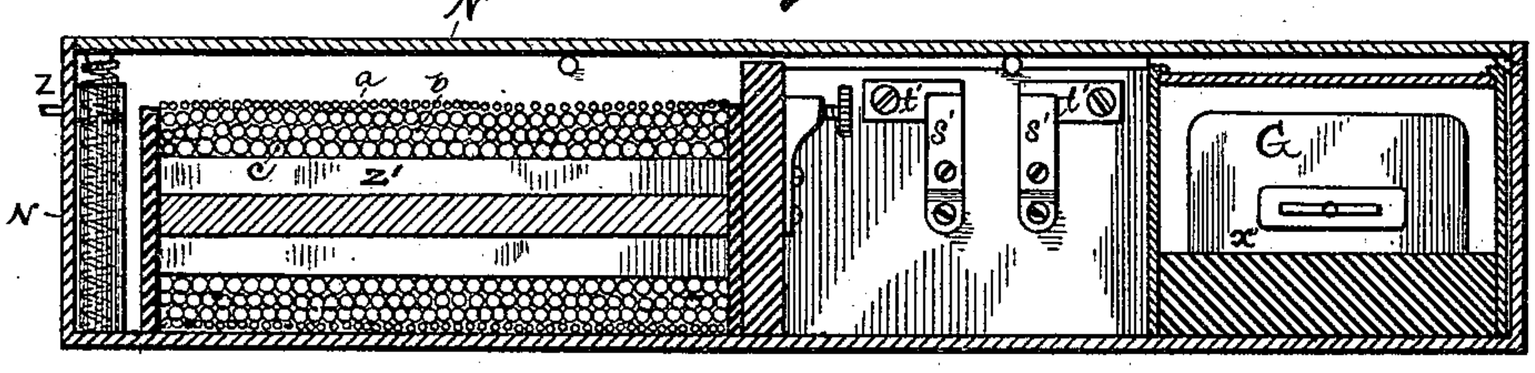
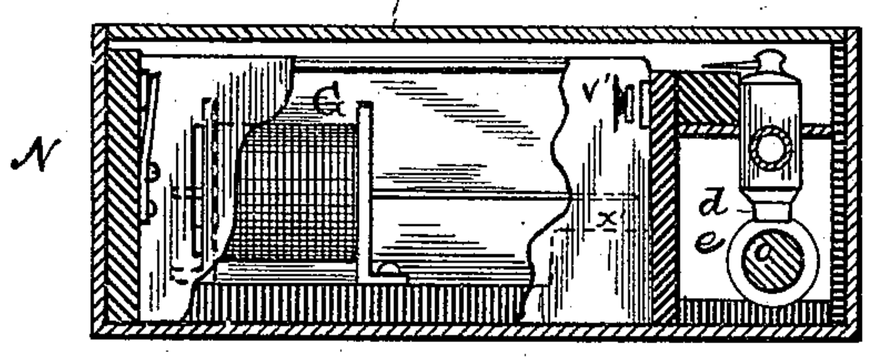


Fig. 9.



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UNITED STATES PATENT OFFICE.

JOHN W. HOWELL, OF NEW BRUNSWICK, NEW JERSEY.

ELECTRIC-CURRENT INDICATOR.

SPECIFICATION forming part of Letters Patent No. 356,041, dated January 11, 1887.

Application filed March 24, 1886. Serial No. 196,346. (No model.)

To all whom it may concern:

Be it known that I, JOHN W. HOWELL, of New Brunswick, in the county of Middlesex and State of New Jersey, have invented a certain new and useful Improvement in Electrical Indicators, of which the following is a specification.

My invention relates to certain improvements upon the electrical indicator set forth in my application filed December 24, 1885, Serial No. 186,653, my object being to increase the convenience, economy, and accuracy of that instrument; and my invention consists in the novel devices and combinations of devices employed by me in accomplishing this object, as hereinafter set forth and claimed.

My invention is illustrated in the annexed drawings, in which Figure 1 is a conventional diagram of the electrical portions of an instrument, illustrating the principle of operation thereof; Fig. 2, a diagram of an instrument, showing one of the arrangements for compensating for changes of heat, which forms part of my invention; Fig. 3, a view of one of the coils; Fig. 3ª, a view of a coil, illustrating a modified arrangement for effecting compensation; Fig. 4, a front elevation of an instrument embodying my invention; Fig. 5, a section of the same; Fig. 6, a diagram of the electrical arrangements thereof; Fig. 7, a top view, with the cover removed, of an instrument, also embodying my invention, designed as a pocket-instrument; Fig. 8, a section on line *x x;* and Fig. 9, one on line *y y* of Fig. 7 with the lamp removed.

My indicator operates upon the principle (covered by Patent No. 289,563,) of employing a resistance sensitive to changes of temperature, (an incandescent electric-lamp carbon,) and the construction employed is preferably that of the Wheatstone bridge—that is to say, my indicator has, as shown in Fig. 1, a high wire resistance, *a*, and a lower wire resistance, *b*, in one arm of the bridge, and an incandescing electric lamp, *l*, and a wire resistance, *c*, in the other arm, the galvanometer G being connected between such arms, and having a terminal, *d*, adjustable along a resistance-coil, *e*, situated between coils *a* and *b*. This apparatus is connected between the points 1 2 of a circuit whose electro-motive force it is designed to measure or indicate, it being adjusted for the standard electro-motive force. An electro-motive force above this standard causes an increase in temperature and a decrease in resistance of lamp *l*, and causes current to flow through the galvanometer, by whose indications the difference of electro-motive force may be determined. A decrease in electro-motive force causes a deflection of the galvanometer in the opposite direction.

The above is as described in the application already referred to. In the instruments constructed as described in that application, and in all other lamp-indicators, difficulty has arisen from the fact that when the instrument remains connected with the circuit the wire-coils continually increase in temperature from the current passing through them, (although the electro-motive force may remain constant,) and thus increase in resistance. The lamp, however, does not so increase.

When the bridge is balanced, the product of the resistances *a* and *c* is equal to that of *b* and *l;* but as the wire coils heat up, *a*, *b*, and *c* increase in resistance, and thus both factors of the product *a c* increase, and only one of product *b l*, and therefore the bridge is thrown out of balance.

I remedy this by so constructing or arranging the coil *b* that it will increase in resistance proportionately more than *a* and *c*, and *b l* is therefore kept equal to *a c*. One way of accomplishing this is shown in Figs. 2 and 3. The resistance-coils are all wound, as shown, upon suitable spools. Lamp *l*, coils *a b e* and galvanometer G are all connected in the same manner as in Fig. 1. The remaining coil is, however, divided into two multiple-arc or parallel parts, c' and c^2. Coil c' is of heavy wire, and is wound by itself upon one spool, *f*. c^2, which, preferably of the same resistance as coil c', is of finer wire, and hence heats more and is wound upon another spool, f', and above coil c^2 is wound the coil *b* in a close coil, as seen in Fig. 3. The effect of this is that the coil *c* helps to heat coil *b*, and therefore an additional effect is produced in coil *b*, and the changes of resistance are thus compensated for. The compensating effect may be pro-

duced by simply winding the coil *b* in a very close coil, as seen in Fig. 3ª, without making any change whatever in the other coils. Coil *b* will then heat more and increase more in resistance proportionately than the others. Where the greatest accuracy is not essential this method of compensation may be used alone.

The preferred arrangement for the purpose of compensation, however, is that which is shown in Fig. 5 and diagrammatically in Fig. 6. The main feature here is the winding of all the coils—except coil *e*—upon the same spool, so that they will all have and maintain practically the same temperature, and making the coil *b*, or preferably only a part of said coil, of a metal different from that of the other coils, and one whose resistance increases more under increased temperature than does that of the other coils. As it is best to employ German silver for the coils, I prefer, for the purpose of compensation, to make a part of coil *b* of copper, which answers the above-named conditions. In describing this arrangement in detail I will also describe the details of construction of the preferred apparatus shown in Figs. 4 5 and 6.

A is a suitable box or case, made principally of wood, having for its back a base-board, B, by which it may be attached to a wall or other support. The box has a partition, C, upon which rests the galvanometer G, whose pointer D extends out in front of a scale arranged as follows: Supports *i*, rising from partition C, carry a brass frame, *k*, which holds the paper strip *k'*, made of a thin translucent paper, on which the divisions of the scale are marked. A portion, E E, of the top and front of the box is made of glass. The lamp *l*, which is one of the resistances of the indicator, is held in a socket, F, supported upon base B, and extends out horizontally above the top of the box. Its light therefore shines through the glass top of box upon the back of the scale and through the same, so that the pointer and scale can be readily observed through the glass at the front of the box, and can be seen more clearly and from a greater distance than with the arrangements heretofore in use. The wire coils *a*, *b*, and *c* are all wound upon a frame, *e'*, supported from the sides of the box, one set of coils being wound upon another, as shown, and the whole may be, and preferably is, in small compact instruments wrapped with a covering, *m*, of asbestus paper or other non-heat-conducting substance. All the coils are thus kept at the same temperature. The coil *e* is wound separately upon a rod, *o*, and upon one side has its insulation filed off to form a bare surface, along which travels spring *d*, carried by sleeve *r* upon rod *s*, and moved by screw *t*, passing through a slot in the front of the box, which may carry a pointer, *u*, moving across a scale, *w'*, above the slot to show position of the moving contact. This construction is fully set forth in the application above referred to.

I is the device for compensating in the galvanometer for the earth's magnetism. This is a well-known device, consisting of a permanent bar-magnet, which is adjustable, so that the galvanometer-needle may be made to stand at zero in whatever position the instrument may be placed. It is adjustable by a handle, J, outside the box. In the bottom of the box is an aperture, K, covered with wire-gauze L, and in the sides of the box are other apertures, M M. These assist in keeping the apparatus cool.

The connections are clearly shown in Fig. 6. Here the coils *a b c* are, for clearness of illustration, shown as wound separately upon the reel. The circuit-conductors are connected to binding-posts 1 2 on the base-board. Four binding-posts, 3 4 5 6, are provided within the box. From post 3, which is connected directly with 1, a wire, 7, extends to lamp *l*, and a wire, 8, to coil *a*. From coil *a* connection is through coil *e*, and then through coil *b* to wire 9, which goes to post 6, connected with terminal 2. The other terminal of lamp *l* is connected by wire 10 with binding-post 4, from which wire 11 goes to coil *c*, whose other extremity is connected with 9.

The galvanometer is connected between posts 4 and 5, and from post 5 a wire, 12, extends to a screw, *v*, which passes through the front of the box and sets against the metal end piece *w*, which suports rods *o* and *s*. This makes spring *p* the terminal of the galvanometer-circuit movable upon coil *e* to balance the bridge.

A portion, *b'*, of coil *b* is made of copper, all the rest of the coils being of German silver. The object of this arrangement has been already fully explained.

A further great advantage of compensating for changes in resistance due to heat, and also specifically of winding all the coils upon a common spool or frame, is the additional compactness of the apparatus. This has enabled me to make what has never been produced before—an instrument of such small size that it can be carried in the pocket, and by which the indications necessary in electric lighting systems are readily made.

N is a flat metal box having a lid or cover, N', held by a spring-catch, *z*. The coils *a*, *b*, and *c* are all wound upon a common frame, *z'*, in the same way as above described. All the metal conducting parts are supported upon cushions of rubber O, or other suitable insulating material. The galvanometer G is placed in a compartment at one end of the box, covered with glass P. Its pointer *w'* plays above the scale *y'*, which is placed upon a raised portion, *x'*, in the bottom of the box. Coil *e* is upon a rod, *o*, and contact-spring *d* travels upon the bared side of said coil, as hereinbefore explained. A key, *v'*, is provided to open and close the galvanometer-circuit.

The lamp *l* is one of small size, and its terminal wires are held upon contact-plates *t' t'* by spring-clips *s' s'*.

This instrument is shown in full size in the

drawings. It will be seen that it is very small and compact, and at the same time equally effective with the larger instrument.

What I claim is—

1. An electrical indicator of that class which operates by the changes in resistance of carbon and metal resistances under variations of temperature provided with a heat-compensating resistance, substantially as and for the purpose set forth.

2. In an electrical indicator of that class which operates by the changes in resistance of carbon and metal resistances under variations in temperature, the combination, with wire coils of one kind of metal, of a wire coil of other metal which increases more in resistance with increased heat, substantially as set forth.

3. In an electrical indicator of that class which operates by the changes in resistance of wire and carbon resistances under variations of temperature, the combination, with wire coils of the same metal, of a coil composed partly of that metal and partly of one which increases more in resistance with increased heat, substantially as set forth.

4. In an electrical indicator of that class which operates by the changes in resistance of wire and carbon resistances under variations of temperature, the coils *a*, *b*, and *c*, all wound on the same spool or frame, substantially as set forth.

5. In an electrical indicator of that class which operates by the changes in resistance of wire and carbon resistances under variations of temperature, the coils *a*, *b*, and *c*, all wound upon the same spool or frame, coil *b* being arranged or constructed so as to increase more in resistance with increased heat than the other coils, substantially as set forth.

6. In an electrical indicator of that class which operates by the changes in resistance of wire and carbon resistances under variations of temperature, the coils *a*, *b*, and *c*, all wound upon the same spool or frame, said coils *a* and *c* being of the same metal, and said coil *b* being partly of that metal and partly of one which increases more in resistance with increased heat, substantially as set forth.

7. In an electrical indicator of that class which operates by the changes in resistance of wire and carbon resistances under variations of temperature, the combination of the box or case, the scale within same composed of transparent or translucent material, the lamp outside the case, and the glass pane through which the light shines upon the back of the scale, substantially as set forth.

This specification signed and witnessed this 16th day of March, 1886.

JOHN W. HOWELL.

Witnesses:
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CHAS. A. GUNDAKER.