No. 748,147. PATENTED DEC. 29, 1903.

M. H. BAKER.

METHOD OF REGULATING ELECTRIC CIRCUITS.

APPLICATION FILED JUNE 28, 1902.

NO MODEL.

Fig. 1.

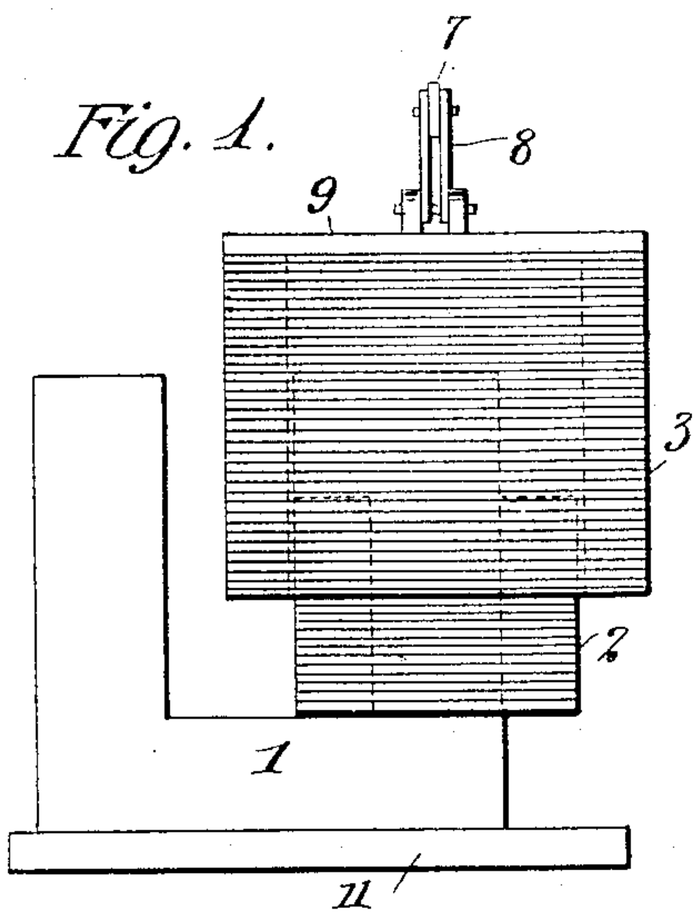


Fig. 2.

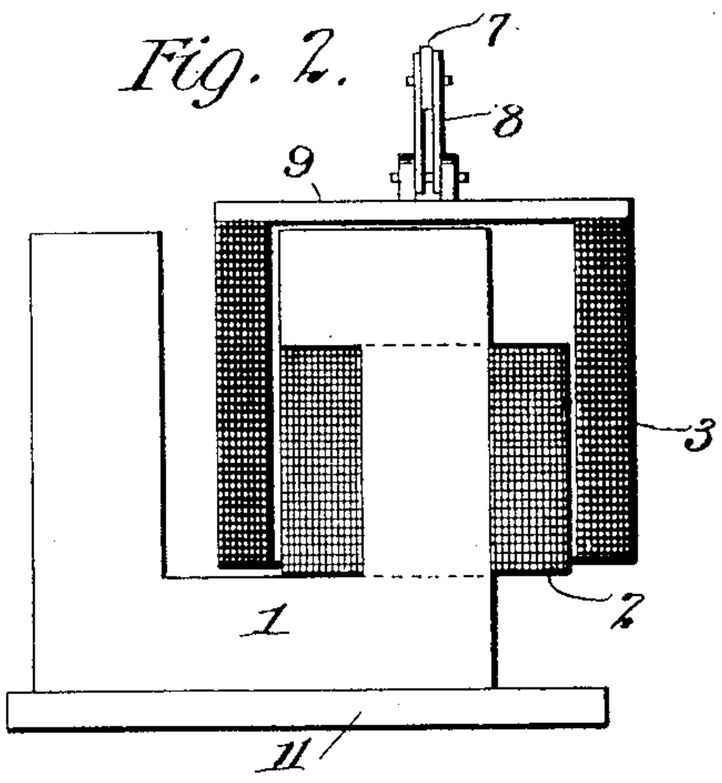
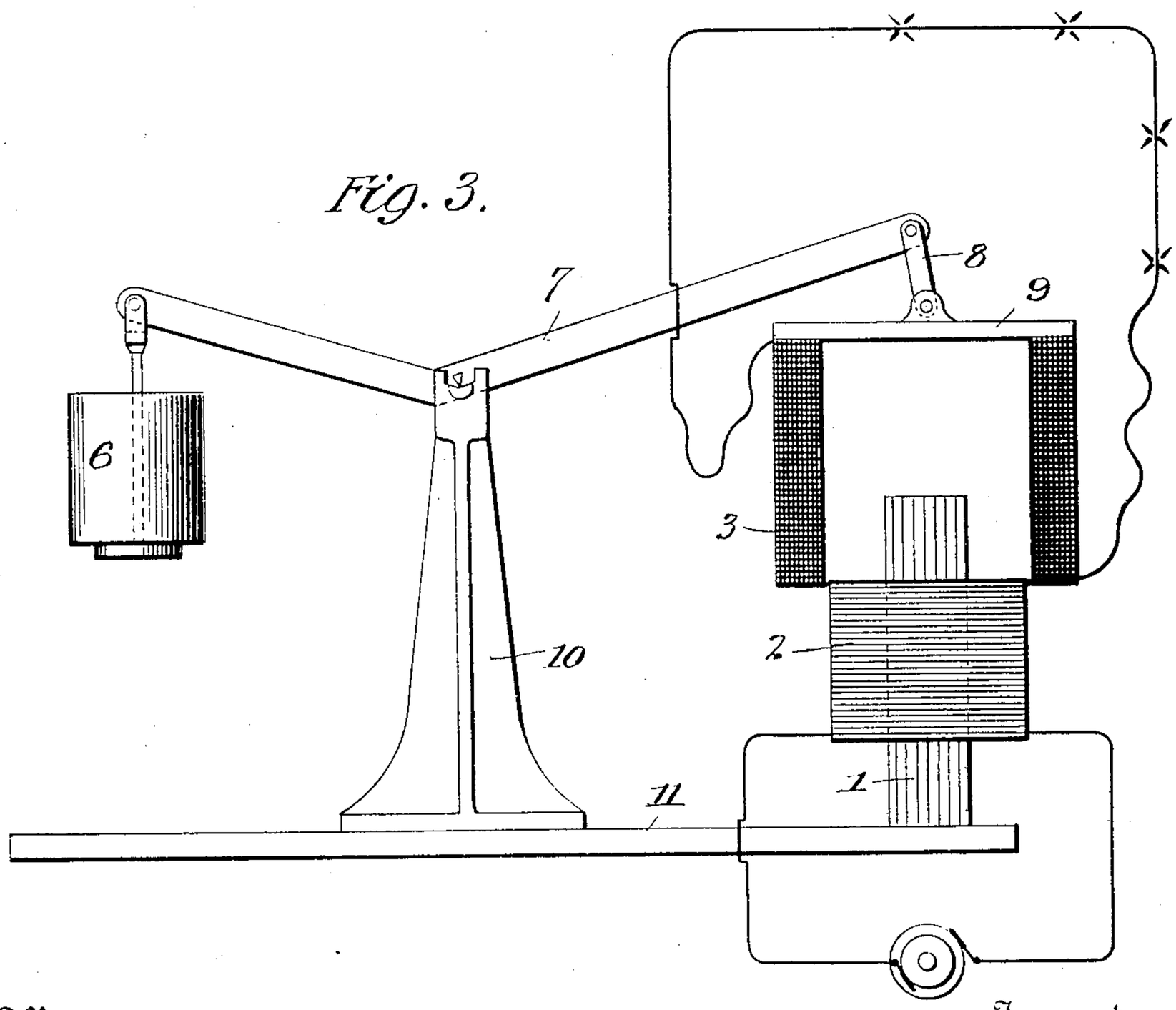


Fig. 3.



Witnesses
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No. 748,147. Patented December 29, 1903.

UNITED STATES PATENT OFFICE.

MALCOLM H. BAKER, OF EAST LIBERTY, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

METHOD OF REGULATING ELECTRIC CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 748,147, dated December 29, 1903.

Application filed June 28, 1902. Serial No. 113,601. (No model.)

To all whom it may concern:

Be it known that I, MALCOLM H. BAKER, a citizen of the United States, and a resident of East Liberty, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Methods of Regulating Electric Circuits, of which the following is a specification.

For regulating alternating-current circuits carrying translating devices, particularly arc-lamps in series, use has been made, among other things, of a transformer having a movable secondary coil adapted to assume various positions relative to a fixed primary coil, and a practically-constant current has been sought to be maintained in the secondary circuit by thus altering the number of leakage-lines of force between the coils. In practice, however, it is found that the power factor of a circuit of this kind is decreased as the load is decreased, so that at one-quarter load, for instance, the system would still be absorbing the full terminal potential of the circuit at the same operating-current as at full load, and although the actual energy consumed would be less, yet it is evident that the conditions would not be favorable for economical commercial operation. The system is, in fact, only suited for operation under approximately full-load conditions. The attempt to remedy the defects of this system by the use of contacts which are movable upon the secondary winding of the transformer is attended with other difficulties, such as that of a multiplication of the parts, a complication of the apparatus, and excessive sparking and wear where the movable contact travels over the various stationary contact-points connected with the secondary winding.

The object of the present invention is to bring about constant-current regulation in alternating-current series circuits by a device which shall maintain a practically-constant power factor at all loads, be automatic in action, and be free from moving electrical contacts or other complications.

In the drawings illustrating my invention, Figure 1 is an end elevation showing the parts of my apparatus at about half-load position. Fig. 2 is a sectional view showing the parts in the position they occupy at approximately full load, and Fig. 3 is a side elevation showing no-load position.

Referring to the drawings, 1 is a U-shaped iron core of suitable dimensions, and upon one leg of the said core are mounted two coils, one of which is stationary and the other movable, the coils being so arranged that one of them may completely inclose the other. These coils are shown at 2 and 3, the former being the stationary coil and the latter the movable coil. The coil 2 is fixed upon one leg of the iron core, and the other or outer coil is arranged to have free motion relative to the fixed coil and the core by passing through the air-gap in the U-shaped core from a position surrounding the inner coil to a position above it, or vice versa. The fixed coil may be taken as the primary coil of a transformer connected with some suitable source of supply, as shown at 4. The movable coil may be made the secondary of the said transformer and be placed in series with a number of arc-lamps or other electrical translating devices. When the movable coil is in its lowest position completely inclosing the fixed coil, the device is simply a static transformer of the open magnetic-circuit type, the ratio of transformation—that is, the ratio of the primary and secondary voltages—depending upon the relative number of turns in the said primary and secondary coils. Any movement of the secondary coil away from the position last described will result in carrying a portion of the secondary coil out of the direct magnetic field through the iron core, and this portion will to a great extent become inoperative so far as the action of transformation is concerned; otherwise expressed, if the two coils shall have been so wound that the secondary and primary voltages are equal when the movable coil is completely inclosing the fixed coil and if the movable coil is then raised to a position where half its turns are above and out of the magnetic field through the iron core it is evident that the active turns of the movable coil are halved—that is, the

movable or secondary coil has as regards the action of transformation substantially half the active turns that it had in its initial position and the transforming ratio—and hence the secondary voltage has been approximately cut in two. If the movement is still further continued and the movable coil be raised until it is completely outside the magnetic field, there will be no action of transformation, and hence the secondary voltage will be zero. As the active turns of the secondary coil are decreased in this way the local reactance of the fixed coil increases until at the position of complete removal of the secondary coil the primary coil is simply an inductance across the electrical source of supply of such amount that the current flowing is negligible. In other words, the action of the primary coil is the same as takes place in the primary of any static transformer when the number of turns of the secondary coil is varied. In passing through the various steps from a position of completely inclosing the primary coil to a position of complete removal from the magnetic field the voltage of the secondary varies from a maximum to a minimum, as does the current of the primary. Now since the apparent primary watts are also diminished in this way the ratio of the true primary to the apparent watts constituting the power factor remains approximately constant.

I have found that it is possible to provide a mechanical force which shall so act upon the secondary coil as to carry it automatically into such a position with relation to the primary coil and the core after any change of resistance takes place in the external circuit of the secondary that the secondary voltage shall always be of such value as to maintain practically constant current. This mechanical force is illustrated in the third figure of the drawings as a weight 6, attached to one end of a bent lever 7, the other end of which is secured by a link 8 to the top plate or cap 9 of the secondary coil 3. The lever 7 is pivoted at the top of a standard 10, mounted on a base 11, which may also support the core 1.

The position which the coils occupy when the secondary completely incloses the primary is the position of full load. Should a lamp or other translating device be switched out of the external circuit, the voltage in the secondary circuit will tend to drop and an impulse of repulsion between the movable coil and the fixed coil and core will be set up, this impulse at first of considerable value. When, however, other translating devices are switched out and the secondary coil travels still farther away from the primary coil, the repulsive effort diminishes. If, therefore, the mechanical force represented by the weight 6 is to vary automatically, so as to bring the secondary coil to equilibrium at a point where it will maintain constant current after changes in the resistance of the external circuit have been introduced, it is evident that the counter weight or force must act so as to increasingly assist the repulsive force by substantially the same amount as the repulsive effort decreases with increments of travel in the movable coil. The arrangement illustrated in Fig. 3 is one which meets these requirements. It will be seen that as the movable coil travels upward and away from the fixed coil the weight 6 increases in effect, owing to the angle which is given to the lever 7. This angle is a critical angle, and its value may be determined in accordance with the principles laid down ni United States Letters Patent No. 684,165, issued to me October 8, 1901. By the same process of determination the angle to be given to the lever 7 (shown in Fig. 3 of this application) can be determined, the angle in this case being turned in an opposite direction from that illustrated in the patent referred to.

In making the statements contained in the last paragraph it is assumed that the weight of the secondary coil is so adjusted as always to exceed the repulsive electrical action—that is, it is assumed that it is necessary to provide a mechanical force which shall always act to assist the upward travel of the secondary coil. The apparatus may, however, be arranged so that the secondary coil shall move downward in order to be removed from the primary coil, in which case the mechanical force must oppose the repulsion. The apparatus may also be arranged so that the primary coil shall move away from the secondary either in an upward or a downward direction, or either of the coils may move sidewise at any angle, and the iron core may be of other shape besides that illustrated.

In the operation of the device herein illustrated and particularly described, it will be noted that as the repulsive effort decreases the assisting action of the weight increases, thereby producing a factor of constancy in the operation of the device.

It will be understood that the device has a certain fixed inductive drop at full load owing to the air-gap.

In another application filed by me June 28, 1902, Serial No. 113,600, I have claimed the apparatus disclosed herein.

I claim as my invention—

1. The method of maintaining a practically constant power factor in a system wherein a transformer is employed to operate translating devices in series in the secondary circuit of the said transformer, which consists in automatically and simultaneously varying the secondary voltage and the primary current in the same sense or direction and in approximately the same proportion.

2. In a system containing a transformer having translating devices in series with the secondary thereof, and one of whose coils is movable with relation to the other, the method of maintaining constant current in the secondary circuit in passing from greater load

to lower load by the successive cutting out of translating devices, which consists in automatically controlling the varying self-induction of the apparatus by the action of a mechanical force, and at the same time progressively reducing the number of secondary coils directly exposed to inductive action.

Signed at New York, in the county of New York and State of New York, this 18th day of June, A. D. 1902.

MALCOLM H. BAKER.

Witnesses:
WM. H. CAPEL,
GEORGE H. STOCKBRIDGE.