

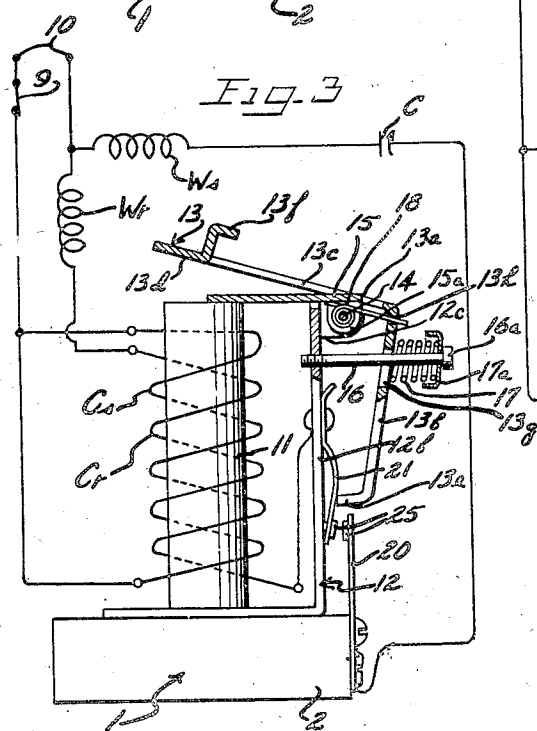
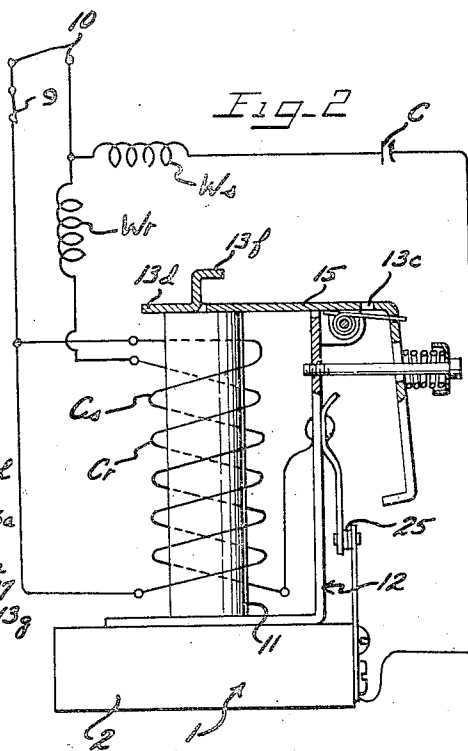
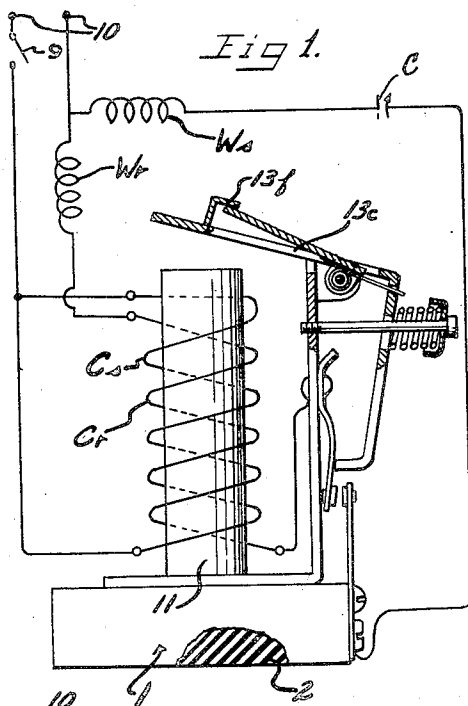
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RELAY

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RELAY

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This invention relates to an improved relay which is particularly adapted for use in controlling the circuit connections of the starting winding of a single phase motor.

Various relay arrangements have been heretofore proposed to automatically effect the disconnection of the starting or phase winding of a single phase motor from the energization circuit upon the acceleration of the motor to a desired speed wherein the main or running windings of the motor are capable of satisfactorily controlling the further operation of the motor. The relay devices which have heretofore been employed have generally been responsive to the current or voltage in the starting winding circuit arriving at a predetermined value whereupon the operation of the relay was effected to disconnect the starting winding from the energization circuit. Arrangements of this type are not only subject to the disadvantage of requiring a highly sensitive performance but have the further disadvantage of being rendered unreliable and inaccurate in operation when the motor is employed in any supply circuit wherein a substantial range of voltage variation is encountered.

Furthermore, relay constructions heretofore known have been uniformly subject to the disadvantage that the movement of the armature member of the relay which effected the deenergization of the starting winding of the motor did not produce such substantial changes in the magnetic circuit of the relay as to insure that the armature would not be immediately re-attracted or otherwise moved to its circuit closing position to produce a recycling operation of the relay. Such recycling tendencies in conventional relays are also particularly noticeable under abnormal line voltage conditions, occurring either at high or low line voltages, depending on the construction of the particular relay.

It is a feature of this invention that a relay construction is provided which, when applied to the control of the energization of the starting winding of a single phase motor, has the advantage of being substantially independent of variations in the line voltage available for energizing such motor, inasmuch as the relay functions to disconnect the starting winding upon the current in the starting winding obtaining a predetermined phase and magnitude relationship with respect to the current flowing in the running winding of the motor. By operating upon the proportional relationships of the current in the starting and running winding circuits, the effects of line voltage variations are substantially eliminated.

A relay constructed in accordance with this invention has the further advantage of incorporating an arrangement wherein the movement of an armature member to effect the opening of the switch contact in the circuit of the starting winding produces such a substantial change in the magnetic circuit of the relay as to insure that the armature member will not again be moved to its circuit closing position irrespective of variations in voltage of the supply source or the load carried by the running winding of the machine, unless the current in the running winding of the motor achieves a sufficiently large magnitude as to be commensurate with the initial starting current of the motor and then the assistance of the starting winding is desirable.

Accordingly, it is an object of this invention to provide an improved relay, and particularly a relay which is responsive to relative magnitude and phase differences of a plurality of exciting currents.

A further object of this invention is to provide an improved starting relay for a single phase motor having starting and running windings characterized by the reliable operation of the relay to disconnect the starting winding from the energizing circuit upon the attainment of a predetermined phase and magnitude relationship of the currents flowing in the starting and running windings of the motor, and such operation being substantially independent of variations of the supply voltage.

Still another object of this invention is to provide a relay construction characterized by the incorporation of a magnetic circuit arrangement which prevents the recycling of the relay after its initial operation until proper conditions are established requiring the re-operation of the relay.

A particular object of this invention is to provide an improved relay for controlling the energization of the starting winding of a single phase motor characterized by the uniform reliable operation of the relay to disconnect the starting winding from the energizing circuit when the current in such starting winding attains a predetermined phase and magnitude relationship to the current in a running winding, and further characterized by the provision of means for preventing the recycling operation of the relay to reinsert the starting winding in the energization circuit unless the motor load is increased to a point wherein the addition of the starting winding energization circuit is necessary to prevent stalling.

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The specific nature of this invention, as well as other objects and advantages thereof, will become apparent to those skilled in the art from the following description of the annexed sheet of drawings which, by way of preferred example only, illustrate one embodiment of the invention.

On the drawings:

Figure 1 is a schematic view of a relay embodying this invention showing it in circuit connection with the windings of a single phase motor and illustrating the position of the components of the relay prior to energization of the motor.

Figure 2 is a view similar to Figure 1 but illustrating the position of the components of the relay after the motor has been energized but before the motor has achieved a sufficient speed wherein it would be desirable that the starting winding be deenergized.

Figure 3 is a view similar to Figure 1 but illustrating the position of the components of the relay after the motor has attained full speed and the starting winding has been disconnected from the energizing circuit.

As shown on the drawings:

Those skilled in the art will recognize that a single phase motor having a main winding and a starting or phase winding, for example a capacitor start motor, can develop a starting torque only when both the main winding and the phase or starting winding are energized. Upon the initial energization of such a motor, a very large current flows in the main winding of the motor and a relatively smaller current flows in the starting winding, which latter current, in the case of the capacitor start motor, is substantially displaced in phase from the current flowing in the main winding. As the motor accelerates and comes up to normal speed, the current in the main winding falls off rapidly while the current in the starting winding builds up with equal rapidity. At the same time, the phase of the current in the starting winding circuit approaches the phase of the current flowing in the main winding. A point is thus reached under any starting conditions wherein the currents flowing in the starting and running windings of the motor will be of substantial equal magnitude and will be substantially in phase with each other.

A relay embodying this invention operates upon the principle of effecting a control action in response to the attainment of a predetermined relationship between the current flowing in the starting winding of the motor and the current flowing in the main winding. By initiating the control action which results in the disconnection of the starting winding from the energization circuit upon the occurrence of such predetermined relationship, the effects of variations of voltage of the energizing circuit are substantially eliminated, for, under any starting conditions, whether the line voltage be higher or lower than normal, at any motor speed wherein it is desired that the disconnection of the starting winding be effected, the currents flowing in the starting and running windings will bear approximately the same relationship to each other in magnitude and phase.

Referring to the drawings, there is shown a relay 1 embodying this invention together with a schematic indication of the connections of such relay with respect to the main winding W_r and the starting winding W_s of a single phase motor. It should be distinctly understood, however, that a relay constructed in accordance with this invention is not limited specifically to use in a single phase motor starting circuit but has desir-

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able characteristics which may be incorporated in other applications, as will become apparent to those skilled in the art as the description proceeds.

The motor windings are energized from a suitable source of alternating current voltage represented by the line terminals 10 and the energization circuit for the main or running winding W_r is completed by closing of the switch 9. An energizing coil C_r of the relay 1 is connected in series with the running winding W_r while a second energizing coil of the relay C_s , wound in opposition to the coil C_r , is connected in series with the starting winding W_s through the switch contacts 25 and a starting condenser C.

The relay 1 preferably embodies a suitable assemblage of magnetic members to define a magnetic circuit having a low permeability gap portion therein. For example, such magnetic members may comprise core 11 which is supported upon the base arm 12a of an L-shaped magnetic frame member 12. Arm 12a is in turn supported on an insulating block 2. The vertical arm 12b of the frame member 12 extends in generally parallel relationship to the core 11 and hence provides at its top end a low permeability air gap between itself and the core 11.

A primary armature member 13 is provided which is movably mounted relative to the magnetic frame member 12 and the core 11 so as to move into a bridging position with respect to the air gap defined between such members. For example, the primary armature member 13 may comprise an inverted L-shaped metal stamping which is pivotally mounted adjacent its vertex to the top end of the vertical frame arm 12b. For this purpose, the frame arm 12b may be provided with integral outturned ears 12c while the armature 13 is provided with a pair of downturned ears (not shown) which are apertured to receive a mounting pin 14 supported by the frame ears 12b.

The primary armature 13 is thus pivotally supported with one arm 13a in a generally horizontal position and the other arm 13b in a generally depending vertical position. The top arm 13a is provided with a recess 13c which extends in a general radial direction with respect to the axis of the pivotal mounting of the primary armature 13. The end portion 13d of the arm 13a is arranged to move into engagement with the top surface of the core 11 and thus the primary armature 13 provides a bridging connection across the air gap of the magnetic circuit in the manner illustrated by the position of the components in Figure 2.

A secondary armature 15 is provided which is also of the leaf type and has a pair of depending ears 15a by which it is coaxially pivotally mounted with the primary armature 13 upon the pivot pin 14. The secondary armature 15 is of suitable dimensions so as to permit it to move freely into the recess 13c of the primary armature 13. Secondary armature 15 may also move into bridging relationship with respect to the air gap in the magnetic circuit, as illustrated by its position in Figures 2 and 3.

In accordance with this invention, it is desired that the movement of the primary armature 13 toward its bridging position with respect to the air gap produce concurrently a movement of the secondary armature 15 toward its bridging position. At the same time, it is desired that the primary armature 13 arrive at its bridging position prior to the arrival of the secondary arma-

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ture 15 at its bridging position. To accomplish these features, the primary armature 13 is provided with an integral upturned projection 13f at the far end of the recess 13c, which projection is turned rearwardly to overlies a portion of the recess 13c. Therefore, as best shown in Figure 1, when the primary armature 13 is in its remote position with respect to the air gap, any movement of the primary armature 13 toward its bridging position will concurrently produce a similar movement of the secondary armature 15. At the same time, the primary armature 13 is free to move away from its bridging position in the magnetic circuit independently of the position of the secondary armature 15.

Means are provided for biasing each of the armatures away from their bridging position with respect to the air gap. For the primary armature, a rod 16 is threaded into the vertical frame arm 12b and a spring 17 operates between a headed end 16a of such rod and the depending arm 13b of the primary armature, the rod 16 passing through a suitable aperture 13g in the primary armature and the spring having a cup-shaped spring seat member 17a retained by the head portion 16a of the rod 16. A torsion spring 18 is provided to bias the secondary armature 15, such spring being wrapped around the supporting pin 14 and having one end anchored against the secondary armature 15 and another end anchored in a suitable recess 13h provided in the depending arm 13b of the primary armature. For a reason to be developed later, the effective force of the spring 17 on the primary armature 13 is made substantially greater than the effective force of spring 18 on secondary armature 15.

Circuit control means are provided which are responsive to the movements of the primary armature 13 to and from its bridging position with respect to the air gap of the magnetic circuit. Such circuit control means may conveniently comprise a pair of switch contacts 25 respectively carried by a leaf-type support arm 20 secured to the insulating base 2 and a resilient leaf-type support arm 21 riveted to the upstanding frame arm 12b. The lower end 13e of the depending arm portion 13c of the primary armature 13 is shaped so as to move into engagement with the resilient support arm 21 and to open the contacts 25 when the primary armature 13 is in its non-bridging position with respect to the air gap of magnetic circuit, and to permit such contacts to close when the primary armature 13 is in its bridging position with respect to such air gap.

The operation of the relay 1 as applied to control of the energization of the starting winding W_s of a single phase motor will now be described.

Referring to Figure 1, it will be noted that when the motor is deenergized, that is when the switch 9 is opened, both the primary armature 13 and secondary armature 15 are held in their non-bridging positions by the springs 17 and 18 respectively and the contacts 25 are maintained open. Upon closure of main switch 9 to start the motor, a large inrush of current is produced through the main winding W_r and hence through the series connected relay coil C_r . The magnetic field developed in the magnetic circuit defined by the core 11 and the frame 12 is sufficiently strong so as to attract the primary armature 13 and both the primary armature 13 and the secondary armature 15 are pulled into their bridging positions, as shown in Figure 2. However, due to the nature of the interconnection between the primary and secondary armatures provided by the projection 13f, the primary armature 13

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arrives at its bridging position prior to the secondary armature 15. Such movement of the primary armature 13 effects the closure of the contacts 25 and hence the starting winding W_s and the condenser C are connected across the energizing circuit through the switch contacts 25 and the relay winding C_s .

As the motor comes up to speed, the current flow through the starting winding W_s increases in magnitude and more nearly approaches in phase the current flowing in the main winding W_r . As a result, the effective magnetic field exerted by the opposed coils C_r and C_s is decreased until, at a predetermined relationship of the current in the starting winding to the current flowing in the running winding, the differential field strength will no longer be capable of retaining the primary armature 13 in its bridging position against the bias exerted by the spring 17. The primary armature 13 will thereupon be moved by spring 17 to its non-bridging position as represented in Figure 3, while the secondary armature 15, due to the lighter bias exerted by its spring 18 will remain in bridging position with respect to the air gap of the magnetic circuit.

This is the normal condition of the relay during the normal operation of the motor. The contacts 25 are of course opened by the movement of the primary armature 13 to its non-bridging position and the starting winding W_s is disconnected from the circuit.

The disconnection of the starting winding W_s will, of course, immediately substantially increase the effective magnetic force exerted by the winding C_r in the magnetic circuit defined by the core 11 and the frame 12. However, due to the fact that the secondary armature 15 is retained in bridging position relative to the air gap of such magnetic circuit, the secondary armature 15 constitutes, in effect, a magnetic short or shunt so far as the primary armature 13 is concerned and hence very little attractive force is exerted upon the primary armature 13 by the current flowing in coil C_r during normal operation of the motor. In any event, the force exerted upon the primary armature 13 tending to make it return to its bridging position, which would of course cause a recycling of the relay, is so small as to be completely overcome by the bias of the spring 17. Therefore, the initial disconnection of the starting winding W_s through the opening of the contacts does not produce a magnetic condition in the relay which would tend to cause the recycling of the relay.

It should be further noted that in the subsequent operation of the motor, variations of the energizing voltage or of the load current drawn by the motor running winding W_r will have no effect upon the primary armature 13 unless the load current reaches an excessive value, corresponding to a current greater than the starting current of the motor. Under such overload conditions, the primary armature 13 may again be reattracted to its bridging position and the starting winding W_s reinserted in the circuit, but it should be noted that under such conditions, it is extremely desirable to have the starting winding re-connected, inasmuch as the speed of the motor must necessarily have been reduced to a point wherein the assistance of the starting winding in regaining the normal speed is a necessity.

Of course, upon the deenergization of the motor by the opening of the main switch 9, the relay coil winding C_r is deenergized and the secondary armature 15 is returned to its initial position as shown in Figure 1 under the bias of the spring 18.

Hence the relay is automatically restored to proper position for the next starting cycle.

From the foregoing description, it will be apparent to those skilled in the art that an unusually simple yet efficient and reliable relay construction is provided by this invention. The operation of the relay to effect the deenergization of the starting winding of a single phase motor is reliably effected independent of the existence of abnormal voltage conditions in the energizing circuit. Furthermore, there is no tendency of the relay to recycle following the initial deenergization of the starting winding or to recycle due to normal variations in energizing voltage or load current drawn by the running winding of the motor. Nevertheless, upon the occurrence of an overload current corresponding to a great reduction in speed of the motor, the relay will operate to reinsert the starting winding to assist in overcoming such extreme conditions. Upon the deenergization of the running winding of the motor, the relay is automatically returned to its initial position ready for another starting cycle operation.

By virtue of the utilization of the current comparison principle rather than operating according to a predetermined magnitude of current or voltage, the entire construction of the relay has been greatly simplified, permitting it to be fabricated in its entirety with components which may be produced by low cost, high quantity production methods.

It will, of course, be understood that various details of construction may be modified through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A relay comprising magnetic members defining a magnetic circuit with an air gap therein, a leaf type primary magnetic armature pivotally mounted relative to said magnetic members and movable into a bridging position across said air gap, said primary armature having a recess extending in a generally radial direction with respect to its pivotal axis, a secondary magnetic armature pivotally mounted relative to said magnetic members coaxially with said primary armature and disposed to move within said recess, said secondary armature also being pivotally movable to a bridging position across said air gap, means interconnecting said primary and secondary armatures to move said secondary armature to its bridging position concurrently with the movement of said primary armature to its bridging position relative to said air gap, said last mentioned means being constructed and arranged to permit said primary armature to reach its said bridging position prior to the secondary armature reaching its bridging position relative to the air gap, resilient means respectively biasing said armatures away from their said bridging positions, the effective bias exerted on said primary armature being substantially greater than the effective bias exerted on said secondary armature, whereby a predetermined decrease in the magnetization of said magnetic circuit will release said primary armature from bridging position

but retain said secondary armature in bridging position, an electric switch operated by movements of said primary armature to and from said bridging position, and means for magnetically exciting said magnetic circuit.

2. The combination defined in claim 1 wherein said primary armature comprises a metal stamping having integral outturned ears at each side of said recess for pivotal mounting of the primary armature, and also having an integral projection overlying a portion of said recess constituting said means connecting the primary and secondary armatures.

3. A relay comprising magnetic members defining a magnetic circuit with an air gap therein, a leaf-type primary magnetic armature pivotally mounted relative to said magnetic members and movable into a bridging position across said air gap, said primary armature having a recess extending in a generally radial direction with respect to its pivotal axis, a secondary magnetic armature pivotally mounted relative to said magnetic members coaxially with said primary armature and disposed to move within said recess, said secondary armature also being pivotally movable to a bridging position across said air gap, an upwardly flanged portion on said primary armature adapted to contact said secondary armature and move said secondary armature to its bridging position after said primary armature has reached its bridging position, first resilient means biasing said primary armature away from its bridging position, second resilient means biasing said secondary armature away from its bridging position, the effective bias exerted on said primary armature being substantially greater than the effective bias exerted on said secondary armature whereby a predetermined decrease in the magnetization of said magnetic circuit will release said primary armature from bridging position but retain said secondary armature in bridging position.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
966,764	Poser	Aug. 9, 1910
1,128,562	Webster	Feb. 16, 1915
1,259,901	Parker	Mar. 19, 1918
1,331,882	Stone	Feb. 24, 1920
1,413,691	Slough	Apr. 25, 1922
1,706,989	Thompson	Mar. 26, 1929
1,981,259	Wertz	Nov. 20, 1934
2,021,199	Pearce	Nov. 19, 1935
2,096,502	Wetzel	Oct. 19, 1937
2,211,701	McGrath	Aug. 13, 1940
2,235,537	Schaefer	Mar. 18, 1941
2,309,349	McMaster	Jan. 26, 1943
2,441,001	Bellamy	May 4, 1948
2,456,169	Bellamy	Dec. 14, 1948

FOREIGN PATENTS

Number	Country	Date
845,757	France	May 22, 1939