(No Model.) 3 Sheets—Sheet 1.

E. THOMSON.

REGULATION OF ALTERNATING CURRENTS.

No. 516,846. Patented Mar. 20, 1894.

Fig. 1.

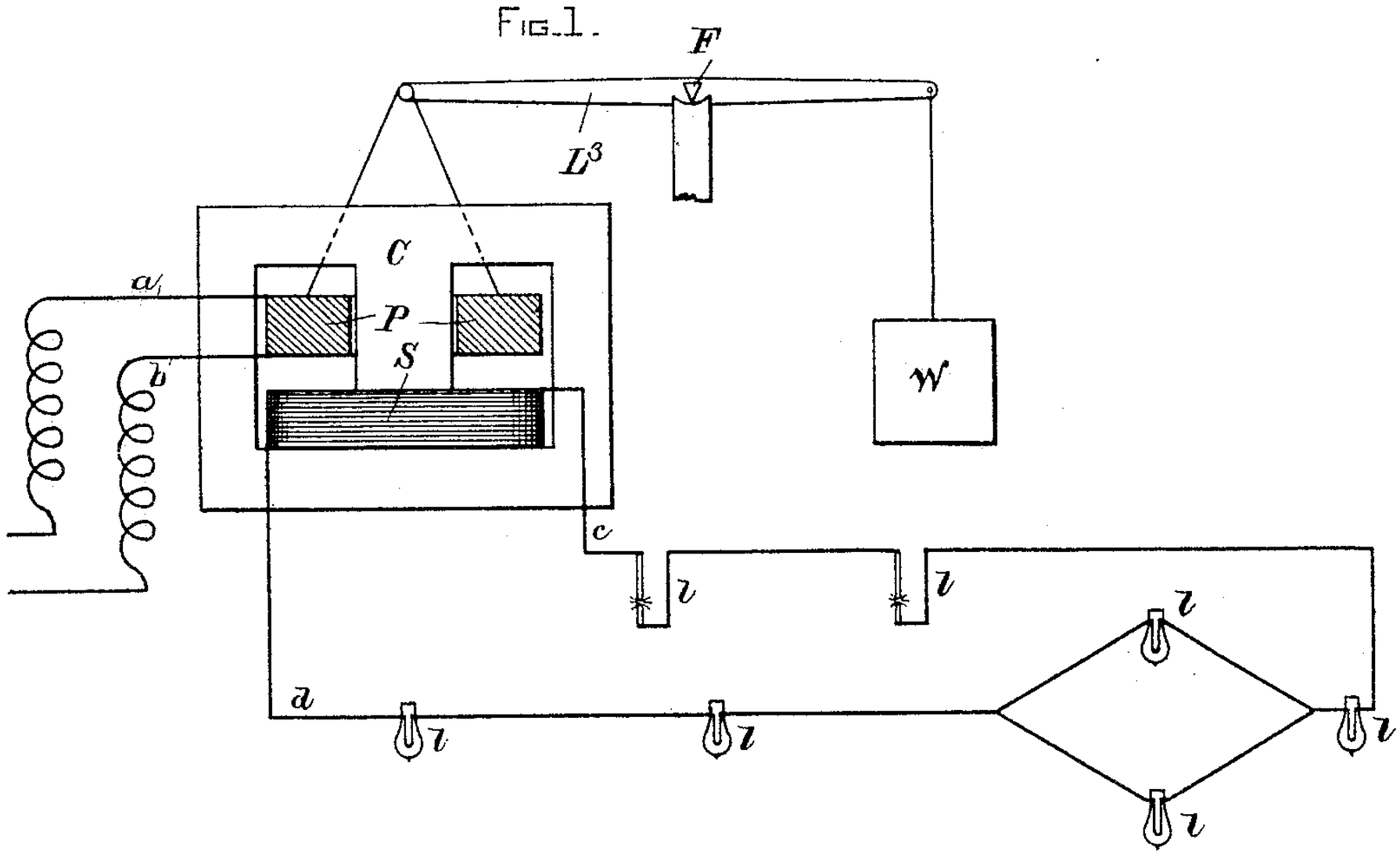

Fig. 2.

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Fig. 3.

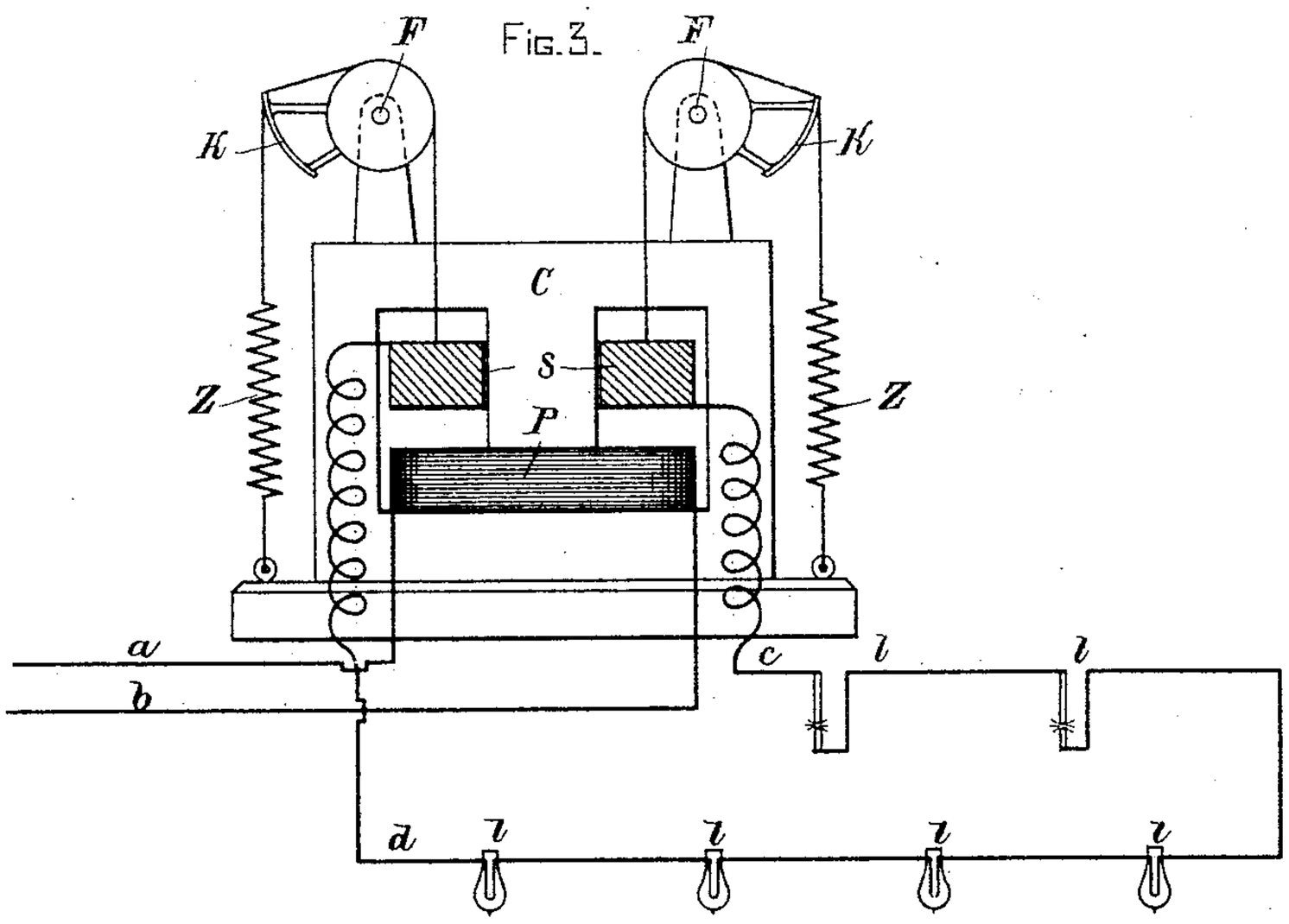
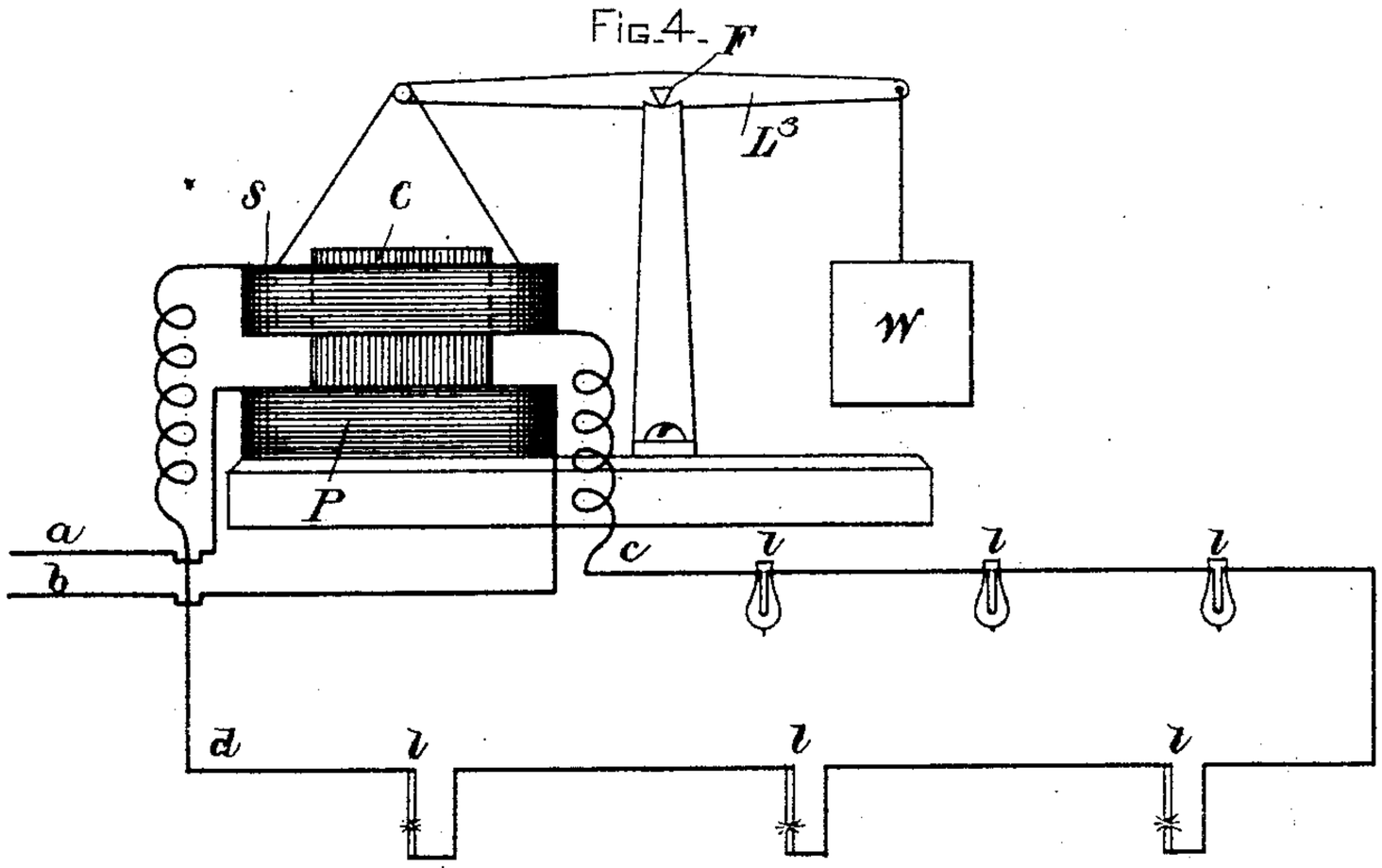


Fig. 4.



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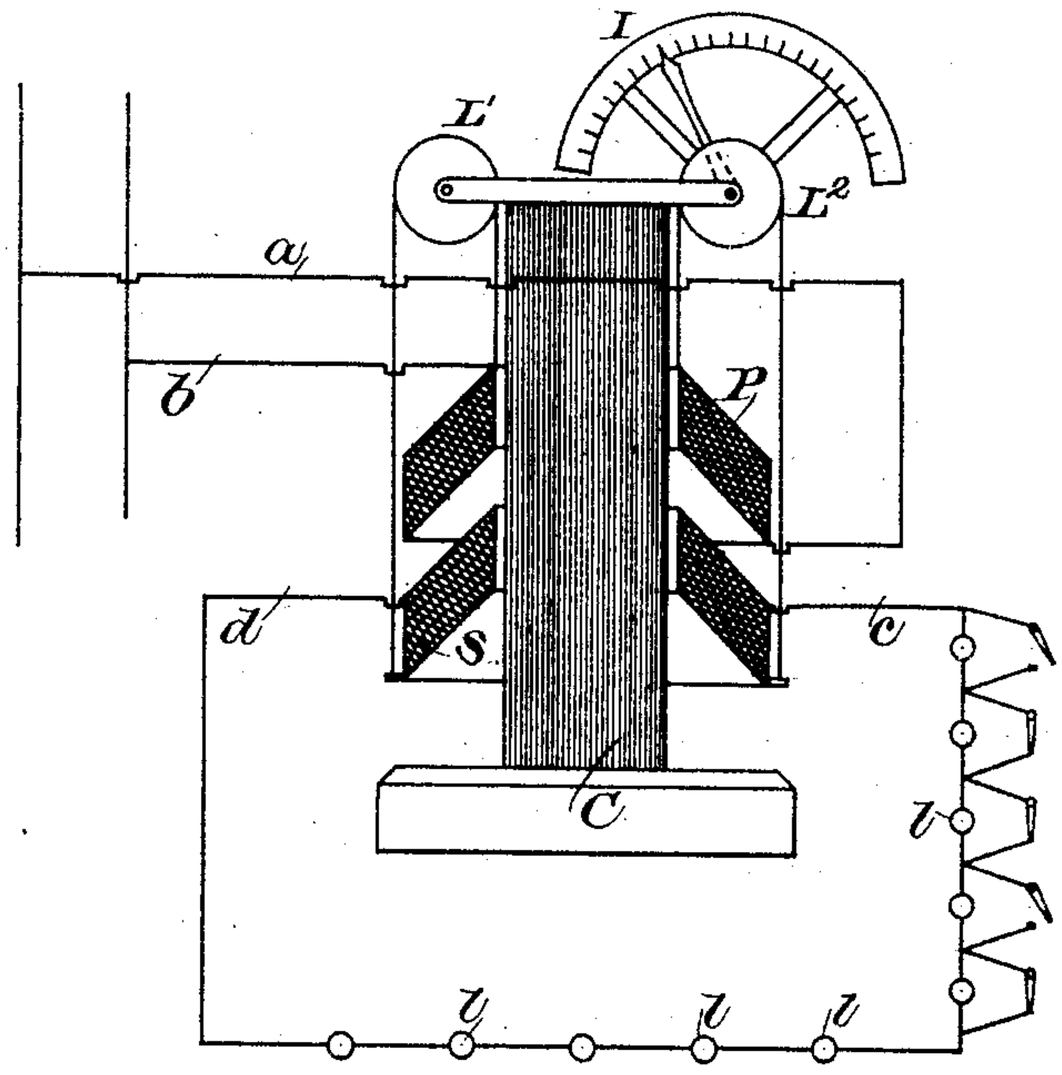

FIG. 5.

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UNITED STATES PATENT OFFICE.

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REGULATION OF ALTERNATING CURRENTS.

SPECIFICATION forming part of Letters Patent No. 516,846, dated March 20, 1894.

Application filed June 9, 1891. Serial No. 395,720. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, in the county of Essex and State of Massachusetts, have invented a certain new and useful Improvement in the Regulation of Alternating Currents, of which the following is a specification.

My present invention relates to the regulation of electric currents of an alternating character and consists in the provision of devices for the purpose of causing an automatic regulation to constant average current strength.

Referring to the accompanying drawings: Figure 1 shows a device embodying the invention. Figs. 2, 3, 4 and 5 show modifications.

In Fig. 1, C represents an ordinary laminated core of iron surrounding the coils P and S. The coil S is a secondary coil in which currents are to be induced by the flow of alternating currents in the primary coil P, which is attached to the mains *a b*. As will be seen the core C threads the two coils P and S and extends outwardly around the coils forming what is known as a closed magnetic circuit. The terminals of the secondary coil S are *c d* and may be carried through a series of lights *l l*, which may be arc lights or incandescent lights, either used singly or in series or together in varying numbers. As shown the coil P is a movable coil while the coil S is a stationary coil, and the coil P therefore is provided with flexible or moving connections with the mains or supply wires. The coil P is mounted so as to be balanced, as it were, against a certain weight, or in other words, to have a certain tendency toward the coil S. Provision may be made for varying this tendency. The arrangement shown is a lever L^3 pivoted at F, on which a counterweight W is hung at its other end, while the coil P occupies the position shown and is sustained partly by the weight W. By increasing or diminishing the amount of the weight W the tendency of the coil P to move toward the coil S may of course be increased or diminished. It is necessary in the working of the device that a certain tendency be allowed to be exerted on the coil P toward S as during action a repulsive effect is manifested tending to drive the coil P away from the coil S. If the coil P had no tendency toward S, or in other words, were perfectly counterbalanced by the weight W, the slightest current in the secondary coil or circuit would cause a repulsion so as to drive it to the farthest range of its position. In accordance therefore with the strength of current in the secondary circuit the tendency of P toward S will be allowed to be greater or less.

The operation of the device is as follows: At the start with the full load of lights *l l l* in the secondary circuit the coil P will be in a position very close or adjacent to the coil S on the core. It may even be actually in contact but it is better not to have it rest in actual contact. Now under these conditions a certain current flows in the secondary circuit and through the series of devices. Let one of these devices or some of them be shunted by the shunting switch and the current in the secondary S will of course tend to increase on account of the diminished resistance in the circuit, but this will be accompanied by a repulsive effort exerted on the coil P the primary coil tending to recede from the secondary, and, under the conditions of counterbalance the coil P will recede until the current in the secondary circuit has arrived at its proper value. By shunting more of the devices in the secondary circuit, a further movement of the coil P would be produced and the range which is given to it will of course correspond to the amount of work which is required or the amount of shunting which it is desired to do in the secondary circuit. In ordinary cases a short-circuit may be formed of the secondary winding and the coil P will then be driven to the extreme point away from the secondary coil.

In Fig. 2 the arrangement is shown modified in that the primary coil P is the stationary coil fed by the wires *a b*, while the secondary coil S is the movable coil either flexibly or otherwise connected with the circuit *c d*. The lights *l l* are in series as before and the action is in no wise different from that of Fig. 1 except that the function of the coils—stationary and moving—are simply reversed.

Instead of employing a set of counter-

weights and lever, such as is shown in Fig. 2, and which may have the disadvantage of being cumbrous and difficult to place, a more compact device is obtained by using the arrangement shown in Fig. 3 in which the moving coil S is supported upon a tape carried around a roller F, F, and on the same axis is a cam surface acted upon by a tape and a spring Z. The curve of the cam surface at K, K, may be such that the force exerted by the spring Z shall be substantially constant, notwithstanding collapse or extension of the spring. This is a well known device for securing uniformity of pull in springs and may be replaced by any well known equivalent, or varied to produce any desirable variation in pull. The action of this form of counterpoise is of course the same as before. Instead of a flexible connection from the movable coil of course a mercury contact allowing free movement may be employed or any other similar device.

Fig. 4 shows a modification in which the core of the coil is laminated or otherwise divided, as by using a bundle of iron wires, and not closed externally to the coils, or in other words, it is an open core. The primary coil is stationary as in Fig. 2 while the secondary coil S is shown movable, and supported, as before, by a counterweight W with the fulcrumed lever L^3. The action of course in this case is the same as before and the only difference is that the magnetic circuits are completed around the core through the air instead of directly through a body of iron, which is present in the former case. In any case the primary and secondary coils respectively in the main and the work circuits are to be arranged in inductive relation, and free to move apart in response to the repulsive action developed under such circumstances, and the action of regulation depends upon what may be called leakage magnetism or air space magnetism set up between the coils when they are separated. When the coils are close together there is very little of this effect because the transformer or induction coil works at a very high efficiency and effectively, whereas when the coils are held at separated positions a considerable magnetic leakage occurs between the coils which drops the induction in the secondary circuit and cuts down the current which would otherwise become abnormal.

It is to be understood that my invention is in no wise confined to the arrangements shown in the drawings, but may be embodied in various devices so long as the above principles of construction and operation are carried out, for example, although I have shown one coil fixed and one movable, it is not necessary that either of them should be fixed, for each may be movable from the other, with suitable devices for forcing them toward one another. Thus in Fig. 5 the arrangement is modified so that the core C is surrounded by two movable coils or more broadly speaking the sets of coils which form the primary P and the sets of coils which form the secondary S are both movable and are balanced one against the other by any suitable means such as cords running over pulleys L', L^2, whereby the coils P and S are permitted to act together or to be separated. Normally they are together and tending to run together, which is accomplished by making the weight of the coil P greater than that of S or in any other way adding to the downward tendency of one coil causing the other coil to be lifted. For convenience in indicating the positions of the coils, especially when they are to be cased in or covered, an indicator I, passing over a dial or scale is provided, which indicator is actuated by the movement of the coils in any desired way. It is shown attached to the axis of the pulley or roller L^2. The upper coil P is in this case the primary, the lower S the secondary and the secondary has lights or other resistances *l*, *l*, *l*, in its circuit, the number of which may be varied, a constant value of current being maintained in the secondary when the primary is fed from a constant potential alternating circuit.

One of the principal objects of the above invention is to at once transform and regulate. For this purpose the primary and secondary will have the necessary proportions, so that, for instance, constant currents of low tension may be produced in circuits of variable resistance by induction from high potential mains.

What I claim as new, and desire to secure by Letters Patent, is—

1. An alternate current regulator comprising primary and secondary induction coils, relatively movable with respect to each other by the repulsive action of the induced and inducing currents, into positions of greater or less inductive action, the said secondary coil being in circuit with the translating devices.

2. An alternate current transformer and regulator, comprising a primary coil in the main circuit, a secondary coil in circuit with translating devices, said coils being movable with respect to each other under the action of the repulsion of the inducing and induced currents, and means tending to move the coils in opposition to the action of the current.

3. An alternate current transformer and regulator comprising primary and secondary coils relatively movable into position of greater or less inductive action, and tending to assume the position of greater inductive effect, but free to be removed by the repulsive action of the currents into positions of less inductive action, the said secondary coil being in circuit with translating devices.

4. The combination of a primary coil connected to the main circuit, a secondary coil connected to translating devices, the said coils being so mounted that they may assume various relative positions to vary their inductive relations, and are free to change their relative positions under the action of the induced and inducing currents, in the coils themselves and independent means tending

to oppose such change of position under the action of said currents.

5. The combination of the primary and secondary coils respectively in the main and work circuits, and relatively movable to and from one another under the action of the current in the coils alone and of suitable opposing means, to vary their inductive relation.

6. The combination of the primary and secondary coils respectively in the main and work circuits, one of said coils being fixed and the other coil being movable with regard thereto under the action of the current therein to vary their inductive relation, and means for opposing such motion of the coil under the action of the current.

7. The combination in a regulating transformer of the fixed coil, the partly counterbalanced movable coil, and one of said coils being in the main and the other in the work circuit.

8. In a regulating transformer, the combination of a fixed coil, a coil movable under the action of the current to the position of minimum induction and provided with flexible circuit connections, translating devices connected thereto by such connections, and means tending to move said coil to the position of maximum induction.

9. The combination in a regulating transformer of the primary and secondary coil wound on an iron core forming a closed magnetic circuit but movable relatively toward and away from each other, to vary the leakage and the inductive effects as described, the said coils being respectively included in the main and the work circuits.

10. The combination in a regulating transformer of the primary and secondary coils wound on an iron core forming a closed magnetic circuit, but movable relatively to each other under the action of the current to vary the leakage and the inductive effects as described, the said coils being respectively included in the main and the work circuits.

11. The method of producing and regulating an alternating current which consists in producing the same by induction from an alternating current, causing such inducing and induced currents to react on one another and utilizing such reactive energy to effect a change in the inductive relation of the currents.

In testimony whereof I have hereto set my hand this 2d day of June, 1891.

ELIHU THOMSON.

Witnesses:

JOHN W. GIBBONEY,

EDWARD M. BENTLEY.