

Jan. 17, 1939.

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2,144,498

TWO-POSITION RECEIVER RELAYS

Filed Dec. 9, 1936

Fig. 1.

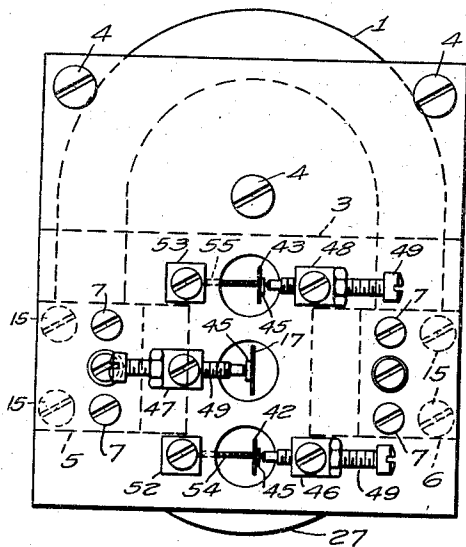


Fig. 2.

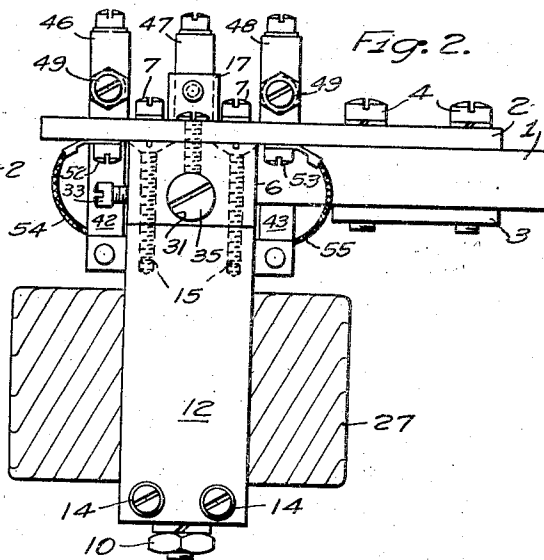


Fig. 3.

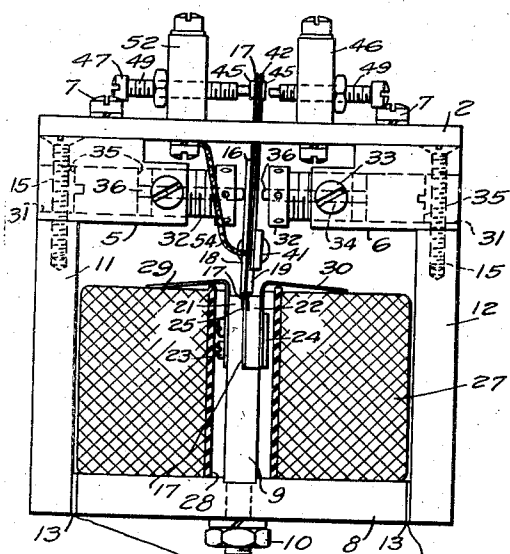
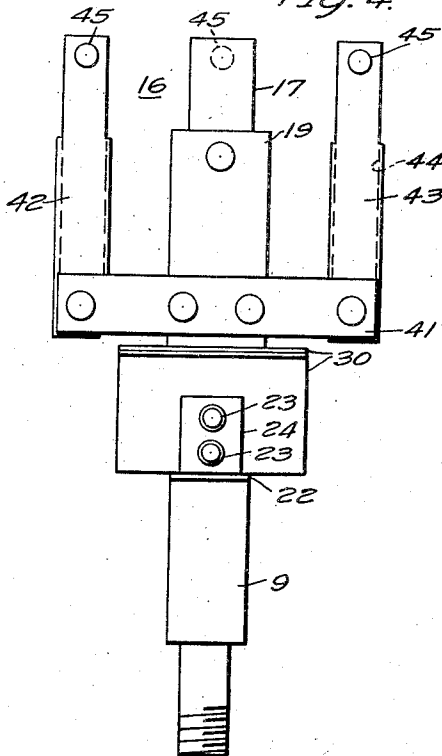


Fig. 4.



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2,144,498

TWO-POSITION RECEIVER-RELAYS

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Application December 9, 1936, Serial No. 114,964

19 Claims. (Cl. 200—93)

Our invention relates to electromagnetic devices and it has particular relation to a sensitive polarized relay which is especially designed and adapted for use as a two-position receiver-relay for use in a carrier-current protective system for transmission lines.

The principal object of our invention is to improve the construction of such relays in order that the same may be extremely sensitive to very small electrical inputs, while at the same time being positive and accurate in its operation.

An object of our invention is to provide a polarized relay in which the center of gravity of the movable armature may be placed as close to the hinged connection of the armature as possible.

A further object of our invention is to provide an improved construction of hinged connection between the movable armature and the stationary core member of a polarized relay.

A further object of our invention is to provide simplified and improved adjustment-means whereby a polarized relay is particularly adapted for use as the receiver-relay of a pilot protective system.

With the foregoing and other objects in view, our invention consists in the parts, structures, combinations, systems and methods hereinafter described and claimed, and illustrated in the accompanying drawing, wherein

Figure 1 is a plan view of a preferred form of embodiment of our electromagnetic device,

Fig. 2 is a side view thereof,

Fig. 3 is an elevational view thereof, with the coil shown in section, and

Fig. 4 is a detailed view of the stationary core member and the hinged armature which is carried thereby.

In common with other polarized relays, our electromagnetic device utilizes a source of magnetomotive force for normally continuously applying a unidirectional polarizing magnetomotive force to the device, and this force-means is commonly in the form of a permanent magnet 1 of horseshoe shape, although other means may be utilized for this purpose. In the preferred form of construction of our device, as shown in the drawing, the permanent magnet 1 is disposed flat against the under side of an insulating top plate 2, against which it is held by means of a non-magnetic plate 3 which is bolted to the top plate 2 by means of three bolts 4. The ends of the poles of the permanent magnet 1 abut against a pair of opposed, spaced, stationary magnetizable pole-pieces 5 and 6 which are held against

the under side of the top plate 2 by means of bolts 7.

The pole pieces 5 and 6 are mounted on the top of an E-shaped stationary pole frame structure comprising a bottom magnetizable bar 8, to the middle of which is secured an upright magnetizable core member 9, secured by means of a nut 10. The E-shaped frame also comprises two vertical magnetizable end-posts 11 and 12. The end posts 11 and 12 are separated from the ends of the bottom bar 8 by means of non-magnetic shims or spacers 13, and are firmly secured to the bar 8 by means of bolts 14 (Fig. 2). The pole pieces 5 and 6 are secured to the tops of the posts 11 and 12, respectively, by means of bolts 15.

The free or upper end of the magnetizable core member 9 carries a movable magnetizable armature member 16 which is mounted so as to extend vertically between the two spaced pole pieces 5 and 6. As shown more particularly in Figs. 3 and 4, our armature member consists of a centrally disposed vertical non-magnetic leaf-spring 17 which is flanked on both sides by substantially non-flexing magnetizable members 18 and 19, respectively, the three parts 17, 18 and 19 being secured together in a unitary structure. The central leaf-spring member 17 extends beyond the magnetizable members 18 and 19 at both the top and at the bottom. The bottom extension of the leaf-spring 17 is clamped to the top of the core member 9 by means of a novel construction of core member whereby the top end is bifurcated or split into two parts 21 and 22, both of which are of magnetizable material. Preferably, the part 21 is integral with the rest of the core member 9, while the part 22 is a separate part which is clamped to the part 21 by means of bolts 23 engaging a nut-plate 24.

The armature 16 is secured to the core member 9 by having the downwardly extending end of the centrally disposed leaf-spring member 17 clamped between the bifurcated ends 21 and 22 of the core member. These bifurcated ends 21 and 22 are provided with notches 25 at their upper ends so that the clamping pressure stops short of the top end of the core member, thereby providing a certain free length of flexible spring 17 which operates as a hinge member for hinging the armature member to the core member.

The flanking magnetizable members 18 and 19 of the armature are thicker than the notches 25 and are spaced from the top end of the core member 9 by a very small air gap, which is conveniently provided by setting the armature in place with feeler gauges (not shown) of some 5

or 8 mils thickness disposed between the bottom ends of the magnetizable strips 18 and 19 and the top ends of the bifurcated parts 21 and 22 of the core member, after which the clamping bolts 23 are tightened and the feeler gauges are removed. The depth of the notches 25 is also small as compared with the thickness of the flanking magnetizable members 18 and 19, and this depth (measured away from the spring 17) may also be of the order of 5 or 8 mils. As a result of this construction, the magnetic flux is transferred between the bottom ends of the magnetic strips 18 and 19 and the top ends of the bifurcated parts 21 and 22 of the magnetizable core member 9, substantially no flux being carried by the leaf-spring 17 because of its non-magnetic material. We have found that it is quite important to provide a hinge-construction in which there is ample provision for a substantially equal division of the magnetic flux between the strips 18 and 19 of the armature, so as to avoid the binding action which would be imposed on the hinge-joint in case there were a strong preponderance of the magnetic flux on one side or the other of the flexible member 17.

The magnetizable core member 9 is surrounded by one or more electric coils 27 which carry the small currents to which the electromagnetic device is sensitively responsive. The coil or coils 27 are preferably mounted on an insulating coil-supporting tube 28 (Fig. 3), and the coil or coils 27 are preferably held in place against the base plate or bar 8 by means of two springs 29 and 30 which are held in place by the clamping bolts 23 of the upper bifurcated end of the core member 9.

Our electromagnetic device is called a two-position receiver-relay, and it is called that because it is intended that the relay shall have two positions, one of which it occupies in its normal deenergized condition, and the other of which it assumes when a small current of the proper polarity traverses the coil 27. In order to hold the relay or electromagnetic device in its normal deenergized position, we prefer to utilize two forces, namely a spring-stress whereby the leaf-spring 17 tends to hold the relay in its normal position, and an unbalanced pull of the north and south poles of the permanent magnet 1, pulling on opposite sides of the armature 16.

To achieve these ends, we have provided a novel construction of our pole pieces 5 and 6, each of which is provided with a threaded hole 31 extending therethrough in a direction which is substantially tangential to the movement of the armature 16. An adjustable magnetizable pole-face screw 32 is operatively engaged in each of the pole-piece holes 31 in the front end thereof adjacent to the armature 16, so as to make it possible to move the effective face of the pole toward and away from the armature 16 for the purpose of adjusting the air-gap between pole-face and the armature. A set-screw 33 is also provided, whereby the pole-face screw may be locked in position after it has been adjusted. Each of the pole-face screws 32 is provided with a central perforation 34, the purpose of which will be subsequently described.

An adjustable stop-screw 35 is also operatively engaged in each of the pole-piece holes 31, the same being disposed in the rear end of said hole, back from the armature 16, and spaced from the pole-face screw 32. A non-magnetizable stop-pin 36 extends through the afore-mentioned central perforation 34 in each pole-face screw

32, and is engaged by the stop-screw 35, being preferably integrally united to the stop-screw 35.

As shown in the drawing, the left-hand stop screw 35 is adjusted so that the non-magnetizable pin 36 presses against the armature 16 in the deenergized position of the relay, so that the spring 17 is placed under slight tension or bending movement, in this position of the relay, thereby tending to hold the armature 16 back against the left-hand stop-pin 36, the displacement of the spring 17 being exaggerated for clearness of illustration in the drawing.

In addition to this adjustment, the two pole-face screws 32 are so adjusted that the left-hand pole-face is slightly closer to the armature 16 than the right-hand pole-face, in the normal deenergized position of the relay, as shown exaggeratedly in the drawing, thus causing the left-hand pole to attract the armature more strongly than the right-hand pole, thus additionally biasing the relay to its normal deenergized position.

The non-magnetic stop-members 36 are designed to prevent the armature member from ever coming into contact with either of the magnetizable pole-face screws 32, so as to prevent the armature from being permanently sealed in position against either of the pole-faces.

It will be noted that we have provided what might be termed a magnetic bridge construction, with two magnetic circuits provided between the poles of the permanent magnet 1, and with the magnetomotive force of the electrical coil 27 connected substantially between the mid points of the two magnetic circuits; so that the magnetomotive force of the permanent magnet 1 is connected across one diagonal of the bridge, and the magnetomotive force of the coil 27 is connected across the other diagonal.

Of the two magnetic circuits which are connected between the poles of the permanent magnet 1, one magnetic circuit is provided by the two pole-pieces 5 and 6, the two pole-face screws 32 which are, in effect, magnetic extensions of the pole-pieces, and the two air-gaps between the faces of these pole-face screws 32 and the armature-member 16. The upper end of the armature member 16 is thus connected at a magnetic potential which is somewhere near the mid-point between the magnetic potentials of the two poles of the permanent magnet 1; and the two air-gaps, one on either side of the armature 16, operate as high-reluctance portions of the magnetic circuit, these portions being very nearly equal to each other, the equality being only slightly displaced by the displacement which is utilized for obtaining the magnetic bias as previously described.

The other magnetic circuit, which is connected in parallel with the magnetic circuit just described, is composed of the two vertical magnetizable posts 11 and 12, the magnetizable base plate or bar 8, and the two non-magnetic spacers 13. It will readily be seen that the principal reluctance of this magnetic circuit occurs in the two non-magnetic spacers 13, which operate like air-gaps, or high-reluctance portions of the magnetic circuit. The mid-point of the base plate 8 is thus at a magnetic potential which is substantially midway between the magnetic potentials of the two poles of the permanent magnet 1.

As a result of the foregoing construction, the device is designed so that normally there is little or no magnetic force tending to move the armature. The magnetic bias tending to hold the

armature in its non-energized position need not be utilized in every case, and in any event it will not be more than a very small portion of the total magnetic force of the permanent magnet; so that normally there will be little, if any, of the permanent-magnet flux flowing vertically in the core-member 9 and in the armature 16.

It will be noted, on the other hand, that all of the magnetomotive force which is produced by the electric coil 27 is applied directly to the vertical magnetic cross-circuit composed of the magnetizable core 9 and the armature 16, so that, if the direction of the current in the coil 27 is such as to oppose the normal biasing action, a relatively slight magnetomotive force in the electric coil 27 will suffice to unbalance the magnetic bridge and to cause the armature 16 to move over against the right-hand stop 36 with a force which is approximately proportional to the product of the magnetomotive force or ampere-turns of the coil 27 and the field-strength of the permanent magnet 1. Thus, it is possible to make the field strength of the permanent magnet 1 very large as compared to the magnetomotive force of the coil 27.

Our armature-member 16 preferably carries one or more circuit-controlling or contact-make-and-break devices for the purpose of controlling one or more electrical circuits in accordance with the position of the electromagnetic device. In the particular form of embodiment shown in the drawing, there are three of these contact-make-and-break devices. The movable element 16 is provided with an insulating cross-piece 41 which is secured thereto at a point close to the hinged connection to the core member 9, so that the center of gravity of the armature may be as close to this hinge-connection as possible, thereby reducing the effective inertia of the movable armature and also tending to avoid bouncing or chattering of the circuit-contacts.

Two of the movable contact-members 42 and 43 of the three circuit-controlling contact devices are carried by the insulating cross piece 41. The third movable contact-member is provided by means of the upwardly extending end of the leaf-spring 17 of the armature-member 16. The two insulated movable contact-members 42 and 43 extend vertically from the insulating cross-piece 41 so as to be substantially parallel to the leaf-spring 17. Preferably, the movable contact members 42 and 43 are made of leaf-spring material, and the lower portions of them are stiffened by means of stiffening ribs or rolled edges 44, so as to limit the flexibility to the upper portions of the contact-members, whereby a better wiping contact may be obtained, and whereby it is possible to utilize a lighter-weight spring-material, thus reducing the inertia of the movable contact-members of our device.

The three circuit-controlling or make-and-break devices may be either normally open contacts or normally closed contacts. As shown, the two outside make-and-break devices are normally open contacts, while the center one is a normally closed contact which is closed when the switch is deenergized. The three movable contact-fingers may be provided with contact making buttons or tips 45 as shown in the drawing.

The three movable contact-fingers cooperate with three stationary contact-terminals 46, 47 and 48, respectively, each terminal having a contact-tipped adjusting screw 49 which may be moved toward or away from its cooperating mov-

able contact-finger for the purpose of adjusting the contacts in a manner which will be obvious.

It will be noted that the central contact-finger 17 is grounded on the frame of the electromagnetic device, whereas the other two movable contact-fingers 42 and 43 are insulated by the insulating cross-piece 41. These insulated movable contact-members 42 and 43 are preferably connected to binding posts 52 and 53 which are carried by the insulating top-plate 2 of the device, the connection being obtained by means of flexible pigtails 54 and 55.

The movable parts of our mechanism are made as light in weight as is possible, in order to increase the sensitivity and the speed of operation of the relay device, and to this end, the movable contact-fingers 42, 17 and 43 are made barely thick enough to avoid welding to the stationary contact-tips for lack of sufficient thermal or heat-storing capacity of the movable contact-fingers.

It should be noted that the non-magnetic shims or spacers 13 which are disposed at the bottom of our field-frame construction serve an even more important purpose than the provision of a high-reluctance parallel magnetic flux path, because these non-magnetic shims tend to keep the variable or alternating flux of the coil 27 out of the permanent magnet 1, thereby protecting the permanent magnet from flux-changes or a shifting of the neutral point which might upset the setting of the relay and eventually weaken the magnet.

As a result of our improved construction of a two-position receiver-relay, it has been possible for us to provide a polarized relay which will operate quickly and reliably in response to anywhere from about 0.5 milliampere up, depending upon the number of turns in the coil, thereby providing a relay which is eminently suitable for carrier-current protective systems, as well as other systems in which a quick and reliable operation is needed in response to extremely minute currents or current-changes.

While we have disclosed our invention in a single preferred form of embodiment which is designed to be illustrative of the principles of the invention, we desire it to be understood that many changes may be made in the details with respect to the furnishing of the permanent-magnet or polarizing flux, the furnishing of the electric-coil magnetomotive force, the number of contacts on the movable armature, and other constructional details of the device. We desire it to be understood that the foregoing and other changes and adaptations may be made by those skilled in the art without departing from the essential spirit and principles of our invention. We desire, therefore, that the appended claims shall be given the broadest construction consistent with their language and the prior art.

We claim as our invention:

1. An electromagnetic device comprising a pair of opposed, spaced stationary magnetizable pole-pieces, a movable magnetizable armature disposed between said pole-pieces, a stationary magnetizable core member, means for supporting said movable armature from said core member in such manner that said armature operates substantially like a hinged extension of said core member so that the armature may move toward and away from one or the other of said pole-pieces, a source of magnetomotive force for normally continuously applying a unidirectional polarizing magnetomotive force to said pole-pieces, electric-coil means surrounding said core member, and

magnetic-circuit means so associated with both of said pole-pieces as to normally apply an intermediate magnetic potential to the rear end of said core member opposite to the end which carries said movable armature.

2. The invention as defined in claim 1, including a bifurcated end of the core member, a leaf-spring member carried by the armature, and means for tightly clamping the end of the leaf-spring member in the bifurcated end of the core member.

3. The invention as defined in claim 1, including the armature-engaging end of the core member being split into two parts both of which are of magnetizable material, means for clamping said parts together, each part having a notch at its end so that the clamping pressure stops short of the armature-engaging end of the core member, the movable armature comprising a leaf-spring member flanked on both sides by substantially non-flexing magnetizable members, the leaf-spring member extending beyond the magnetizable flanking members at the core-engaging end of the armature, said extending end of the leaf-spring member being clamped between the two parts of the split end of the core member.

4. The invention as defined in claim 1, including the armature-engaging end of the core member being split into two parts both of which are of magnetizable material, means for clamping said parts together, each part having a notch at its end so that the clamping pressure stops short of the armature-engaging end of the core member, the movable armature comprising a leaf-spring member flanked on both sides by substantially non-flexing magnetizable members, the leaf-spring member extending beyond the magnetizable flanking members at the core-engaging end of the armature, said extending end of the leaf-spring member being clamped between the two parts of the split end of the core member, said leaf-spring member being of small flux-carrying capacity, and said flanking magnetizable members being thicker than said notches and being spaced by a small air-gap from the unnotched portion of the split end of said core member.

5. The invention as defined in claim 1, including said movable armature having an insulating cross-piece secured thereto at a point close to the hinged connection to the core member, a lightweight contact-spring carried by said cross-piece and extending longitudinally with respect to said armature, and a stationary contact-device cooperating with said contact-spring.

6. The invention as defined in claim 1, including at least one of said pole-pieces having a threaded hole extending substantially tangentially to the movement of the armature, an adjustable magnetizable pole-face screw operatively engaged in said pole-piece hole in the front end thereof adjacent to the armature, said pole-face screw having a central perforation, an adjustable stop-screw operatively engaged in said pole-piece hole in the rear end thereof back from the armature, and a non-magnetizable stop-pin extending through said central perforation and engaged by said stop-screw.

7. The invention as defined in claim 1, including the hinged supporting means for the armature being a leaf-spring member secured to both the armature and the core member, an adjustable back-stop means for said armature whereby said leaf-spring member may be biased, and means for adjusting the positions of the faces of both of the pole-pieces in a line which is sub-

stantially tangential to the movement of the armature.

8. An electromagnetic device comprising a pair of opposed, spaced stationary magnetizable pole-pieces, a movable magnetizable armature disposed between said pole-pieces, a stationary magnetizable core member, means for supporting said movable armature from said core member in such manner that said armature operates substantially like a hinged extension of said core member so that the armature may move toward and away from one or the other of said pole-pieces, said two pole-pieces and the intervening armature comprising one double-air-gap magnetic circuit of high reluctance, with the armature having an intermediate magnetic potential, means for providing a second magnetic circuit having two high-reluctance portions and an intermediate portion for engaging the rear end of said core member opposite to the end which carries the movable armature, a source of magnetomotive force for normally continuously applying a unidirectional polarizing magnetomotive force to the ends of both of said magnetic circuits, and electric-coil means surrounding said core member.

9. The invention as defined in claim 8, including a bifurcated end of the core member, a leaf-spring member carried by the armature, and means for tightly clamping the end of the leaf-spring member in the bifurcated end of the core member.

10. The invention as defined in claim 8, including the armature-engaging end of the core member being split into two parts both of which are of magnetizable material, means for clamping said parts together, each part having a notch at its end so that the clamping pressure stops short of the armature-engaging end of the core member, the movable armature comprising a leaf-spring member flanked on both sides by substantially non-flexible magnetizable members, the leaf-spring member extending beyond the magnetizable flanking members at the core-engaging end of the armature, said extending end of the leaf-spring member being clamped between the two parts of the split end of the core member.

11. The invention as defined in claim 8, including the armature-engaging end of the core member being split into two parts both of which are of magnetizable material, means for clamping said parts together, each part having a notch at its end so that the clamping pressure stops short of the armature-engaging end of the core member, the movable armature comprising a leaf-spring member flanked on both sides by substantially non-flexing magnetizable members, the leaf-spring member extending beyond the magnetizable flanking members at the core-engaging end of the armature, said extending end of the leaf-spring member being clamped between the two parts of the split end of the core member, said leaf-spring member being of small flux-carrying capacity, and said flanking magnetizable members being thicker than said notches and being spaced by a small air-gap from the unnotched portion of the split end of said core member.

12. The invention as defined in claim 8, including said movable armature having an insulating cross piece secured thereto at a point close to the hinged connection to the core member, a light-weight contact-spring carried by said cross-piece and extending longitudinally with respect

to said armature, and a stationary contact-device cooperating with said contact-spring.

13. The invention as defined in claim 8, including at least one of said pole-pieces having a threaded hole extending substantially tangentially to the movement of the armature, an adjustable magnetizable pole-face screw operatively engaged in said pole-piece hole in the front end thereof adjacent to the armature, said pole-face screw having a central perforation, an adjustable stop-screw operatively engaged in said pole-piece hole in the rear end thereof back from the armature, and a non-magnetizable stop-pin extending through said central perforation and engaged by said stop-screw.

14. The invention as defined in claim 8, including the hinged supporting means for the armature being a leaf-spring member secured to both the armature and the core member, an adjustable back-stop means for said armature whereby said leaf-spring member may be biased, and means for adjusting the positions of the faces of both of the pole-pieces in a line which is substantially tangential to the movement of the armature.

15. An electromagnetic device comprising a stationary electric-coil means, a stationary magnetizable field-frame means operatively associated with said electric-coil means, said field-frame means comprising a magnetizable core member, a movable magnetizable armature, the core member having a bifurcated end, a leaf-spring member carried by the armature, and means for tightly clamping the end of the leaf-spring member in the bifurcated end of the core member.

16. An electromagnetic device comprising a stationary electric-coil means, a stationary magnetizable field-frame means operatively associated with said electric-coil means, said field-frame means comprising a magnetizable core member, a movable magnetizable armature, and means for supporting said movable armature from said core member in such manner that said armature operates substantially like a hinged extension of said core member, the armature-engaging end of the core member being split into two parts both of which are of magnetizable material, means for clamping said parts together, each part having a notch at its end so that the clamping pressure stops short of the armature-engaging end of the core member, said movable armature comprising a leaf-spring member flanked on both sides by substantially non-flexing magnetizable members, the leaf-spring member extending beyond the magnetizable flanking members at the core-engaging end of the armature, said extending end of the leaf-spring member being clamped between the two parts of the split end of the core member.

17. An electromagnetic device comprising a stationary electric-coil means, a stationary magnetizable field-frame means operatively associated with said electric-coil means, said field-frame means comprising a magnetizable core member, a movable magnetizable armature, and

means for supporting said movable armature from said core member in such manner that said armature operates substantially like a hinged extension of said core member, the armature-engaging end of the core member being split into two parts both of which are of magnetizable material, means for clamping said parts together, each part having a notch at its end so that the clamping pressure stops short of the armature-engaging end of the core member, said movable armature comprising a leaf-spring member flanked on both sides by substantially non-flexing magnetizable members, the leaf-spring member extending beyond the magnetizable flanking members at the core-engaging end of the armature, said extending end of the leaf-spring member being clamped between the two parts of the split end of the core member, said leaf-spring member being of small flux-carrying capacity, and said flanking magnetizable members being thicker than said notches and being spaced by a small air-gap from the unnotched portion of the split end of said core member.

18. An electromagnetic device comprising a stationary electric-coil means, a stationary magnetizable field-frame means operatively associated with said electric-coil means, said field-frame means comprising a magnetizable core member, a movable magnetizable armature, and means for supporting said movable armature from said core member in such manner that said armature operates substantially like a hinged extension of said core member, said movable armature having an insulating cross-piece secured thereto at a point close to the hinged connection to the core member, a light-weight contact-spring carried by said cross-piece and extending longitudinally with respect to said armature, and a stationary contact-device cooperating with said contact-spring.

19. An electromagnetic device comprising a stationary electric-coil means, a stationary magnetizable field-frame means operatively associated with said electric-coil means, said field-frame means comprising a magnetizable core member and a pole-piece, a movable magnetizable armature disposed in operative relation to said pole-piece, and means for supporting said movable armature from said core member in such manner that said armature operates substantially like a hinged extension of said core member, said pole-piece having a threaded hole extending substantially tangentially to the movement of the armature, an adjustable magnetizable pole-face screw operatively engaged in said pole-piece hole in the front end thereof adjacent to the armature, said pole-face screw having a central perforation, an adjustable stop-screw operatively engaged in said pole-piece hole in the rear end thereof back from the armature, and a non-magnetizable stop-pin extending through said central perforation and engaged by said stop-screw.

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