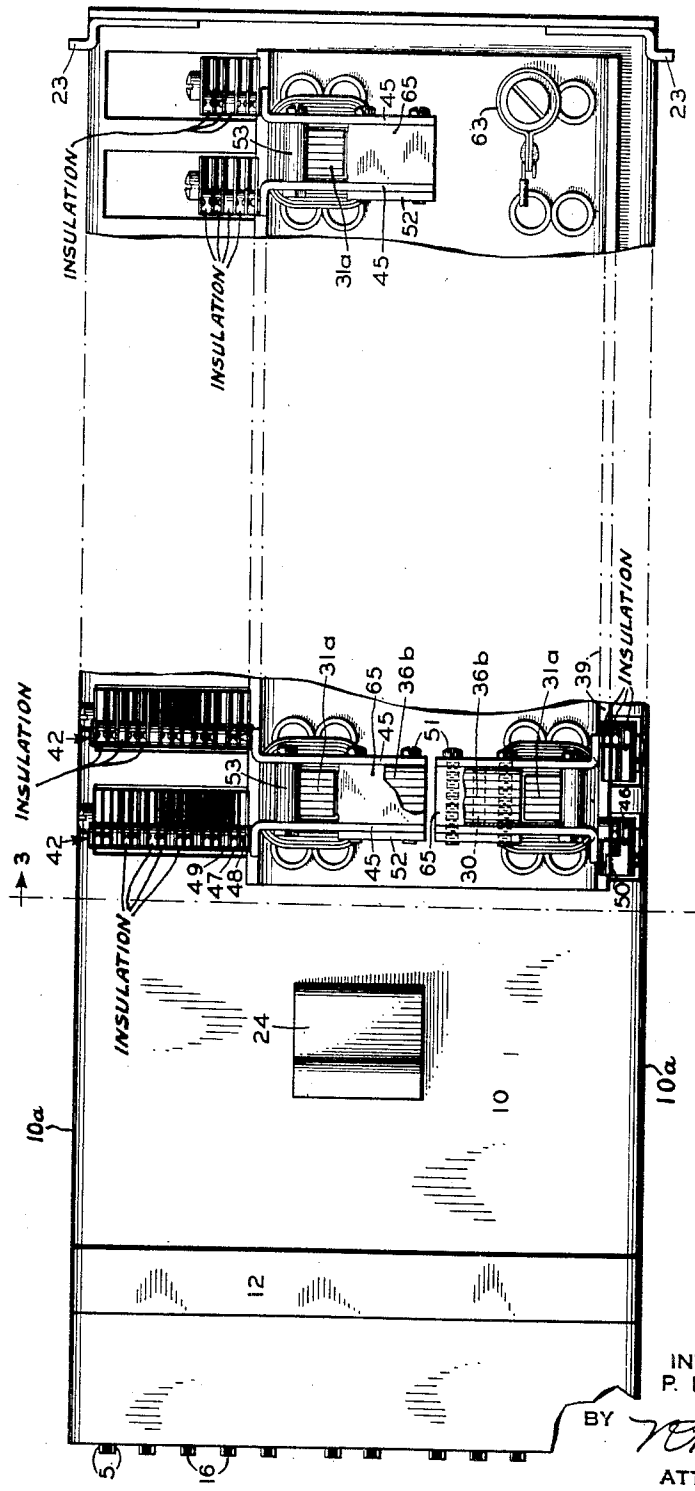
Sept. 22, 1942. P. H. ESTES 2,296,431

ELECTROMAGNETIC RELAY STRUCTURE

Filed Feb. 8, 1939 3 Sheets-Sheet 1

FIG. 1.



INVENTOR
P. H. ESTES
BY
ATTORNEY

Sept. 22, 1942. P. H. ESTES 2,296,431

ELECTROMAGNETIC RELAY STRUCTURE

Filed Feb. 8, 1939 3 Sheets-Sheet 2

FIG. 2.

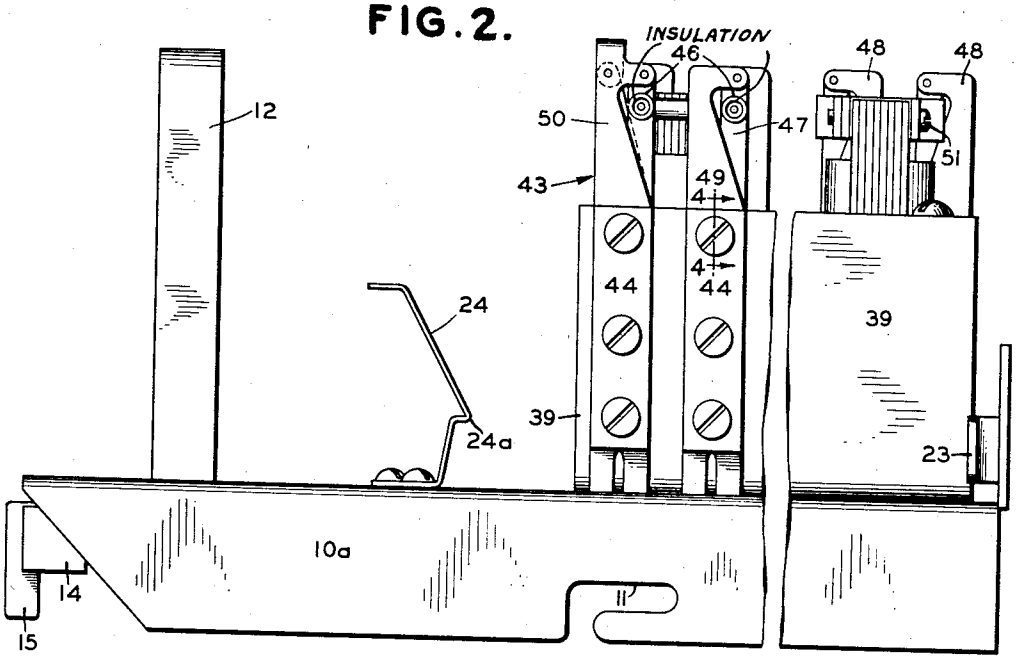
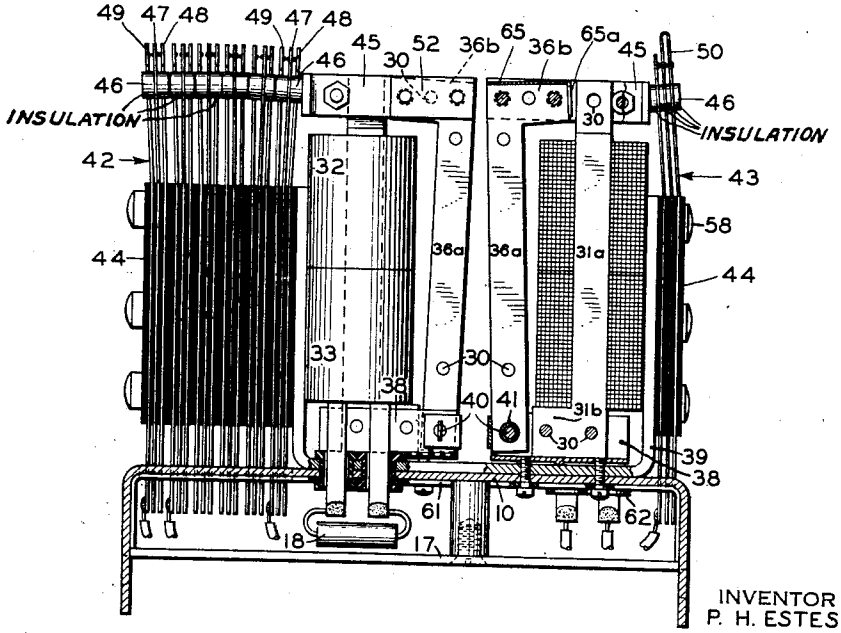


FIG. 3.



INVENTOR
P. H. ESTES

BY W. F. Presson

ATTORNEY

Sept. 22, 1942. P. H. ESTES 2,296,431

ELECTROMAGNETIC RELAY STRUCTURE

Filed Feb. 8, 1939 3 Sheets-Sheet 3

FIG. 4.

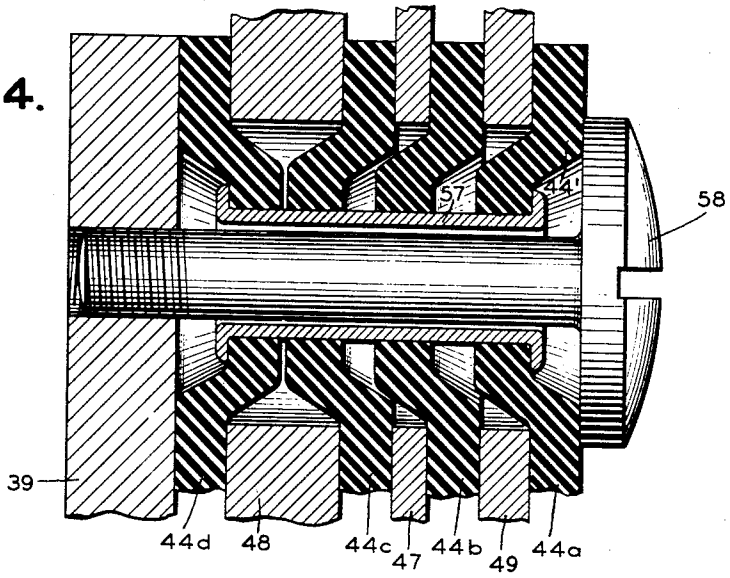


FIG. 5.

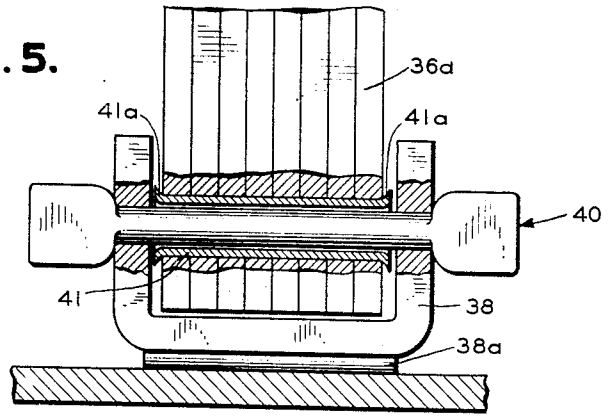
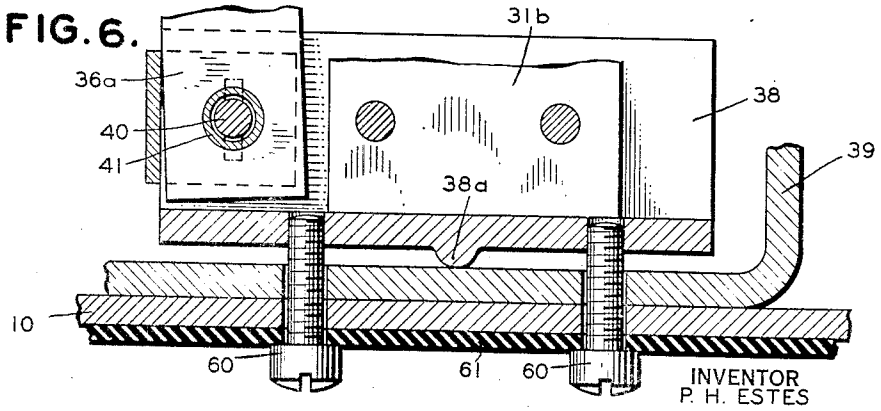


FIG. 6.



INVENTOR
P. H. ESTES

BY

ATTORNEY

Patented Sept. 22, 1942

2,296,431

UNITED STATES PATENT OFFICE

2,296,431

ELECTROMAGNETIC RELAY STRUCTURE

Phillip H. Estes, Rutherford, N. J., assignor to The Western Union Telegraph Company, New York, N. Y., a corporation of New York

Application February 8, 1939, Serial No. 255,185

8 Claims. (Cl. 200—104)

This invention relates to electromagnetic relay structure, and more particularly to a suitable relay assembly adapted to actuate a number of sets of contact springs simultaneously for controlling a plurality of telegraph or other circuits.

Various selecting and switching circuits employed in telegraph, telephone or other communication systems require that a number of circuits be controlled simultaneously by a relay which thus must operate a considerable number of spring contacts. Relays which control a number of circuits by means of a number of spring contacts have heretofore been employed, but such relays have not been able to develop the desired high force on the contact springs, so that the springs employed necessarily have been so light that they get out of adjustment easily, or if the contact springs have been of suitable thickness to insure stable operation the amount of power necessary for positive operation of the relay has been undesirably high.

An object of the present invention is to obviate the various disadvantages of relays heretofore employed, and to provide a relay structure which insures positive operation of a large number of heavy contact springs without requiring the use of undesirably high operating current for actuating the relay.

A more specific object of a suitable relay which develops a high operating torque per ampere turn, and which is rugged and dependable and requires but a minimum of attention in service.

Another object is a relay of the foregoing character, in which close tolerances in manufacture are not required, and in which the greater number of parts thereof may be stamped from sheet metal and thereby is adapted for quantity production methods with consequent lower manufacturing costs.

A further object is a relay of the character described in which only a relatively small number of different kinds of parts are employed, and in which the parts may be standardized so that only a few different kinds of sub-assemblies are required in order to assemble relays of different kinds of circuits in which the operating characteristics of the relays and the number of circuit-controlling contact springs required may vary within wide limits.

Additional objects and attendant advantages will be apparent from the following detailed description, taken in connection with the accompanying drawings, in which:

Fig. 1 is a top plan view of a unit comprising a bank of relays constructed in accordance with the invention, the unit being shown with the relay protective cover removed;

Fig. 2 is a side elevation of the relay bank, partly broken away, with the protective cover removed;

Fig. 3 is a vertical section taken along the line 3—3 of Fig. 1, with certain parts broken away;

Fig. 4 is a fragmentary sectional view taken along the line 4—4 of Fig. 2, showing details of one of the contact spring assemblies;

Fig. 5 is a view showing details of the armature pivotal mounting structure; and

Fig. 6 shows certain details of the adjustable bracket that carries the magnet core and armature.

Referring particularly to Figs. 1 and 2, the relay bank unit comprises a channel-shaped base 10 of sheet metal, the sides 10a of which each has two bayonet slots 11 that receive blades or lugs on a relay supporting rack or framework (not shown) for releasably locking the unit in its operating position, the base also having a handle 12 riveted or otherwise secured thereto to facilitate handling and insertion or removal of the unit in or from the supporting framework. The base also has secured thereto, as by screws, terminal strips of insulation which carry the terminals or slip connections 15 that engage complementary spring clips mounted on and insulated from the relay supporting framework for connecting the relay circuits to the associated apparatus. The strips 14 are spaced from the underside of the base 10 to provide sufficient clearance between the terminals 15 and the base. As shown, the terminals or blades 15 are mounted in pairs, thereby securing greater rigidity of the blade contact structure and preventing misalignment of the blades, the blades of each pair being separated by a strip 16 of insulation, the opposite ends of the blades being soldered to the wires which connect the blades to the relays and contacts controlled thereby.

A plate 17, Fig. 3, provides a protective cover for the terminals of the relays and contact springs, the plate being secured to the base 10 by means of machine screws so that it may readily be removed to give access to the relay and spring terminals. Where it is necessary to connect a resistance unit between certain terminals, a small unit may be employed, with an insulating sleeve 18 to prevent the unit from touching the terminals 15.

A protective rectangular metal cover (not shown) is provided for the relay bank, the cover

having slotted portions that engage lugs 23 secured to the base 10 and provide a hinged joint for the cover. The opposite or front end of the cover is held locked by a spring 24 that has a portion 24a, Fig. 2, which enters and engages an apertured portion of the cover. When the spring 24 is pressed back by the hand of an attendant, the front end of the cover is released and may be raised, the cover pivoting about the lugs 23. After the front of the cover has been raised to a predetermined height, for example, when the cover makes an angle of 45° with the base, the configuration of the slots permits the cover to be taken off and laid aside. By means of the construction disclosed, the cover may be left on the relay bank until after the bank is removed from its supporting framework, so that it is not necessary to first remove the cover, with the attendant hazard of contacting live connections, before the relay bank is removed from service.

Fig. 3 is a view, in elevation, of two of the relays, each of which comprises an L-shaped laminated relay core comprising an upwardly extending vertical leg 31a that passes through and supports the relay coils 32 and 33, and a laterally extending horizontal leg 31b. Coacting with the relay core is a laminated L-shaped armature comprising an upwardly extending leg 36a and a laterally extending leg 36b, the core and armature being formed from two identical stacks of L-shaped laminations firmly secured together by rivets 30. The horizontal leg 31b of the core stack and the lower end of the vertical leg 31a thereof are received within, and attached by means of rivets to, a channel-shaped mounting bracket 38 of magnetisable material, the latter being secured to a mounting that consists of a U-shaped plate member 39, which, in turn, is secured to the base 10. The lower end of the upwardly extending leg 36a of the armature is pivoted at 40 to the bracket 38 by means of a pin and sleeve bearing hereinafter described in detail.

Bracket 38 is so shaped that it overlaps both the core and the armature on the ends of the armature and core and the sides thereof, in order to increase the area of the air gap between the two. This results in a substantial decrease in the reluctance of this portion of the magnetic circuit, and enables the relay to operate with smaller operating currents, or substantially increases the force exerted on the contact springs with a given current through the coil. The upwardly projecting sides of the bracket 39 provide supports for the contact spring assemblies or pile-ups 42 and 43. The various contact springs are insulated from each other and also from their supporting structure by suitable strips 44 of insulation. The upper or outer end of the leg 31a of the core coacts with the free end 36b of the armature. Secured to the side of the free end 36b of the armature are two non-magnetic side straps 45, Figs. 1 and 3, which extend beyond the adjacent core faces of the leg 31a and operate against a plug 46 of insulation, Fig. 3, which is passed through the contact spring 47 adjacent to the end of the associated side strap 45. Each plug comprises two identical halves, each half having a recessed portion and a bore therethrough, and an eyelet is passed through the bores of the adjoining halves and its ends are peened over in the recessed portions to firmly lock the two halves of the block to the tongue spring 47.

Fig. 5 shows the details of the armature pin and sleeve bearing. The sleeve 41 is passed through a hole drilled through the laminations of the armature 36, the sleeve having a tight fit with the armature, and the ends 41a of the sleeve are expanded so that the sleeve is firmly positioned within the armature. Only a small clearance is provided between the ends 41a and the adjacent portion of the bracket 38, thereby to prevent undesirable side play in the armature. Passing through the two sides of the bracket 38 and through the sleeve 41 is a pin 40 which has a tight fit with the sides of the bracket, the pin being flattened at each end to prevent displacement thereof. The clearance between the sleeve 41 and pin 40 is just sufficient to enable the armature to turn without introducing appreciable friction, but is sufficiently close to prevent side play in the armature. The construction described obviates the disadvantages attendant to constructions heretofore employed in which the pin bears on the metal of an armature since, particularly where a laminated structure is used to reduce or prevent eddy currents, as in the instant case, small burrs are left in the bore through the armature, which burrs tend rapidly to cut the mounting pin and cause play in the armature after a period of service. Preferably, the pin 40 and sleeve 41 are made from stainless steel.

The manner in which the bracket 38 is secured to the plate member 39 is shown in detail in Fig. 6. The bracket is provided with a central transverse rib portion 38a that extends substantially across the bracket, and by means of which the bracket can be rocked into any desired adjusted position, depending upon the degree to which the two securing screws 60 respectively are tightened. By means of this construction the magnet sub-assembly including the magnet core, armature and strips 45 may be adjusted with respect to the plugs 46 of the associated contact assembly, and thus enable any desired degree of tension to be applied to the armature by the springs, without affecting the adjustment of the air gap between the free end 36b of the armature and the outer or upper end of the leg 31a of the magnet core. In order to prevent the possibility of contact of the various wires and connections with the metal base 10, a sheet 61 of insulation, Figs. 3 and 6 is held in position against the underside of the base 10 by grommets 62 of insulation, through which the relay coil terminals pass. The heads of the screws 60, in their adjusted positions bear against the insulating sheet 61.

In addition to the relays and spring assemblies shown, the relay bank may contain auxiliary devices, such as the resistance 63, Fig. 1, and may contain vacuum tubes or other apparatus for use with the circuits to which the unit is connected, all of this apparatus and equipment forming a part of the removable unit.

It will be noted that in the spring assembly shown at the left hand side of Fig. 3, the contact springs are arranged in sub-assemblies or groups of three, the center spring 47 of each sub-assembly or group normally making contact with the spring 48 of the group when the relay is not energized, the spring 47 moving away from spring 48 and contacting spring 49 upon energization of the relay. The plug 46 above described operates against a similar plug 46 passed through the contact spring 47 of the next sub-assembly of springs, and so on for the entire number of contact sets in the assembly.

Upon energization of the relay the springs 47 of each contact set are simultaneously moved out of contact with the springs 48 and into contact with the springs 49 of the sets. Thus, a large number of contacts may simultaneously be switched from one group of circuits to another group of circuits. It will be understood that the number of sets of contact springs, and the various functions of such spring, will vary depending upon the nature of the circuits with which the relay is employed and the manner in which the circuits are to be switched or operated.

Fig. 4 discloses various features of the contact spring sub-assemblies. It will be seen that each of the insulating strips is embossed at 44' so that the convex surface of the embossed portion of a strip, for example 44*a*, enters a hole in the adjacent contact spring and extend into the concave side of the next insulating strip 44*b*. A similar arrangement obtains with regard to the insulating strips 44*b* and 44*c*. The fourth or last insulating strip 44*d* of the sub-assembly is reversed, as shown, in order that its concave surface will be adjacent either to the mounting bracket 39, or to another contact spring sub-assembly, as shown at the left hand portion of Fig. 3. Each sub-assembly is secured by means of eyelets 57, the two ends of each eyelet being spun over in the concave portions of the first and last insulating strips of the sub-assembly. By means of this construction, the contact springs are insulated from the mounting screws 53 without the use of insulating tubing, as has heretofore been required. The sub-assemblies may each be handled as a unit without the possibility of displacement of the contact springs and separating strips of insulation. Furthermore, the sub-assemblies may be grouped together in any desired combination. It will be noted that the contact spring 48 is thicker than the remaining contact springs of the sub-assembly to enable clamping of the two opposed insulating strips 44*c* and 44*d*. Both faces of the contact sub-assembly are flat, and thus a sub-assembly may be used either on the outside of a contact pileup or within the contact pileup, since no metallic projections extend from the flat surfaces of the sub-assembly.

The side straps 45 have holes therethrough at the point of attachment to the armature, which holes may be elongated to allow the adjustment of the working air gap, the straps being maintained in each of their adjusted positions by means of the machine screws 51, which thread into side pieces 52, Fig. 1. A spacer 53 is secured to and extends between the side straps 45 at the rear face of the pole 31*a* in order to provide a back stop for the armature.

As will be seen from Fig. 2, the contact springs 49 each has a cutaway portion or configuration such that these springs do not interfere with the movement of the springs 47 and insulating plugs 46, although it will be understood that various different types of contact springs may be employed with the relay structure disclosed. For example, the contact springs may be of the type shown by spring 50, which has a make-before-break contact, or the contact springs may be of the type which have apertures therein to permit free sliding movement of the plugs or bushings 46 passing therethrough.

As will be noted from the description and drawings, only five different kinds of sub-assemblies are required to assemble a relay bank having any desired number of relays and capable of operation of various types of circuits. These sub-assemblies comprise (1) the magnet having core and armature stacks 31 and 36, a sleeve and pin bearing 40 and 41, channel bracket 38, two side straps 45, spacer 53 and side piece 52; (2) the energizing relay coils 32 and 33; (3) a transfer contact set comprising plug 46, contact springs 47, 48 and 49, and four insulating strips 44; (4) a make-before-break contact set comprising plug 46, springs 47, 48 and 50, and four insulating strips 44; and (5) a relay mounting structure comprising base 10, plate 16, bracket 39 and a fiber insulating sheet 61. It will be understood that any number of the foregoing sub-assemblies may be employed in various combinations, depending upon the nature and number of circuits to be controlled by the relay bank.

Preferably, the materials in the relay assembly are 45% nickel-iron alloy for the core 31 and bracket 38; 8–18% stainless steel for the armature side straps 45 and the side strap spacers 53. In order to provide greater continuity of the cross-section of the magnetic part, all the rivets and screws which pass through the core and armature are of 14% chromium stainless steel which has magnetic properties comparable to soft iron. Bakelite or other suitable insulating material is employed for the contact spring plugs 46, spacers 44 and other insulating parts. German silver is used for the contact springs 47, 48, 49 and 50; and a 25% zinc-silver alloy for the contacts carried by the springs. No plating or finish is applied to any of the above parts, since the metallic members are in themselves corrosion resistant materials. It will be understood that various other known materials may be used instead of those mentioned.

The operating windings may be divided, as illustrated, into two independent sections 32 and 33 for flexibility so that the relay can be used either as a low resistance or a high resistance single current instrument, a locking relay or a polar relay. When using the relay with polar operated circuits, one coil, for example, coil 33, is energized from a constant D. C. source. The torque on the armature is a function of two factors: (1) the force exerted by the contact springs acting to force the armature away from the pole 31*a*, and (2) the force produced by the flux tending to close the working air gap. These two forces are both dependent on the position of the armature. The spring pressure is a function of the spring deflection; the flux is proportional to the length of the air gap and the force it exerts is proportional to the square of the gap length. These two factors, therefore, can be adjusted so that the armature will remain in either of its two positions. If the gap is small, the force exerted by the flux is larger than the spring pressure; if the gap is large, the spring pressure exceeds the magnetic pull. Reversal of the armature position can be accomplished by energizing the coil 32, which either aids or opposes coil 33 according to the polarity of the current applied. If the armature is in the open position (Figs. 1 and 3) and coil 32 aids coil 33, the flux is increased and overcomes the spring pressure, moving the armature to its closed position. A reversal of the current in coil 32 produces a decrease in flux and the armature is forced by the spring pressure into its open position. The operating current is controllable by varying the air gap, the spring pressure or the current through coil 33, which latter coil may be replaced by a permanent magnet. It will be appreciated that

other types of coils may be used and the arrangement and number thereof may be varied, depending upon the operating characteristics desired. It will also be understood that the relay may be of the slow operating type, and that the time of operation or time of release of the armature may be controlled by the use of the short-circuited windings, copper rings, shunt capacitors, and the like.

In order to prevent sticking of the armature against the core, due to residual magnetism or eddy currents, a plate **65** of non-magnetic material may be provided for each armature, the plate being held by the screws **51** that pass through the armature and side pieces **45** and **52**. The plate **65** has a portion **65***a* bent over the end of the armature so that it extends between the armature and core and maintains a small non-magnetic gap between them when the armature is in closed position. The plate **65** may also be used as a designation plate, by stamping thereon identifying numbers, letters or other indicia.

While the invention has been described in detail with reference to one preferred embodiment and use thereof, it is to be understood that this has been done for the purpose of illustration only, and that various changes, modifications and substitutions will readily be apparent to those skilled in the art from an understanding of the invention herein disclosed, and that the invention is not limited except as indicated by the scope of the appended claims.

I claim:

1. An electromagnetic relay comprising a core of magnetisable material, the ends of said core forming the opposite magnetic poles respectively of an electromagnet, an energizing winding around said core, an armature, means for pivotally mounting one end of the armature adjacent to one of the ends of said core, the free end of the armature being positioned adjacent to and attractable by the other end of said core, a contact spring assembly, an insulating member carried by certain of the springs of said assembly, an actuating member of non-magnetic material secured to the free end of the armature and movable therewith, said actuating member extending longitudinally along the line of thrust of said free end of the armature and past and in close proximity to said other end of the core and engaging said insulating member for actuating said certain of the contact springs upon movement of the armature relative to the core.

2. An electromagnetic relay comprising a core of magnetisable material, the ends of said core forming the opposite magnetic poles respectively of an electromagnet, an energizing winding around said core, an armature, means for pivotally mounting one end of the armature adjacent to one of the ends of said core, the free end of the armature being positioned adjacent to and attractable by the other end of said core, a contact spring assembly, an insulating member carried by certain of the springs of said assembly, an actuating member of non-magnetic material secured to the free end of the armature and movable therewith, said actuating member extending longitudinally along the line of thrust of said free end of the armature and past said other end of the core and engaging said insulating member for actuating said certain of the contact springs upon movement of the armature towards the core, and stop means on said actuating member for engaging said core to limit the extent of movement of the armature away from the core.

3. An electromagnetic relay comprising a core of magnetisable material, the ends of said core forming the opposite magnetic poles respectively of an electromagnet, an energizing winding around said core, an armature, means for pivotally mounting one end of the armature adjacent to one of the ends of said core, the free end of the armature being positioned adjacent to and attractable by the other end of said core, a plurality of contact spring assemblies, insulating members carried by certain of the springs of said assemblies, actuating members of non-magnetic material secured to different faces respectively of the free end of the armature and movable therewith, said actuating members extending longitudinally along the line of thrust of said free end of the armature and past and in close proximity to said other end of the core and respectively engaging the insulating members of said spring assemblies.

4. An electromagnetic relay comprising a core of magnetisable material, the ends of said core forming the opposite magnetic poles respectively of an electromagnet, an energizing winding around said core, an armature, means for pivotally mounting one end of the armature adjacent to one of the ends of said core, the free end of the armature being positioned adjacent to and attractable by the other end of said core, a plurality of contact spring assemblies, insulating members carried by certain of the springs of said assemblies, actuating members of non-magnetic material secured to different faces respectively of the free end of the armature and movable therewith, said actuating members extending longitudinally along the line of thrust of said free end of the armature and past said other end of the core and respectively engaging the insulating members of said spring assemblies, and a stop member of non-magnetisable material secured to and extending between said actuating members for engaging said core to limit the extent of movement of the armature away from the core.

5. An electromagnetic relay comprising a core of magnetisable material, the ends of said core forming the opposite magnetic poles respectively of an electromagnet, an energizing winding for said core, an armature, means for pivotally mounting one end of the armature adjacent to one of the ends of said core, the free end of the armature being positioned adjacent to and attractable by the other end of said care, electrical contact members, means for mounting said contact members, means for causing actuation of the contact members by the free end of the armature, a bracket member carrying said core and armature as a unit independently of said contact members, and means for adjusting the position of said bracket member in a manner to adjust the position of said unit and hence the free end of said armature towards and from said electrical contact members without changing the length of the air gap between the free end of the armature and said other end of the core.

6. An electromagnetic relay comprising a core of magnetisable material, the ends of said core forming the opposite magnetic poles respectively of an electromagnet, an energizing winding for said core, an armature, means for pivotally mounting one end of the armature immediately adjacent to one of the ends of said core, and means for decreasing the reluctance of the air gap between the pivotally mounted end of the armature and the adjacent end of the core, said

means comprising a member of magnetisable material extending between and substantially adjoining the sides and ends each of the armature and core in such manner as to increase the effective area of said air gap.

7. An electromagnetic relay comprising a core of magnetisable material, the ends of said core forming the opposite magnetic poles respectively of an electromagnet, an energizing winding for said core, an armature, means for pivotally mounting one end of the armature immediately adjacent to one of the ends of said core, the free end of the armature being positioned adjacent to and attractable by the other end of said core, electrical contact members, means for mounting said contact members for actuation by the free end of the armature, a bracket member carrying said core and armature as a unit, and means for adjusting the position of said bracket member thereby to adjust the position of the free end of said armature relative to said electrical contact members without changing the length of the air gap between the free end of the armature and said other end of the core, said bracket member being composed of material of high magnetic permeability and extending between and substantially adjoining the pivoted end of the armature and the adjacent end of the core in such manner as to increase the effective area of the air gap between them.

8. An electromagnetic relay comprising a core of magnetisable material, the ends of said core forming the opposite magnetic poles respectively of an electromagnet, an energizing winding for said core, an armature, means for pivotally mounting one end of the armature adjacent to one of the ends of said core, the free end of the armature being positioned adjacent to and attractable by the other end of said core, electrical contact members, means for mounting said contact members for actuation by the free end of the armature, a bracket member carrying said core and armature as a unit, a support for said bracket member, and means comprising a fulcrum for said bracket member disposed between said bracket member and said support for adjustably securing the bracket member to the support and to enable the bracket member to be rocked about said fulcrum for adjusting the position of said bracket member thereby to adjust the position of the free end of said armature relative to said electrical contact members without changing the length of the air gap between the free end of the armature and said other end of the core.

PHILLIP H. ESTES.