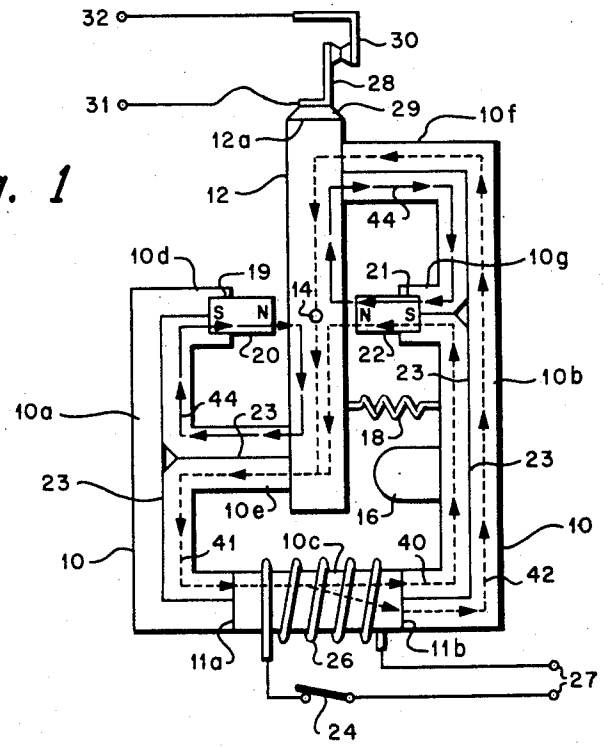
Nov. 17, 1959 R. J. COPPOLA 2,913,639

POLARIZED A.C. OPERATED RELAY

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Fig. 1



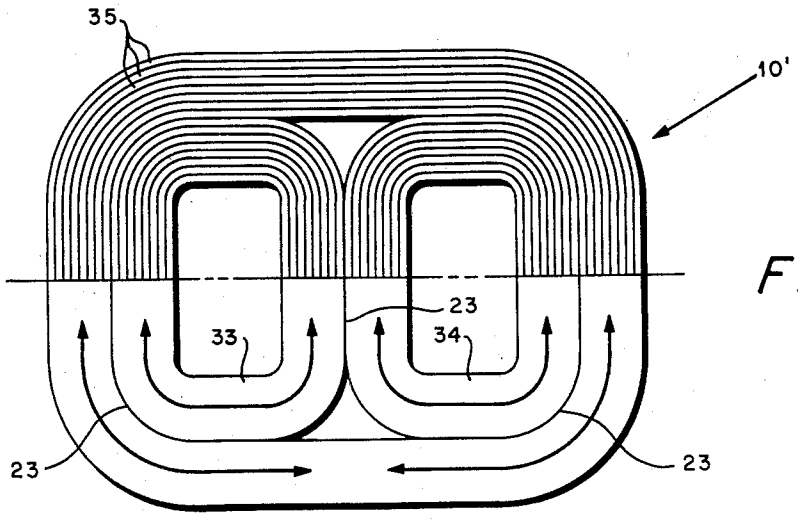


Fig. 2

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Fig. 3

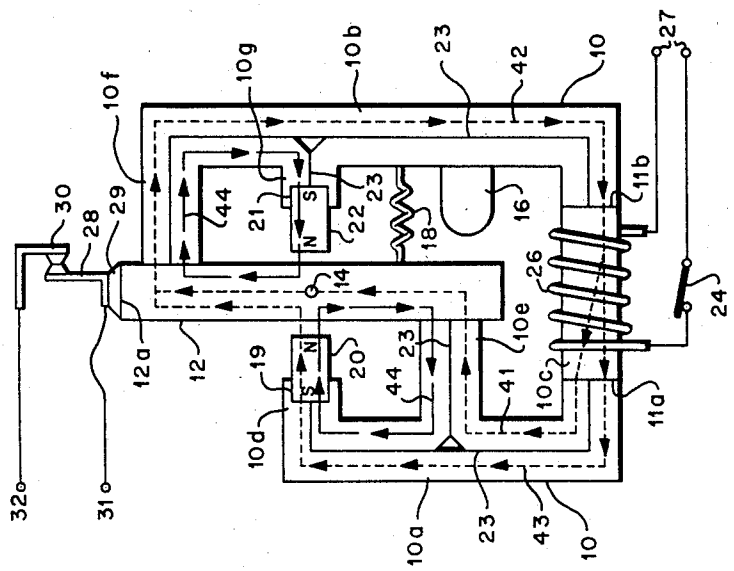
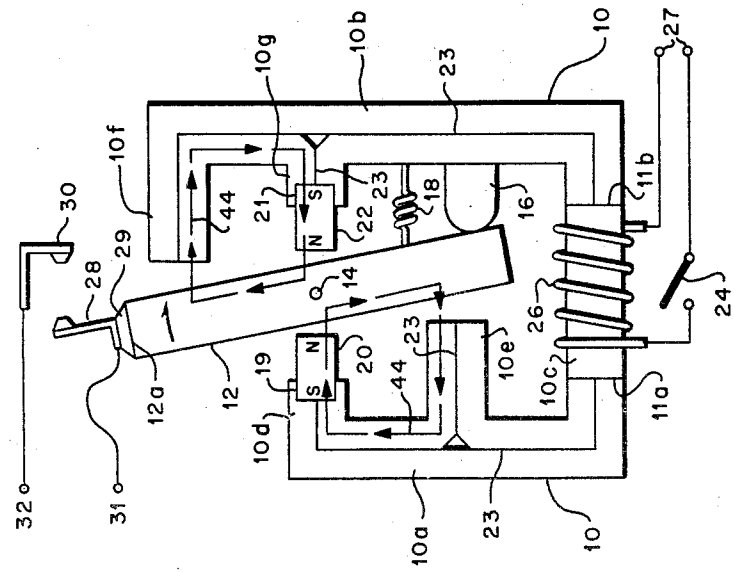


Fig. 4



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POLARIZED A.C. OPERATED RELAY

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Application January 20, 1956, Serial No. 560,467

4 Claims. (Cl. 317—156)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to a polarized A.C. operated relay and more particularly to a relay that will operate from single phase A.C. power without the use of rectifiers, shorted turns, condensers, or multiple coils or windings.

Present relays designed for use in connection with A.C. current rely on one or more of the following principles of operation:

a. A rectifier in series with the relay coil to rectify the A.C. current and permit only a D.C. pulsating current to flow in the coil.

b. A shorted turn around a portion of the magnetic pole of the relay to produce the shaded pole effect which is two fluxes out of phase with each other from a single phase supply.

c. Multiple coils with or without condensers and magnetic circuits to produce out of phase attractive forces on the armature of the relay.

Each of these arrangements has at least one major disadvantage, e.g., the unreliable performance of the rectifiers and condensers, the excessive heat generated by the use of shorted turns, and the added weight and space required when more than one coil is used.

The present invention overcomes the disadvantages of existing A.C. operated relays by providing a particular shaped iron core having only one small single phase coil for the complete operation of the relay. The shape of the laminated iron core is such that the pivoted armature is mounted with respect to the iron core such that it is urged in rotation in the same direction for both directions of the input signal. A pair of permanent magnets judiciously placed provides sufficient attractive forces when the actuating current or flux passes through zero to prevent chattering. The very simplicity of the arrangement described herein provides a relay construction which is highly resistant to shock and high frequency vibration and avoids all of the disadvantages described in connection with the present A.C. relays noted above.

Therefore, an object of the present invention is the provision of an A.C. operated relay which is simple in construction and is highly resistant to shock and high frequency vibration.

Another object is to provide a polarized A.C. operated relay having a uniquely shaped iron core and a rotatable iron armature mounted with respect to said core in such a manner that double positive torque is developed in both directions of the A.C. current supply.

A further object of the invention is the provision of a polarized A.C. operated relay utilizing a pair of permanent magnets as part of a magnetic circuit designed to accomplish the effect of single phase operation of the relay with completely adequate pickup and drop-out voltage values.

A final object of the present invention is the provision

of a polarized A.C. operated relay having an iron laminated core of unique shape carrying the A.C. coil input, a pair of permanent magnets mounted in a particular manner with respect to said iron core, and an iron armature mounted for rotation adjacent to said permanent magnets and said laminated iron core for rotation in the direction of closing the relay switch during both current directions of the input A.C. signal.

The exact nature of this invention as well as other objects and advantages thereof will be readily apparent from consideration of the following specification relating to the annexed drawing in which—

Figs. 1 and 3 show a preferred form of the inventive relay in its energized state, in both halves of the input A.C. cycle.

Fig. 2 shows detailed construction features of the iron core in the relay.

Fig. 4 shows the relay in its deenergized state.

Referring to Figs. 1, 3 and 4, iron core **10** is constructed of a pair of legs **10***a* and **10***b* joined at their lower ends by the section **10***c*. Core **10** is sliced through at **11***a* and **11***b* thereby permitting section **10***c* to be rotated 90° for reasons explained below. Leg **10***a* is provided with projections **10***d* and **10***e*, while leg **10***b* is provided with projections **10***f* and **10***g*. Iron core **10** may be made of laminated sections and is rectangular or square, in cross section, as will be hereinafter described. Within the space confined by core **10** is an iron armature **12** mounted for rotation about a shaft **14**. An element **16** of non-magnetic material acts as a stop for armature **12**, there being a spring **18** connecting iron core **10** and the bottom extremity of iron armature **12** for biasing said armature **12** against stop **16**, as in Fig. 4. Of course, any other biasing and stop arrangement may be used. Between armature **12** and core **10**, mounted in slots **19** and **21** cut in projections **10***d* and **10***f*, respectively, are two permanent magnets **20** and **22** with their north poles facing opposite armature **12**. Core **10** is also provided with a separation line **23** which is described in greater detail below. Armature **12** has a limited movement between its position against stop **16**, illustrated in Fig. 4 and its other position in contact with projections **10***e* and **10***f*, shown in Figs. 1 and 3.

For inducing flux in core **10**, there is wrapped around section **10***c* a coil **26** connected through a switch **24** to a pair of input leads **27** connected to the A.C. energizing power supply (not illustrated). Mounted on top face **12***a* of iron armature **12** is a movable switch element **28** separated from core **12** by an insulated layer **29**. Of course, switch element **28** may be located in any other convenient location, and may be of the three pole type for use with three phase A.C. power.

Core **10** is constructed by modifying a commercially available laminated core **10′** illustrated in Fig. 2. Core **10′** is built up from a pair of rolled cores **33** and **34**. Each core **33** and **34** is formed, as is understood in the art, by rolling a flat, thin ribbon **35** of suitable magnetic properties, coated with a proper insulating material, over a mandrel having, in this case, a square shape. Cores **33** and **34** are then placed side by side and more of said ribbon **35** is rolled over the whole assembly until the desired thickness is reached. Thus, core **10′** is constructed of a plurality of laminations, which are shown in some detail above the center line. When a magnetic field is applied to the core, the flux lines will, of course, follow the laminations. The portion of core **10′** below the center line partially illustrates schematically the flux distribution in solid lines which follow the line of core construction due to the manner of laminating the core. Core **10**, illustrated schematically in Figs. 1, 3 and 4, is cut from or made up from a core or cores identical to the construction of core **10′** of Fig. 2. Therefore, core **10** has

the identical separation lines **23** shown in connection with core **10'** of Fig. 2 for indicating the distribution of the flux lines throughout the core.

Operation of the polarized A.C. operated relay is as follows: In Fig. 1 the relay is in its energized state, brought about by closing switch **24** and applying the A.C. voltage to coil **26**, inducing flux in core **10**. The flux lines reverse direction every half cycle, as is understood in the art, in accordance with the reversal of the current in coil **26**.

At a particular instant the flux in coil **10** has the distribution and directional aspect as illustrated in Fig. 1. The flux lines **40** and **42**, starting from section **10***c*, flow up through leg **10***b*. At projection **10***g*, the flux lines **40** and **42** separate due to the separation of laminations **35**. Flux lines **40** flow through permanent magnet **22** to armature **12**, and being blocked by the orientation of magnet **20**, flows through projection **10***e*. Flux lines **42** flow up leg **10***b*, through projection **10***f* and armature **12**, combining with lines **40** in projection **10***e*. The lines return, it will be seen, to section **10***c* on one side of separation line **23**; however, due to the fact that section **10***c* is rotated 90° to permit redistribution of the flux lines across the cross section of core **10**, the flux lines **40** and **42** redistribute themselves in section **10***c* to complete the circuits, as illustrated.

Fig. 3 shows the relays in its energized state during the opposite half of the cycle shown in Fig. 1. It will be noted that flux line **42** has merely reversed direction while flux line **40** has disappeared entirely. Instead, a new flux line **43** has appeared in leg **10***a* of core **10**. Also, the flux line **41** appearing in Fig. 1 has reversed its direction when the current through coil **26** is reversed. Therefore, the flux represented by lines **42** and **41** merely reversing direction each half cycle may be identified as the A.C. flux while the flux represented by lines **40** and **43** are termed the pulsating flux since no reversal occurs, only intermittent flow in the same direction. The A.C. and pulsating flux may be characterized as the variable flux of the relay.

It may be pointed out that with the relay energized, as in Fig. 1, about 90% of the induced flux may be concentrated in line **42**, with the remainder in line **40**. This compares with 25% and 75%, respectively, when the relay is in its deenergized position at the instant switch **24** is closed, before armature **12** has begun to close. As is understood in the art, this is due to a difference in reluctance which exists when armature **12** is separated from projection **10***f* and when the gap is closed.

The constant unidirectional flux, identified by lines **44**, produced by permanent magnets **20** and **22**, holds armature **12** in the closed position during the short interval the alternating and pulsating fluxes pass through zero each half cycle. If switch **24** is opened, thereby withdrawing the source of the pulsating and alternating flux, the relay will be deactivated because permanent magnets **20** and **22** do not create enough unidirectional flux to maintain armature **12** in its closed position against the action of spring **18**. However, magnets **20** and **22** by their presence, provide just sufficient holding force to prevent "chattering" of armature **12** due to the passing of the alternating and pulsating flux through zero each half cycle. The presence of magnets **20** and **22** in preventing chattering of the relay not only do not sacrifice operating characteristics, however, but the flux from these magnets also helps to lower the pick-up and drop-out voltages of the relay which are important characteristics for a relay which can be expected to operate under a wide range of conditions.

When coil **26** is deenergized, the portion of the developed armature torque produced by the alternating and pulsating flux reduces to zero. As already noted, the remaining developed armature torque which is produced by the constant flux from the permanent magnets is less than the contact and armature spring torque. Under these conditions the armature will be thrown to the deenergized position wheer it will remain until the coil is reenergized.

Thus, it is seen that there has been provided a polarized A.C. operated relay of relatively simple and rugged construction. The polarized A.C. relay of this invention accomplishes all the functions of an A.C. relay without utilizing either rectifiers in series with the relay coil and condensers in parallel with said coil or shading coils or a plurality of coils and magnetic circuits to produce out of phase attracted forces on the armature of the relay.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

What is claimed is:

1. A single phase A.C. relay comprising a magnetic core having a pair of legs, each leg including a projection therefrom, said projections being mutually opposed and spaced along the length of the respective legs so as to be in mutual axial alignment, electromagnetic coil means mounted on said magnetic core for producing therein an alternating current flux, permanent magnet means mounted on each of the projections having like pole faces thereof opposing each other, elongated armature means pivotally interposed at a midpoint thereof between said like pole faces for movement between a normally unenergized position and an energized position, said elongated armature means forming separate unidirectional magnetic flux circuits with each of said permanent magnet means including each of said projections and each of said legs, and an alternating current magnetic flux circuit with said legs and the magnetic core, spring biasing means biasing said armature means to the normally unenergized position in the absence of alternating current flux, each of said unidirectional magnetic flux circuits including said armature means and each respective projection and leg tending to but insufficiently intense to rotate said armature means into its energized position, whereby energization of said electromagnetic coil means produces sufficient additional magnetic flux in said core to cause the rotation of said armature means from its normal unenergized position to its energized position.

2. A single phase A.C. relay comprising a magnetic core having a pair of legs, elongated armature means mounted between said legs for pivotal movement, permanent magnet means mounted on each of said legs with the pivotal mounting therebetween and the same magnetic pole of each magnet means facing said armature means, said magnetic core and said armature means forming a separate constant unidirectional flux path for each said magnet means and a variable flux path, said armature means rotatable between a first position closing a gap in each of said constant unidirectional flux paths and a second position opening both of said gaps, said gaps being also in said variable flux path, means sufficiently biasing said armature means in its second position to overcome the attraction of said permanent magnet means in the absence of said variable flux, means for subjecting said core to an alternating magnetic field for inducing said variable flux, and means included in said core for directing said variable flux through the particular permanent magnet means having the same polarity as the instantaneous direction of said variable flux to assist said particular permanent means to overcome said biasing means and rotate said armature means into said first position.

3. A single phase A.C. relay comprising a magnetic core with a separation line for forming non-interfering flux paths and having a pair of legs, elongated armature means mounted between said legs for pivotal movement,

permanent magnet means mounted on each of said legs with the pivotal mounting therebetween and the same magnetic pole of each magnet means facing said armature means, said armature means forming a separate closed constant unidirectional flux circuit for each said magnet means and a closed variable flux circuit, said circuits following non-interfering paths in said magnetic core, said armature means rotatable between a first position closing a gap in each of said constant unidirectional flux circuits and a second position opening both of said gaps, said gaps being also in said variable flux circuit, means sufficiently biasing said armature means in its second position to overcome the opposite attraction of said permanent magnet means in the absence of variable flux, means for subjecting said core to an alternating magnetic field for inducing variable flux, and means included in said core for directing said variable flux through the particular permanent magnet means having the same polarity as the instantaneous direction of said variable flux to assist said particular permanent magnet means to overcome said biasing means and rotate said armature means into said first position.

4. A single phase A.C. relay comprising a magnetic core with a separation line for forming non-interfering flux paths and having a pair of extended substantially parallel legs, elongated armature means mounted between and substantially parallel to said legs for pivotal movement, permanent magnet means mounted on each of said legs with the pivotal mounting therebetween and the same magnetic pole of each magnet means facing

said armature means, said armature means forming a separate closed constant unidirectional flux circuit for each said magnet means and a closed variable flux circuit, said circuits following non-interfering paths in said magnetic core, said armature means rotatable between a first position closing a gap between said armature means and said core in each of said constant unidirectional flux circuits and a second position opening both of said gaps, said gaps being on opposite sides of said pivotal mounting and also in said variable flux circuit, means sufficiently biasing said armature means in its second position to overcome the opposite attraction of said permanent magnet means in the absence of variable flux, means for subjecting said core to an alternating magnetic field for inducing said variable flux, and means included in said core for directing said variable flux through the particular permanent magnet means having the same polarity as the instantaneous direction of said variable flux to assist said particular permanent magnet means to overcome said biasing means and rotate said armature means into said first position.

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