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A. H. B. WALKER

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APPARATUS FOR OPERATING DEVICES HAVING A NEGATIVE
RESISTANCE CHARACTERISTIC FROM AN ALTERNATING
ELECTRIC CURRENT SUPPLY CIRCUIT
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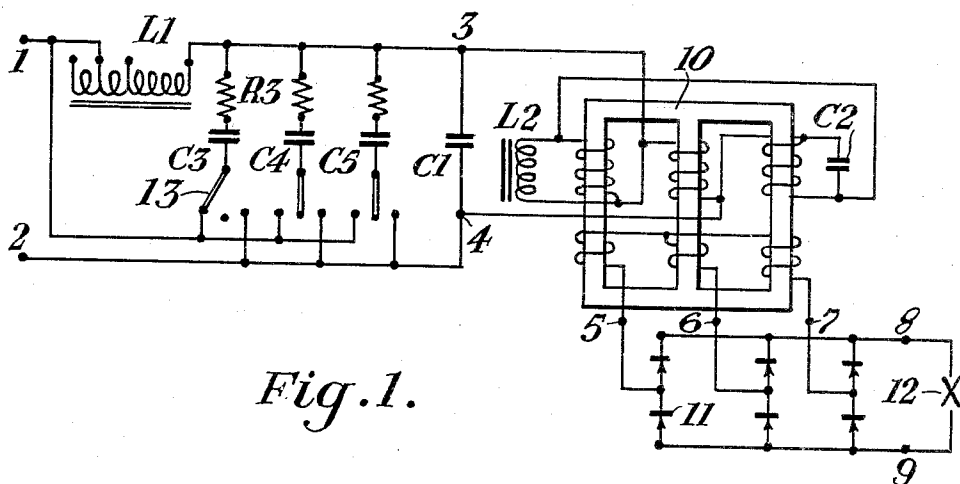


Fig. 1.

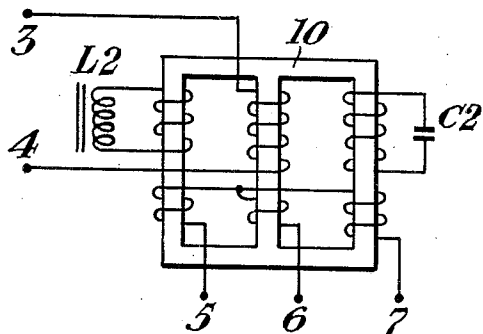


Fig. 2.

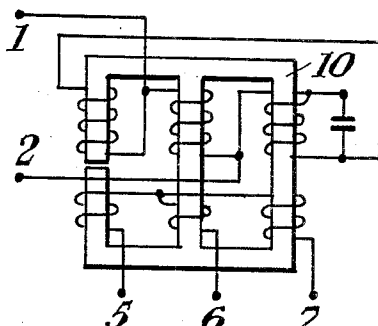


Fig. 3.

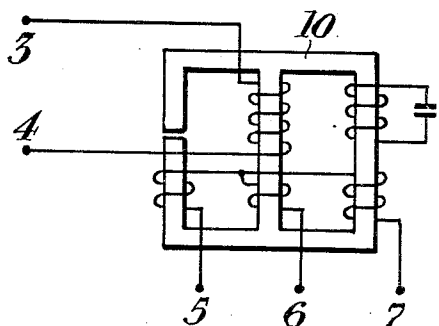


Fig. 4.

INVENTOR.
Alec Hervey Bennett Walker.
BY *[Signature]*
HIS ATTORNEY.

UNITED STATES PATENT OFFICE

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APPARATUS FOR OPERATING DEVICES HAVING A NEGATIVE RESISTANCE CHARACTERISTIC FROM AN ALTERNATING ELECTRIC CURRENT SUPPLY CIRCUIT

Alec Hervey Bennett Walker, London, England,
 assignor, by mesne assignments, to The Union
 Switch and Signal Company, Swissvale, Pa., a
 corporation of Pennsylvania

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6 Claims. (Cl. 321—57)

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This invention relates to apparatus for operating devices having a negative resistance characteristic by direct current derived from an alternating electric current supply circuit and has for its object to provide improved apparatus of this character for supplying current which is substantially constant and free from ripples.

In order to enable arc lamps, welding and other devices having a negative resistance characteristic to be operated from an alternating current supply circuit it is necessary to include in the operating circuit a ballast impedance device for the purpose of maintaining stable operation.

It is well known that when a cinema projector arc is operated directly from a single phase rectifier, an objectionable beat may occur between the frequency of light pulsation and of the shutter frequency, resulting in a low frequency pulsation of the light on the screen when a film is being projected, and such an arc may operate noisily, emitting a hum due to the light pulsations, and to overcome these troubles by a conventional smoothing filter it is necessary to use extremely large capacitors due to the low voltage and low impedance of the arc circuit. However none of the above objections apply to an arc fed from a balanced polyphase supply circuit, and as described in the specification of the United States Patent No. 2,253,053, issued on August 19, 1941, to Stevens et al. It is advantageous to supply a device such as the arc lamp of a cinematograph projector with operating current from a single-phase supply circuit through a phase converter and rectifier system; and various forms of phase converter, including those described in the specification above-mentioned, may be utilised for this purpose.

When operating a device such as the arc lamp of a cinematograph projector from a single-phase supply system through a phase converter generating an artificial polyphase supply, followed by a transformer and rectifier, the necessary ballast impedance has hitherto been interposed in the artificial polyphase circuit or load side of the phase converter.

According to the present invention, the ballast impedance device is connected in series on the supply circuit side of the phase converter, with a corresponding saving in the size and cost of this apparatus, a corresponding simplification of the ballast device, and a simplification of the method of adjustment of the working current.

The ballast impedance device may be of any suitable type, being advantageously constituted,

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for example, by a series connected condenser and inductance circuit of the kind described, for example, in United States patent to Boucherot, No. 548,511, and in the specification of the British Patent No. 473,368, granted to Westinghouse Brake & Signal Company, Limited, and others.

I shall now describe one form of apparatus embodying my invention and several modifications thereof and shall then point out the novel features thereof in claims.

Referring to the accompanying drawing, Fig. 1 illustrates one form of apparatus embodying my invention, while Figs. 2, 3 and 4 illustrate different alternative forms of the polyphase transformer 10 of Fig. 1.

Similar reference characters refer to similar parts in each of the views.

In carrying the invention into practice the apparatus may comprise a combined phase converter and transformer 10 having three core limbs each provided with primary and secondary windings. In the form shown in Fig. 1, the three primary windings are delta-connected, the winding on one of the core limbs being connected across the terminals 3 and 4 of a suitable condenser C1 connected in series with a suitable inductive reactor L1 to the supply circuit terminals 1 and 2. The reactive characteristics of the condenser C1 and the reactor L1 are arranged to be substantially equal and opposite at the frequency of supply so that the series connected capacity and inductance constitute an approximately resonant circuit. The current supplied to the primary windings of transformer 10 is by this arrangement substantially constant for any given value of supply voltage and is independent of variations in the impedance of the load circuit connected to terminals 3 and 4. Preferably the connection of one of the supply terminals to the reactor L1 is arranged to be effected to one or other of a number of tappings on the inductive winding as shown, so as to allow for different supply circuit voltages, while a number of auxiliary circuits each containing a relatively small condenser C3, C4, C5, etc., are arranged to be connected by the switches 13 alternatively across the whole of the winding or a fixed portion thereof or across the condenser C1, singly or in various combinations. These adjustable connections enable the current supplied to the primary windings of transformer 10 to be varied in calibrated steps as required to meet conditions of lamp operation without interruption of the circuit; while the calibration of these steps

is not disturbed by adjustment of the tappings for supply circuit voltages.

The primary winding on another of the core limbs in Fig. 1 is connected in parallel with a suitable reactor L2, across terminals 3 and 4 in series with the corresponding primary winding on the third core limb which is connected in parallel with a suitable condenser C2. The reactance L2 and condenser C2 are so proportioned as to constitute a phase converting device by which the currents in the three primary windings and the magnetic fluxes in the corresponding core limbs are substantially equally displaced in phase from each other.

It will be evident that the reactor L2 and condenser C2 may also be arranged as a ballast impedance device to supply a constant current to the primary windings across which they are connected.

The three secondary windings are connected in star or delta, their output terminals 5, 6 and 7 being connected to the input terminals of a three-phase rectifier system 11, of any suitable type, the rectified current output terminals 8 and 9 of this system being directly connected to the terminals of the arc lamp 12.

In operation it will be understood that the apparatus may be adjusted for different supply circuit voltages by means of the tappings on the reactor L1 above referred to, the reactance functioning as a auto-transformer while by transferring (by means of the single pole changeover switches 13) one or more of the auxiliary condenser circuits from connection in parallel with the reactor L1 to connection in parallel with the condenser C1 which is connected in series with the reactor L1, the rectifier current supplied to the arc circuit terminals 8 and 7 can be varied during operation as described without interruption of the main circuit.

This has the particular advantages that the ripple current is readily kept small over a wide range of arc operating conditions, that the arc current may be instantly adjusted, while in operation, in a large number of small steps to cover all requirements of carbon and projection circumstances relating to print density, atmospheric fog, etc., and further, that a constant current is maintained in the arc, giving high stability of operation at high efficiency and without the use of wasteful ballast resistances in the load circuit.

If desired, small damping resistances R3 as shown, may be permanently connected in series in the auxiliary condenser circuits to prevent current surges during the transfer of these circuits.

In an alternative construction shown in Fig. 2, the three primary windings arranged on the core as above described are not connected to one another, the primary winding on the central core limb only being connected to the supply circuit terminals 3 and 4 while the primary windings on the two outer limbs are connected in closed circuits including the reactance L2 and condenser C2 respectively.

In a further modification shown in Fig. 3 the primary windings on the transformer core are delta connected and the reactor L2 which in Fig. 1 is connected in parallel with the primary winding on one of the outer core limbs is omitted this core limb being provided with a suitable air-gap.

In a still further modification shown in Fig. 4, the primary windings are not connected with each other, and the winding on one of the outer core limbs which is provided with an air-gap is omitted altogether.

It will be evident that in all the forms of apparatus above described the ballast impedance device constituted by the series connected condenser C1 and reactor L1 connected to the supply circuit terminals 1 and 2 is located on the supply circuit side of the phase converter L2, C2 and transformer 10 so that the latter and the rectifier system 11 is not required to transmit the energy absorbed in the ballast impedance device and may thus be of correspondingly less size and cost.

It will be understood that the invention is not limited to the particular constructions above described by way of example which however possess the particular advantages explained, and that various modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. Current regulating apparatus for operating a device having a negative resistance characteristic by direct current derived from a single phase alternating current supply circuit, comprising a ballast impedance and a polyphase transformer provided with a phase converter and connected to said device through a polyphase rectifier, said ballast impedance comprising a condenser and reactor connected in series across the terminals of said supply circuit and having substantially equal and opposite reactive characteristics at the supply frequency, the output terminals of said ballast impedance being connected to the primary winding of at least one phase of said polyphase transformer, said ballast impedance and the phase converter associated with said transformer cooperating to cause the delivery of balanced polyphase currents regulated to compensate for changes in the resistance of said device to said rectifier in such manner that said rectifier is caused to supply a substantially constant direct current derived from said polyphase currents to said device.

2. Current regulating apparatus for operating a device having a negative resistance characteristic by direct current derived from a single phase alternating current supply circuit, comprising a ballast impedance and a polyphase transformer provided with a phase converter, said apparatus having a polyphase rectifier connected to its output terminals, for supplying direct current to said device, said ballast impedance comprising a condenser and reactor connected in series across the terminals of said supply circuit and having substantially equal and opposite reactive characteristics at the supply frequency, said condenser being connected across the primary winding of at least one phase of said transformer, the phase converter associated with said transformer being arranged to cause the delivery of balanced polyphase currents to the secondary terminals to which said rectifier is connected, said ballast impedance acting to vary the voltage impressed on said primary winding to compensate for changes in the resistance of said device so that said rectifier is caused to supply a substantially constant direct current to said device.

3. Current regulating apparatus for operating a device having a negative resistance characteristic from a single phase alternating current supply circuit, comprising in combination, a ballast impedance consisting of reactive elements of substantially equal and opposite reactance at the supply frequency connected in series across the terminals of said supply circuit, a phase converter comprising a reactor and a condenser connected

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in series across the terminals of one of said reactive elements, a polyphase transformer having three primary windings and three secondary windings, one primary winding being connected across the terminals of one of said reactive elements and the others across said reactor and said condenser, respectively, and means for supplying current regulated by said apparatus to said device, comprising three pairs of series connected rectifiers, connected in parallel across output terminals to which said device is connected, the mid-point connection of the rectifiers of each pair being connected to a different secondary terminal of said transformer, whereby said rectifiers supply direct current successively to said device when supplied with polyphase alternating current by said transformer.

4. Current regulating apparatus for operating a device having a negative resistance characteristic from a single phase alternating current supply circuit comprising transformer means having polyphase primary and secondary windings and a ballast impedance consisting of reactive elements of substantially equal and opposite reactance at the supply frequency interposed between the terminals of said supply circuit and said transformer means, arranged to compensate for variations in the resistance of said device by supplying a substantially constant single phase current to at least one of the polyphase primary windings, said apparatus also including a phase converter arranged to cause balanced polyphase voltages to be developed at the terminals of said secondary windings when said one primary winding is supplied with single phase current, and means for supplying current regulated by said apparatus to said device, comprising a plurality of rectifiers interposed between polyphase terminals of said secondary windings and said device, said rectifiers being arranged to supply direct current successively to said device.

5. Current regulating apparatus for operating a device having a negative resistance characteristic from a single phase alternating current supply circuit comprising transformer means having polyphase primary and secondary windings, a regulator consisting of reactive elements of substantially equal and opposite reactance at the supply frequency interposed between the supply terminals of said circuit and said transformer means, arranged to supply a substantially constant single phase current to at least one of the polyphase primary windings, which is proportional to the supply voltage, and independent of

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the resistance of said device a series of taps for adjusting the inductive element of said regulator for different supply voltages, a plurality of condensers having a capacity relatively small in comparison with that of the capacity element of said regulator, means for connecting said condensers singly or in combination across either element of said regulator to vary the current delivered thereby in calibrated steps without interruption of its circuit, a phase converter arranged to cause balanced polyphase voltages to be developed at the terminals of said secondary windings when said one primary winding is supplied with single phase current, said apparatus having a polyphase rectifier connected to said secondary terminals for supplying rectified polyphase current regulated by said apparatus to said device.

6. Current regulating apparatus for operating a device having a negative resistance characteristic by direct current derived from a single phase alternating current supply circuit, comprising a polyphase transformer having primary and secondary windings, a ballast impedance comprising a condenser and reactor having opposite reactive characteristics connected in series across the terminals of said supply circuit and having output terminals to which at least one primary winding of said polyphase transformer is connected, a plurality of condensers having a capacity relatively small in comparison with the condenser of said ballast impedance, means for connecting said condensers singly or in combination across either the condenser of reactor of said ballast impedance to adjust the current delivered thereby in calibrated steps, and phase converting means associated with said transformer for causing balanced polyphase currents to be induced in said secondary windings when said one winding is supplied with current from said ballast impedance, said apparatus having a polyphase rectifier connected to said secondary windings for supplying current regulated by said apparatus to said device.

ALEC HERVEY BENNETT WALKER.

REFERENCES CITED

The following references are of record in the file of this patent:

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2,364,558	Stocker	Dec. 5, 1944