

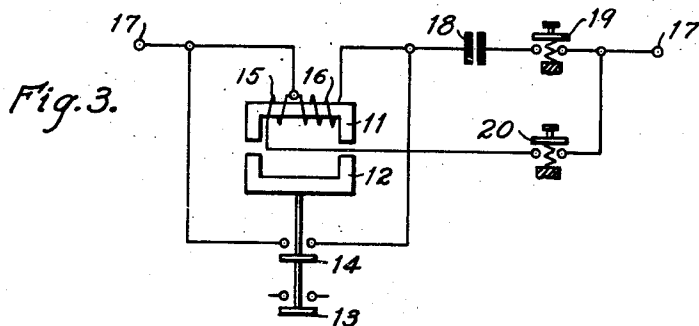
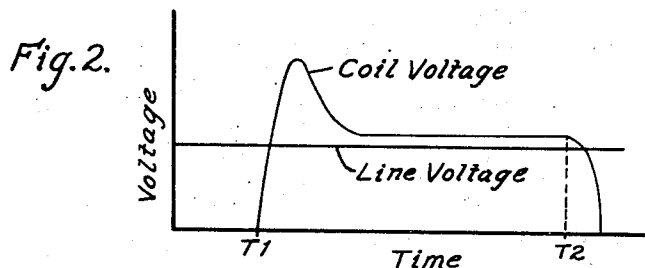
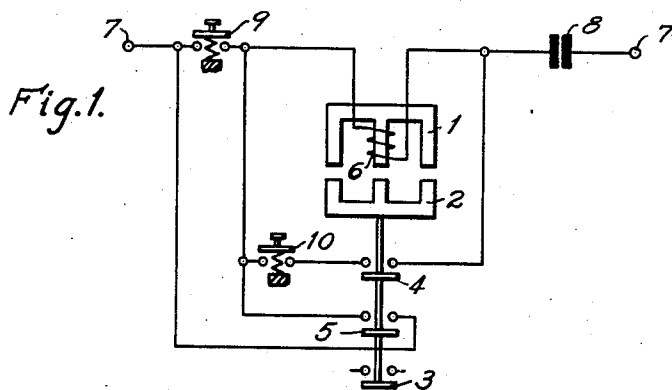
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J. B. OWENS ET AL

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RELAY CONTROL CIRCUIT

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WITNESSES:

James A. Young
Chas. W. Perry

INVENTORS

James B. Owens and
Robert H. Hiltson.

BY

Paul E. Friedmann
ATTORNEY

UNITED STATES PATENT OFFICE

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RELAY CONTROL CIRCUIT

James B. Owens and Robert H. Hitson, Wilkinsburg, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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Our invention relates to circuits for controlling the operation of electromagnetic relays.

In automatic switching or relay equipment, it is often desirable to cause a contactor or other electromagnetic relay to drop out by short circuiting its operating coil. This may be accomplished by connecting a resistor in series with the coil in order to limit the short circuit current. This method, however, requires a considerable current consumption when used with relays which have a wide inductance variation between the open and closed condition of the appertaining magnetic circuit. With such relays, if the resistance in series with the coil is made low enough to allow the relay to pick up from the open position, a rather high current will flow through the coil in the closed position.

Similar conditions exist with relays whose magnetic circuit has sufficient residual magnetism to hold the armature in closed position after cessation of the pick-up excitation imposed on the coil. When such residually held relays are provided with a control contact for short circuiting the coil after temporary excitation of the coil, the use of a series resistor for limiting the current during short-circuit periods of the coil has also the result of requiring a rather high current due to the considerable change in coil inductance between open and closed relay positions.

It is an object of the invention to provide a control circuit for electromagnetic relays that permits short circuiting the relay coil while operating with a low pick-up (open position) current and also with a low holding (closed-position) current.

Another object of the invention is to achieve the just-mentioned advantage by means of circuit devices of simple design and low cost so as to be comparable, in these respects, with the above-mentioned use of series resistors.

A still further object of the invention is to provide a relay circuit for alternating-current operation which reduces the burden on the source of control current by securing a more favorable power factor than that prevailing in series resistor circuits.

An object of the invention is also to devise a relay circuit which affords an accelerated pick-up performance on closing without placing an overvoltage on the relay coil.

In order to achieve these objects, and in accordance with our invention, we connect a capacitor in series with the relay coil to be short circuited and dimension this capacitor electri-

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cally with respect to the coil so that in the open position of the relay a resonant rise in voltage is caused in the series circuit, thereby producing a voltage across the coil which is higher than the terminal voltage of the relay circuit. When the relay picks up, the increased inductance of its operating coil causes the series combination to depart considerably from resonance so that the voltage impressed on the operating coil drops accordingly. Hence this tuned series arrangement provides a high voltage across the operating coil when such voltage is favorable in order to pick up the relay armature and a lower voltage when the armature is in closed position so that such lower voltage is sufficient to hold the relay magnetically sealed. In contrast thereto, the above-mentioned use of a resistor in series with a relay coil of greatly variable inductance provides a low coil voltage before the armature picks up a higher voltage to hold the armature closed, which is contrary to the favorable conditions afforded by a tuned series capacitor.

If in a relay controlled circuit according to the invention the operating coil is short circuited after the armature has picked up, the capacitor alone is connected across the terminals of the circuit and draws only a low current, for instance less current than passed previously through the coil circuit.

Figure 1 of the drawing shows the diagram of a relay control circuit according to the invention.

Fig. 2 is a voltage time diagram explanatory of conditions occurring in a circuit according to Fig. 1; and

Fig. 3 represents diagrammatically another embodiment of a control circuit according to the invention.

Referring to Fig. 1, the relay, whose operation is to be controlled, has a laminated and substantially E-shaped magnetic field structure 1 and an appertaining armature 2 also of laminated and E-shaped design. The armature 2 is movable vertically with respect to the field structure 1 against gravity bias and operates a main relay contact 3. This contact is shown as representative of a large number of available contact devices involving one or several make or break contacts in any combination needed for the particular control function to be performed by the relay circuit. The movable armature assembly according to Fig. 1 is further provided with an interlock contact 4 and a self-holding contact 5. The control coil 6 of the relay, mounted on the

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stationary field structure 1, is connected between the two terminals 7 of the relay circuit. Series connected with coil 6 between terminals 7 are a capacitor 8 and a control contact 9, the latter being shown as a normally open push-button contact. Another control contact 10, normally biased toward open position, is connected across coil 6 in series with the above-mentioned interlock contact 4.

The magnetic circuit of the relay has negligible retentive magnetism and is of such type as to develop a considerable change in the inductance of coil 6, depending on whether the armature 2 is in the illustrated dropped position or whether the armature is lifted and in engagement with the field piece 1. That is, the resistance of coil 6 to the flow of alternating current therethrough is low when the armature is in open position and high when the armature is in closed position. Capacitor 8 and coil 6 are rated so that they form a circuit combination which is substantially in resonance when coil 6 has low inductance but is considerably out of tune with the frequency of the alternating control current when the armature is closed and the coil inductance correspondingly high.

The closure of contact 9 completes the series circuit of capacitor 8 and coil 6 between terminals 7. Assuming the armature to be dropped out as shown, the resonance system is tuned and causes a high voltage to appear across coil 6. As a result, the relay magnet is sufficiently energized to lift the armature 2. This causes a reduction in coil voltage, but since a low excitation is required to merely hold the relay in the closed position, the reduced voltage is again sufficient for a proper relay operation. The closure of armature 2 actuates the main contacts of the relay and has also the effect of closing a self-holding circuit at contact 5. As a result, contact 9 can now be released without affecting the operation of the relay. When thereafter the contact 10 is temporarily closed, it short circuits and thereby de-energizes the coil 6, thus releasing the armature assembly to move under its bias into the open position.

The voltage conditions prevailing at relay coil 6 during the just-mentioned operation of the system are typified by the schematic diagram of Fig. 2. When contact 9 is closed at the moment T1, the coil voltage increases rapidly above the line voltage applied to the terminals 7 and then declines while the armature moves toward the stationary field structure of the relay. At the end of the armature movement, a stable coil voltage is reached which is considerably lower than the initial peak voltage and, for instance, somewhat above the terminal voltage. When the coil 6 is short circuited by closing contact 10 at the time point T2, the coil voltage drops to zero and the line voltage is applied across the capacitor 8. The capacitor draws less current than did previously the capacitor coil combination so that the short circuiting does not have the effect of increasing the current consumption. The presence of the capacitor in the coil circuit of the relay has further the advantage of correcting the power factor of this circuit and thereby reduces the burden imposed on the current source. Due to the steep increase in voltage immediately upon the closure of the coil circuit, the response of the relay is accelerated without placing a continuous overvoltage on the coil.

In the modification according to Fig. 3, the relay has a stationary field structure 11 and a mov-

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able armature 12, both preferably laminated, which form together a retentive magnetic circuit. That is, this circuit contains a magnetic material whose remanent magnetism is sufficient to hold the armature sealed against the field structure once the magnetic circuit has been properly magnetized. The armature 12 actuates an assembly of contacts which includes one or several main contacts, such as the one denoted by 13, and an auxiliary contact 14 which closes shortly before armature 12, during its closing movement, reaches the end of its travel, or which is time delayed and hence closes only after the armature 12 has abutted against the field structure.

The field structure 11 is provided with two coils 15 and 16 respectively. Coil 16 is the main operating coil of the relay and is connected between the circuit terminals 17 in series with a capacitor 18 and a normally open control contact 19. Another control contact 20, normally biased toward its open position, is connected in series with coil 15 directly between the terminals 17.

When the magnetic parts 11 and 12 are demagnetized, the armature assembly assumes the illustrated open position under the effect of its gravity or other biasing force. When contact 19 is temporarily closed, the circuit of coil 16 is completed through the series capacitor 18. Capacitor 18 is tuned as described previously so that a high initial voltage appears across coil 16. This voltage suffices to magnetize the magnetic circuit of the relay so that armature 12 is attracted and sealed against the field structure 11, thereby increasing the reactance of coil 16. Consequently, at the end of the armature closing movement, the coil voltage is reduced to a lower value. The closing contact 14 short circuits the coil 16 and thereby terminates the electric excitation of the magnetic relay circuit. However, the residual magnetism in this circuit is normally sufficient to maintain the relay in sealed condition. If the short circuit at contact 14 should be established at an instant near the zero passage of the energizing voltage so that the residual magnetism is insufficient to seal the armature, the movable assembly will drop off so that another magnetizing and short circuiting cycle is initiated and if necessary repeated until the armature remains sealed. The short circuiting of the coil imposes the terminal voltage across the capacitor 18. In order to cause the relay to drop out, contact 20 is temporarily closed. This completes the circuit of coil 15 which is rated for providing a weak demagnetizing effect. Consequently, a few voltage cycles of the demagnetizing current suffice to reduce the residual magnetism of the relay below the value necessary for holding the armature in picked-up position. The armature assembly will then follow its bias and return to the illustrated dropped off position. It will be obvious that the advantages mentioned above in conjunction with the embodiment of Fig. 1 are also realized with relay circuits according to Fig. 3.

Those skilled in the art will further understand from the foregoing disclosure that the modifications as to details and specific circuit arrangements can be made within the gist of our invention and without departing from the essential features of the invention, as set forth in the claims attached hereto.

We claim as our invention:

1. A relay control circuit comprising, in combination, an electromagnetic relay having an armature biased toward open position and a magnet coil for moving said armature into closed po-

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sition, said coil having low inductance when said armature is in open position and high inductance when said armature is in closed position; terminal means for supplying energizing alternating current to said coil; a capacitor connected with said coil between said terminal means and tuned relative to said coil so as to form together therewith a series circuit which is substantially resonant at said low inductance and substantially non-resonant at said high inductance; and control means connected across said coil for short circuiting, when actuated, said coil in series to said capacitor.

2. A relay control circuit comprising, in combination, an electromagnetic relay having an armature biased toward open position and a magnet coil for moving said armature into closed position, said coil having low inductance when said armature is in open position and high inductance when said armature is in closed position; terminal means for supplying energizing alternating current to said coil; a capacitor series connected with said coil and said terminal means and tuned relative to said coil so as to form together therewith a circuit which is substantially resonant at said low inductance and substantially non-resonant at said high inductance; a control contact series-connected with said coil and said terminal means for selectively closing and interrupting the series connection of said coil and said terminal means; and a normally open control contact connected across said coil for short-circuiting said coil in series with said capacitor in order to cause said armature to move under its bias to open position.

3. A relay control circuit comprising, in combination, an electromagnetic relay having an armature biased toward open position and a magnet coil for moving said armature into closed position, said coil having low inductance when said armature is in open position and high inductance when said armature is in closed position; terminal means for supplying energizing alternat-

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ing current to said coil; a capacitor series connected with said coil and said terminal means and tuned relative to said coil so as to form together therewith a circuit which is substantially resonant at said low inductance and substantially non-resonant at said high inductance; a normally open control contact series connected with said coil between said terminal means for closing the series connection of said coil and said terminal means; a self-holding contact controlled by said armature and connected across said control contact so as to maintain said series connection closed upon actuation and release of said control contact; and another normally open control contact connected across said coil for short-circuiting when closed said coil in series with said capacitor.

4. A relay control circuit comprising, in combination, an electromagnetic relay having a retentive magnetic circuit which includes an armature biased toward open position; a magnetizing coil inductively associated with said magnetic circuit for causing, when energized, said armature to move into closed position, said coil having low inductance when said armature is in open position and high inductance when said armature is in closed position; terminal means for supplying energizing alternating current to said coil; a capacitor connected with said coil between said terminal means and tuned relative to said coil so as to form together therewith a series circuit which is substantially resonant at said low inductance and substantially non-resonant at said high inductance; a contact controlled by said armature and connected across said coil for short-circuiting said coil in series with said capacitor when said armature is in closed position; and controllable means for demagnetizing said magnetic circuit.

JAMES B. OWENS.
ROBERT H. HITSON.