(No Model.) 2 Sheets—Sheet 1.

E. THOMSON.

APPARATUS FOR REMOVING INDUCTIVE EFFECTS FROM ELECTRIC LINES.

No. 454,890. Patented June 30, 1891.

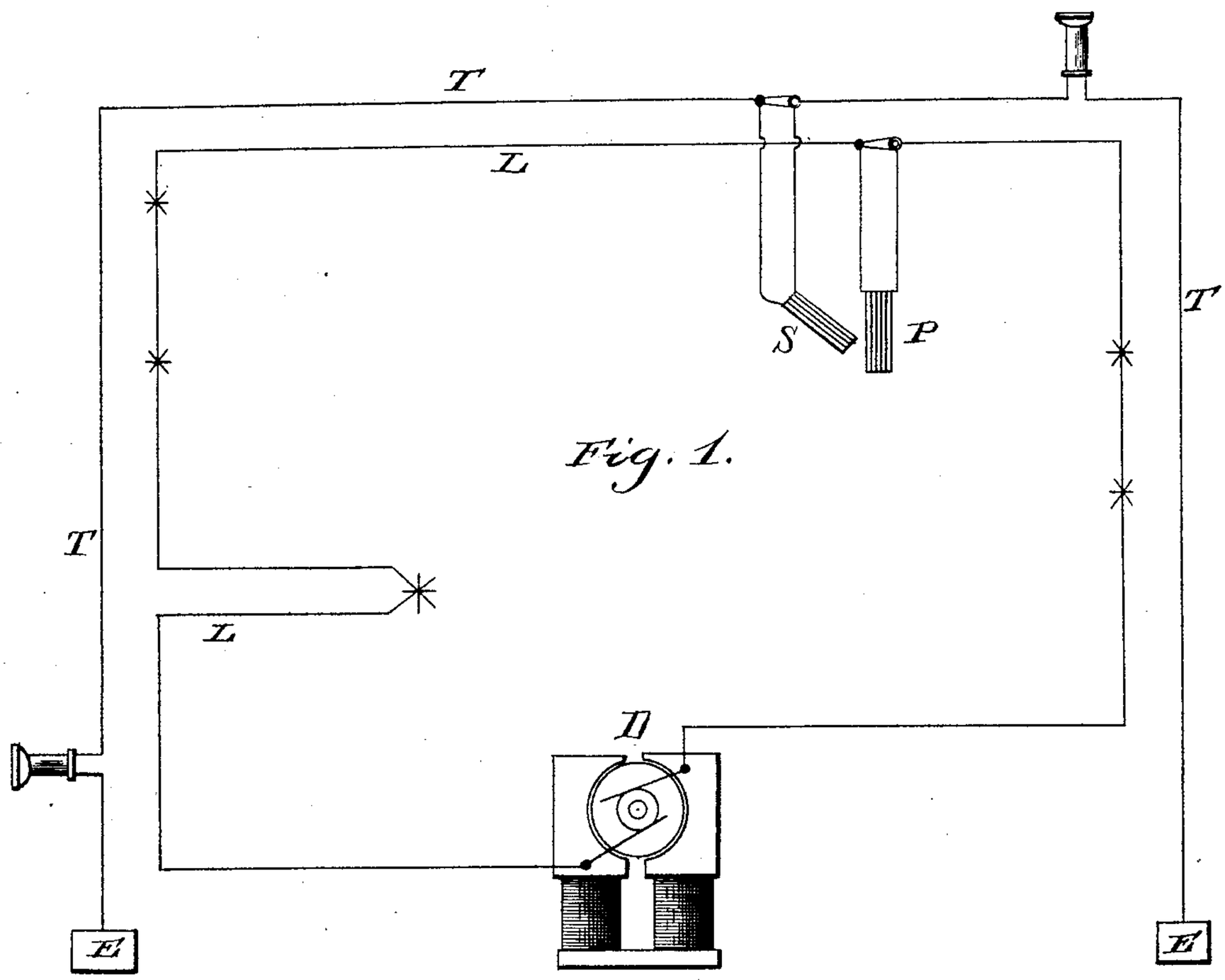


Fig. 1.

Fig. 2.

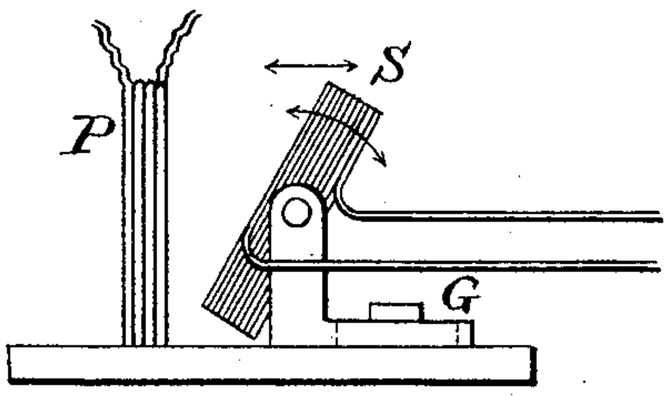
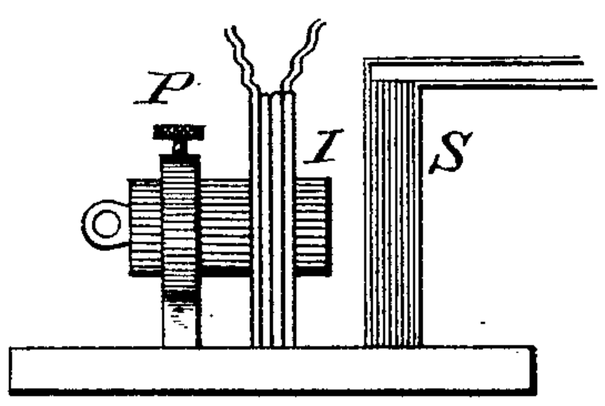


Fig. 3.



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(No Model.) 2 Sheets—Sheet 2.

E. THOMSON.

APPARATUS FOR REMOVING INDUCTIVE EFFECTS FROM ELECTRIC LINES.

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Fig. 7.

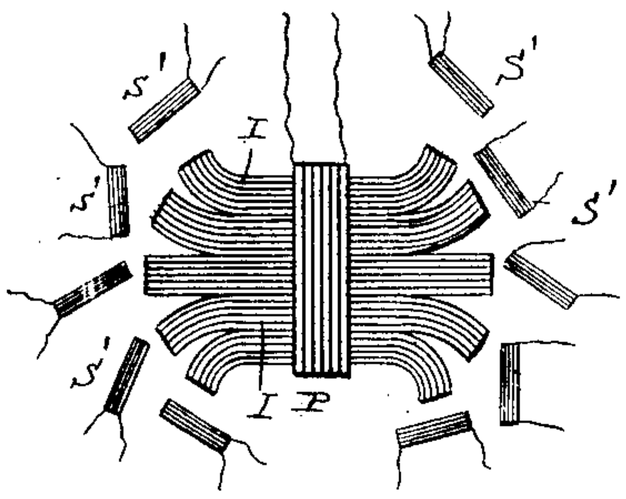


Fig. 4.

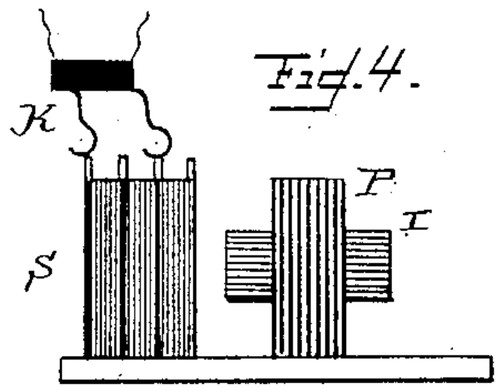


Fig. 9.

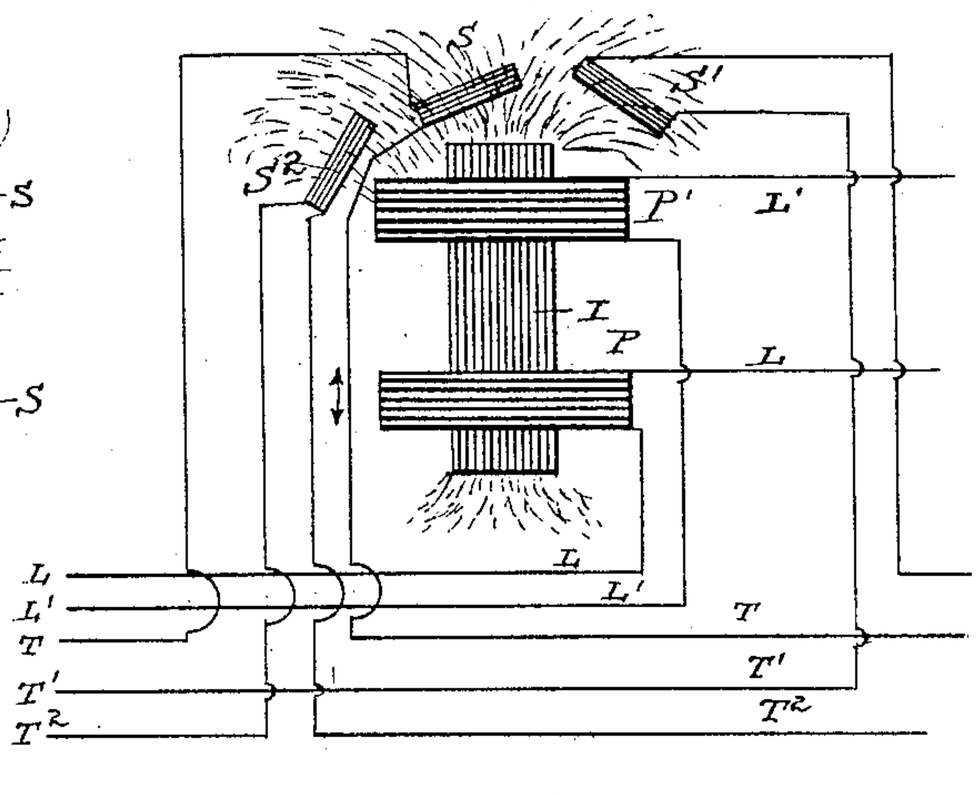


Fig. 8.

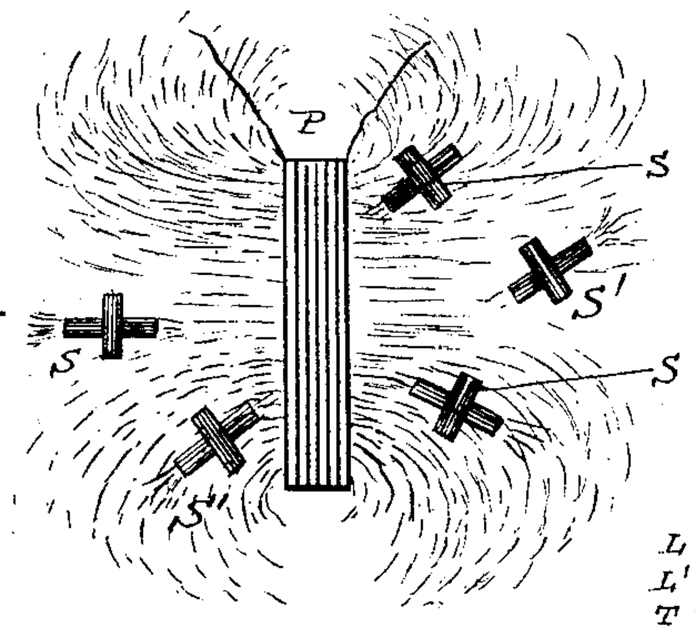


Fig. 6.

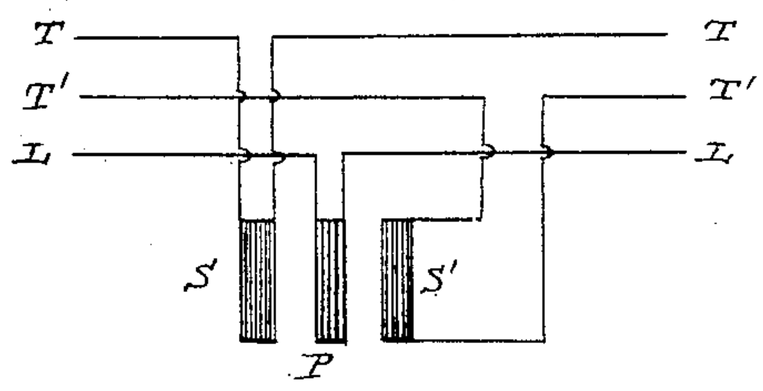
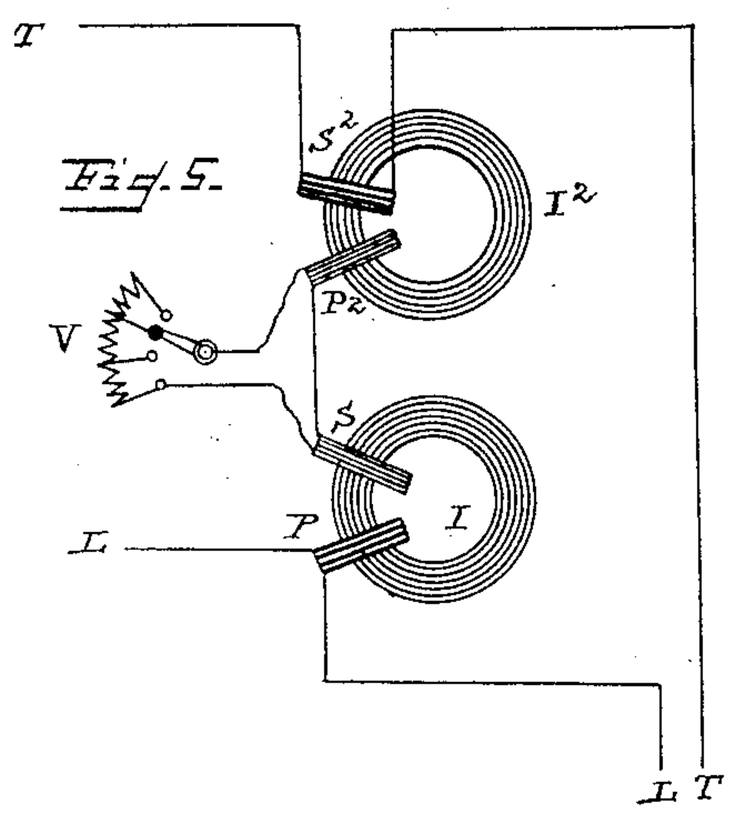


Fig. 5.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR REMOVING INDUCTIVE EFFECTS FROM ELECTRIC LINES.

SPECIFICATION forming part of Letters Patent No. 454,890, dated June 30, 1891.

Application filed April 8, 1889. Serial No. 306,386. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented a certain new and useful Apparatus for Removing Induction Effects from Electric Lines, of which the following is a specification.

My invention relates to that class of devices by which harmful effects of induction on any electric line produced by another may in a large measure be removed and nearly obviated. It is especially applicable to removing the effect on telephonic systems of induction from electric-lighting lines running parallel thereto over considerable spaces, which induction may rise to an amount making the use of the telephonic lines difficult and troublesome.

My present invention is designed as an improvement on that method of compensating for the induction of one line upon another in which the removal of the inductive effects of one circuit or line upon another is attained by establishing in another portion of circuit, taking the form of a coil, a counter-induction equal to the induction of the lines themselves one on the other. To carry out this plan it is only necessary to insert into the line receiving the harmful induction a coil which is magnetically related or inductionally related to another coil in the line itself producing the trouble to adjust the angular positions of the two coils with respect to each other, or their distance apart, or both, or the amount of iron which is inclosed by them, or by both of them, or the portion of the magnetic circuit which traverses one of them, or both of them, until the desired amount of counter or inverse induction takes place, which balances the induction originally found. It is necessary, of course, that the connections be so made that an impulse inductively set up shall be met by a reverse or opposite impulse also inductively set up. One of these impulses, however, is that which is due to the long lines in parallelism on poles or in conduits, and the other is that due to the adjustment of the inducing-coils one to the other. It is not essential that the coil in the telephonic or other circuit be directly related inductively to the balancing-coil in the electric-light circuit or inducing-circuit, as it is sufficient to have the electric-light circuit act upon an induction apparatus as a primary whose secondary is connected as a primary for another induction-coil whose secondary in turn is in the telephonic circuit. Currents of secondary, tertiary, or other induction may therefore be employed, provided that the reflection, as it were, of the impulses of one circuit into the other is not attended by an irregular displacement of phase or lag or correspondence in time of the impulses, so that they cannot be brought into harmony for counteracting each other.

The general object of my invention is to obtain a compensation for the induction from one line to several others in a simple and effective manner without in so doing causing one of the affected lines to induce currents upon another affected line or lines. Thus in the case of two telephone-circuits affected by an electric-light wire my invention permits the induction of the electric-light wire upon both telephone-wires to be eliminated without causing induction from one telephone-wire to another.

My invention consists, essentially, in setting up a counteracting field of induction, which operates upon both telephone-circuits, each of which latter is arranged in a different portion of the field of counter-induction, but in position not to induce upon the other.

My invention consists, also, in certain other improvements, to be first described, and then specifically stated in the claims.

In the accompanying drawings, Figure 1 illustrates a simple case of induction between a telephone-line and an electric-light line compensated by a counter-induction adjustable in accordance with one part of my invention. Figs. 2, 3, 4, and 5 illustrate ways of varying the counter-induction. Figs. 6, 7, 8, and 9 are diagrams illustrating my present invention.

In Fig. 1 the line T T T represents an ordinary telephone-line, which lies parallel to a line L L L either along a part or the whole of its course. The line in the electric-lighting circuit is one in which fluctuations or alternations occur in the current supplied from a generator or source D. In the telephone-line are the ordinary instruments of any pattern. Under the circumstances the electric-light

line will influence the telephone-line inductively, and if the lengths of wire which are parallel are sufficient may give rise to some trouble in the use of the telephonic instruments. Looped into the electric-light line at any convenient point is the coil P, of moderate dimensions or comparatively small number of turns, according to the strength of the current and the induction which it is expected to balance. Placed near it, either parallel to it or at an angle with its axis, is a coil S, generally of much finer wire, and including with it the telephone-circuit T as a loop. By adjusting the relative angular positions of the coils S and P with respect to each other while listening at a telephone in the telephone-line a counter-induction may be set up equal to that which is produced on the main line, thus producing silence in the telephonic circuit.

Fig. 2 shows a simple arrangement for adjustment of the coil P as mounted in a vertical plane on a base, while the coil S is mounted on an axis which permits it to be turned at any angle with the plane of P, and a slotted slide at G permits its approach and recession, as needed, from the coil P. The coil S may in fact be arranged to be inverted, so as to insure the correct direction of its impulses. The adjustment so provided makes it easy to balance inductions found to exist, provided the coils P and S are of sufficient size or magnetizing-power relatively. Very small coils are, however, capable of overcoming the induction, and may be made smaller still if one or both of them are provided with an iron core.

Fig. 3 shows the coil P provided with an adjustable iron core I or an iron-wire bundle, which can be moved through the axis of the coil P toward and from the coil S, thereby modifying the inductive effects as may be needed.

In Fig. 4 the coil P, with its core I, is placed opposite a sectional coil S, whose sections are differently related as to distance from P, as shown, with a device or sliding contact K for including different portions of the wire S in the telephonic circuit to which it is connected. It is not necessary, however, that the induction be direct, providing the relation of phases of induction are not greatly disturbed. Thus in Fig. 5 L L may be a parallel electric-light line and the line T T a telephone-line. In the circuit L L is a coil P, wound upon a ring-core I. On the same core a secondary coil S is also wound, and therefore takes up inductively the waves or impulses transmitted to it by induction from the coil P in the electric-light line. The coil S is, however, connected with the coil P^2 on another core I^2, on which again is placed a secondary S^2, inserted into the telephone-line. A variable resistance V may be introduced into the circuit of S and P^2 for modifying the inductional strength of the current. In this case it is evident that the coils in the lighting and telephone lines P and S^2, respectively, may be at considerable distances apart, while the balancing-induction is transmitted in a neutral and separate circuit.

Having described some of the ways of adjusting and supplying counter-induction, I will proceed to describe some of the ways of carrying out my present invention.

In Fig. 6, T T and T′ T′ indicate two lines parallel with or adjacent to varying extents or varying distances to the electric-light line L L, with alternating or fluctuating currents flowing thereon. The coil P in the electric-light line has on one side of it adjustably placed a coil S in the circuit of the line T T, and in the other side a similar coil S′ in the circuit of line T′, whereby the coil P may inductively act on both circuits T T and T′ T′. The coils S S′ are kept sufficiently far apart as not to allow cross-talk by induction from one of the telephone-coils to the other.

Fig. 7 illustrates a modified way of permitting a single coil P of moderate size in an electric-light line to affect inductively a number of coils variably placed as to the power of induction and each inserted in a particular telephone-circuit without permitting the approach of the small telephonic-circuit coils to allow cross-induction or cross-talk. The small coils are adjusted both as to the position and angle, &c., and arranged around the coil P, which may be without a core of any kind, or which may have a core I, of iron-wire bundles, threaded through it and run in different directions, as indicated, to separately-influenced coils S′, &c., which coils are connected in individual telephone-circuits.

In Fig. 8 the coil P is of rather large dimensions and each of the small telephonic coils S S′, &c., is wound upon an iron core and placed at a proper position in the air-field developed by the coil P to receive the balancing or counter induction required to remove the active induction of the telephone-lines to which it is connected.

Fig. 9 indicates how, when several lines are inductively related and induction occurs from one to the other, they may be made to balance their inductive effects. I have shown here two electric-light lines L L and L′ L′ acting inductively in varying degrees on three telephone-lines T T, and T′ T′, and T^2 T^2, the lines being at different distances apart and different distances one from the other, and receiving, therefore, different degrees of inductive effect. In the circuit of the lighting-line L L is placed the coil P, and also the coil P′ in the circuit L′ L′, which is so made, however, that the line L′ L′ is the stronger in its inductive effect upon the coils S, &c., it (L′) being nearer to the telephone-lines. It is therefore given a position on the common core I nearer to the compensating-coils for the telephone-circuits S S′ S^2. The line T, being close to the electric-light lines, receives the most powerful induction, and its coil S is therefore in the strongest field of the core I. The coil S′ is in the cir-

cuit to the line T′ T′ and receives the next weaker induction, and the coil S′ is in the circuit of line T^2 T^2, which is farthest away from the electric-light lines and receives the weakest inductive effect. The coil S^2 is placed at an inefficient inductive relation with the core I. Many other modifications in the lay-out of the devices or the plans of their positions and proportions may be made by those skilled in the art.

It will be observed in the case of Fig. 9 that the two or more electric-light lines act to give a composite field of induction, into which are independently inserted, without inductive relation to each other, telephone-coils or anti-induction generators. The absence of appreciable cross-induction in the counter-induction apparatus which is secured in the arrangement, Fig. 9, is also obviously secured in the arrangements shown in Figs. 7 and 8, since in the latter cases likewise the coils in the several telephone-lines are established at different parts of the field and out of inductive relation to one another. The use of the air-field, as described, also conduces to freedom from cross-talk from one telephone-line to the other through the compensating devices.

What I claim as my invention is—

1. In an apparatus for compensating for induced currents upon two or more circuits from another, the combination, substantially as described, of a reactionary magnetic field produced by the inducing-circuit, and compensating coils for the induced circuits placed in different parts of said field, but out of inductive relation to one another.

2. The combination, substantially as described, with two or more inducing electric lines and two or more electric lines inductively affected thereby, of a compound compensating air-field produced by the currents of the two inducing-circuits, and counter-inducing coils or induction-generators for the several affected lines placed out of inductive relation to one another, each in a composite air-field produced by the said inducing lines or circuits.

3. The combination, substantially as described, of two or more inducing electric lines and two or more telephone-circuits inductively affected thereby and each provided with a counter-inducing coil or induction-generator placed in a composite air-field produced by the two inducing-lines, each counter-inducing coil or generator for a telephone-line being located in position to be out of inductive relation to the coil or generator for other telephone-line.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 1st day of April, A. D. 1889.

ELIHU THOMSON.

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J. R. JOHNSON.