Aug. 21, 1956 A. F. HORLACHER 2,760,026

RELAY

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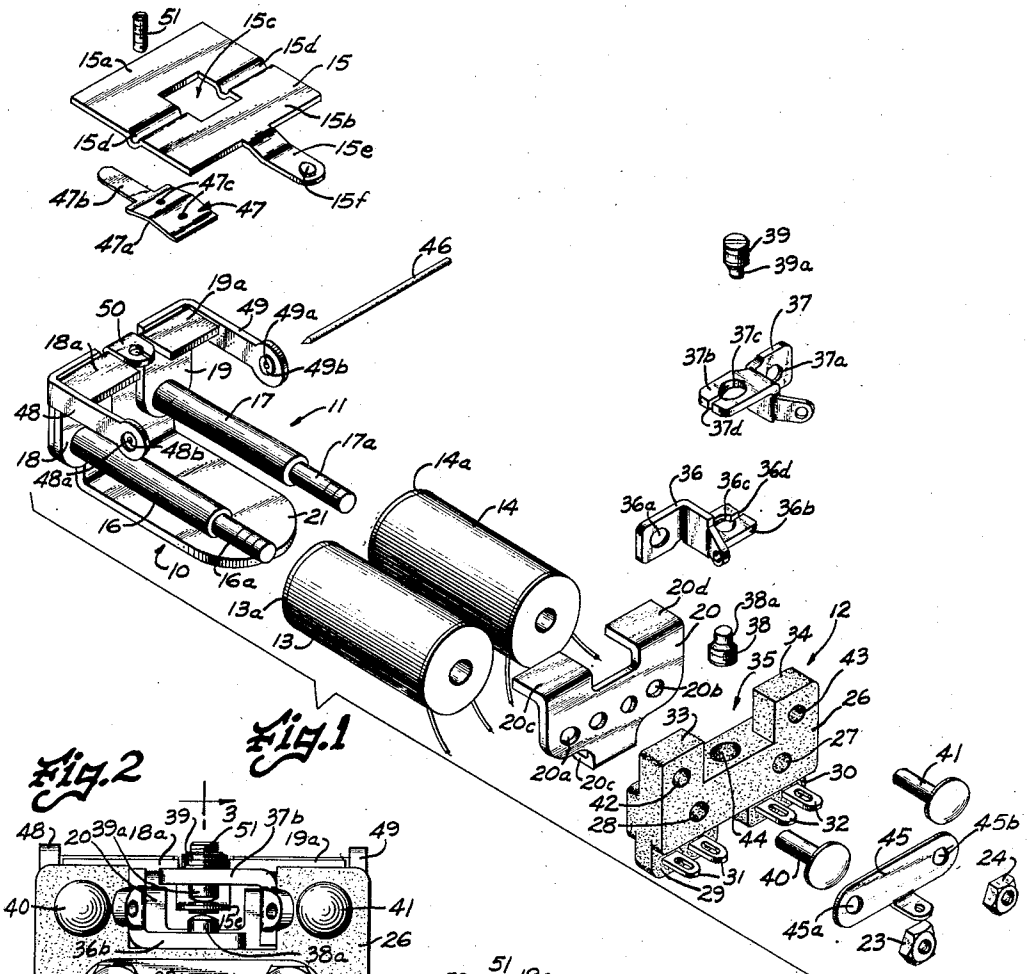


Fig. 1

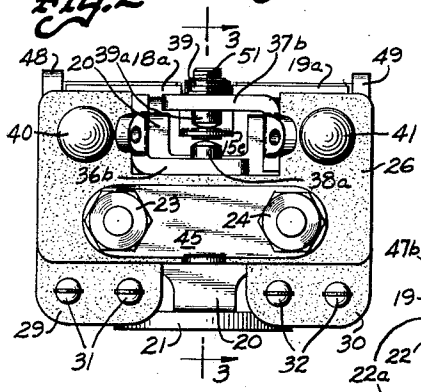


Fig. 2

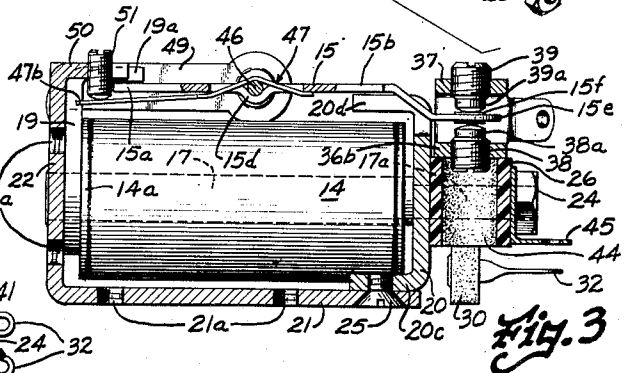


Fig. 3

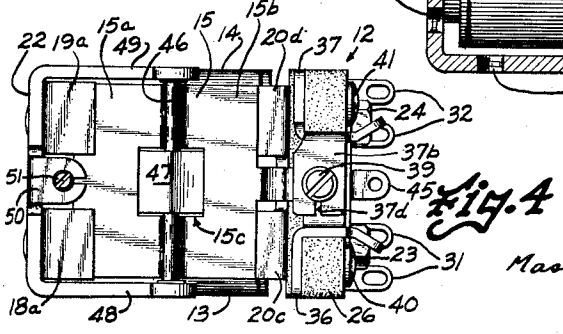


Fig. 4

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RELAY

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Application January 8, 1951, Serial No. 205,023

14 Claims. (Cl. 200—87)

The present invention relates to electrical relays and more particularly to an improved direct current relay which is suitable for use in applications where the relay structure may be subjected to considerable vibration from external forces and yet high relay sensitivity to small currents is required.

In relay applications of the character mentioned, of which aircraft applications are typical, relays which will not falsely operate when subjected to large external vibratory forces must be used. To solve this problem it has previously been proposed (see Patent No. 2,455,049, Edwards et al., granted November 30, 1948) to so mount the movable contact controlling armature of the relay structure that the armature is dynamically balanced and hence will not respond to the applied vibratory forces. In general, however, prior relay structures suitable for use in such applications do not have the required sensitivity to small currents, are usually quite complicated structurally, and are so constructed as to require a large amount of mounting space.

Accordingly, it is an object of the present invention to provide a sensitive shockproof relay which is of simple and economical construction, is small in size and requires only a small amount of mounting space.

It is another object of the invention to provide an improved relay of the character described which may be easily and quickly assembled and adjusted and may be readily disassembled to permit replacement or substitution of field coils.

In accordance with still another object of the invention, the field structure, supporting frame and terminal assembly of the relay are so arranged as to facilitate disassembly thereof to permit removal and replacement of the field coils.

It is a further object of the invention to provide an improved relay of the character described which embodies an exceedingly simple arrangement for supporting the contact controlling armature and for biasing this armature to its normal setting.

The invention, both as to its organization and method of operation, together with other objects and advantages thereof will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

Fig. 1 is an explosion view illustrating in disassembled relationship the components of a relay characterized by the features of the present invention;

Fig. 2 is an end view of the present improved relay when fully assembled;

Fig. 3 is a side sectional view, taken along the section lines 3—3 in Fig. 2, further illustrating the present improved relay; and

Fig. 4 is a top elevational view of the relay.

Referring now to the drawing, the present improved relay is there illustrated as generally comprising a frame 10, a field structure 11, a stationary contact and terminal assembly 12, a pair of field coils 13 and 14 and a movable contact controlling armature 15. As best shown

in Figs. 1 and 3, the field structure 11 comprises a pair of cores 16 and 17, a pair of L-shaped pole pieces 18 and 19 and a third U-shaped pole piece 20. All of these components are formed of a suitable magnetic material such as Allegheny electrical metal. The frame 10 is of one piece construction and comprises an L-shaped member formed of non-magnetic material such as brass having a long leg 21 extending longitudinally of the cores 16 and 17 and a short leg 22 extending at right angles to the leg 21 and the cores 16 and 17.

In fabricating the present improved relay, the frame 10, the cores 16 and 17 and the pole pieces 18 and 19 are assembled together and rigidly interconnected to form one complete subassembly. To this end, the cores 16 and 17 are provided at their left ends as viewed in Fig. 1 with end portions of reduced cross section which are projected through openings in the pole pieces 18 and 19 and registering openings in the leg 22 of the frame 10 and are peened over to provide the equivalent of rivet connections between the described parts. In addition, small rivets, not shown but disposed above the cores 16 and 17, are also utilized fixedly to connect the pole pieces 18 and 19 with the end leg 22 of the frame 10.

The cores 16 and 17 are adapted slidably to receive and support the formed bobbins 13*a* and 14*a* upon which the coils 13 and 14 are respectively wound. Preferably, the bobbins 13*a* and 14*a* are molded from a suitable thermosetting insulating material such as nylon having the required insulating and heat resisting properties, and are provided with axial bores which fit rather tightly on the cores 16 and 17. At the ends thereof which are remote from the pole pieces 18 and 19, the cores 16 and 17 are provided with end portions 16*a* and 17*a* of reduced diameter which are threaded to mount assembly nuts 23 and 24 and are utilized to support the third pole piece 20 and the contact and terminal assembly 12. More specifically, the pole piece 20 is provided with openings 20*a* and 20*b* through the center leg thereof which are adapted to receive the ends 16*a* and 17*a* of the cores 16 and 17. This pole piece also serves rigidly to interconnect the identified ends of the cores 16 and 17 with the end of the frame leg 21. To this end, the lower leg 20*c* of the pole piece 20 is threaded to receive a flat headed machine screw 25 which extends through a suitable opening formed in the frame leg 21.

The details of the stationary contact end terminal assembly 12 are best illustrated in Figs. 1, 2 and 3 of the drawing. As there shown, this assembly comprises a supporting member 26 molded from a suitable thermosetting insulating material such as Bakelite and having spaced openings 27 and 28 therethrough for receiving the core ends 16*a* and 17*a*. As viewed from the front of the relay, the insulating member 26 is generally H-shaped, being provided with two spaced apart and downwardly extending legs 29 and 30 for supporting the coil terminals 31 and 32. Specifically, these terminals extend through spaced apart openings in the identified legs and are spun over at their inner ends so that they are rigidly mounted upon the legs 29 and 30 of the supporting member 26. It will be understood that the terminal ends of the coils 13 and 14 may be soldered to the inner ends of the terminals 31 and 32 after the relay is assembled.

Along its upper edge, the insulating member 26 is provided with two supporting legs 33 and 34 which are spaced apart to provide a contact receiving slot 35 therebetween, and are utilized respectively to support two terminal elements 36 and 37 which act as supporting elements for two stationary contacts 38 and 39. More specifically, the terminal elements 36 and 37 are rivet connected to the legs 33 and 34 of the member 26 by means of rivets 40 and 41 which pass through openings 42 and 43 in the legs 33 and 34 and aligned openings

36*a* and 37*a* in the terminal elements **36** and **37** and are peened over at their inner ends. When mounted upon the legs **33** and **34** of the insulating member **26** in the described manner, the terminal elements **36** and **37** are provided with contact supporting ears **36***b* and **37***b* which project laterally outward from the legs **33** and **34** into the slot **35** between these legs and are disposed one above the other in the manner best shown in Fig. 3. These contact supporting ears of the terminal members **36** and **37** are respectively provided with threaded openings **36***c* and **37***c* for receiving the stationary contact screws **38** and **39**. In order to clamp these screws in positions to which they may be adjusted, the ears **36***b* and **37***b* are also slotted at their outer ends as indicated at **36***d* and **37***d* to permit deformation of the ear parts into clamping engagement with the threads of the contact screws. As shown, the supporting member **26** is also provided with a centrally disposed bore **44** which is vertically aligned with the threaded opening **36***c* in the terminal ear **36***b* to permit the lower contact screw **38** to be threaded into this opening from the lower side of the member **26**. The insulating member **26** is also utilized to support a terminal element **45** which, as more fully explained below, is electrically connected to the movable contact of the relay structure. Specifically, this terminal element is provided with spaced openings **45***a* and **45***b* for receiving the core ends **16***a* and **17***a* and is adapted to act as washer means against which the assembly nuts **23** and **24** are drawn in assembling the terminal and contact assembly **12** with the field structure **11** of the relay.

As best shown in Figs. 1 and 3 of the drawing, the pair of L-shaped pole pieces **18** and **19** are respectively provided with pole face legs **18***a* and **19***a* which extend toward the front end of the relay, i. e., toward the contact and terminal assembly **12**. The third pole piece **20** is likewise provided with a pair of spaced apart pole face legs **20***c* and **20***d* which extend rearwardly of the relay toward and in alignment with the pole face legs **18***a* and **19***a* of the pole pieces **18** and **19**. As will be seen in Fig. 3, the pole face legs **18***a* and **19***a* of the two pole pieces **18** and **19** are vertically displaced above the pole face legs **20***c* and **20***d* by an amount such that the lower surfaces of the legs **18***a* and **19***a* are vertically displaced above the upper surfaces of the pole face legs **20***c* and **20***d*; this for the purpose of permitting the relay armature to be mounted in overlapping relationship with the identified pole face legs while preserving a parallel relationship between the armature and the axis of the coils **13** and **14** in the manner more fully explained below.

In order selectively to move a movable contact **15***f* back and forth between the opposed contact ends **38***a* and **39***a* of the contact screws **38** and **39**, thereby to perform the desired circuit switching operations, the armature **15** which is provided to actuate the movable contact **15***f*, is pivotally supported intermediate its ends at a point approximately midway between the ends of the field structure **11**. More specifically, this elongated armature is provided with a rear end portion **15***a* which is disposed in proximity to and overlaps the under sides of the pole face legs **18***a* and **19***a* and is provided with an opposed front end portion **15***b* which is disposed in proximity to and overlaps the upper sides of the pole face legs **20***c* and **20***d*. In the central portion thereof, the armature **15** is provided with a rectangular opening **15***c* which is intersected by a transversely extending recess **15***d* provided to seat a pivot pin **46**. Along the front edge and midway between the sides thereof, the armature **15** is also provided with a projecting contact finger **15***e* which fixedly mounts the movable contact **15***f* at the extended end thereof.

In accordance with one important feature of the present invention, an elongated flat spring element **47** is provided which is utilized for the dual purpose of clamping the pivot pin **46** in the recess **15***d* and of biasing the armature **15** in a direction to move the opposed end portions **15***a* and **15***b* thereof away from the pole face legs of the pole pieces **18**, **19** and **20**. More specifically, the spring element **47** is provided with a first rectangular portion **47***a* which is slightly dished in the manner shown in Fig. 1 and is adapted to extend upwardly from the bottom side of the armature through the opening **15***c*, over the pivot pin **46** and back through the opening **15***c* so that the front end thereof overlaps the under side of the armature. This portion of the spring element **47** is provided with spaced apart tool receiving openings **47***c* which are used in assembling the relay. The spring element **47** is also provided with a second portion **47***b* which extends along the under side of the armature and projects beyond the rear end of the armature. When the three components **15**, **46** and **47** are assembled, the pivot pin **46** is clamped in position within the recess **15***d* so that the ends thereof project beyond the sides of the armature. If desired, the pivot pin **46** may be provided with a centering slot along the length and midway between the ends thereof for receiving the spring part **47***a* and thus prevent longitudinal movement of the pivot pin in the recess **15***d*.

For the purpose of pivotally supporting the pivot pin **46** at the ends thereof, the frame member **10** is provided with bendable arms **48** and **49** which project outwardly from the rear leg **22** of the frame along opposite sides of the armature and are provided at their ends with bearing holes **48***a* and **49***a* for receiving the ends of the pivot pin **46**. To prevent the sides of the armature from frictionally engaging the supporting arms **48** and **49**, the supporting ends of the latter are provided with pressed-in portions which form inwardly extending bosses **48***b* and **49***b* coaxially with the bearing holes **48***a* and **49***a*. These bosses are adapted to engage the armature sides adjacent the pivot pin and thus prevent the rearwardly extending side edges of the armature from scraping against the supporting arms **48** and **49**.

In order to utilize the spring element **47** as an armature biasing spring, the frame **10** is equipped with an ear **50** which extends outward from the rear leg **22** of the frame and projects between the pole face legs **18***a* and **19***a* of the pole pieces **18** and **19**. This ear is provided with a threaded opening for receiving a threaded adjusting screw **51**. Specifically, the lower end of the screw **51** passes by the rear edge of the armature **15** and engages the extended end of the second spring portion **47***b* to bias the armature **15** for counterclockwise movement about its pivotal axis.

Briefly to consider the manner in which the component parts of the relay are assembled to form the described relay structure, it is again noted that the parts **10**, **16**, **17**, **18** and **19** are separately assembled to form a complete subassembly. Also, the parts of the terminal and contact assembly **12**, i. e., the parts **26**, **31**, **32**, **36**, **37**, **38**, **39**, **40** and **41** are separately assembled to form a subassembly. In bringing the described subassemblies and other parts of the relay into fully assembled relationship, the coils **13** and **14** are first slipped onto the cores **16** and **17** respectively, following which the pole piece **20** is telescoped over the ends **16***a* and **17***a* of the coils **16** and **17** until the center leg of this pole piece abuts the shoulders terminating the reduced diameter ends **16***a* and **17***a* of the cores **16** and **17**. In this connection, it is noted that the coil bobbins **13***a* and **14***a* are of substantially the same length as the main sections of the cores **16** and **17** so that when the pole piece **20** is brought to bear against the shoulders along the two cores, the coils are prevented from moving longitudinally of the cores. With the pole piece **20** in the position indicated, the assembly screw **25** may be threaded into the tapped opening in the pole piece leg **20***c* through the screw receiving opening in the end of the frame leg **21**, thereby to complete the field structure assembly and

to hold the coils 13 and 14 in their assembled positions on the cores 16 and 17.

The next operation is that of assembling the terminal and contact assembly 12 with the field structure 11. To this end, the core ends 16*a* and 17*a* are extended through the openings 28 and 27 in the supporting member 26, following which the terminal element 45 is positioned on the core ends 16*a* and 17*a* and the assembly nuts 23 and 24 are threaded on these core ends to clamp the member 26 between the pole piece 20 and the terminal element 45. The final operation is that of assembling the armature 15 with the remaining components of the relay structure. This is accomplished by positioning the spring 47 to project the portion 47*a* thereof through the opening 15*c* in the center portion of the armature. A hairpin-like assembly tool having outturned ends inserted through the openings 47*c* in the spring part 47*a* from the top side of the armature 15 may now be used to move the two parts 15 and 47 into their final assembly positions in the relay structure. Specifically, this tool is manipulated to move the armature 15 until the movable contact 15*f* is inserted between the contact ends 38*a* and 39*a* of the contact screws 38 and 39, after which the armature 15 may be moved rearwardly to position the rear end portion 15*a* thereof beneath the pole face legs 18*a* and 19*a* of the pole pieces 18 and 19 and to bring the recess 15*d* in alignment with the bearing openings 48*a* and 49*a* in the supporting arms 48 and 49. With the rear end portion 15*a* of the armature 15 bearing against the under sides of the pole face legs 18*a* and 19*a* and the movable contact bearing against the contact end 39*a* of the screw 39, the described hairpin-like assembly tool may now be pulled away from the relay field and frame structure to flex the spring portion 47 away from the recess 15*d* and thus permit the pivot pin 46 to be inserted through the bearing hole 49*a* along the recess 15*d*, beneath the spring portion 47*a* and through the bearing hole 48*a* to establish the desired pivotal mounting for the armature 15. After the pin 46 is thus moved to the desired position, the hairpin tool may be withdrawn from the opening 47*c* in the spring portion 47*a*, permitting this spring portion partially to return to its normal unflexed setting, thereby to clamp the pivot pin 46 in the recess 15*d*. Thus, the armature 15 is pivotally supported at the ends of the supporting arms 48 and 49. Following this operation, the biasing screw 51 may be threaded into the ear 50 to engage the rear end of the spring part 47*b* and establish the desired bias on the armature 15.

Briefly to consider the manner in which the present improved relay may be adjusted, it will be understood that the stationary contact screws 38 and 39 may be adjusted as required to establish the desired amount of armature travel between the back and front contact positions of the movable contact 15*f*. Further, the biasing screw 51 may be adjusted as required to establish the desired normal bias on the armature 15 to prevent the movable contact 15*f* from chattering when engaged with the stationary back contact 39*a* while permitting positive operation of the armature to the contact make or front contact position when the coils 13 and 14 are energized. In this regard, the desirability of maintaining air gaps of the same length between the ends of the armature 15 and the pole face legs 18*a*, 19*a*, 20*c* and 20*d* of the three pole pieces will be readily apparent. Adjustment of the lengths of the air gaps between the ends of the armature and one or more of the identified pole face legs of the pole pieces may be made by using a pair of pliers to bend the supporting arms 48 and 49 up or down relative to the frame leg 21, thereby to change the position of one or both of the supports for the pivot pin 46.

From the preceding explanation, it will be understood that in order to rotate the armature 15 to move the movable contact 15*f* out of engagement with the back contact 39*a* and into engagement with the front contact 38*a*, it is necessary to energize the field coils 13 and 14. Since the terminals of both coils are separately brought out to the terminal elements 29 and 30, it will also be understood that these coils may be energized in series or parallel as desired. When energized, a magnetic field is set up in the field structure which traverses the cores 16 and 17, the pole pieces 18, 19 and 20, the armature 15 and the air gaps between the ends of this armature and the pole face legs of the identified pole pieces. The resulting magnetic attraction between the pole face legs of the pole pieces and the opposed ends of the armature 15 causes this armature to be pivoted in a clockwise direction as viewed in Fig. 3 against the bias of the spring 47 to move the contact 15*f* out of engagement with the back contact 39*a* and into engagement with the front contact 38*a*. In this regard, it will be understood that the two stationary contacts 38*a* and 39*a* are insulated from the remaining parts of the relay structure. The movable contact 15*f*, on the other hand, is connected to the common terminal element 45 over a conductive path which includes the armature 15, the spring 47, the screw 51, the frame 10 and the cores 16 and 17. It will be noted that all parts of this conductive path are either clamped or stressed into engagement so that the contact resistances between the different pairs of engaged parts are relatively low, and hence the overall resistance of the described path is small.

From the foregoing explanation, it will be understood that the present improved relay is of simple and economical construction and is highly compact in arrangement. Moreover, the arrangement of the magnetic circuit is such that a maximum amount of magnetic pull is exerted upon the armature 15 with a given amount of power input to the field coils 13 and 14. In this regard, it will be noted that all of the magnetic flux produced in the field structure traverses the armature 15, that large pole face areas are provided to overlap both ends of the armature and thus assist in moving the armature to its contact make position against the bias of the spring 47, and that the structure is so arranged that very short air gaps may be used throughout. It will also be apparent that the present improved structure is so compact that it may be mounted in a very small space in either of two positions. Thus, the threaded openings 22*a* in the frame leg 22 may be employed to receive mounting screws for the purpose of mounting the relay in an upright position, in which case the mounting space required for the relay is the rectangular area defined by the outer edges of the insulating member 26. On the other hand, the threaded openings 21*a* in the frame leg 21 may be employed to receive the ends of mounting screws used to mount the relay in a horizontal position, in which case the mounting space required is approximately the area defined by the length and width of the relay as shown in Fig. 4. In either case, the longest dimension of the mounting space required is something less than two and one-half inches. As will be apparent from the above description of the armature supporting arrangement, the relay is relatively insensitive to vibratory forces impressed thereon from external sources. Specifically, the shockproof character of the relay structure is achieved by so mounting the armature 15 that this armature is dynamically balanced. In this connection, it is noted that the portion of the armature which extends rearwardly from the pivot pin 46 toward the pole pieces 18 and 19 is of the correct mass to counterbalance the mass of the forward end of the armature, the finger 15*e* and the movable contact 15*f* carried by this finger. To achieve precise dynamic balancing of the armature 15, the length of the rear end portion 15*a* of the armature is made greater than the length of the front end portion 15*b* by an amount such that the extra material in the rear end armature portion 15*a* counterbalances the finger 15*e* and the movable contact 15*f*. With this arrangement, vibratory forces impressed upon the armature 15

through the supporting frame 10 have the effect of tending to move both end portions of the armature in the same direction and thus cancel out with the result that no appreciable movement of the armature is produced in response to such forces.

While one embodiment of the invention has been described, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention as defined in the appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A relay having a movable contact, comprising a field structure provided with at least one pole piece, a movable contact controlling armature having a portion disposed in proximity to said pole piece, a supporting member, a spring engaged at two places by the armature and engaged by the supporting member intermediate said two places pivotally to support said armature on said supporting member, and means including said spring for biasing said armature in a direction to move said portion thereof away from said pole piece.

2. A relay having a movable contact, comprising a field structure provided with at least one pole piece, a movable contact controlling armature having a portion disposed in proximity to said pole piece and provided with an opening through a second portion thereof, a spring carried by said armature and provided with an intermediate portion extending through said opening, means including said intermediate portion of said spring for pivotally supporting said armature, and means coacting with said spring to bias said armature in a direction to move said first-named portion thereof away from said pole piece.

3. A relay having a movable contact, comprising a field structure including a pair of spaced apart pole pieces, a movable contact controlling armature having opposed ends disposed in proximity to said pole pieces and provided with an opening through a central portion thereof, a spring provided with a portion extending through said opening, and means including said spring for pivotally supporting said armature intermediate the ends thereof and for biasing said armature in a direction to move the ends thereof away from said pole pieces.

4. A relay having a movable contact, comprising a field structure including a pair of spaced apart pole pieces, a movable contact controlling armature having opposed ends disposed in proximity to and spaced from opposite sides of said pole pieces, said armature being provided with an opening through a central portion thereof, a spring provided with a first portion extending through said opening and a second portion extending beyond one of the ends of said armature, means including said spring for pivotally supporting said armature intermediate the ends thereof, and means coacting with said second portion of said spring to bias said armature in a direction to move the ends thereof away from said pole pieces.

5. A relay having a movable contact, comprising a field structure including a pair of spaced apart pole pieces, a movable contact controlling armature having opposed ends disposed in proximity to said pole pieces and provided with an opening through a central portion thereof, said armature having a recess extending transversely thereof and intersecting said opening, a pivot pin disposed in said recess and provided with ends projecting beyond the sides of said armature, a spring provided with a first portion extending through said opening over said pivot pin and back through said opening to clamp said pivot pin in said recess, means coacting with the ends of said pivot pin pivotally to support said armature, said spring including a second portion extending beyond one end of said armature, and means coacting with said second portion of said spring to bias said armature in a direction to move the ends of said armature away from said pole pieces.

6. A relay having a movable contact, comprising a field structure including a pair of spaced apart pole pieces, a movable contact controlling armature having opposed ends disposed in proximity to said pole pieces and provided with an opening through a central portion thereof, said armature having a recess extending transversely thereof and intersecting said opening, a pivot pin disposed in said recess and provided with ends projecting beyond the sides of said armature, a spring provided with a first portion extending through said opening over said pivot pin and back through said opening to clamp said pivot pin in said recess, a frame supporting said field structure and provided with bendable arms extending longitudinally of said armature on either side thereof, said arms having bearing holes at the ends thereof for receiving the ends of said pivot pin, thereby pivotally to support said armature, said spring including a second portion extending beyond one end of said armature, and means adjustably carried by said frame for engaging said second portion of said spring at a point beyond said one end of said armature, thereby adjustably to bias said armature in a direction to move the ends of said armature away from said pole pieces.

7. A relay comprising a field structure including a pair of spaced apart pole pieces, an armature having opposed ends disposed in proximity to said pole pieces and provided with an opening through a central portion thereof, said armature having a recess extending transversely thereof and intersecting said opening, a pivot pin disposed in said recess and provided with ends projecting beyond the sides of said armature, a spring provided with a first portion extending through said opening over said pin and back through said opening to clamp said pin in said recess, means coacting with the ends of said pivot pin pivotally to support said armature, a contact carrying finger projecting from one end of said armature and counterbalanced by the other end of said armature, said spring including a second portion extending beyond the other end of said armature, and means coacting with said second portion of said spring to bias said armature in a direction to move the ends of said armature away from said pole pieces.

8. A relay comprising a field structure including a pair of spaced apart pole pieces, an armature having opposed ends disposed in proximity to said pole pieces and provided with an opening through a central portion thereof, said armature having a recess extending transversely thereof and intersecting said opening, a pivot pin disposed in said recess and provided with ends projecting beyond the sides of said armature, a spring provided with a first portion extending through said opening over said pin and back through said opening to clamp said pin in said recess, a frame supporting said field structure and provided with bendable arms extending longitudinally of said armature on either side thereof, said arms having bearing holes at the ends thereof for receiving the ends of said pivot pin, thereby pivotally to support said armature, a contact carrying finger projecting from one end of said armature and counterbalanced by the other end of said armature, said spring including a second portion extending beyond the other end of said armature, and means adjustably carried by said frame for engaging said second portion of said spring at a point beyond said other end of said armature, thereby adjustably to bias said armature in a direction to move the ends of said armature away from said pole pieces.

9. A relay having a movable contact, comprising a field structure including a pair of spaced apart cores, a pair of L-shaped pole pieces separately connected to said cores at the same ends thereof and a third U-shaped pole piece detachably connected to said cores at the other ends thereof, said pair of pole pieces having pole face legs extending toward said third pole piece and said third pole piece having a pole face leg extending toward the pole face legs of said pair of pole pieces, an L-shaped frame rigidly connected to said cores and said pair of pole pieces to form a sub-assembly and provided with a leg end detachably connected to one leg of said third pole piece, coils slidably supported upon said cores, a terminal and

contact assembly removably supported on said cores at the same ends thereof as said third pole piece, whereby said coils may be removed from said cores after first disconnecting said assembly and third pole piece from said core ends and frame, a movable contact controlling armature having opposed ends disposed in proximity to the pole face legs of said pole pieces, and means pivotally supporting said armature intermediate its ends upon said frame.

10. A relay having a movable contact, comprising a field structure including a pair of spaced apart cores and pole pieces connected to said cores at the ends thereof and provided with pole face ends extending toward each other, one of said pole pieces being removably supported on corresponding ends of said cores, coils slidably supported on said cores, a terminal and stationary contact assembly removably supported on the same ends of said cores as said one pole piece, whereby said coils may be removed from said cores after first removing said assembly and one pole piece from said core ends, a movable contact controlling armature having opposed ends disposed in proximity to the pole face ends of said pole pieces and provided with an opening through a central portion thereof, a spring provided with a first portion extending through said opening and a second portion extending beyond one end of said armature, means including said first portion of said spring for pivotally supporting said armature intermediate its ends, and means coacting with said second portion of said spring for biasing said armature in a direction to move the ends thereof away from the pole face ends of said pole pieces.

11. A relay having a movable contact, comprising a field structure including a pair of spaced apart cores and pole pieces connected to said cores at the ends thereof and provided with pole face ends extending toward each other, a frame supporting said field structure, one of said pole pieces being detachably connected to corresponding ends of said cores and detachably connected to said frame, coils slidably supported on said cores, a terminal and stationary contact assembly removably supported on the same ends of said cores as said one pole piece, whereby said coils may be removed from said cores after first disconnecting said assembly and one pole piece from said core ends and frame, a movable contact controlling armature having opposed ends disposed in proximity to the pole face ends of said pole pieces and provided with an opening through a central portion thereof, said armature having a recess extending transversely thereof and intersecting said opening, a pivot pin disposed in said recess and provided with ends projecting beyond the sides of said armature, a spring provided with a first portion extending through said opening over said pivot pin and back through said opening to clamp said pivot pin in said recess, said frame having bendable arms extending longitudinally of said armature on either side thereof for pivotally supporting said pivot pin at the ends thereof, thereby pivotally to support said armature, said spring having a second portion extending beyond one end of said armature, and means carried by said frame for coacting with said second portion of said spring to bias said armature in a direction to move the ends thereof away from the pole face ends of said pole pieces.

12. A relay having a movable contact, comprising a field structure including a pair of spaced apart cores, a pair of L-shaped pole pieces separately connected to said cores at the same ends thereof and a third U-shaped pole piece detachably connected to said cores at the other ends thereof, said pair of pole pieces having pole face legs extending toward said third pole piece and said third pole piece having a pole face leg extending toward the pole face legs of said pair of pole pieces, an L-shaped frame rigidly connected to said cores and said pair of pole pieces to form a subassembly and provided with a leg end detachably connected to one leg of said third pole piece, coils slidably supported upon said cores, a terminal and contact assembly removably supported on said cores at the same ends thereof as said third pole piece, whereby said coils may be removed from said cores after first disconnecting said assembly and third pole piece from said core ends and frame, a movable contact controlling armature having opposed ends disposed in proximity to the pole face legs of said pole pieces and provided with an opening through a central portion thereof, said armature having a recess extending transversely thereof and intersecting said opening, a pivot pin disposed in said recess and provided with ends projecting beyond the sides of said armature, a spring provided with a first portion extending through said opening over said pivot pin and back through said opening to clamp said pivot pin in said recess, said frame having bendable arms extending longitudinally of said armature on either side thereof for pivotally supporting said pivot pin at the ends thereof, thereby pivotally to support said armature, said spring having a second portion extending toward said pair of pole pieces and projecting beyond the end of said armature, said frame having an ear extending between the pole face legs of said pair of pole pieces and overlying said second portion of said spring, and an adjustable armature biasing screw threaded through said ear and engaging said second portion of said spring, thereby adjustably to bias said armature in a direction to move the ends of said armature away from the pole face legs of said pole pieces.

13. A relay comprising a field structure including a pair of spaced apart pole pieces, an armature having opposed ends disposed in proximity to said pole pieces, a supporting member, spring means engaged at two places by said armature and engaged intermediate thereof by said supporting member to pivotally support said armature on said supporting member, means including said spring means for normally biasing the ends of said armature away from said pole pieces, and a contact carrying finger projecting from one end of said armature and counterbalanced by the other end of said armature.

14. A relay having a movable contact comprising a field structure having a pole piece, an armature supporting structure, a movable contact controlling armature having a portion thereof disposed in proximity to said pole piece and having ends, means including a spring mounted on said armature and pivotal supporting means carried by said supporting structure intermediate the ends of the armature for supporting said armature for pivotal movement about an axis intermediate the ends of said armature, and means carried by said supporting structure for engaging said spring to bias said portion of said armature away from said pole piece.

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