(No Model.)

E. THOMSON.

ELECTRICAL TRANSFORMER.

No. 486,916. Patented Nov. 29, 1892.

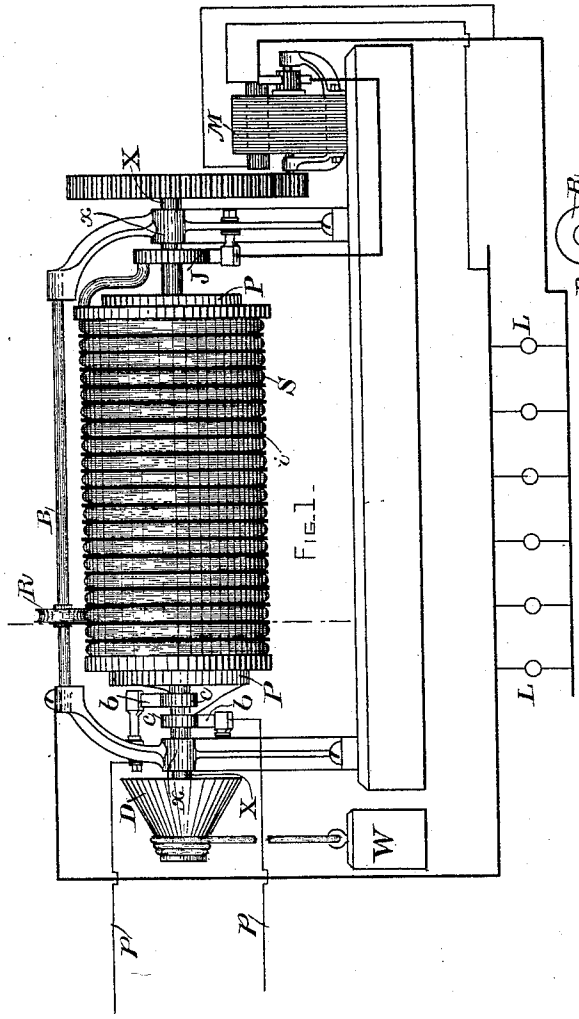

FIG. 1.

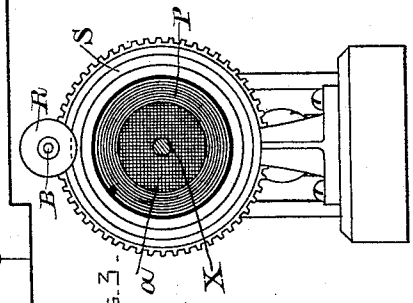

FIG. 3.

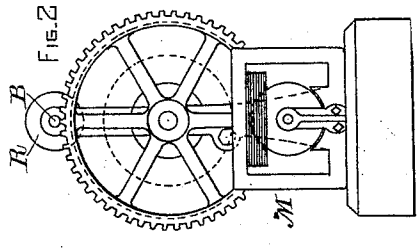

FIG. 2.

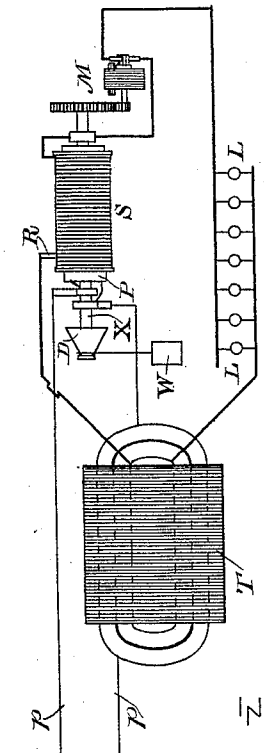

FIG. 4.

WITNESSES.

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UNITED STATES PATENT OFFICE.

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ELECTRICAL TRANSFORMER.

SPECIFICATION forming part of Letters Patent No. 486,916, dated November 29, 1892.

Application filed May 23, 1892. Serial No. 434,075. (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, State of Massachusetts, have invented a certain new and useful Improvement in Transformers, of which the following is a specification.

My present invention relates to an adjusting device for controlling the potentials delivered to the secondary circuits of transformer systems, where under the conditions of working there would be a considerable variation of potential with varying load, so that on a change from light to full load condition there would be a considerable drop of electro-motive force, such as would render the system ineffective for the operation of incandescent lamps in multiple arc.

My invention briefly consists in providing a transformer feeding currents to a secondary circuit, with means for varying the effective inductive lengths of the secondary or primary winding, such means being capable of making the variation of relation of inductive length in a continuous or unbroken manner, whereby the lights are kept steady during the adjustment. It is not new, as I am aware, to vary the length of the secondary or the primary of an induction-coil used in lighting by steps, as by a number of contacts with a traveling contact moved thereover. My invention, however, provides a continuous smooth movement and at the same time makes the action of adjustment automatic or dependent upon the load which is being used in the system or upon load on the particular secondary in question. In an extended transformer distribution system with alternating currents one transformer or transformer substation may be heavily loaded at a time when another is but lightly loaded, and if the drop on the lines, primary and secondary, plus the drop in the transformer on a heavily-loaded section, exceeds a certain amount the lamps fed thereby will not be properly lighted, while, on the other hand, the absence of drop on the other portion of the system may cause undue brilliancy or an undue increase of potential above the normal to exist. It is, moreover, desirable to construct the system in many cases so that a considerable drop of potential may exist, as otherwise the amount of copper employed in the lines and in the transformers is excessive.

My invention provides a device which can be used in conjunction with ordinary transformers to effect the necessary regulations or can be used as a transformer itself, if desired. Various modifications in the construction and arrangements of the parts may be made; but I shall describe, in connection with the invention, substantially those elements which are required in practice without restricting myself to the particular embodiment of them.

In the accompanying drawings, Figure 1 is a side elevation of a self-regulating transformer embodying my invention, the circuit connection being indicated diagrammatically. Fig. 2 is an end elevation thereof. Fig. 3 is a section on line 3 3 in Fig. 1, and Fig. 4 shows a modified arrangement.

In the form shown in Figs. 1, 2, and 3 there is mounted on a horizontal shaft X, journaled in bearings x, an iron core made up of laminated iron or iron-wire bundles a, (see Fig. 3,) around which is wound a primary coil P, connected to the primary wires p, conveying the supply current. Outside of the primary coil P is wound a secondary coil, the outer turns of which S are laid bare, but are kept from lateral contact by insulation i. They form, as it were, a screw-thread or helix. A grooved roller R, carried on a conducting-bar B, is arranged so that on the rotation of the coils P S the contact-roller R will travel over the wire S, and according to the direction of rotation will include more or less of the turns S in the circuit through the lights L L, one terminal of said circuit being carried to the bar or roller R and the other to a contact-ring J, to which the other terminal of the secondary coil S is attached. Current is carried into the primary coil by suitable contact-rings c and brushes b, so as to permit the rotation of the transformer. Placed in the secondary circuit or light circuit L L is a small alternating-current motor M, the torque of which increases with the increase of load L L, and the purpose of which is to rotate the transformer by any suitable gearing or connection—such as that shown in the drawings—

and cause the roller R to roll over the outer turn S and vary the length of the secondary coil in action, putting additional coils in circuit as the load increases. Acting counter to the motor M is a weight W, attached to a cord to be wound upon a conical drum D, so that the leverage of the weight increases as the torque of the motor M increases under varying load By this means a condition of stability is reached for each change of load. The armature of motor M receives the whole or a definite part of the current passing through the lights. The field-magnet of the motor M may be excited by a shunt taken across the mains or in any suitable manner. It will be understood that the motor M typifies any construction of motor in which the torque by alternating currents flowing in it increases as the current increases through it. If the torque of the motor M in winding up the weight W decreases, as by a decrease of lights at L L by open-circuiting them, then the weight W reasserts itself and turns the mechanism backward. The adjustments are such that on the lightest load L L the first turns of the secondary S are included or put in action, or just such a number of turns as will give the requisite electro-motive force. As the load L L increases, the motor M begins to turn and wind up the weight W, and the shape of the conical drum D is made such that for each addition of load or current the turning given is just such as to increase the length of the secondary coils in action, so as to bring up the electro-motive force upon the lamps to the normal and compensate for all drop. For the very lightest loads the motor M does not need to act at all; but only under a certain increase of the lamp-load L L will it come into action to begin the movement.

Fig. 4 shows one of the ways in which my invention may be applied to supplement the action of an ordinary transformer or to effect the regulation in such a transformer. The transformer is represented at T, being one of the ordinary alternating-current type used for electric lights. The primary line *p* is connected through the main primary coil of the transformer T and in series also through the primary coil of the regulating-transformer at P. The secondary coil of the larger transformer T is connected, also, in series with the secondary of the regulating-transformer S, or, in other words, the turns of the secondary of the regulating-transformer are variable and are in series with the secondary turns of T, which latter are not varied, while the two primaries of the regulating-transformer and the transformer T are in series. Virtually by this connection the regulating-transformer becomes an adjustable part of a transformer system, including the fixed part T, and the regulating action of the regulating-transformer is accomplished by the motor M and the counter torque device D W, acting in opposition to the motor M, in accordance with the variations in the load L L. The capacity for variation may be such that all of the turns of the secondary S of the regulating-transformer are required to be cut out by rotation and shifting the contact R under light load, and all of the turns put in under full load. It will be seen that in cutting out the secondary turns S under light load there is also kept in circuit the primary P of the regulating-transformer, which then acts as a self-inductive coil and tends to save energy. It is also evident that were it not for complexity the variation of the effective lengths might with proper arrangements of circuits be made in the primary instead of in the secondary circuit, and I do not limit myself to the particular circuit, whether primary or secondary, which is operated upon or varied in effective length in accordance with the load. I have shown what I deem the most feasible and practical arrangement. It is obvious that instead of the counter torque device D W, counteracting spiral springs having similar properties may be used.

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

1. A transformer for electric circuits, provided with means for varying the length of one of its windings in a continuous unbroken manner, substantially as set forth.

2. A transformer for electric circuits, having means for automatically varying the effective inductive length of one of its windings in a continuous unbroken manner simultaneously with the change in load, substantially as described.

3. A transformer for electric circuits, having one of its windings bare, and a traveling contact maintaining a continuous unbroken connection with said winding, substantially as described.

4. A transformer for electric circuits, having one of its windings bare, and a traveling contact adapted to roll in contact with said winding, substantially as described.

5. A transformer for electric circuits, arranged to rotate on a longitudinal axis and having one of its windings bare, and an axially-movable roller bearing upon said winding, substantially as set forth.

6. The combination, with a rotatable transformer having one of its windings bare, of a traveling contact resting continuously upon said winding and means for rotating the transformer, substantially as set forth.

7. The combination, with a transformer mounted on a longitudinal shaft and having one of its windings bare, of a traveling contact bearing upon said winding and a motor controlled by the load upon the secondary circuit and arranged to rotate the shaft, substantially as described.

8. The combination, with a transformer mounted on a longitudinal shaft, of a traveling contact maintaining a continuous unbroken connection with one of the windings thereof, a motor responding to variations in the load upon the secondary circuit, arranged

to rotate the shaft in one direction, and a counterbalance tending to rotate the shaft in the opposite direction, substantially as set forth.

9. The combination, with a transformer having its outer coil bare and mounted upon a longitudinal shaft, of a traveling contact maintaining a continuous unbroken contact with said coil, a motor for rotating the shaft in one direction, and a counterbalance arranged to exert an increasing torsional force upon the shaft in the opposite direction, substantially as set forth.

10. The combination, with the transformer mounted upon a longitudinal shaft X and having its outer coil S bare, of a roller R, arranged to slide axially upon the rod B and to maintain a continuous contact with the coil S, a motor geared to the shaft, and a conical drum D, secured to the shaft and having a cord and weight attached thereto, substantially as described.

In testimony whereof I have hereto set my hand this 20th day of May, 1892.

ELIHU THOMSON.

Witnesses:

JOHN W. GIBBONEY,

BENJAMIN B. HULL.