July 31, 1945. E. R. MORTON 2,380,541

RELAY

Filed Sept. 26, 1941

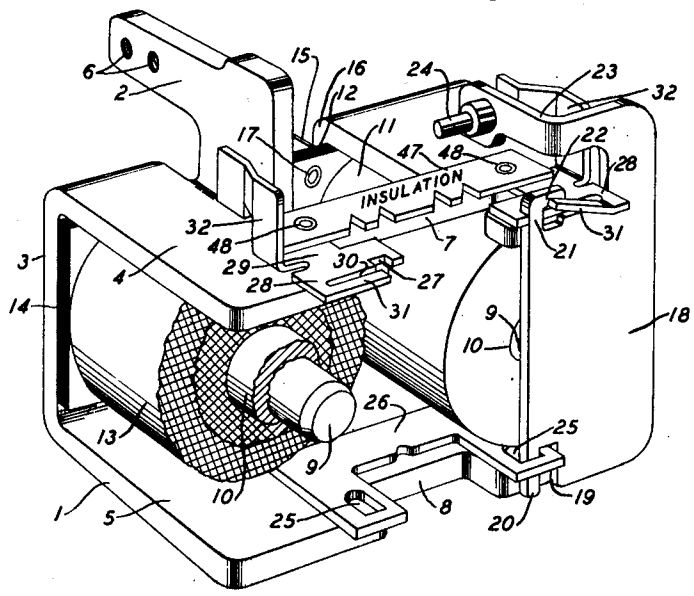

FIG. 1

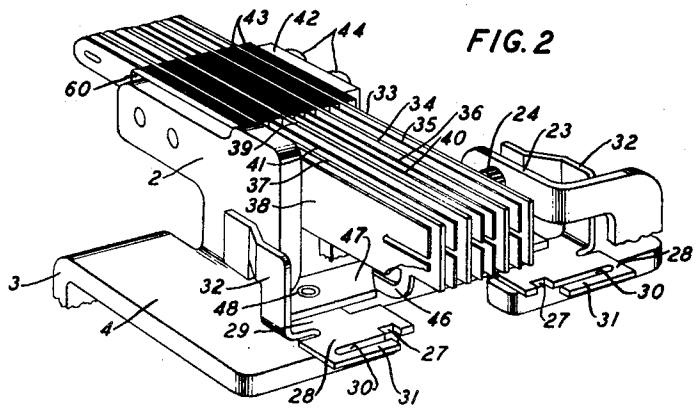

FIG. 2

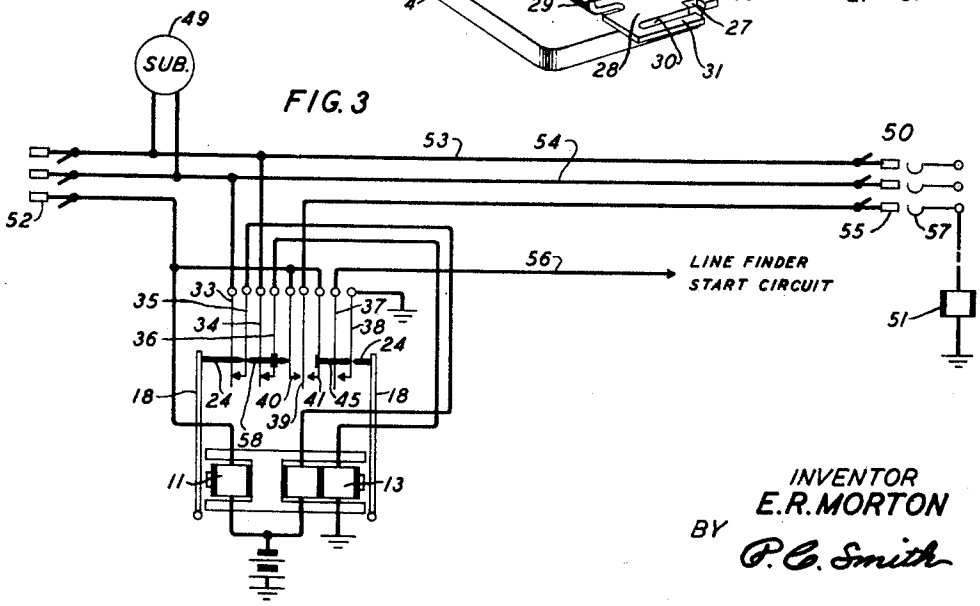

FIG. 3

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RELAY

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12 Claims. (Cl. 200—98)

This invention relates to relays and more particularly to a combined line and cut-off relay structure for use on subscribers' lines of telephone systems.

In telephone systems and particularly in systems of the step-by-step type, each subscriber's line is provided with a line relay and a cut-off relay, the two windings of the line relay being energizable in a circuit extending from the terminals of the central office battery over two pairs of normally closed contact springs comprising a part of the cut-off relay and the calling line loop when the calling subscriber closes the line loop at his substation to initiate a call. The line relay upon energizing is instrumental in closing two pairs of contact springs, over one pair of which a circuit is established to start an idle line finder in search of the calling line and over the other pair of which the winding of the cut-off relay is connected to the test or sleeve conductor of the calling line terminating in multiplied bank terminals of all line finders having access to the calling line. When the started line finder finds the calling line and its test brush encounters the test multiple of such line, the circuit prepared by the operated line relay for the cut-off relay is completed and the cut-off relay operates to open its two pairs of normally closed contacts to thereby disconnect the windings of the line relay from the calling line loop. It also closes a third pair of contacts whereby the cut-off relay locks itself to the circuit completed over the test brush of the line finder and is thus maintained operated following the release of the line relay resulting from the disconnection of the windings thereof from the calling line loop.

Some suggestions have heretofore been made for combining the line and cut-off relays into a single unit to effect savings in manufacturing and installation costs and to effect a saving in mounting space on the apparatus rack at the central office. Since several thousand of both line and cut-off relays are required each year to meet the normal expansion of installed telephone offices and to meet the normal demand for new office installations, it is apparent that a relay structure which would perform all of the functions of both the usual line and cut-off relays in a reliable manner and which could be simplified to such an extent as to effect material manufacturing, installation and maintenance costs would be of great value.

It is therefore the object of the present invention to simplify the structural details of a combined line and cut-off relay assembly, to reduce thereby the cost of manufacture, installation and maintenance and to effect more reliable operation.

To attain this object and in accordance with one feature of the present invention, the magnetic circuit of the assembly comprises a channel-shaped field piece having two cores extending from the base of the channel forwardly between the flanges thereof upon one of which is supported a two winding line relay coil and upon the other of which is supported a cut-off relay coil. To complete the magnetic circuit, two armatures are provided which are pivoted on axes extending at right-angles to the flanges of the channel and which are attractable toward the forward edges of the channel flanges and toward the pole face ends of the cores. Stamped out of the flat blank from which the field piece is formed is a bracket member which before the blank is bent into its channel shape is bent at right angles to the upper flange to serve as a support for a single spring pile-up. The spring pile-up comprises nine springs suitably insulated from each other and from the bracket member, two pairs of which are normally closed and may be opened by a rearwardly extending arm of the armature associated with the cut-off relay coil by the attractive movement of such armature, one pair of which is normally open and may be closed by the rearwardly extending arm of the armature associated with the line relay coil by the attractive movement of such armature, and the remaining three springs forming a group, the middle spring of which is fixed and the other two springs of which are engageable with the middle spring by the attractive movement of the armatures associated with the line relay and cut-off relay coils respectively.

In accordance with a further feature of the invention, each of the armatures is stamped from flat stock with upper and lower pintles integral therewith. For pivoting the armatures, a lower pivot plate having pivot holes for receiving the lower pintles of the two armatures is suitably secured as by spot-welding to the lower flange of the field piece member and an upper pivot plate having pivot notches for receiving the upper pintles of the two armatures is welded to the upper flange. For holding the upper armature pintles in such notches, the upper pivot plate is provided with retaining fingers which may be bent in such a manner as to engage the upper pintles of the armatures after the armatures have been placed in their proper positions with their lower pintles in the pivot holes of the lower

pivot plate and with their upper pintles in the pivot notches of the upper pivot plate. The upper pivot plate is also provided with rearwardly extending members bent from the ends thereof to lie in planes extending at right-angles to the plane of the upper flange which serve as backstops for the armatures.

Other features of the invention will be apparent from the following detailed description taken in connection with the accompanying drawing in which:

Fig. 1 is a perspective view of a relay assembly in accordance with the present invention with the spring pile-up and one armature omitted and one of the relay coils shown partly in cross section;

Fig. 2 is a perspective view of the upper portion of the relay assembly illustrating the mounting of the spring pile-up; and

Fig. 3 illustrates diagrammatically a circuit application of the improved relay assembly.

The relay assembly is provided with a channel-shaped field piece member 1 which is bent into the shape best disclosed in Fig. 1 from a blank punched from a sheet of magnetic iron. In stamping out the blank the metal is cut away in such a manner as to leave the bracket member 2 which, after the blank has been formed into the required channel shape by bending, serves as a support for a spring pile-up. After the blank has been stamped out the bracket member 2 is bent at its point of attachment to the upper flange 4 so that the bracket lies in a plane at right-angles to the upper surface of the flange and with its end extending rearwardly beyond the base portion 3. The main portion of the blank is then bent into a channel shape having a base portion 3 and upper and lower parallelly disposed flanges 4 and 5. The rear end of the bracket member 2 is provided with two threaded holes 6 for receiving the screws by which the spring pile-up is secured thereto. The flanges 4 and 5 have their forward edges cut away to form the recesses 7 and 8 to permit better accessibility for adjusting the contact springs.

The base portion 3 of the field piece member 1 is provided with two holes (not shown) in which the rear ends of two cores 9 are secured. To enable the cores to be secured to the base portion 3, the rear ends of the cores are reduced in diameter where they extend through the holes in the base portion 3 and are counterbored to produce tubular portions, the rear edges of which protrude beyond the rear surface of the base portion 3 and are headed over to rivet the cores securely to the base portion. After the cores 9 are riveted in place, the forward edges of the flanges 4 and 5 and the front ends of the cores are ground or machined to be in good alignment.

Each core 9 is surrounded by a tubular copper sleeve 10, the rear end of which is knurled to hold the rear spoolhead of a coil and the core being knurled near its rear end to hold the sleeve thereon. The coil 13, mounted on the left-hand core 9 as viewed in Fig. 1, is a line relay coil having two equal windings, secured as by pyroxylin cement to the rear spoolhead 14 which may be of suitable insulating material such as phenol fibre and having four winding terminal lugs (not shown) secured thereto in the usual manner. The coil 11, mounted on the right-hand core 9, is a cut-off relay coil having a single winding secured to the rear spoolhead 12 which may also be of suitable insulating material such as phenol fibre and having two winding terminal lugs 15 secured thereto in the usual manner, as by eyelet rivets 17. The winding terminal lugs of the two coils extend rearwardly through a cut-out portion 16 which is formed from the blank in stamping out the bracket member 2.

Associated with the forward end of each core 9 is an armature 18 stamped from magnetic iron. Each armature is provided at its inner lower corner with a slot 19 to form a lower pintle 20 and at its upper inner corner with a pintle 21 aligned with the lower pintle 20 and having an outwardly extending portion 22 for a purpose to be later described. The outer upper portion of each armature is provided with an arm 23 extending upwardly and then inwardly and bent at right-angles to serve as a member for operating certain springs of the spring pile-up. The bent portion of the arm extends toward the rear end of the relay assembly and has a spring operating stud 24 of insulating material, such as hard rubber, seated in a hole therein. The two armatures are similar except that they are reversely stamped and bent. The lower pintles 20 of the two armatures are seated in holes 25 in the forwardly extending arms of a U-shaped pivot plate 26 which may be welded or otherwise secured by its base to the inner face of the lower flange 5. In welding the plate 26 to the flange, the ends of the arms of the plate are permitted to extend sufficiently beyond the forward edge of the lower flange 5 so that when the pintles 20 of the armatures are inserted through the holes 25 the pintles will be permitted to turn freely but will be held against undue separation from the edge of the lower flange. The upper pintles 21 of the two armatures are seated in notches 27 in the forwardly extending arms 28 of an upper U-shaped pivot plate 29 which may be welded or otherwise secured by its base portion to the upper face of the upper flange 4. The arms 28 of the plate 29 are provided with slots 30 extending parallel to the front ends thereof which thereby provide the retaining fingers 31 bendable upwardly as disclosed in the right portion of Fig. 1 to position their ends opposite the extensions 22 of the upper armature pintles 21 for the purpose of retaining the pintles 21 of the armatures in the pivot notches 27 of the pivot plate 29. The pivot edges of the two armatures are held in approximate normal engagement with the edges of the upper and lower flanges 4 and 5 by the two pivot plates 26 and 29.

Each end of the upper pivot plate 29 is provided with an L-shaped arm 32 bent upwardly at right-angles and extending toward the rear of the assembly. These arms serve as backstops against which the arms 23 of the armatures are normally engaged and which may be bent to adjust the air-gaps between the outer edges of the armatures 18 and the front edges of the flanges 4 and 5. To prevent the ends of the armature arms 23 from adhering to the ends of the backstop arms 32, cooperating contact bars, such as are employed for contact springs, may be welded to the adjacent faces of such arms.

A single spring pile-up is provided which comprises four fixed springs and five movable or armature springs cooperating therewith, two of the fixed springs 33 and 34 have their contacts normally engaged by the contacts of the associated armature springs 35 and 36. A third fixed spring 37 has its contacts normally disengaged from the contacts of the associated armature spring 38 and the fourth fixed spring 39 is positioned between the associated armature springs

40 and 41 but with its contacts normally disengaged from the contacts of the springs 40 and 41. All but one of the springs are insulated from each other, from the bracket 2 on which the spring pile-up is secured and from the outer clamping plate 42 by interposed strips 43 of insulating material, such as phenol fibre, and are secured to the bracket 2 by screws 44 which extend through aligned holes in the clamping plate 42, in the springs and in the insulating strips 43 into the threaded holes 6 in the bracket 2. One spring 38 is grounded to the bracket 2 by the metallic spacing member 60. The shanks of the screws are, in the usual manner, surrounded by sleeves of hard rubber for insulating them from the springs through the holes in which they pass. Each spring terminates at its rear end in a soldering terminal to enable external wiring conductors to be connected therewith. Each armature spring has its contact end bifurcated with a contact welded to each section thus formed, the pair of contacts on each spring cooperating with a pair of contacts welded to the associated fixed spring.

Referring to Fig. 3 the insulating stud 24 secured to the arm 23 of the cut-off relay armature extends freely through a hole provided in the fixed spring 33 and engages against the outer surface of the armature spring 35. Aligned with the stud 24 and ring-staked to the armature spring 36 is a stud 58 of insulating material which passes freely through a hole in the fixed spring 34 with its outer end engaged against the inner surface of the armature spring 35 and with its inner end engaged against the outer surface of the armature spring 40. Thus by the attraction of the armature associated with the cut-off relay coil 11, the studs 24 and 58 cause the movement of armature springs 35 and 36 to disengage their contacts from the contacts of fixed springs 33 and 34 and the movement of armature spring 40 to engage its contacts with the contacts of fixed spring 29. The insulating stud 24 of the line relay armature engages the outer surface of the armature spring 38. Aligned with this stud and ring-staked to the armature spring 41 is a stud 45 of insulating material which passes freely through a hole in the fixed spring 37 with its outer end engaged against the inner surface of the armature spring 38. Thus by the attraction of the armature associated with the line relay coil 13, the studs 24 and 45 cause the movement of the armature springs 38 and 41 to engage their contacts with the contacts of the fixed springs 37 and 39 associated therewith. The armature springs are all so pretensioned that through the insulating studs they normally press the arms 23 of the two armatures 18 against the backstop arms 32 in which position the outer edges of the armatures are separated from the front edges of the flanges 4 and 5 by suitable air-gaps.

For determining the normal positions of the contact ends of the fixed springs 33, 34, 37 and 39, each of these springs is provided near its contact end with a downwardly extending tang 46 which is engaged in a positioning strip 47 of insulating material such as phenol fibre. This strip is riveted to the pivot plate 29 by eyelet rivets 48. The upper flange 4 of the field piece member 1 is provided with holes (not shown) for receiving the heads of such rivets whereby the plate 29 may lie in close engagement with the upper surface of the flange 4 for welding thereto.

Due to the cut-out portions 7 and 8 of the flanges 4 and 5 and the corresponding recesses formed between the arms of the U-shaped pivot plates 26 and 29 welded to such flanges, greater access is attained for the insertion of a tool for adjusting the contact gaps between the springs of the spring pile-up.

Fig. 3 illustrates the application of the improved relay assembly to a subscriber's line of a dial switching system served by a line finder. In this figure the relay assembly has been schematically disclosed to better illustrate its operation. A subscriber's substation is illustrated by the circle 49, a line finder by the brush set 50 and the test relay of the line finder by the rectangle 51. In the installation of the relay assembly, two terminals of the line relay coil 13 are connected respectively to the battery and ground bus-bars of the central office battery and the other two terminals are connected to the armature springs 35 and 36, one terminal of the cut-off relay coil 11 is connected to the battery bus-bar and the other terminal is connected to the two armature springs 40 and 41 and to the sleeve multiples 52 of the subscriber's line appearing in the banks of all connector switches having access to such line. The springs 33 and 34 are connected to ring and tip conductors 53 and 54 of the line, the spring 39 is connected to the sleeve or test multiples 55 of the line in the banks of all line-finder switches having access to the line, such, for example, as the switch 50 and springs 37 and 38 are connected to the line-finder start circuit and to ground respectively.

With the relay assembly thus connected, when the subscriber at substation 49 removes his receiver from the switchhook to initiate a call, a circuit is established from ground through the right winding of line relay coil 13 over the normally closed contacts of springs 34 and 36, tip conductor 53 of the calling line over the line loop through the substation 49 and then returning over the ring conductor 54, over the normally closed contacts of springs 33 and 35 to battery through the left winding of line relay coil 13. Coil 13 thus becomes energized to attract the associated armature thereby moving armature springs 38 and 41 to engage their contacts with the contacts of the fixed springs 37 and 39, respectively. The engagement of the contacts of springs 37 and 38 closes the line-finder start circuit 56 to start an idle line finder in search of the calling line and the engagement of the contacts of springs 39 and 41 prepares an operating circuit for the cut-off relay coil 11 from battery through such coil over the contacts of springs 39 and 41 to the sleeve or test terminal 55 thereby placing potential on such terminal and the multiples thereof to indicate to a started line finder that the line is in a calling condition.

It will be assumed that the line finder indicated by the brush set 50 is started to hunt for the terminals of the calling line. As soon as the test brush 57 engages the test terminal 55 of the line, a circuit is established from ground through the winding of test relay 51 over brush 57 and terminal 55 for completing the circuit of the cut-off relay coil 11. Coil 11 thereupon energizes, the copper sleeve on its core permitting a quick build-up of current through its winding whereby the test relay 51 of the line finder is enabled to operate quickly. With the coil 11 energized, the associated armature is attracted to disengage the contacts of springs 35 and 36 from the contacts of springs 33 and 34 to thereby disconnect the windings of the line relay coil 13 from the calling line loop and to engage the contacts of spring 40 with the contacts of spring 39. With

the contacts of these latter springs now engaged, a holding circuit for the cut-off relay coil 11 is established from battery through such coil over the contacts of springs 39 and 40, test terminal 55 and line-finder brush 57 to ground at the line finder to hold the cut-off relay coil energized after its initial operating circuit is opened at the contacts of springs 39 and 41 by the retraction of the line relay armature. Since the core of the line relay is provided with a copper sleeve, the retraction of the line relay armature whereby the contacts of springs 39 and 41 become opened, is delayed for a sufficient interval to insure that the holding circuit for the cut-off relay coil 11 has been established by the engagement of the contacts of springs 39 and 40. Coil 11 is now maintained energized over its holding circuit until the line finder becomes released following the restoration of the receiver to the switchhook at the calling line substation.

While the relay assembly has been disclosed as applied to a subscriber's line terminating in the bank of a line finder, it will be apparent that a change in the arrangement of the springs of the spring pile-up would enable the relay to be used in other types of dial switching and manual systems.

What is claimed is:

1. A relay assembly comprising a channel-shaped field piece, two cores secured to its base and extending forwardly between the flanges thereof, a relay coil supported on each of said cores, armatures attractable to the forward pole edges of the flanges of said field piece and to the ends of the respective cores, a bracket struck out from the central portion of said field piece and lying in a plane perpendicular to the plane of the upper flange of said field piece and a single spring pile-up supported on said bracket, certain of the springs of which are operable by the armature associated with one core and certain of the springs of which are operable by the armature associated with the other core.

2. A relay assembly comprising a channel-shaped field piece, two cores secured to its base and extending forwardly between the flanges thereof, a first relay coil supported on one of said cores, a second relay coil supported on the other of said cores, armatures attractable to the forward pole piece edges of the flanges of said field piece and to the ends of the respective cores, a bracket struck out of the upper flange of said field piece and bent at right-angles to the surface thereof, and a spring pile-up supported on said bracket, certain of the springs of which are operable by the armature associated with the second relay coil and other springs of which are operable by the armature associated with the first relay coil.

3. A relay assembly comprising a channel-shaped field piece, two cores secured to its base and extending forwardly between the flanges thereof, a first relay coil supported on one of said cores, a second relay coil supported on the other of said cores, armatures attractable to the forward pole-piece edges of the flanges of said field piece and to the ends of the respective cores, a bracket struck out of the upper flange and base portions of the blank from which said field piece is formed prior to the formation thereof into its channel shape, said bracket being bent at right-angles to the surface of the upper flange with its rear end extending beyond the rear face of the base of the field piece and a spring pile-up secured to the rear end of said bracket with its contact springs extending forwardly, certain of said springs being operable by the armature associated with said second relay coil and other of said springs being operable by the armature associated with said first relay coil.

4. A relay assembly comprising a channel-shaped field piece, two cores secured to its base and extending forwardly between the flanges thereof, a first relay coil supported on one of said cores, a second relay coil supported on the other of said cores, rear spoolheads for said coils having rearwardly extending coil terminal lugs secured thereto, armatures attractable to the forward pole-piece edges of the flanges of said field piece and to the ends of the respective cores, a bracket struck out of the upper flange and base portions of the blank from which said field piece is formed whereby when said blank is bent into its channel form an opening is provided in the base portion through which said coil terminal lugs extend, said bracket being bent at right-angles to the surface of the upper flange with its rear end extending beyond the rear face of the base of the field piece and a spring pile-up secured to the rear end of said bracket with its contact springs extending forwardly, certain of said springs being operable by the armature associated with said second relay coil and other of said springs being operable by the armature associated with said first relay coil.

5. A relay assembly comprising a channel-shaped field piece, two cores secured to its base and extending forwardly between the flanges thereof, a first relay coil supported on one of said cores, a second relay coil supported on the other of said cores, a spring pile-up supported on the upper flange of said field piece, armatures attractable to the forward pole-piece edges of said flanges and to the ends of the respective cores for operating springs of said pile-up, each of said armatures having upper and lower pintles formed integrally therewith, a lower pivot plate secured to the lower flange of said field piece having pivot holes in which the lower pintles of said armatures are engaged and an upper pivot plate secured to the upper flange of said field piece having notches therein in which the upper pintles of said armatures are engaged and bendable fingers formed integrally with the upper pivot plate for holding said upper armature pintles in their assembled position in said notches.

6. A relay assembly comprising a channel-shaped field piece, two cores secured to its base and extending forwardly between the flanges thereof, a first relay coil supported on one of said cores, a second relay coil supported on the other of said cores, a spring pile-up supported on the upper flange of said field piece, armatures attractable to the forward pole-piece edges of said flanges and to the ends of the respective cores for operating springs of said pile-up, each of said armatures having upper and lower pintles formed integrally therewith, a lower pivot plate secured to the lower flange of said field piece having pivot holes in which the lower pintles of said armatures are engaged, an upper pivot plate secured to the upper flange of said field piece having notches in its front edge in which the upper pintles of said armatures are engaged, bendable fingers formed integrally with said upper pivot plate for holding said upper armature pintles in their assembled positions in said notches and arms bent up from the ends of said upper plate serving as backstops for said armatures.

7. In a relay assembly, a channel-shaped field

piece, two cores secured to its base and extending forwardly between the flanges thereof, a first relay coil supported on one of said cores, a second relay coil supported on the other of said cores, a spring pile-up supported on the upper flange of said field piece comprising a plurality of fixed springs having positioning tangs and cooperating armature springs, armatures attractable to the forward pole-piece edges of said flanges and to the ends of the respective cores for operating said armature springs, each of said armatures having upper and lower pintles formed integrally therewith, a lower pivot plate secured to the lower flange of said field piece having pivot holes in which the lower pintles of said armatures are engaged, an upper pivot plate having notches in which the upper pintles of said armatures are engaged and bendable fingers formed integrally with said upper pivot plate for holding said upper armature pintles in their assembled positions in said notches, and a notched strip of insulating material secured to said upper pivot plate in the notches of which the tangs of said fixed springs are engaged.

8. A relay comprising a channel-shaped field piece, a core secured to its base and extending forwardly between the flanges thereof, a relay coil supported on said core, an armature attractable to the forward pole-piece edges of the flanges of said field piece and to the end of said core, a bracket struck out of the upper flange and base portions of the blank from which said field piece is formed prior to the forming thereof into its channel shape, said bracket being bent at right-angles to the surface of the upper flange with its rear end extending beyond the rear face of the base of the field piece and a spring pile-up secured to the rear end of said bracket with its contact springs extending forwardly, certain of said springs being operable by said armature.

9. A relay comprising a channel-shaped field piece, a core secured to its base and extending forwardly between the flanges thereof, a relay coil supported on said core, a rear spoolhead for said coil having rearwardly extending coil terminal lugs secured thereto, an armature attractable to the forward pole-piece edges of the flanges of said field piece and to the end of said core, a bracket struck out of the upper flange and base portions of the blank from which said field piece is formed whereby when said blank is bent into its channel form an opening is provided in the base portion thereof through which said coil terminal lugs extend, said bracket being bent at right-angles to the surface of the upper flange with its rear end extending beyond the rear face of the base of the field piece and a spring pile-up secured to the rear end of said bracket with its contact springs extending forwardly, certain of said springs being operable by said armature.

10. A relay comprising a channel-shaped field piece, a core secured to its base and extending forwardly between the flanges thereof, a relay coil supported on the core, a spring pile-up supported on the upper flange of said field piece, an armature attractable to the forward pole-piece edges of said flanges and to the end of said core for operating springs of said pile-up, said armature having upper and lower pintles formed integrally therewith, a lower pivot plate secured to the lower flange of said field piece having a pivot hole in which the lower pintle of said armature is engaged, an upper pivot plate secured to the upper flange of said field piece having a notch therein in which the upper pintle of said armature is engaged and a bendable finger formed integrally with the upper pivot plate for holding said upper armature pintle in its assembled position in said notch.

11. A relay comprising a channel-shaped field piece, a core secured to its base and extending forwardly between the flanges thereof, a relay coil supported on said core, a spring pile-up supported on the upper flange of said field piece, an armature attractable to the forward pole-piece edges of said flanges and to the end of said core for operating springs of said pile-up, said armature having upper and lower pintles formed integrally therewith, a lower pivot plate secured to the lower flange of said field piece having a pivot hole in which the lower pintle of said armature is engaged, an upper pivot plate secured to the upper flange of said field piece having a notch in its front edge in which the upper pintle of said armature is engaged, a bendable finger formed integrally with said upper pivot plate for holding said upper armature pintle in its assembled position in said notch, and an arm bent up from one end of said upper plate serving as a backstop for said armature.

12. A relay comprising a channel-shaped field piece, a core secured to its base and extending forwardly between the flanges thereof, a relay coil supported on said core, a spring pile-up supported on the upper flange of said field piece comprising a plurality of fixed springs having positioning tangs and cooperating armature springs, an armature attractable to the forward pole-piece edges of said flanges and to the end of said core for operating said armature springs, said armature having upper and lower pintles formed integrally therewith, a lower pivot plate secured to the lower flange of said field piece having a pivot hole in which the lower pintle of said armature is engaged, an upper pivot plate secured to the upper flange of said field piece having a notch in its front edge in which the upper pintle of said armature is engaged, a bendable finger formed integrally with said upper pivot plate for holding said upper armature pintle in its assembled position in said notch, and a notched strip of insulating material secured to the upper pivot plate in the notches of which the tangs of said fixed springs are engaged.

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