Oct. 25, 1949. J. E. WILLING ET AL 2,486,086

RELAY

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FIG. 1.

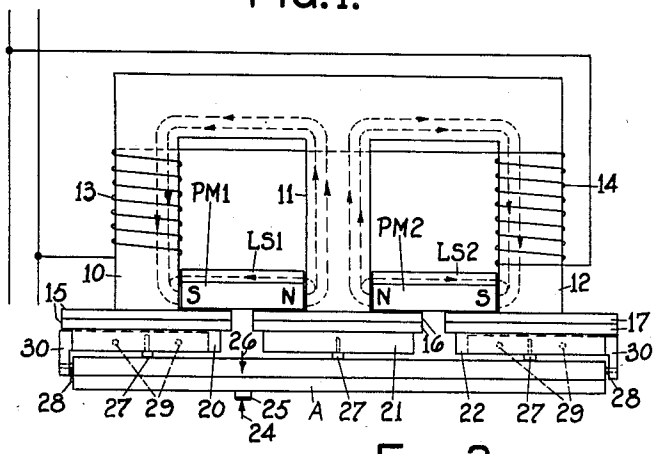


FIG. 2.

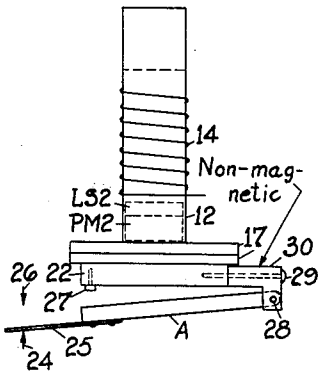


FIG. 3.

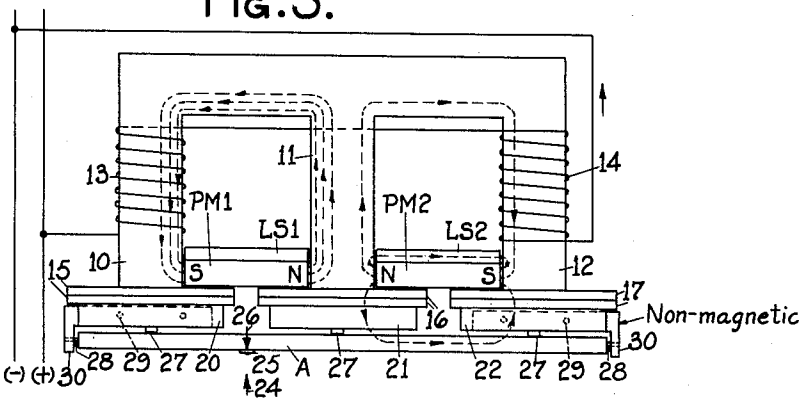
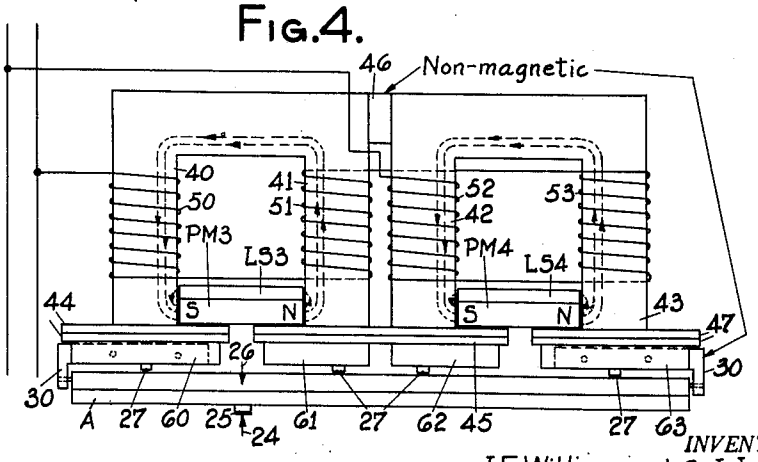


FIG. 4.



INVENTORS.
J.E. Willing and G.J. Johanek
BY
Neil W. Preston,
Their ATTORNEY

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RELAY

Joseph E. Willing and George J. Johanek, Rochester, N. Y., assignors to General Railway Signal Company, Rochester, N. Y.

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4 Claims. (Cl. 175—339)

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This invention relates to relays and more particularly to a relay of the neutral retained type.

By the term "neutral retained" when used in connection with relays is meant a relay structure in which a neutral armature will not release in response to pole changing of the energizing circuit of the relay. It is quite common, particularly in railway signalling practice, to employ a neutral relay, that is, a relay which will be picked up irrespective of the direction of direct current flow through its windings to manifest the flow of current in a circuit which circuit is also used for controlling a polar electro-responsive device, and where it is desired to have such neutral relay remain picked up during pole changing of the current in such circuit. In other words, the neutral relay is to manifest whether or not current is flowing in the circuit irrespective of its direction; whereas, the polar device may be such as to operate only if the current is of one polarity or may be a device which will operate in a particular manner depending upon the polarity of the current flow in the circuit. When a neutral relay is used in a circuit of this type, it is quite often necessary that the relay not drop momentarily to its retracted position due to a sudden change in the polarity of the current flowing in the circuit. It is, of course, understood that an ordinary neutral relay of the tractive armature type will in most instances momentarily assume its retracted position due to pole changing of its energizing circuit and in railway signalling such momentary operation of a relay to its deenergized position may cause a signal to momentarily give the wrong indication. Also, since it is quite common practice for one signal to be controlled by the next signal in advance such momentary dropping of a relay may cause a so-called tumble-down of signal indications to occur. What is meant by tumble-down of signal indications is that a momentary change in a signal indication will cause the next signal in the rear to produce a similar momentary change of signal indication and this may be repeated ad infinitum or at least to the end of a particular portion of the signal system. This is, of course, very undesirable and must be avoided.

Sometimes the neutral armature in a neutral-polar relay is provided with means for causing it to be retained during pole changing of the energizing current for the relay. A relay of this type is known as a retained neutral-polar relay. The patent to Larson No. 1,852,210 dated April 5, 1932 discloses a relay of this type. Not only is it desirable in many instances to have the neutral

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armature of a neutral relay not drop to its retracted position during pole changing of the energizing circuit, but it is also highly desirable that such armature should remain in its attracted position in spite of momentary opening of its energizing circuit. The relay disclosed in the Larson patent does not satisfy this latter requirement. This shortcoming in the Larson patent was overcome in the patent to Hitchcock, No. 2,056,147, dated September 29, 1936 by providing a rectifier in the energizing circuit of the small auxiliary magnet which acted to retain the main armature up both during pole changing and momentary opening of the energizing circuit of the relay. Rectifiers are, however, not tolerated on some railway signalling systems by reason of their susceptibility to damage by lightning disturbances, or the like.

In view of the foregoing and other important considerations, it is proposed to provide a relay the neutral armature of which will not be momentarily dropped due to either pole changing of its energizing circuit or momentary opening of its energizing circuit and which does not employ rectifiers. One object of the present invention resides in the provision of two polar relay structures each including a permanent magnet and both acting on a single soft iron armature and so connected in series or multiple that current of one polarity will render one of these structures effective and current of the other polarity will render the other structure effective together with means for rendering each of these polar structures slow releasing.

Another object of the present invention resides in the provision of such a permanent magnet between the poles of a soft iron yoke in a relay structure such that the soft iron yoke normally serves as a shunt for the flux emitted by such permanent magnet as a result of which the electro-magnet responds only if current of one polarity is applied thereto, and to employ two such electro-magnets to actuate a single armature regardless of the polarity of such current.

Another object of the present invention resides in the provision of leakage strips adjacent the permanent magnet just mentioned so that the permanent magnet is less apt to be demagnetized by excessive current such as might occur due to a lightning disturbance or the like.

In accordance with one form of the present invention a three-pole soft iron yoke is provided between the middle and each outside pole opposite which are provided permanent magnets between the poles so that the back yoke of this

relay structure serves as a magnetic shunt for both of the permanent magnets employed.

Other objects, purposes and characteristic features of the present invention will in part be described hereinafter and will in part be obvious from the accompanying drawings, in which—

Fig. 1 illustrates in elevation a relay embodying the present invention;

Fig. 2 shows a side view of the relay shown in Fig. 1;

Fig. 3 shows the relay illustrated in Fig. 1 with its energizing circuit energized by current of one polarity and its armature in the attracted position; and

Fig. 4 shows a modified form of the relay illustrated in Fig. 1.

The drawings have been devised to illustrate the invention more for the purpose of showing the necessary structural characteristics of the relay than showing the detailed design of a commercial device. For this reason the drawings have been made fragmentary in nature eliminating, for instance, the housing for protecting the relay structure against weather, the terminal blocks for supporting the fixed contacts and lead-in and lead-out wires of the relay and the coil structure; it being believed that a disclosure and explanation of the essential structural characteristics will be sufficient for an understanding of the principles of the invention so that they may be readily adapted to any particular relay designed for specific purposes, such as railway signalling, or the like.

Structure—Figs. 1, 2 and 3.—Referring to Figs. 1, 2 and 3 of the drawings the soft iron core structure 10—12 of the relay illustrated is of the three-pole type the outer two legs 10 and 12 of which are provided with coils 13 and 14 whereas the middle leg 11 is provided only with conducting washers or slugs 16 which function to render the relay slow dropping in the usual manner. The outside legs 10 and 12 are similarly provided with metallic washers or slugs 15 and 17 respectively. Directly above conducting washers 15 and 16 and between the legs 10 and 11 is provided a permanent magnet PM1 to bridge the airgap between these legs 10 and 11. A similar permanent magnet PM2 is arranged between the legs 11 and 12 and directly over the slugs 16 and 17. These permanent magnets are preferably of the very high coercive force type and are preferably constructed of the material known in the trade as Alnico but may be of any other well-known type such as chrome steel or cobalt. If Alnico is used the type known as Black Streak which has exceptionally high coercive force may be used, if desired. These permanent magnets PM1 and PM2 are preferably partially shunted by leakage strips LS1 and LS2. This electro-magnet structure of the retained neutral relay of the present invention may be similar to that disclosed in the prior application of Duffy, Ser. No. 542,203, filed June 26, 1944, now Patent No. 2,414,583, dated January 21, 1947, to which reference may be had. The three legs 10, 11 and 12 of the relay core structure preferably terminate in enlarged pole pieces 20, 21 and 22. As more clearly shown in Fig. 2 of the drawings the armature A is provided with a movable contact 25 which may engage either a back fixed contact 24 or a front fixed contact 26. The armature A is preferably pivoted, as shown, by the pin 28 extending into a fixed bracket 30 of non-magnetic material secured to the poles 20 and 22 as through the medium of screws 29.

It will be observed that the coils 13 and 14 are so wound and connected that if current is applied thereto to produce a downwardly directed magneto-motive force in one of these coils this same current will produce an upwardly directed magneto-motive force in the other coil, and vice versa. It will also be observed that the permanent magnets PM1 and PM2 both have their north pole N adjacent the middle leg 11 and have their other or south pole S against the associated outer leg of the core structure 10—12. The magnetism produced by the permanent magnets PM1 and PM2 has been conventionally shown in Fig. 1 of the drawings by dotted lines containing arrows. From this it will be seen that magnetism flows upwardly through the middle leg 11, separates at the upper end of this leg and substantially equally divides so that substantially equal amounts flow downwardly through the legs 10 and 12 back to the south poles S of these permanent magnets. The core structure 10—12 is preferably constructed of low reluctance soft iron such as annealed silicon steel so that this core structure serves as a very efficient shunt for shunting the magnetism emitted by the permanent magnets PM1 and PM2 away from the armature A, so that insufficient magnetism will pass through the armature A to pick it up, and so that this armature remains in its retracted position.

Operation—Figs. 1, 2 and 3.—Referring now to Fig. 3 of the drawings, this drawing shows the same structure as illustrated in Fig. 1 except that direct current is assumed to be passed through the circuit including the two coils 13 and 14 in series as conventionally shown by being connected to wires having (+) and (—) direct current applied thereto as illustrated. It will be observed that the current flow through the coils 13 and 14 is in a direction to augment the magnetism in the leg 10 of the relay but so as to decrease the amount of magnetic flux in the leg 12 of the relay, the amount of flux existing in the middle leg remaining substantially the same as heretofore. Since the direction of current flow is such that the shunting effect of the portion from leg 11 to leg 12 of the back yoke structure 10—12 is less than it was heretofore but the shunting effect for the left-hand portion of the relay (leg 10 to leg 11) is more pronounced than it was heretofore it will be seen that part of the flux emitted by the permanent magnet PM2 must find new paths and will pass through the right-hand portion of the armature A to thereby cause this armature to be attracted toward the pole pieces 20, 21 and 22 to an extent in engagement with the residual pins 27. It will be observed that the magnetism passing through the right-hand portion of the armature A (Fig. 3) must pass through the conducting washers or slugs 16 and 17. This magnetism after it has once been built up will not readily fall to zero by reason of the currents induced in these slugs or washers 16 or 17 of good conducting material. These currents produce magneto-motive forces tending to maintain such magnetic flux. For this reason, if the current in the circuit for the coils 13 and 14 is suddenly reversed, as may be a common occurrence when the invention is practiced in the railway signalling field, this flux in the right-hand portion of the relay armature and passing through the slugs 16 and 17 will be maintained for a longer time than is necessary for flux to be built up in the left-hand portion of the relay during pole changing of its energizing circuit. The arma-

ture A will therefore not drop. The momentary opening of the energizing circuit will also not cause momentary dropping of the armature A by reason of the sustaining effect produced by the slugs or washers 16 and 17 of copper or other low resistance conducting material.

It should be understood that, if desired, one of the permanent magnets PM1 and PM2 of the Fig. 1 structure may be turned end-for-end if the direction of turns in one of coils 13 and 14 is also reversed. In such modified arrangement there would then be normally practically no magnetism passing through the middle leg 11, so that the cross-section of this middle leg could be somewhat reduced.

Structure—Fig. 4.—In Fig. 4 of the drawings has been illustrated a modified form of the invention and embodying the same operating principles as those embodied in the form shown in Figs. 1, 2 and 3. The principal difference between the structure shown in Fig. 4 and that shown in Fig. 1 is that two independent magnetic circuits are provided in the Fig. 4 structure whereas in the Fig. 1 structure the middle leg is common to the two electro-magnets including coils 13 and 14 respectively. It will be observed that in Fig. 4 two U-shaped cores are provided with contact legs 40 and 41 and legs 42 and 43 respectively. These U-shaped cores are bridged by permanent magnets PM3 and PM4 respectively which are shunted by leakage strips LS3 and LS4 respectively. It will be observed that the four legs 40, 41, 42 and 43 having pole pieces 60, 61, 62 and 63 respectively are provided with conducting washers or slugs 44, 45 and 47. The washers 45 are preferably double, that is, are single washers having two holes therein. The coils 50, 51, 52 and 53 contained on these legs 40, 41, 42 and 43 respectively are so wound and connected that the magneto-motive forces produced by these coils, when current is passed through the circuit including these coils in series, is such that when such current flows in one direction the induced magneto-motive forces for the left-hand structure will be in the same direction in the closed magnetic circuit as the magneto-motive force produced by the permanent magnet PM3 whereas for the right-hand structure it will be in a direction in the closed magnetic circuit to oppose the magneto-motive force of the permanent magnet PM4 and that the reverse will be the case when the direction of this current flow in such circuit is reversed. As shown, the legs 41 and 42 are held in firm spaced relationship at their lower end by double washer 45 and are held in firm spaced relationship at the upper end by a block 46 of non-magnetic material. In other words, the Fig. 4 structure really comprises two magnetically isolated relay core and coil structures such as disclosed in the Duffy patent constructed to act on the same tractive type armature of soft iron and these structures are so connected in their operating circuit that one of these relay structures will attract the armature when current flows in one direction and the other relay structure will attract the armature when the current flows in the opposite direction, together with means for rendering both of these relay structures slow releasing. It is thus seen that the functional result of the relay shown in Fig. 4 is substantially the same as that of the relay structure illustrated in Fig. 1 of the drawings for which reason it is deemed unnecessary to specifically consider the operation of the relay illustrated in Fig. 4 of the drawings.

The leakage strips LS1 and LS2 of Fig. 1 and the leakage strips LS3 and LS4 shown in Fig. 4 are not only desirable to prevent destruction of the permanent magnets as by lightning but they are also desirable to prevent destruction of the permanent magnet when excessive currents are applied to the relay, in that such current if of one polarity opposes one of these permanent magnets and if of another polarity opposes the other of these permanent magnets. In spite of the advantages afforded by these leakage strips the retained neutral relay of this invention does not necessarily incorporate or require them and they may be omitted, if desired.

It should be understood that the neutral retained relay of the present invention may be either included in series in a control circuit or may be connected in multiple thereto. Also, if such neutral retained relay includes two or more windings these windings may be connected in series, in multiple or in series-multiple.

Having thus shown and described several embodiments of the present invention it should be understood that they do not include all structural forms that may be used in practicing the invention and that the particular embodiments illustrated have been selected to facilitate disclosing the underlying principles of the invention and its mode of operation and that various changes, modifications and additions may be made to the disclosure shown in practicing the invention without departing from the spirit and scope of the invention so long as these changes come within the scope of the following claims.

What we claims as new is:

1. In a relay of the character described, an armature normally assuming a retracted position, electro-magnetic means comprising two electro-magnetic structures located adjacent said armature and affording respective oppositely poled electro-magnetic circuits acting when energized with a particular polarity to attract said armature, permanent magnets magnetically connected in multiple with said electro-magnetic structures and so poled as to render one of said electro-magnetic structures effective to attract said armature only when its electro-magnetic circuit is energized with a particular polarity, and as to render the other of said electro-magnetic structures effective to atrract said armature only when its electro-magnetic circuit is energized with the opposite polarity, a leakage strip in multiple with each of said permanent magnets, and short circuited turns on each of said magnetic structures near said armature for at times tending to maintain said armature in its attracted position.

2. In a retained neutral relay, an electro-magnetic core structure having two independent legs and one common central leg magnetically connected by a common back portion, a single pivoted armature cooperating with the open ends of the three legs of said core structure, a permanent magnet located between each independent leg and said common leg, the two permanent magnets having like poles adjacent said common leg of said core structure, whereby each permanent magnet normally has its flux shunted by the adjacent legs and back portion of the core structure, an energizing winding on that portion of each of said independent legs of said core structure which is included in the magnetic shunt for the associated permanent magnet, a short circuited coil on each leg between the permanent magnet and the armature to thereby

give a slow releasing effect when the flux has been passing through that leg for actuating said armature, whereby the energization of said windings with one polarity causes flux to pass through one independent leg and said common leg to effectively actuate the armature, whereas the energization of said windings with the opposite polarity causes flux to pass through the other independent leg and said common leg to effectively actuate the armature, and whereby a quick reversal in the polarity of energization of said windings or a momentary removal of energy from said windings does not cause said armature to release.

3. In a retained neutral relay, two spaced electro-magnetic core structures each having two independent legs magnetically connected by a back portion, a single pivoted armature cooperating with both of said core structures, a permanent magnet located between the open ended legs of each core structure so as to be shunted thereby, a winding on that portion of each core structure which is included in the magnetic shunt of the respective permanent magnet, the windings of both said core structures being connected in series, a short circuited coil on that portion of each leg of said core structure which does not shunt the associated permanent magnet to thereby give a slow releasing effect when that core structure provides magnetic flux for effectively actuating the cooperating armature, whereby the energization of said windings with one polarity causes magnetic flux from one core structure to effectively actuate the armature, whereas the energization of said windings with the opposite polarity causes flux from the other core structure to effectively actuate said armature, and whereby a quick reversal of the polarity on said windings does not result in the momentary release of said armature, and said armature

is slow in releasing upon the complete deenergization of said windings.

4. In a retained neutral type relay, a pivoted armature normally biased to a particular position, a magnetic core structure cooperating with said armature for at times actuating it to its opposite position, said core structure comprising two permanent magnets and a U-shaped magnetic shunting portion for each permanent magnet, a winding for each shunting portion, and a leakage member adjacent each permanent magnet and positioned parallel thereto, a short circuit means associated with said magnetic core structure and located thereon adjacent that portion of the core structure which brings it into cooperative relation with said armature, whereby energization of said windings with one polarity causes magnetic flux from one permanent magnet to actuate said armature whereas energization of said windings with the opposite polarity causes magnetic flux from the other permanent magnet to actuate said armature, and whereby the release of said armature is delayed upon the deenergization of said windings.

JOSEPH E. WILLING.
GEORGE J. JOHANEK.

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