Aug. 24, 1943. R. L. PEEK, JR 2,327,549

TWO-STEP RELAY

Filed Sept. 23, 1942

FIG. 1

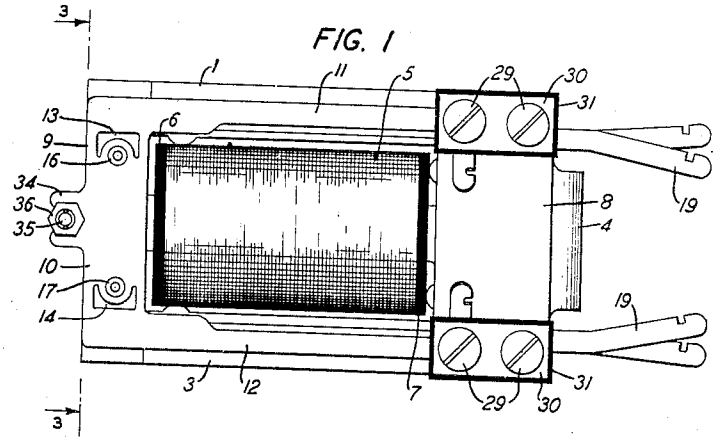


FIG. 2

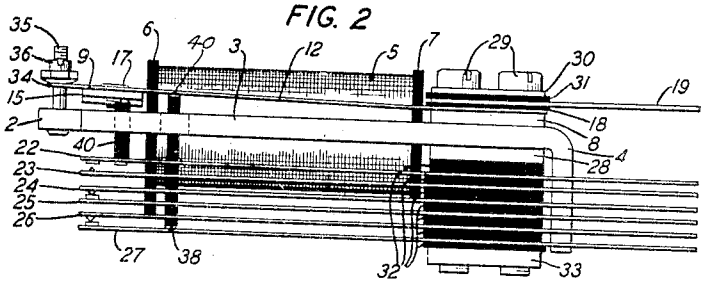


FIG. 3

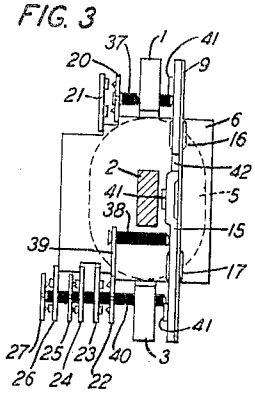


FIG. 4

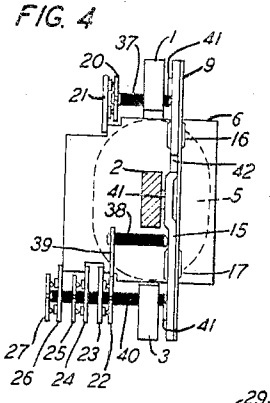


FIG. 5

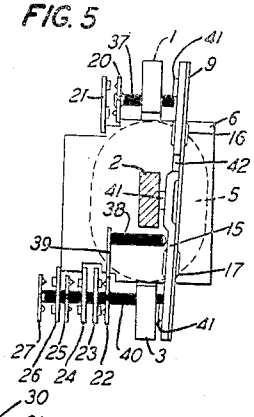


FIG. 6

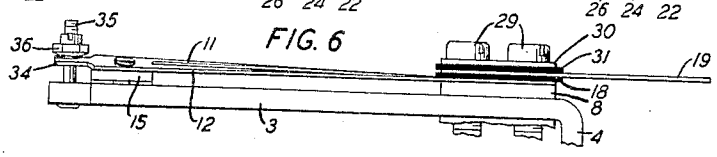
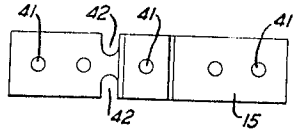


FIG. 7



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TWO-STEP RELAY

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Application September 23, 1942, Serial No. 459,390

7 Claims. (Cl. 200—104)

This invention relates to relays and more particularly to relays for use in the circuits of telephone systems.

It is sometimes desirable in the circuits of telephone or other systems to provide relays which are so designed that certain of the contacts thereof are operable upon one degree of energization of the relay coil and that other contacts are only operable upon a greater degree of energization of the coil. Such relays are generally known as two-step relays. Relays of this general type have heretofore been proposed for use on subscribers' lines of telephone systems to perform the dual function of line relays and cut-off relays. The line relay usually associated with a subscriber's line of the step-by-step dialing switching system, for example, has two pairs of normally open contacts which become closed when the line relay winding is energized over the calling line loop upon the removal of the substation receiver from the switchhook when the subscriber initiates a call, one pair of which contacts are effective to establish the line finder start circuit and the other pair of which are effective to connect the winding of the cut-off relay to the test sleeves of the line appearing in the banks of all line finders having access to the line. The associated cut-off relay is provided with one pair of normally open contacts and two pairs of normally closed contacts, the latter contacts being in the circuit of the winding of the line relay and effective when the cut-off relay winding is energized in response to the seizure of the line by a started line finder to disconnect the line relay from the calling line loop and the former contacts serving to establish a holding circuit for the cut-off relay to hold it operated following the release of the line relay and until the connection is released and the line finder is restored to normal. This is only one specific use to which a relay of the type disclosed in this application might be put.

It is apparent that with an adequate design, a relay structure can be constructed, the armature of which is operable in a certain manner or to a certain amount upon one degree of energization of the relay winding over one circuit, for example, over the subscriber's line loop, to close certain of its normally open contacts and the armature of which is operable in a certain other manner or to a greater amount upon a further degree of energization of the relay winding over another circuit, for example, over the line finder test circuit, to close other of the normally open contacts and to open others of its normally closed contacts.

It is therefore the object of the present invention to provide a relay simple in structure and efficient in operation which will be operable in two very definite steps. To attain this object, an E-shaped field piece with a coil surrounding its middle or core arm is provided with a spring supported armature attractable to the forward ends of the three arms, the armature being attracted in a linear motion to the three arms upon a partial energization of the coil and subsequently attracted by a rocking motion on the middle arm as a fulcrum to one of the outer or return pole-piece arms upon a stronger energization of the coil.

The operation and structural details of the improved relay constructed in accordance with the invention will be more readily understood from the following detailed description taken in connection with the accompanying drawing in which:

Fig. 1 is a side elevational view of the relay;

Fig. 2 is a bottom plan view of the relay;

Fig. 3 is an end elevational view of the relay taken along the section line 3—3 of Fig. 1 showing the armature in its normal unattracted position;

Fig. 4 is a similar end elevational view with the armature shown in first step attracted position;

Fig. 5 is a similar end elevational view with the armature shown in its second step attracted position;

Fig. 6 is a partial bottom plan view of the relay showing the manner in which the armature supporting spring is flexed when the armature assumes its second step attracted position; and,

Fig. 7 is a detail view of the armature.

The relay has an E-shaped field piece of magnetic material having three forwardly extending arms 1, 2 and 3 and a bracket portion 4 bent at right-angles from its rear edge to serve as a support for the relay upon a suitable mounting rack. An energizing coil 5 having a front spoolhead 6 provided with the usual side notches for positioning the fixed springs of the spring pile-ups of the relay and a rear spoolhead 7 is supported on the middle or core arm 2 and within the two outer or return pole-piece arms 1 and 3 of the field piece. Supported on one face of the rear end of the field piece and separated therefrom by the spacer 8 is a reed spring member 9 preferably of hard nickel-silver. The member 9 is of substantially rectangular formation having a wide rear portion by which it is supported on the spacer 8, a front portion 10 and two side arms 11 and 12. The front portion 10 is cut away near each end

thereof to form two ears 13 and 14 to which the transversely extending armature 15 is secured by the eyelet rivets 16 and 17.

Supported on the rear end portion of the spring member 9 and insulated therefrom by interposed strips 18 of insulating material are two coil terminal lugs 19. Supported on the other face of the rear end of the field piece opposite the two side arms 1 and 3 are two spring pile-ups. Each of the spring pile-ups may comprise any desired number and arrangement of contact springs but since it is assumed that the relay disclosed is expressly designed for use as a combined line and cut-off relay assembly, the upper spring pile-up comprises one pair of normally open contact springs including one movable or armature spring 20 and one fixed spring 21 and the lower spring pile-up comprises one pair of normally open contact springs 22 and 23 and two pairs of normally closed contact springs 24 and 25 and 26 and 27, of which springs 22, 25 and 27 are movable or armature springs and springs 23, 24 and 26 are fixed springs.

The coil terminal lugs 19, the spring member 9, the spacer 8, the spacers 28 and the spring pile-ups are suitably clamped to the rear end of the field piece by screws 29 which pass through holes in the clamping plates 30, in the insulating strip 31, in the lugs 19, in the insulating strips 18, in spring member 9, in the spacing plate 8, in the field piece, in the spacers 28, in the insulating strips 32 and in the contact springs into threaded holes in the clamping plates 33. The terminal lugs 19 and the contact springs are insulated from each other, from the field piece and from the clamping plates 30 and 33 by the interposed insulating strips 18, 31 and 32 and the clamping screws 29 have their shanks surrounded by the usual sleeves of insulating material (not shown) for insulating them where they extend through holes in the coil terminal lugs and in the contact springs.

The movable or armature springs have their contact ends bifurcated with each section thus formed provided with a contact bar and each mating or fixed spring is provided with a pair of cooperating contact bars whereby double contacts are provided between each pair of mating springs.

For operating the movable or armature springs the armature spring 20 has a stud 37 of insulating material ring-staked thereto with its inner end engaging against the inner face of the side portion 11 of the spring member 9, the armature spring 22 has a stud 38 of insulating material ring-staked to an inwardly extending arm thereof and engaging against the armature 15 adjacent the center portion thereof and the armature spring 24 has a stud 40 of insulating material ring-staked thereto and extending freely through holes in the armature spring 22 and the fixed springs 23, 24 and 26 with the inner end thereof engaged against the inner face of the side portion 12 of the spring member 9 and the outer end thereof engaged against the armature spring 27.

The forward or free end of the spring member 9 is provided with a bifurcated tongue portion 34 which freely embraces the backstop screw 35. The screw 35 is secured to the end of the core arm 2 of the field piece and has threaded thereon a backstop nut 36 which serves as a backstop to limit the releasing movement of the armature 15 and to adjust the normal air-gaps between the armature and the ends of the arms 1, 2 and 3 of the field piece.

The armature 15 is bent into the shape best disclosed in Fig. 3 with its central portion so bent that normally the air-gap between the pole face of its central portion and the pole face of the core arm 2 of the field piece is narrower than the air-gaps between its two end portions and the pole faces of the return pole-piece arms 1 and 3 of the field piece. Stop discs 41 of non-magnetic material are welded or otherwise secured to the pole faces of the armature at points opposite the pole faces of the arms 1, 2 and 3 of the field piece. As best disclosed in Fig. 7, the cross section of the armature is reduced at one end adjacent to its center portion by the notches 42 for the purpose of restricting the magnetic flux which can flow through that end of the armature.

The structural details of the relay having now been described, the manner in which the relay functions will be discussed. With the relay coil 5 deenergized, the armature is held by the pressure of the armature springs of the spring pile-ups in the position disclosed in Fig. 3 in which position the tongue 34 of the spring member 9 is engaged against the backstop nut 36 and the two end portions of the armature are equally spaced from the pole faces of the return pole-piece arms 1 and 3. When now the coil 5 is partially energized the armature 15 is attracted in a linear movement until the stop disc 41 on the central portion of the armature engages the pole face of the core arm 2 and the end portions of the armature are nearer to the pole faces of the return pole-piece arms 1 and 3 but still separated therefrom by equal air-gaps. It will be assumed that the initial energization of the coil 5 is not sufficient to further operate the armature. The armature is now in its first step operated position shown in Fig. 4, in which position the armature presses upon the operating studs 37 and 38 to cause the engagement of armature spring 20 with its mate spring 21 and to cause the engagement of the armature spring 22 with its mate spring 23. The movement of the stud 40 is not, however, sufficient to cause the armature springs 25 and 27 to disengage their mate springs 24 and 26. At this time the flux flowing through the upper end of the armature as viewed in Fig. 4 to the return pole-piece arm 1 substantially saturates the armature at its restricted portion between the notches 42.

If the coil 5 now becomes fully energized, the increased flow of flux through the armature due to the saturated condition of the restricted portion of the armature is directed across the air-gap between the lower end of the armature, as viewed in Fig. 4, and the pole-piece arms 3 and since the stop disc 41 on the central portion of the armature is engaged against the pole face of the core arm 2, the armature is operated in a rocking movement until the stop disc 41 on the lower end of the armature engages the pole face of the lower pole-piece arm 3. This second step operated position of the armature is illustrated in Fig. 5 in which position the armature spring 22 is held in engagement with its mate spring 23 and the armature springs 25 and 27 are moved by the operating stud 40 out of engagement with their mate springs 24 and 26. Since due to its rocking movement, the upper end of the armature has been moved away from the upper pole-piece arm 1, the pressure upon the stud 37 is relieved to permit spring 20 to become disengaged from its mate spring 21.

When the coil 5 becomes deenergized, the relay

armature returns to its normal position illustrated in Fig. 3.

If the relay is employed as a combined line and cut-off relay in a circuit of the type previously described, the coil 5 may be energized in a first circuit over the calling line loop to operate the armature in its first step to engage spring 20 with spring 21 to establish the line finder start circuit and to engage spring 22 with spring 23 to prepare a second operating circuit for the coil 5 over the test terminal multiples in the banks of line finders having access to the calling line. When the line finder finds the line, the coil 5 becomes more strongly energized over this second circuit to operate the armature in its second step whereupon springs 22 and 23 are maintained in engagement to hold the second operating circuit of the coil 5 closed, to disengage springs 20 and 21 to open the line finder start circuit and to disengage springs 25 and 27 from springs 24 and 26, respectively, to disconnect the coil 5 from its first energizing circuit over the line loop. Since the invention primarily relates to the structure of the improved relay and not to any particular circuit application thereof, the circuit application above described has not been illustrated.

Structures other than that above described may be employed to obtain the same general type of two-step operation, as the only essential requirements are the provision of two alternative magnetic paths, an armature capable of closing only one of these paths at a time and a constriction limiting the flux that may pass through one of the paths.

What is claimed is:

1. In a relay, an E-shaped field piece, an armature extending transversely across the forward ends of the pole-piece arms of said field piece, a spring member for supporting said armature to enable a linear movement thereof toward said pole-piece arms and a rocking movement on the middle one of said arms, contact springs selectively operable in response to the two movements of said armature, and an energizing coil surrounding the middle one of said arms operable upon its partial energization to cause the linear movement of said armature and operable upon a stronger energization to cause the further rocking movement of said armature.

2. In a relay, an E-shaped field piece, an armature extending transversely across the forward ends of the pole-piece arms of said field piece, a spring member secured at one end to the rear end of said field piece and having two forwardly extending arms secured at their forward ends to the ends of said armature, whereby said armature is free to move in a linear movement into engagement with the middle one of said pole-piece arms and is free to thereafter move in a rocking movement about said middle pole-piece arm as a fulcrum into engagement with one of said other pole-piece arms, contact springs selectively operable in response to the two movements of said armature, and an energizing coil surrounding the middle one of said pole-piece arms and operable upon its partial energization to cause the linear movement of said armature and operable upon a stronger energization to cause the further rocking movement of said armature.

3. In a relay, an E-shaped field piece, an armature extending transversely across the forward ends of the pole-piece arms of said field piece, said armature being reduced in cross-sectional area at a point on one side of its center, whereby the flux carrying capacity of that end of said armature is reduced, a spring member for supporting said armature to enable a linear movement thereof toward said pole-piece arms and a rocking movement on the middle one of said arms, contact springs selectively operable in response to the two movements of said armature, and an energizing coil surrounding the middle one of said arms and operable upon its partial energization to cause the linear movement of said armature and to cause the magnetic saturation of the constricted portion of said armature and operable upon a stronger energization to cause the further rocking movement of said armature.

4. In a relay, an E-shaped field piece, an armature extending across the forward ends of the pole-piece arms of said field piece, said armature having the pole face of the central portion thereof extended beyond the plane of the pole faces of its end portions whereby the air-gap between said central portion and the middle arm of said field piece is narrower than the air-gaps between the end portions of said armature and the outer pole-piece arms of said field piece, a spring member for supporting said armature to enable a linear movement thereof toward said pole-piece arms and a rocking movement on the middle one of said arms, contact springs selectively operable in response to the two movements of said armature, and an energizing coil surrounding the middle one of said arms and operable upon its partial energization to cause the linear movement of said armature and operable upon a stronger energization to cause the further rocking movement of said armature.

5. In a relay, an E-shaped field piece, an armature extending transversely across the forward ends of the pole-piece arms of said field piece, said armature having the pole face of the central portion thereof extended beyond the plane of the pole faces of its end portions whereby the air-gap between said central portion and the middle arm of said field piece is narrower than the air-gaps between the end portions of said armature and the outer pole-piece arms of said field piece, said armature being further provided with oppositely disposed notches to provide a reduced cross-sectional area between said central portion and one of said end portions whereby the flux carrying capacity of that end of the armature is reduced, a spring member for supporting said armature to enable a linear movement thereof toward said pole-piece arms and a rocking movement on the middle one of said arms, contact springs selectively operable in response to the two movements of said armature, and an energizing coil surrounding the middle one of said arms and operable upon its partial energization to cause the linear movement of said armature and to cause the magnetic saturation of the constricted portion of said armature and operable upon a stronger energization to cause the opposite end portion of said armature to be rocked toward the associated pole-piece arm.

6. In a relay, an E-shaped field piece, an armature extending transversely across the forward ends of the pole-piece arms of said field piece, a spring member for supporting said armature to enable a linear movement thereof toward said pole-piece arms and a rocking movement on the middle one of said arms, a first pair of normally disengaged contact springs positioned beneath one end of said armature, a second pair of normally disengaged and two pairs of normally en-

gaged contact springs positioned beneath the other end of said armature, studs operable by the movement of said armature for operating said pairs of contact springs, and an energizing coil surrounding the middle one of said arms and operable upon its partial energization to cause the linear movement of said armature to engage both of said normally disengaged pairs of springs and operable upon a stronger energization to cause the further rocking movement of said armature to disengage said first pair of contact springs and to disengage said two pairs of normally engaged contact springs while maintaining second pair of contact springs engaged.

7. In a relay, a field piece having a plurality of pole pieces providing two alternative paths for the flow of flux therethrough, an armature attractable to said pole pieces to close either one of said flux paths, one of said flux paths having a portion constricted in cross-sectional area whereby the flux carrying capacity of that path is reduced, a spring member for supporting said armature, and an energizing coil associated with said field piece and operable upon its partial energization to cause an attraction of said armature to close one of said flux paths and to cause the magnetic saturation of said constricted portion of said path and operable upon a stronger energization to cause the further attraction of said armature to close the other of said flux paths.

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