(No Model.)

G. H. E. TROUVELOT.

INDUCTION COIL.

No. 273,643. Patented Mar. 6, 1883.

Fig. 1.

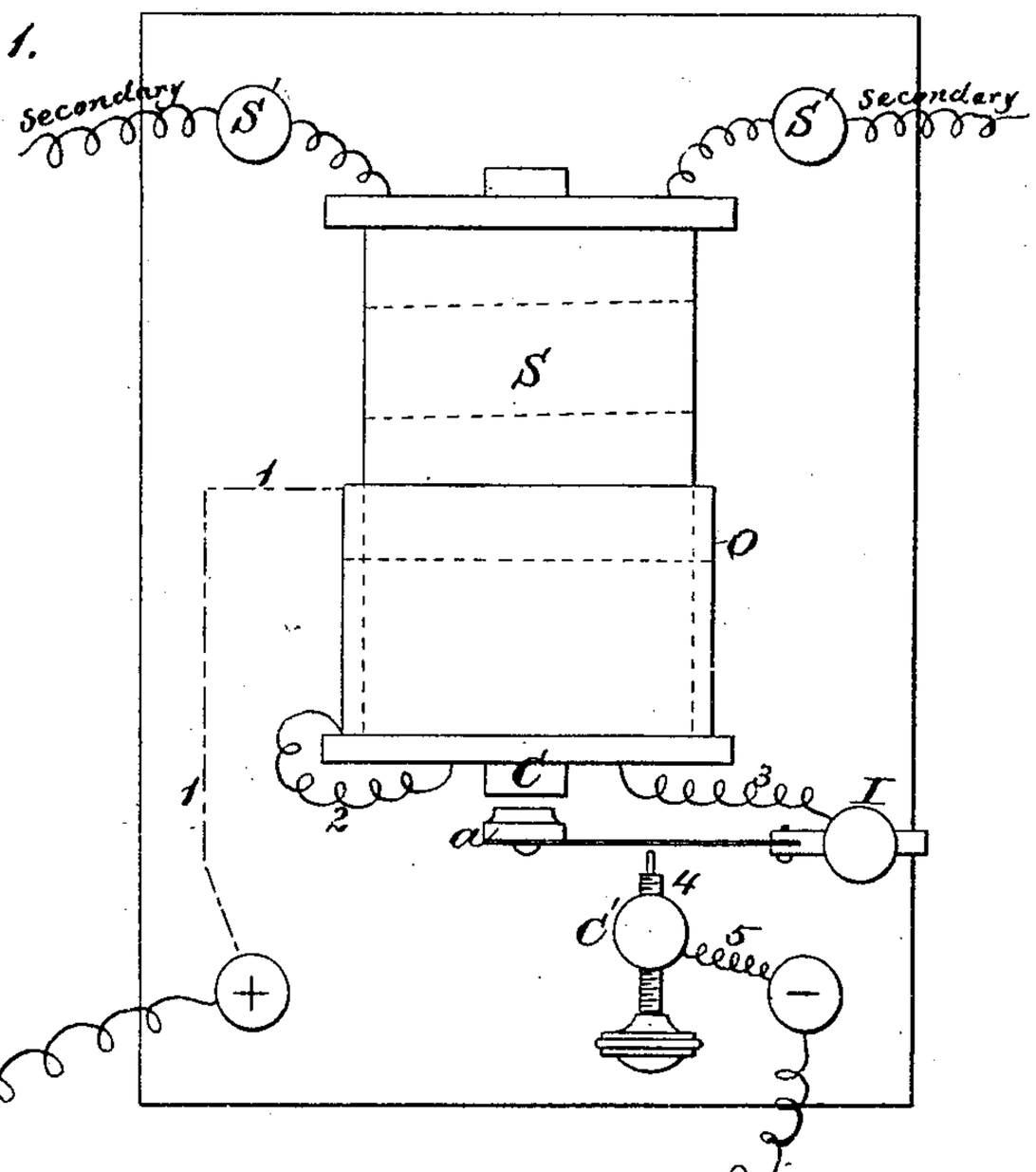
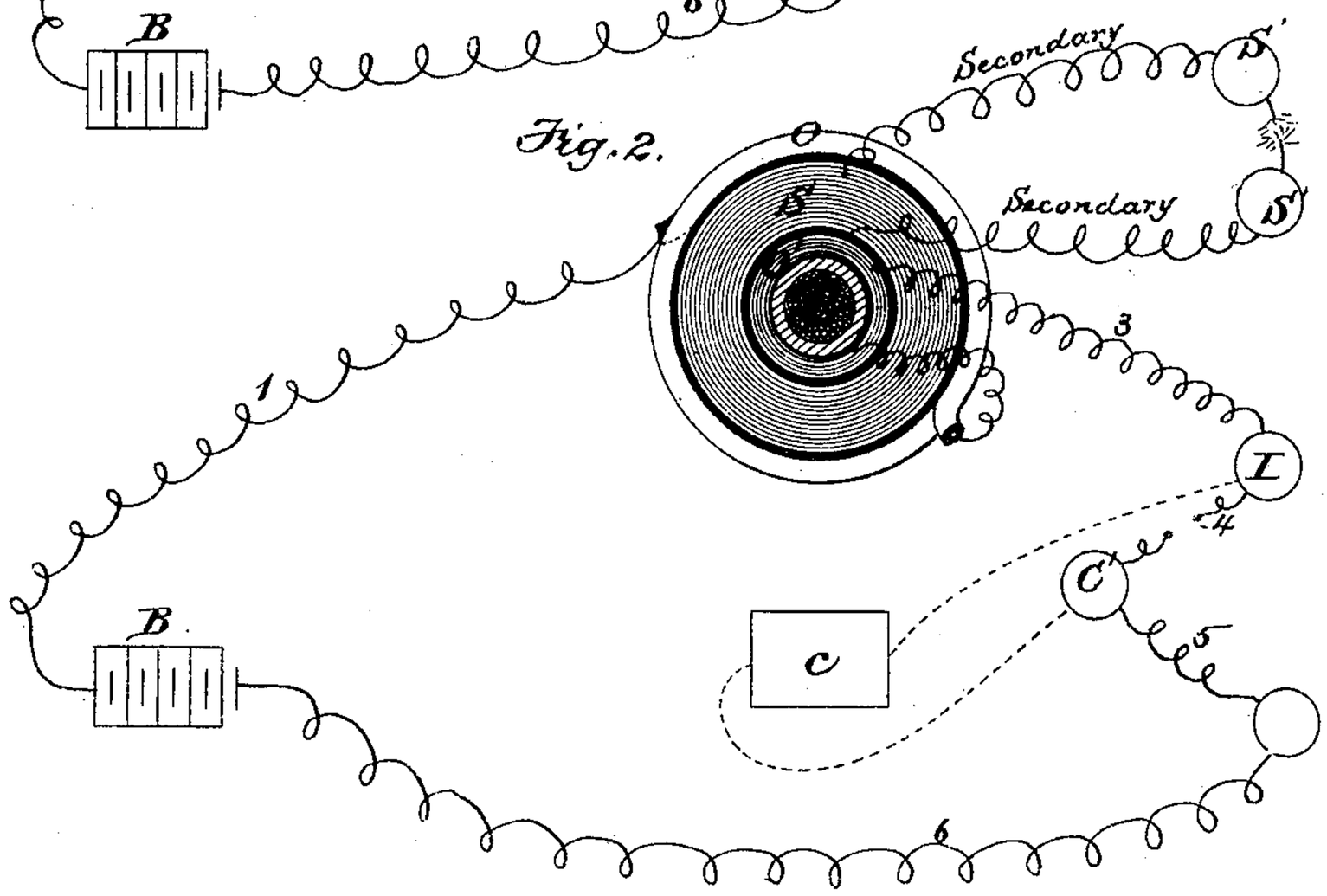


Fig. 2.



Witnesses:
Joseph Leitch
W. J. Thorton

Inventor:
Geo H. E. Trouvelot
by Wright Brown
Attys

UNITED STATES PATENT OFFICE.

GEORGE H. E. TROUVELOT, OF CAMBRIDGE, MASSACHUSETTS, ASSIGNOR TO HIMSELF AND E. B. WELCH, OF SAME PLACE.

INDUCTION-COIL.

SPECIFICATION forming part of Letters Patent No. 273,643, dated March 6, 1883.

Application filed May 8, 1882. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. E. TROUVELOT, of Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Induction-Coils, of which the following is a specification.

My invention has for its object to provide an induction-coil in which a primary current of a given electro-motive force will yield a secondary current of higher tension than in any induction-coil heretofore used, and in which a current of a given high tension can be transformed into a current of greater quantity than heretofore.

To these ends my invention consists, as a whole, in an induction-coil having its primary circuit composed of an outer and an inner coil, forming parts of the same circuit, and a secondary circuit interposed between said inner and outer portions of the primary circuit, as I will now proceed to describe.

Of the accompanying drawings, forming a part of this specification, Figure 1 represents a plan view of a form of induction-coil embodying my invention, and Fig. 2 represents a transverse section of the coil and a diagram of the connections.

The same letters of reference indicate the same parts in all the figures.

In the ordinary inductorium, as heretofore constructed, there have always been two distinct circuits in the coil—viz., the primary and the secondary—one of these being wholly within the other, excepting, of course, its terminals, it being immaterial whether the primary or the secondary circuit is the inner one. The primary circuit always consists of a wire of low resistance, as compared with that of the secondary circuit, when a tension-induced current is to be produced.

In carrying out my invention I make the primary circuit in two parts or sub-coils, O O′, one of which, O, is placed outside of and the other, O′, within the secondary coil S, as shown in Fig. 2, both of said parts forming a part of the same circuit. The line or course of propagation of the current from, say, a galvanic battery, B, through the outer and inner parts, O O′, is indicated by the figures 1, 2, 3, 4, 5, and 6, the wire 2 connecting the parts O O′. The circuit is opened and closed at the juncture of the armature *a* and the screw-contact fitted into the post C′. In the screw-cups *s′ s′* are the terminals of the secondary circuit.

C represents the iron or steel core of the induction-coil.

I represents the armature-post, and C′ the screw contact post. Between these the wire 4 is represented in Fig. 2 as broken, to indicate the location of the armature. The posts I and C′ may be connected each respectively to a terminal of a condenser, *c*, if one is used. This latter needs no further explanation than that it may be either an intensity or quantity condenser.

The portions O O′ are suitably insulated from the interposed secondary coil, and the outer portion does not necessarily cover the entire length of the coil, as shown in Fig. 1.

To elucidate my improvement as clearly as possible, I will first describe the operation of an ordinary induction-coil.

When a current of electricity is made to course through the primary wire of an ordinary induction-coil, the core becomes magnetized. The adjacently-situated iron armature forming part of the rheotome is thereby forcibly attracted to it, and owing to this mechanical action the normal primary circuit is opened, the core loses its state of magnetization, the mutual attraction between the core and armature practically ceases, and owing to the resilient action of the spring-bar or other retracting device the armature resumes its original position of rest against a contact and the circuit is again closed, the same modes of action recurring. During these actions in the primary circuit induced currents are set up in the secondary circuit. Thus at the opening and closing of the primary currents by induction there are produced secondary currents of an inverse order. These last are the same in quantity, but not in length. The duration of the direct induced currents is always less than that of the inverse currents, and it is owing to this that the former are capable of overcoming greater resistances than the latter. The difference in duration between these two kinds of currents is due to the influence of the extra currents which are engendered at each opening and at each closing of the inducing-current. When the primary circuit is closed

an inverse extra current is produced in the secondary circuit. Consequently this latter circuit is subjected at this instant to a double influence—viz., to that of the battery-current and to that of the inverse extra current. The first of these currents equally engenders an inverse extra current. The second, at the instant it commences, also develops an inverse current in this same secondary circuit, and at its moment of cessation a direct current. Moreover, the first current engendered by the extra current is in a direction contrary to the inverse current developed by the action of the battery-current, and it therefore diminishes the intensity of the inverse current in question. As to the second current induced by the extra current, its direction will be the same as the inverse current due to the inducing one, and as it is produced almost instantaneously after this last inverse or indirect current, everything takes place as if this latter were really prolonged.

It is thus seen that the inverse extra current which is engendered at the closing of the primary circuit must diminish the tension of the inverse current in the secondary circuit, and that this is the case is proven by experiment. The direct extra current which is formed when the inducing-current is interrupted acts upon the induced or secondary circuit like unto the inverse extra current, but with a very much less degree of intensity, because, the inducing-current being open at the moment of its formation, it cannot establish itself freely in this circuit, as does the inverse extra current which is developed when the circuit is closed. It then results from this that the duration of the direct induced current in the secondary wire must be less, and as a consequence its intensity greater, than that of the induced inverse or indirect current in the same wire. In order to give the direct induced current the greatest possible intensity, it is necessary to suppress, or at least to considerably enfeeble, the direct extra current by the use of a condenser, as usually known.

I have found by practical tests that by my improved arrangement of the circuits previously described I obtain a valuable increase of the tension of the induced current over that produced by the ordinary coil, and enhance the value of the induced current, as I will now explain.

In the original embodiment of my invention I placed the usual coarse primary within the fine secondary wire, and outside of this latter I wound the outer portion, O, of the primary circuit, consisting of a wire much coarser and in that case shorter than the inner primary one, and forming part of a continuous circuit from the battery through the inner primary coil. The current would first traverse the low-resistance outer primary, and thence the inner primary and interrupter to battery again, the effect being to not only reduce the size of the spark produced between the screw-contact and the armature spring-bar at the instant of opening the circuit, but also at the same time to increase the spark produced between the terminals of the secondary circuit. I also found that if the secondary be closed by the hands and body of the experimenter, for example, the simple intercalation of but a few feet of wire as the outer portion of the primary circuit, in the manner described, would produce "shocks" of very much greater intensity. It therefore appears that by my invention the disruptive discharge at the interrupter is avoided to a great extent, and that this usual waste of energy is practically utilized in producing an advantageous effect in the secondary circuit.

My theory or explanation of the improved result of my invention is this: The current exerts its influence first upon the outer layers of the secondary circuit, and thus starts the propagation of the induced extra current, so that by the time it is fully under way (necessarily there must be a wax and wane, representable by an ordinate and abscissa curve) the influence is exerted from within the inner primary outward. This prolongs the inverse current, which as ordinarily is much shorter, and tends to raise its tension, inasmuch as there is evidently greater absorption of electrical energy from the primary to the secondary, as evinced by a diminution of the disruptive spark at the instant of opening the battery-current. Thus, owing to the prolongation of the inverse current and the rate of interrupter vibrations, or, in other words, the recurrence of the same actions, there is an approach to a coalescing or union of the inverse and direct currents, as also a tendency to raise the tension in general. On the opening of the inducing-circuit, for like reasons, the direct extra current is also lengthened, so that the influence of the primary current is exerted longer, and therefore produces the effects described. Inversely to these phenomena, if a high-tension current is sent through the fine secondary wire, an induced current is engendered within the primary wire; but this latter has the quantity attribute. This quantity quality of the induced current is increased by the use of my principles of construction. The wire of the outer portion, O, of the primary circuit should be wound in the same direction as that of the inner portion, O', to produce the best results.

In case it be desirable to have the induced current in the secondary wire sent on several independent circuits, the said secondary wire may be divided into any number of separate helices, as shown in dotted lines in Fig. 1. I have found that the best conditions exist when the wire of the outer primary portion is of a coarser gage than that of the inner primary. In fact, it would appear that there exists a mathematical ratio between the gages of the two coupled wires and their lengths in order to secure the best results. I have obtained an excellent effect by using an inner primary of No. 28 gage to an outer primary of No. 14 gage, the lengths being respectively forty feet and

three feet; but an outer primary consisting of two sections has also been used, the first of coarse and the other of finer wire, each being found capable of reproducing the phenomenon as described, but in different degrees. Hence I do not limit myself to any particular number of wires or helices in either part of the primary circuit, nor to any particular size or sizes of wire.

The principles of construction of my improved inductorium are applicable to telephonic apparatus, and also to all such apparatus as necessitate the use of an induction-coil. The applicability of said invention I do not limit or restrict to the ordinary induction-coil employing an interrupted current originated by the action or use of a rheotome, as it may be used in induction-coils employing any kind or class of electrical and magnetic currents.

I claim—

An induction-coil having an inner and outer primary helix included in the same circuit and inclosing the secondary coil or coils, the outer primary helix being of shorter and thicker wire than the inner portion of the same circuit, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 26th day of April, 1882.

GEORGE H. E. TROUVELOT.

Witnesses:
C. F. BROWN,
A. L. WHITE.