Oct. 4, 1960 T. E. GARDNER 2,955,240

RELAY CONSTRUCTION

Filed May 27, 1954

3 Sheets-Sheet 1

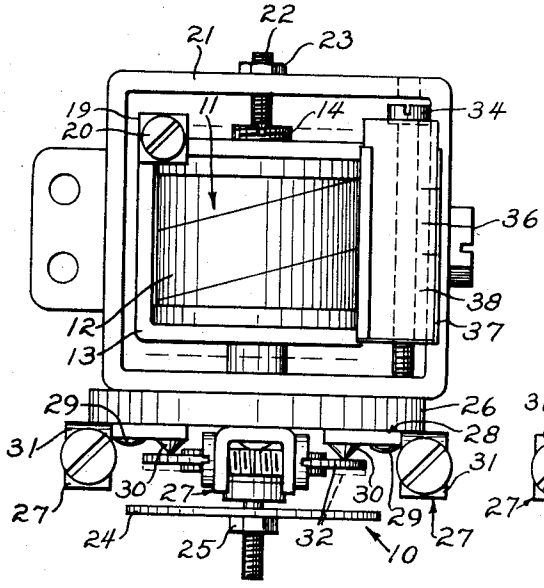


Fig. 1

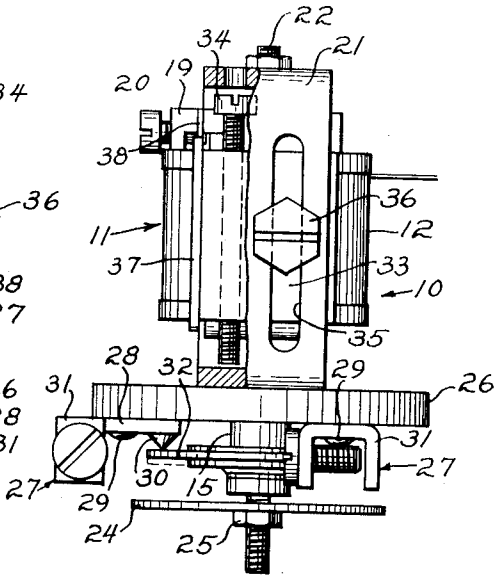


Fig. 2

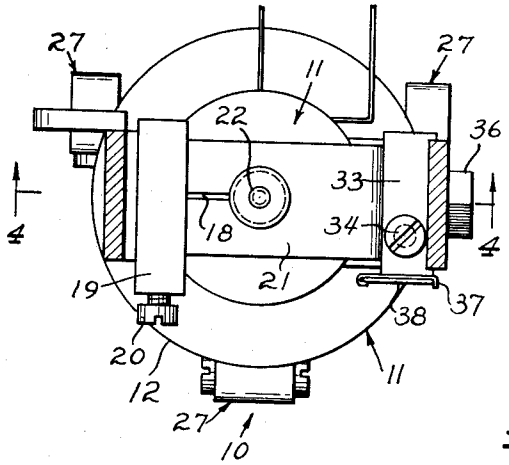


Fig. 3

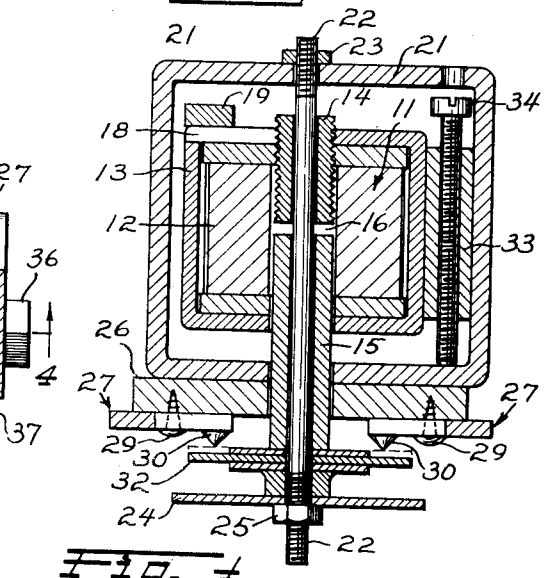


Fig. 4

INVENTOR

THOMAS E. GARDNER

BY Jones & Young

AGENTS

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RELAY CONSTRUCTION

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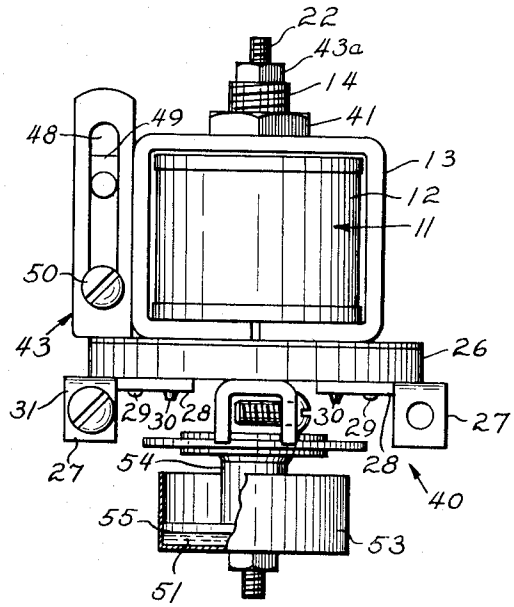


Fig. 5

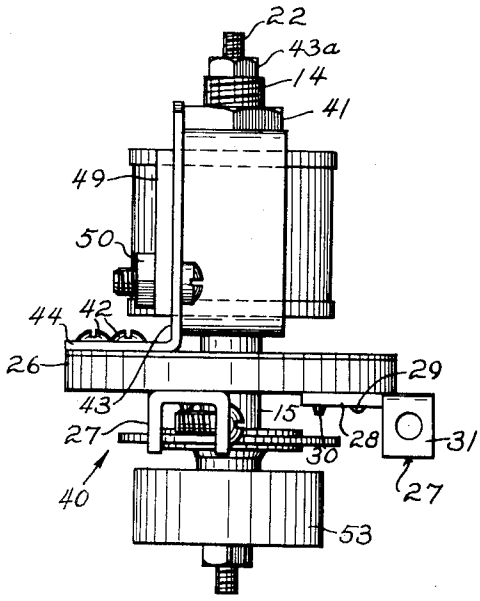


Fig. 6

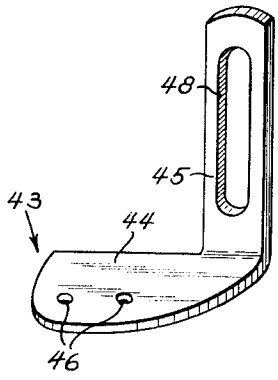


Fig. 7

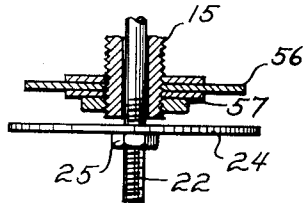


Fig. 8

INVENTOR.
THOMAS E. GARDNER
BY
Jones & Young
AGENTS

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Fig. 9

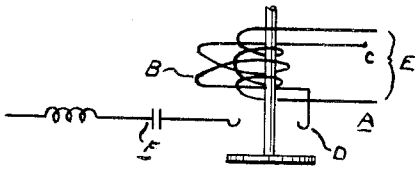
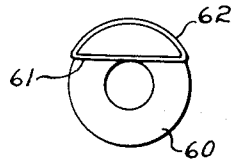


Fig. 10



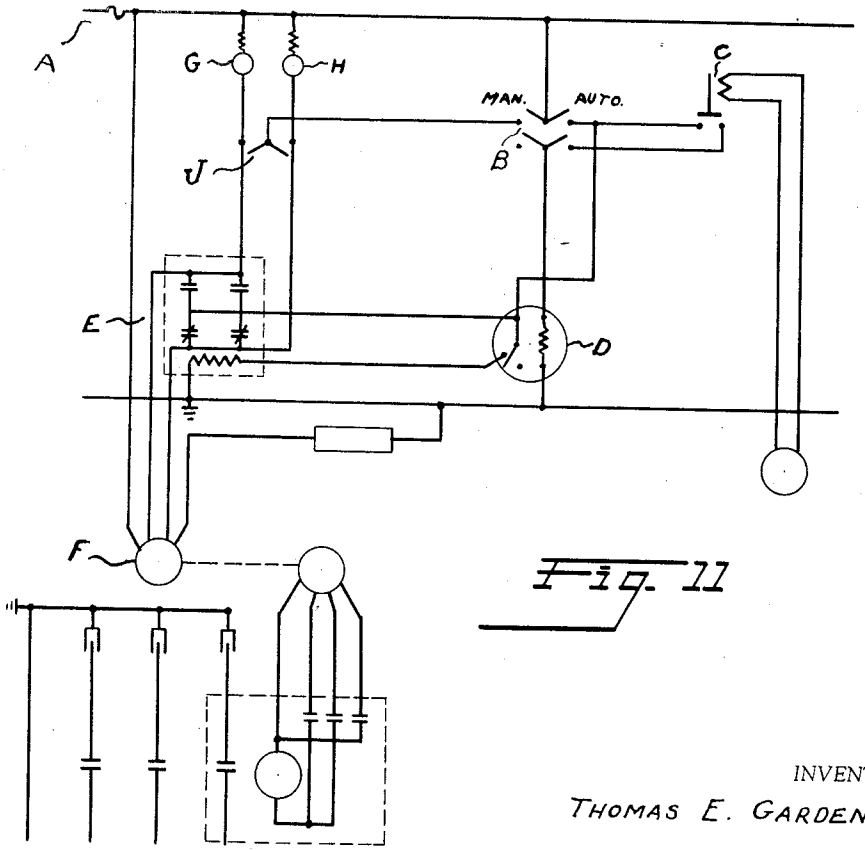


Fig. 11

INVENTOR
THOMAS E. GARDENER

BY Jones + Young
AGENTS

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Patented Oct. 4, 1960

2,955,240

RELAY CONSTRUCTION

Thomas E. Gardner, 2300 Hales Road, Raleigh, N.C.

Filed May 27, 1954, Ser. No. 432,719

1 Claim. (Cl. 317—176)

The present invention relates to a relay and more particularly to an improved electro-magnetic relay having a high degree of control and adjustability to provide a high drop-out of the relay at any selected value within its entire rated range of operation.

A present day relay possesses a minimum and maximum pickup or contact making value which provides the relay with a rated range of operation. This rated range of operation is generally determined by the number of turns of wire in the coil assembly of the relay as well as the size of wire employed to make up the coil.

However, such relays possess an undesirable operational characteristic that has limited their use or necessitated the use of additional equipment to compensate for or offset such a characteristic. This objectionable feature is due to the fact that such prior relays will drop out or break contact only at a value just below the rated minimum pick-up value. By way of example, a relay having a rated range of operation of 4 to 16 amperes is employed extensively in the power transmission field as a safety device. In such a relay, it will normally drop out at about 3.5 amperes. In the normal use of this relay, the system conditions often require that the relay be adjusted to pick-up or make contact at an intermediate value i.e. 10 amperes. When this operation is necessary, the usefulness of the relay is materially lessened since the relay will still drop-out or break contact at a point just below the minimum pick-up value i.e. 3.5 amperes, of the relay. This low drop-out feature when an operational setting other than the minimum value is employed often results in a false indication of power line conditions which could be harmful thereto as well as being generally economically and operationally undesirable.

This objectional inherent low drop-out characteristic of prior relays has been found to be primarily due to the fact that the distance or the air gap spacing between the fixed pole and the movable pole or armature is always the same when the armature is picked-up to close the circuit, regardless of the pick-up setting of the relay. Thus, the relay then can only drop-out at the drop-out value of just less than the minimum pick-up setting since no compensation has been made for the adjustment of the increased pick-up value above the minimum setting.

It has been found that the high drop-out of a relay is possible at any value throughout the entire rated range of operations of any given relay by providing a relay with an adjustable or variable air gap between the fixed and movable poles of the relay to coordinate with the adjusted pick-up value above the minimum value. By providing the relay with the adjustable air gap, the difference between the pick-up value and the drop-out value will remain the same throughout the entire rated range of operation of the relay. Thus, such a relay made in accordance with the present invention and having, for example, a minimum pick-up value of 4 amperes and a drop-out value of 3.5 amps, will have a drop-out value of 9.5 amps when the operating pick-up value is adjusted to 10 amps.

It is therefore a principal object of the present invention to provide a relay having a fine degree of adjustability of calibration throughout its rated range of operation.

Another object of the present invention is to provide a relay having a high drop-out value at any selected pick-up value within the entire rated range of operation of the relay.

A further object of the present invention is to provide a relay having an adjustable air gap between the fixed and movable poles of the relay.

Yet another object of the present invention is to provide a relay in which the differential between the rated minimum pickup value and the drop-out value will be the same throughout the rated range of operation for the relay.

Still another object of the present invention is to provide a relay of the plunger-type which will possess a high drop-out value throughout the rated range of operation.

Yet a still further object of the present invention is the provision of a relay having a time delay action to prevent instantaneous tripping.

An additional object of the present invention is the provision of a relay having adjustability both with respect to pick-up and drop-out current values.

Another object of the present invention is the provision of a relay requiring but a simple adjustment to select the desired pick-up value and simultaneously set the air gap spacing to provide a high drop-out with respect to the selected pick-up value.

A still further object of the present invention is the provision of a relay that is a low-burden instrument having universal use in a wide range of use with either current or voltage sources.

Yet another object of the present invention is the provision of a relay that is of simple construction and requires very little time and effort to adapt to existing relays.

Yet another object of the present invention is the provision of a relay that will positively seal-in when contact is made and will in addition tend to eliminate chattering.

Other and additional objects of the present invention will become apparent from the following description taken in conjunction with the annexed drawings.

Broadly stated, an electro-magnetic relay made in accordance with the present invention comprises magnetic circuit means, having a minimum and maximum pick-up value, a fixed pole member constituting a portion of the magnetic circuit means, a movable pole member constituting a portion of the magnetic circuit means, said pole members being opposed to and spaced from one another forming an air-gap spacing therebetween, and means to adjust the air gap between the pole members when other than the minimum pick-up value is employed.

To the accomplishment of the foregoing and related ends, the present invention then consists of the means hereinafter fully described and particularly pointed out in the claim, the annexed drawings and the following description setting forth in detail certain means in the carrying out of the invention, such disclosed means illustrating, however, but several of the various ways in which the principle of the invention may be employed.

The present invention is illustrated, by way of example, in the accompanying drawings in which:

Figure 1 is a front elevation of one form of a relay made in accordance with the present invention;

Figure 2 is a side elevation of the relay shown in Fig. 1;

Figure 3 is a top plan of the relay shown in Fig. 1;

Figure 4 is a cross sectional view of the relay shown in Fig. 1 illustrating the details of the coil assembly and the pole construction;

Figure 5 is a front elevation partly in section of a second form of the invention.

Figure 6 is a side elevation of the relay shown in Fig. 5.

Figure 7 is an enlarged perspective view of an attachment plate to be mounted on the relay as shown in Fig. 5.

Figure 8 is a fragmentary front elevation of a third form of a relay made in accordance with the present invention by which the adjustability of the air cap gap can be achieved;

Figure 9 is a fragmentary schematic wiring diagram illustrating a method of providing a tight sealing-in of the contact of the relay when used with a tripping circuit.

Figure 10 is an exploded fragmentary view of the fixed pole illustrating the slugging of its end to eliminate chattering.

Figure 11 is a schematic wiring diagram illustrating one particular use of a relay made in accordance with the present invention.

Referring now to the drawings and with particular reference to Figs. 1–4, an illustrative and preferred form of a plunger-type electro-magnetic relay made in accordance with the present invention generally designated by reference number **10** is shown. It is to be understood that while the present invention will be illustrated throughout with reference to plunger-type relays, this is not to be construed that the invention only has utility with respect to this type. To the contrary, the present invention can be readily employed with other types of electro-magnetic relays such as, for example, the clapper type.

The relay **10** comprises a magnetic circuit **11** of generally conventional design and having a coil assembly **12** positional within a metal frame **13** which functions as the flux return path. The coil assembly **12** and the frame **13** are each provided with an aligned central opening extending axially therethrough to receive a normally fixed pole member **14** in one end thereof and a movable pole member or armature **15** at the opposite end thereof. This construction results in the formation of an air gap **16** between the two pole members **14** and **15** within the coil assembly **12**.

The normally fixed pole member **14** is threadably secured to the frame **13** and while it is adjustable, it usually will remain in its originally fixed position. It is preferred that in this particular form of the invention that means be provided to prevent an accidental movement of the pole member **14** from its originally fixed position. This may be accomplished, as illustrated, by providing the top portion of the frame **12** with a split portion **18** extending from its outer edge inwardly along its top surface to the opening into which the fixed pole member **14** is threaded. A clamping bar member **19** having its ends turned downwardly resulting in a generally U-shaped configuration is detachably mounted to the top portion of the frame **13** over the split **18**. The clamping member **19** is longer than the width of the frame **12** and has a threaded opening extending through one of its down-turned ends into which a set screw **20** is threadably positioned. This construction results in one of the down-turned ends of the clamping member **19** engaging one side of the leading edge of the top portion of the frame **13** while the set screw **20** is adjusted to rest against the opposite edge of the frame **12**. Thus a tightening on the screw **20** will force a drawing together or a pinching of the split portion **18** and will positively lock the fixed pole members **14** to the frame **13** into tight engagement therewith at its desired position.

In this form of the invention, an outer metal frame **21** within which the magnetic circuit **11** is centrally positioned in spaced relation thereto is necessary. While it has not been positively ascertained, it is believed that the outer frame **21** functions in some way in assisting the main magnetic circuit **11** when energized. The basis for this belief is the fact that a finer control of the relay is possible as well as resulting in a tighter sealing-in of the contacts when the relay **10** is energized. The primary purpose of the outer frame **21** however is to provide a mounting by which the means for varying the air gap can be secured.

The fixed and movable pole members **14** and **15** and the top and bottom portions of the outer frame **21** are each provided with an alined opening resulting in a passage extending completely through the entire magnetic circuit **11** and the outer frame **21** axially thereto. A threaded mounting shaft or stud **22** extends completely through and beyond this resulting passage and functions to connect the magnetic circuit **11** to the outer frame **21** and to additionally provide a guideway for the movement of the armature **15**. A lock nut **23** is secured to the shaft **22** on top of the outer frame **21** to connect them together in locked position. Similarly, the opposite end of the shaft **22** is provided with an adjustable stop plate **24** in the form of a disk or the like to act as a stop against the downward movement of the armature **15**. The stop plate **24** may be held in place by means of a lock nut **25**.

An insulated contact plate **26** is secured to the bottom face of the outer frame **21** by screws or the like. The contact plate **26** is made from a non-conducting, non-metallic material and is provided with a plurality of contact assemblies **27** secured to its bottom surface thereon. The contact assemblies **27** each comprises a metal strip **28** secured to the bottom surface or face of the contact plate **26** by means of a screw **29**, a contact point **30** positioned on and adjacent the inner end of the strip **28** and a binding post member **31** secured to the opposite end of the strip **28**. This assembly functions as one contact making point for the relay circuit when the relay **10** is energized.

A metal contact plate **32** is fixedly secured by any suitable means to the outer free end of the movable pole member or armature **15** and is positioned below the insulated contact plate **26**. Thus upon an energization of the magnetic circuit the movable core member **15** is picked-up or pulled in causing the metal contact plate **32** to engage the contact points **30** carried by the insulated plate **26** to close the actuating circuit of the relay.

In this form of the invention illustrated in Figs. 1–4, the air gap is varied to provide the high drop-out characteristics by moving the coil assembly **11** up or down with respect to the outer frame **21** and the movable core number **15**. To accomplish this, a sliding bar **33** of non-conducting metal, such as, for example, brass, is permanently secured to one side of the frame **13** between it and the outer frame **21**. The bar **33** is provided with a threaded passageway extending completely therethrough, through which an adjusting screw rod **34** is positioned. The screw rod **34** has one end resting against the inner face of the bottom portion of the outer frame **21** with the other end resting against the inner face of the opposite top portion of the outer frame **21**. This construction results in a raising and lowering of the magnetic circuit **11** upon an actuation of the screw rod **34**. To facilitate the actuation of the screw rod **34**, the face of the outer frame **21** immediately adjacent the actuating end of rod **34** is provided with a small opening to permit the passage of a screwdriver therethrough to engage the actuating head of the rod.

To insure the locking of the magnetic circuit **11** in place at all times, the outer frame **21** is provided with a guideway slot **35** along its side immediately adjacent the bar **33**. The bar **33** possesses a threaded opening in alignment with the slot **35**. A locking screw **36** extends through the slot **35** and into the threaded opening of the bar **33** where, upon a tightening of the screw **36**, the magnetic circuit **11** will be tightly secured to the outer frame **21** against any movement therewith.

It will be found advantageous in the many uses of the relay **10** to provide indicating or calibrated means to show the degree of adjustment or the pick-up setting at which

the relay is operating. This may be done by providing one of elongated free face of the bar **33** with channel guideway means **37** into which an indicating plate **38** is slidably positioned. The plate **38** will contain various calibrated settings to indicate, by comparison with a fixed point carried by the outer frame **21** immediately adjacent the indicating plate **38**, the operating conditions of the relay **10**.

In the operation of prior relays, the adjusting of such relays to permit it to operate at a higher pick-up value than its minimum rated value has been accomplished merely by lowering the stop plate thus causing the armature to be lowered. This lowering increases the distance between the armature and the fixed pole of the magnetic circuit thus requiring a greater energization to pick-up the armature. In the form of the invention shown in Figs. 1–4, it is possible to simultaneously adjust the relay to pick up at a desired setting or value other than the minimum setting and at the same time vary the air gap between the fixed and movable poles of the relay so that the drop-out differential will be the same as that existing when the relay is operating at its minimum setting.

By way of illustrating a relay made in accordance with this form of the invention and having a 10 ampere minimum setting and a maximum setting of 40 amperes will be described in use, for example, in a power transmission system. Conditions in the power system often require that the pick-up value of the relay be well above its minimum pick-up value of 10 amperes i.e. 30 amperes. To set the relay to pick up at 30 amperes all that is necessary is to first loosen the locking screw **36** and then to adjust the magnetic circuit by the use of a screwdriver or screw rod **34** until the indicia on the indicating plate **38** corresponding to 30 amperes is aligned with a fixed point or setting on the outer frame **21**. The locking screw **36** is then tightened to lock the adjusted magnetic circuit in its desired value. This adjustment thus assures that the relay will pick up at 30 amperes and will drop out at about 29.5 amperes since the air gap distance has been varied from what it was for the minimum setting.

Referring now to Figs. 5–7, a second form of a relay made in accordance with the present invention is shown. In this modification, the air gap is varied by limiting the distance the armature and its contact plate can travel during the pick-up occasioned by the energization of the relay. In this description like numerals will be employed for parts corresponding to like parts in the form of the invention shown in Figs. 1–4.

The relay **40** has basically the same magnetic circuit **11** as the preferred form described hereinbefore and comprises a coil **12** mounted within a frame **13** and is provided with fixed and movable pole members **14** and **15**. In this form of the invention, no outer frame such as outer frame **21** shown in the preferred form is required thus it is not necessary to impart a split portion to the frame **13** to lock the fixed pole member **14** in place. In this form of the invention, the fixed pole member **14** may be locked in place by a lock nut **41**. Similarly the mounting shaft **22** is held in place by means of a nut **43***a* resting against the top free face of the fixed pole member **14**.

Similarly, the insulated contact carrying plate **26** and its associated parts hereinbefore described is identical in its basic construction except that its association and mounting with respect to the relay is radically different as will be described more fully hereinafter. The contact plate **32** likewise is of the same structure except parts associated therewith may be, if desired, modified in the manner more fully described hereinafter.

The insulated contact plate **26** is normally fixed directly to the under-face of the bottom portion of the frame **13**. However, in this form of the invention, it will be necessary to have the insulated contact plate **26** and its associated parts movable vertically with and independently from the armature **15** and capable of being locked in any position.

This vertical movability of the insulated contact plate **32** can be accomplished by means of a connecting plate **43** which comprises a base portion **44** and an elongated upright portion **45** positioned to one end of said base at right angles thereto. The base portion **44** is provided with several openings **46** by which the connecting plate **43** may be secured to the top surface of the contact plate **26** by means of screws **47** in fixed relation thereto.

The upright portion **45** is provided with an elongated guideway slot **48** by which the connecting plate may be secured to and in slidable relation with a mounting frame **49** that is normally carried by the frame **12** of the relay. This association is to permit the upright portion **46** of the frame **44** to be secured to the mounting arm or frame **49** by means of a nut and bolt arrangement **50** passing through the elongated slot **48** and through openings of the frame **49**. This construction makes it possible to connect the insulated plate **26** to the frame **12** by means of connecting plate **43** for independent vertical movement.

It has been found desirable in many instances, particularly in the power transmission field, to have a time delay action on the relay to prevent instantaneous pick-up. To provide this time delay, a dash pot assembly **51** may be substituted for the stop plate **24** employed in the form of the invention shown in Figs. 1–4. The dash pot assembly comprised a cylindrical or piston plate at its free end normally resting on the surface of the oil in the tank **53**. The opposite end of the plunger **54** is secured to the contact plate **32** or armature **15** by any suitable means and is movable therewith. When the armature **15** is picked-up upon an energization of the relay **40**, the surface tension of the oil in the tank **53** will tend to slow down the upward movements of the armature **15** thus giving a time delay action before the circuit is closed. It is to be understood that if a time delay action is desired for the form of the invention shown in Figs. 1–4, the dash pot assembly **51** may be substituted for the stop plate **24** shown therein. Alternately, if desired, it is to be understood that a similar substitution of the stop plate **24** may be made for the dash pot assembly **51** in the form of the invention just described.

In the operation of this form of the invention to provide the high drop-out feature when the relay is to be operated above its minimum pick-up value, the dash pot assembly **51** is lowered on the mounting shaft **22** causing the armature or movable pole member **15** and the contact plate **32** to drop down therewith. This operation is normal in adjusting present day relays. When the adjustment of the armature **15** has been made to impart the desired pick-up value to the relay, the screw **50** is next loosened permitting the connecting plate **43** secured to the insulated contact plate **32** to be lowered. After the insulated plate **32** has been lowered a distance sufficient to achieve the same differential that exists between the rated minimum pick-up value and the drop-out value, screw **50** is tightened to lock the insulated plate **32** in its new position. In the operation of the relay **40**, it will be obvious that the lowering of the insulated plate **32** will shorten the distance that the armature **15** can travel during its pick-up operation upon the energization of the relay **40** thus lengthening the air gap distance between the armature **15** and the fixed pole member **14** when the contacts are in engagement. This construction results in the relay dropping out at a high value which is just below the selected pick-up value.

Referring now to Fig. 8 wherein still another construction is shown in fragmentary form by which the adjustability of the air gap between the fixed and movable pole members may be accomplished. In this illustrative form of the invention a conventional relay is used with the only modification being made with respect to the movable pole member and its contact plate normally carried thereby in fixed position.

The movable pole member or armature **15**, shown in Fig. 8 will be threaded at its lower end. Similarly, con-

tact plate **56** will be threaded to permit its movement vertically on the armature **15**. A lock nut **57** is provided to lock the contact plate **56** at any desired point on the armature **15**. Heretofore, the contact plate and armature have been fixed in permanent relationship to one another permitting no movement with respect to one another.

In the operation of the form of the invention shown in Fig. 8, when the relay is to be operated at a pick-up value other than at its minimum setting, the stop plate **24** is lowered to give the desired pick-up value. The contact plate **56** is then adjusted vertically on the armature **15** to a point at which the relay will have a high drop-out with respect to the selected pick-up value. The plate **56** is then locked in position. It is believed apparent that by the adjustment of the contact plate 56 with respect to armature **15**, the air gap distance will be obviously varied thus giving the desired high drop-out feature.

It will be found desirable in many uses of a relay made in accordance with the present invention to insure a positive sealing-in of the contacts, and to prevent or lessen chattering when the relay is used for tripping circuits. Fig. 9 illustrates schematically one manner in which this may be accomplished in a tripping action. As shown in Fig. 9, A represents a relay made in accordance with the present invention, for example, the form of the invention shown in Figs. 1–4. B represents several turns of wire wrapped around the coil of the relay A with one end connected to the negative side of a D.C. source as at C with the opposite end connected to a dummy contact post D carried by the insulated contact plate of the relay A. The relay A is connected on one side to either an A.C. current or A.C. voltage source E and on the opposite side to a tripping circuit generally designated by reference numeral F at the insulated contact plate of the relay A. When the relay A is energized by an A.C. power source causing the armature of the relay to pick-up and make contact with the contact plate, the direct current imposed on the magnetic circuit will result in a flux shifting of the A.C. power source. This action will result in a complete sealing-in of the contacts of the relay and will eliminate chattering.

Referring now to Fig. 10 wherein a modified form of a fixed pole member found desirable to use with a relay made in accordance with present invention is shown. This modification will be found useful to eliminate chattering of the relay as well as permitting a more sensitive calibration of the instrument. In Fig. 10, the fixed pole member **69** is generally of conventional design with the exception that the bottom face of its free end, which will be positioned within the coil assembly, is provided with a centrally disposed transverse slot **61**. A piece of brass wire **62** or other non-conducting wire is then inserted in the slot **61** and wrapped half-way around the lower end of the fixed pole member. This construction will result in a "slugging" of the relay iron and will function as a flux shifter to reduce chattering of the relay.

To illustrate a practical application of a relay made in accordance with the present invention, reference is now to be had with respect to Fig. 11, wherein its use in a capacitor switching control circuit is illustrated schematically. Referring now to the schematic wiring diagram, A represents the control voltage line from any desired source. The current is supplied by a current transformer in the control voltage line from or by the line in which the capacitors are positioned. A switch B is provided for either manual or automatic operation, and in the following description it will be set in the latter position. A high drop-out relay C made in accordance with the present invention is pre-set for the heater circuit of a thermal relay D. The thermal relay D is connected to an auxiliary relay E which is, in turn, connected to actuate a motor F for switching the capacitor.

In the illustrative system, the contacts of the relay C are normally closed, the heater circuit of the thermal relay D is inactive or cool. However, when the current reaches a predetermined setting, the contacts of the relay C will open, resulting in an energization of the heater circuit of the thermal relay. After a time delay occasioned by the heating up, the thermal relay D will actuate the auxiliary relay E to open the switch of the motor F. When the current falls below a certain value, the contacts of the relay C will pick-up resulting in a de-energization of the heater circuit of the thermal relay D. After a time delay, this action will result in an actuation of the auxiliary relay E which will close the switch of the motor F resulting in the switching of the capacitors.

A red neon lamp G may be present to show that the capacitor motor switch is closed, while the green neon lamp H is used to show that the capacitor motor switches are open. A toggle switch J may be used to open or close the motor switch through auxiliary relay E manually when the selector switch B is on manual position. A voltage coil also may be substituted in the high drop-out relay C and supplied by a potential to operate the circuit as a voltage capacitor switching control. Furthermore, a combination of a current and voltage relay made in accordance with the present invention could be used for capacitor switching with current and voltage supervision over the current, or vise versa.

An electro-magnetic relay made in accordance with the present invention has a wide field of application and can be employed in any field in which present day relays are used. Therefore, the description of the use of the invention with respect to the power transmission field is illustrative in character only. Further, it is to be understood that the relay made in accordance with the present invention may be energized by any power source, such as current or voltage means.

While certain representative embodiments and details have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in this art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

I claim:

An electro-magnetic relay comprising magnetic circuit means having a minimum and a maximum pick-up value, a fixed pole member constituting a portion of the magnetic circuit means, a movable pole member constituting a portion of the magnetic circuit means, said pole members being opposed to and spaced from one another forming an air gap therebetween, a metal frame around and in vertical alignment with said magnetic circuit means, connecting and adjusting means associating said magnetic circuit means within said metal frame, for vertical movement therein independent of said movable pole member to adjust the movable pole member to pick-up at a value above the minimum pick-up value of and simultaneously adjust the air gap spacing between the pole members to compensate for the changed pick-up value.

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