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ANTIREVERSER FOR ALTERNATING CURRENT CIRCUITS.

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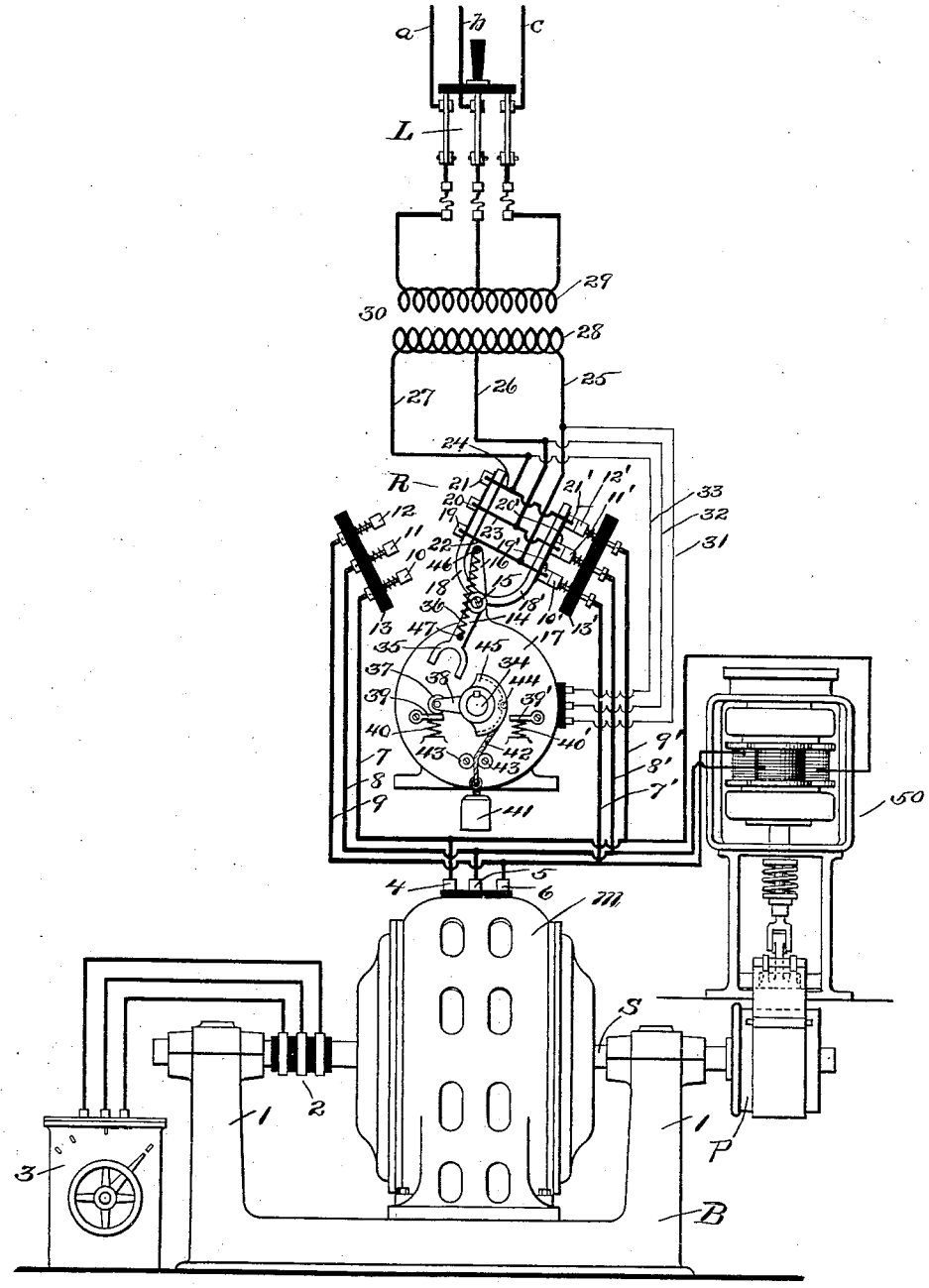
**1,066,721.** Patented July 8, 1913.

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# UNITED STATES PATENT OFFICE.

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## ANTIREVERSER FOR ALTERNATING-CURRENT CIRCUITS.

1,066,721. Specification of Letters Patent. Patented July 8, 1913.

Application filed December 5, 1906. Serial No. 346,371.

*To all whom it may concern:*

Be it known that I, ERNEST L. GALE, SR., a citizen of the United States, residing at Yonkers, in the county of Westchester and State of New York, have invented a new and useful Improvement in Antireversers for Alternating-Current Circuits, of which the following is a specification.

My invention relates to protecting means for translating devices and one of its objects is the provision of automatic means for reversing the connections to a translating device upon the phase relation of the currents being reversed on the line.

A further object of the present invention is to provide means for reversing motor connections, upon a reversal of the main line current so that the motor will always operate in the direction desired.

Another object of my invention is the provision of an antireversing switch which shall be held firmly in closed position free from chattering noises due to alternations of current.

Another object is to open-circuit or interrupt the main line current upon the line voltage dropping below a predetermined value; also to effect the application of a brake on failure of current supply to the motor.

Other objects of the invention will appear hereinafter the novel combinations of elements being pointed out in the claims.

In the accompanying drawing is shown one form of my invention applied to a multiphase electric motor but I wish it to be understood that it may be applied to other translating devices if desired. Furthermore, I do not limit myself to any particular details of construction or arrangement of parts as it is obvious that those skilled in the art may make various modifications without departing from the spirit and scope of my invention.

Referring to the drawing, *m* indicates a multiphase motor supported on a suitable bed-plate B and having its shaft S mounted in the bearings 1, 1. At one end of the shaft is shown a pulley P. The motor may be connected to the apparatus to be operated in any desired manner. At the other end of the shaft S is a series of insulated slip rings to connect the rotor circuits to the starting device 3, which in this case, is manually operated but which may be substituted by any automatic starting device if desired.

The motor terminals 4, 5, 6 are connected respectively by means of the leads 7, 8, 9 to the spring-pressed contacts 10, 11, 12 which are mounted on the inclined fixed support 13 of insulation. The motor terminals are also connected to the spring-pressed contacts 10′, 11′, 12′ by means of the leads 7′, 8′, 9′, said contacts being mounted on the inclined insulating support 13′. The said contacts 10, 11, 12 or 10′, 11′, 12′ may have any arrangement desired relatively to each other so long as they may be engaged by the contacts mounted on the gravity lever 14. The vertical inclined arrangement in the drawing is set forth for the sake of clearness. In any event, however, when a gravity switch lever is used, the spring-pressed contacts are preferably symmetrically arranged as shown. The switch lever 14 is pivoted in this instance to a bracket 16 secured to the frame of the auxiliary alternating current motor 17. This lever is here shown as provided with two upwardly extending arms 18, 18′ which carry the insulated contacts 19, 20, 21 and 19′, 20′, 21′. If desired, the arms 18, 18′ may be a single arm and the contacts 19, 19′, etc., respectively, made integral with each other. They are practically so even as shown in the drawing, as they are cross-connected respectively by means of the conductors, 22, 23, 24, which are respectively connected to the wires 25, 26, 27 leading to the terminals of the secondary winding 28 of the transformer 30. The primary winding 29 of this transformer is connected to the main line switch L, which when closed, connects the main lines *a*, *b*, *c* of a source of two or three-phase alternating current directly to the transformer primary terminals. Now when the main line switch L is closed and the contacts 19′, 20′ and 21′ are respectively in engagement with the contacts 10′, 11′ and 12′, alternating current will be fed to the motor to start the same in a certain direction, and the starting apparatus 3 may be used to increase the speed of the motor.

The auxiliary motor 17 is connected by means of the leads 31, 32 and 33 to the wires 25, 26 and 27, respectively. If desired the auxiliary motor may be connected directly

to the main lines *a*, *b*, *c* or to a separate transformer if a different voltage is desired. Whenever, therefore, the main line switch L is closed, the auxiliary motor receives current and will tend to rotate its shaft 34 in a certain direction to operate the motor-reversing switch R if necessary.

The lower end of the gravity lever 14 is provided with a fork 35 in the path of an anti-friction roller 37 at the outer end of the arm 38 fixed to the shaft 34. Also in the path of said roller are limit stops 39, 39′ cushioned by means of springs 40, 40′. These spring-pressed stops are in reality resilient abutments for the purpose of absorbing vibrations of the arm 38 due to the alternations of current in the auxiliary motor 17.

When the current is cut off from the auxiliary motor 17, a centering device is depended upon to return the arm 38 to substantially central or vertical position. Any suitable centering device may be used but in this instance I have shown a weight 41 suspended by means of the flexible connection 42 from the point 44 of the segment 45 which is keyed to the auxiliary motor shaft 34. This flexible connection may be a rope, strap or the like and preferably passes between the anti-friction rollers 43, 43 mounted on fixed bearings attached to the auxiliary motor frame. As shown in the drawing, the point 44 is in substantial alinement with the arm 38 and when the auxiliary motor is energized, the rope 42 winds partly on the segment 45, the latter being grooved for this purpose. Now when the current is interrupted to the auxiliary motor 17 the weight 41 will move the arm 38 to vertical position. In doing so the fork 35 will be struck after the said arm 38 acquires a certain momentum and this action will have the effect of quickly opening the motor-reversing switch R. It is true that the switch lever arm 14 may then be given sufficient momentum to cause the same to fly past center and thus allow the spring 36 to tend to move the reversing switch R to its opposite position, but the weight 41 will prevent this in holding the arm 38 in nearly vertical position. When the parts are at rest the points 46 and 47 to which the ends of the spring 36 are connected should be in substantial alinement with the pivotal point 15 though this is not essential. For any given phase relation of the main lines *a*, *b*, *c* the auxiliary motor will always tend to move in the same direction when supplied with current, say to the left as indicated. As soon as the fork 35 is moved a short distance to the left by the arm 38, the spring 36 will act to assist gravity in closing the switch R in its right-hand position and holding the same in such position. It will therefore be seen that there is no possibility of any chattering noises or beating at the switch contacts due to alternations of current in the electric device for operating such switch. When the switch is vertically arranged, the spring 36 could be omitted, but if placed in a horizontal position this spring or other tension device would be essential to hold the switch closed. When the switch R has been moved to its right-hand position, as indicated in the drawing, the various phase wires between the transformer and motor *m* may be traced as follows: From the left-hand terminal of the secondary 28, a wire 27 leads to the contact 21′ which is in engagement with the contact 12′, the latter being connected by means of the wire 9′ to the motor terminal 4; the central terminal of the secondary 28 is connected to the motor terminal 5 by means of the wire 26, contacts 20′, 11′ and wire 8′; and the right-hand terminal of the secondary 28 is connected to the motor-terminal 6 by means of the wire 25, contacts 19′, 10′, and wire 7′.

Should for any reason the phases of the main line become reversed whether the motor *m* is stationary or in operation, the auxiliary motor 17 would immediately turn its shaft in the right-hand direction. The fork 35 would then be struck a hammer blow by the roller 37 and the arms 18, 18′ with their contacts, swing to the left so that the contacts 19, 20 and 21 would respectively engage the spring-pressed contacts 10, 11 and 12. The object of this operation is to obtain the same relative connections between the main line phases and the motor as before so that the latter will operate in the same direction as it did when the switch R was closed in its right-hand position.

By reversing the connections of any two of the main lines *a*, *b*, *c* or by interchanging any two of the wires *a*, *b*, *c*, a reversal of the phase relation of the main line circuit is obtained. Assuming, therefore, that the wires *a* and *c* have been accidentally interchanged, the phase relation of the leads 31, 32 and 33 of the auxiliary motor 17 will be reversed so that the latter will reverse its rotation and throw the switch R to its left-hand position. When the wires *a* and *c* are thus interchanged, the leads 25 and 27 and consequently the wires 7′ and 9′ are also in effect interchanged so that the main motor *m* would start in the wrong direction or tend to reverse if in operation.

When the switch R is thrown to its left-hand position, the lead 25 which corresponds to the interchanged main line *a*, is now connected to the motor terminal 4 and the lead 27, corresponding to the main line *c* is connected to the motor terminal 6. It will therefore be seen that the same phase relation between the main line circuit and the motor windings is maintained even after the phase relation of the main line has been reversed. Furthermore, by reason of the anti-reversing apparatus, the motor *m* will operate in the

desired direction independently of the phase relations of the main line circuit.

If the wire *b* were interchanged with the wire *a* or with the wire *c*, the result would be the same. In each case the motor 17 would be reversed and the switch R thrown to its left-hand position. In any event the lines *a*, *b* and *c* should correspond respectively with the motor terminals 4, 5 and 6, or all the connections interchanged so that the motor *m* will operate in the same direction as before. For instance, if the wire *a* is interchanged with wire *b* and the switch R consequently thrown to its left-hand position, wire *a* will be connected to motor terminal 5 instead of 4; wire *b* to terminal 6 instead of 5; and wire *c* to terminal 4 instead of 6. The phase relation of the motor windings will therefore remain the same although the phase relation of the main lines has been changed. So also if wires *b* and *c* are interchanged and the switch R moved to its left-hand position, wire *a* will be connected to motor terminal 6 instead of 4; wire *b* to terminal 4 instead of 5; and wire *c* to terminal 5 instead of 6. Consequently when wires *a* and *c* are interchanged, the automatic gravity switch restores the exact connections, but when wires *a* and *b* or *b* and *c* are interchanged, all the motor connections are changed in such a way that the phase relation of the stator windings remains the same as during normal operation. That is, the anti-reversing switch will maintain the direction of rotation of the field in the stator of the motor *m* the same for all possible operative connections of the main line current to the motor *m*.

It should be undestood that I do not limit myself to any particular use to which my invention may be put. For instance, the main motor may be any one of various types of alternating current motors, or any kind of direct-current motor, and the auxiliary motor constructed to use the same kind of current. In any event, if there is any reversal of current on the main line, the anti-reversing switch will prevent the current from being reversed in the motor. By reference to the drawing it will be seen that I have in this instance connected brake apparatus 50 to the conductors 7′, 8′ and 9′. That is the brake release magnet of the usual brake apparatus is supplied with current from the conductors 7′, 8′ and 9′ when both the reversing switch R and the manual main line switch L are closed. It is therefore evident that when the potential between the branch conductors 31, 32 and 33 which connect the auxiliary motor to the conductors 25, 26 and 27 reach points beyond the anti-reversing switch R with respect to the motor *m*, falls below a predetermined value the arm 38 will strike the fork 35 a hammer blow to open the anti-reversing switch R and thus interrupt the supply of current to both the brake magnet and the main motor. The brake will therefore at once act to slow down and stop the motor. If desired, the application of the brake may be retarded in any suitable manner.

Without limiting myself to the precise construction of details and arrangement of elements herein disclosed, what I claim and desire to have protected by Letters Patent of the United States is:—

1. The combination with a translating device, of a source of alternating current therefor, and means responsive to interchange of phase relation of current for preventing reversal of said translating device without stopping said translating device.

2. The combination with a translating device, of a main line circuit or circuits therefor, and means responsive to interchange of phase relation of current in the main line for preventing reversal of said translating device while only momentarily cutting off the current from said translating device.

3. The combination with a translating device, of a main line circuit or circuits therefor, and an anti-reversing switch responsive to reversal of phase relation of current in the main line for preventing the reversal of said translating device without stopping said translating device.

4. In motor controlling apparatus, the combination with a main line or lines, connections between said main line or lines and said motor, and an anti-reversing switch responsive to a reversal of phase or interchange of phase in the main line or lines, to prevent the said reversal of phases or of said interchange of phase from effecting the reversal of said motor, without stopping the latter.

5. The combination with an alternating current motor, of a main line circuit or circuits therefor, and an anti-reversing switch connected between said main line circuits and said motor responsive to a change in the phase relation to prevent the reversal of said motor when the phase is reversed or phases interchanged in the main line circuits without stopping the motor.

6. The combination with a motor, of a main line circuit therefor, an anti-reversing switch for said motor, and means responsive to a change in phase relation for automatically operating said switch to prevent reversing of the motor when the phases in the main line circuit are reversed or interchanged.

7. The combination with a motor, of a main line circuit, an anti-reversing switch connected between the main line circuit and said motor, and an electric device connected to the main line and operating said switch upon reversal of phases or interchange of

phases in the main line circuit to prevent the motor from reversing without stopping the same.

8. The combination with an alternating-current motor, of a source of alternating-current, an anti-reversing switch, and an electric device dependent upon said source of alternating current to operate said switch to maintain the currents and phase relations in the motor the same whatever the currents or phase relations in said source of current.

9. The combination with an alternating-current motor, of a source of alternating current therefor, an anti-reversing switch, and means dependent upon reversal of phase relations or interchange of phase relations in said source of current for operating said switch to maintain the phase relations in the motor the same.

10. The combination with a multiphase motor, of a main line circuit or circuits for conducting multiphase current to said motor, an anti-reversing switch, and an electric device dependent upon reversal or interchange of phase relations of current in the main lines for operating said switch to prevent a reversal or interchange of phase relation in the motor.

11. The combination with a motor, of a main line anti-reversing switch, an auxiliary motor for operating said switch, and connection between the main line and auxiliary motor to effect a quick reversal of the latter when phase relations in the main line are reversed or interchanged to actuate the switch.

12. The combination with an alternating-current motor, of an anti-reversing switch therefor, means for holding said switch in open circuited position, an electric device for operating said switch to closed position, and connections for said electric device to operate the same and effect a quick operation of the anti-reversing switch to the opposite position.

13. The combination with a motor, of main line conductors therefor, an anti-reversing switch for said motor, means for holding said switch in open circuited or central position, an electric device for actuating said holding means to release the switch to one of its closed positions, and connections with said electric device to effect a quick reversal thereof and also of the anti-reversing switch when the phase relations of the current in the main line conductors are reversed or interchanged.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

ERNEST L. GALE, Sr.

Witnesses:
Alfred C. Bechet,
Chas. M. Nissen.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."