

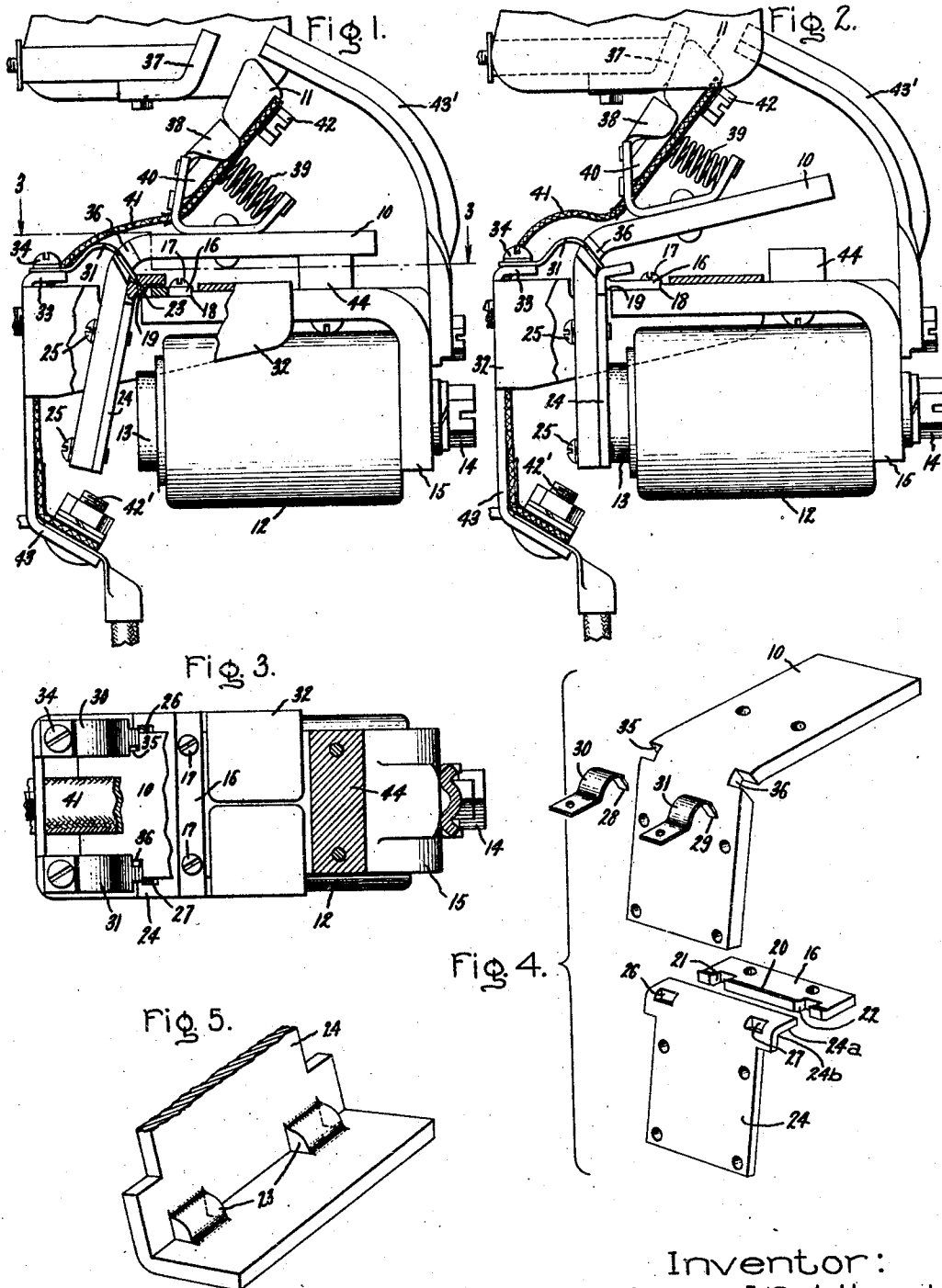
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ELECTROMAGNET

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ELECTROMAGNET

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My invention relates to electromagnets, more particularly to electromagnets for operating switches or contactors having pivoted armatures, and has for its object a simple, reliable and inexpensive pivot mounting for the armature.

More specifically, my invention relates to a pivotal bearing for the armature which does not have any sliding movement between the engaging bearing surfaces while these surfaces are secured together against displacement with respect to each other.

In carrying out my invention in one form I pivotally mount the armature on a knife-edge bearing member and provide the armature, or a supporting member attached to the armature, with V-shaped notches in its opposite sides and laterally displaced with respect to each other with the bottom bearing portions of the notches or apices of the V's in alignment with each other and forming a pivot axis for the armature. Thus one or more of these notches is disposed on the knife-edge supporting bearing while a pair of knife-edge supporting bearings, which may be spring members, are disposed in the V-shaped slots on the opposite side and hold or press the armature on the knife-edge supporting bearing. By reason of the fact that the bearing points of the knife-edge supporting bearing and of the spring bearing members are in alignment with each other, the forces exerted by the springs do not impede the free pivotal movement of the armature member or supply any bias to the armature member.

I also provide magnetic holding means for opposing initial movement of the armature to its attracted position thereby to prevent movement of the armature when the supply of excitation applied to the operating coil is too low to move the armature to its fully attracted position and wipe the movable contact into its fully closed position. It will be understood that the initial attractive force applied to the armature when the coil is energized is relatively low and increases as the armature moves toward its attracted position. Likewise the force required to move the armature is ordinarily relatively low at the beginning of its movement but increases suddenly to a relatively high value when the movable contact engages the stationary contact. Thus a very low voltage may be sufficient to move the armature to this contact engaging position but insufficient to complete the closing movement. This results in poor contact conditions and welding together of the contacts. I provide a magnetic shunt which applies a re-

straining force to the armature so as to prevent initial movement of the armature except when the voltage is high enough to complete the closing movement, this restraining force, however, dropping to zero very soon after the beginning of the armature movement. This magnetic shunt feature of my invention is covered by my divisional application Serial No. 517,422, filed January 7, 1944.

For a more complete understanding of my invention, reference should be had to the accompanying drawing in which Fig. 1 is a side elevation view partly in section of a contactor embodying my invention showing the armature in its open circuit position; Fig. 2 is a view similar to Fig. 1 but showing the armature in its circuit closed position; Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1 looking in the direction of the arrows; Fig. 4 is a view in perspective of the various parts forming the pivot mounting for the armature; while Fig. 5 is a fragmentary perspective view showing details of construction.

Referring to the drawing, I have shown my invention in one form as applied to an L-shaped armature member 10 carrying a movable contact 11 and operated to its circuit closed attracted position by a suitable operating coil 12. The coil 12 is provided with a core member 13 extending through it and secured as by a screw 14 at its right-hand end, as seen in the drawing, to an L-shaped core member 15. This core member 15, which as shown is a solid unlaminated piece of magnet core iron, extends upward from the central core member 13 and then substantially at right angles in parallel relation with the coil so that its left-hand end is substantially in the same plane as the end of the core 13.

For pivotally mounting the armature on the end of the core member 15 a bar 16 is mounted on the upper side of the core member 15 at its left-hand end and suitably secured to the core member as by screws 17. As shown, the core member is cut away somewhat, as indicated at 18, to form a seat for the bar 16. Also, the left-hand edge or side of the bar projects at 19 somewhat beyond the end of the core member. This bar 16, as shown most clearly in Fig. 4, provides by its upper left-hand edge 20 a knife-edge pivot bearing for the armature 10, this bearing 20 being discontinuous by reason of two slots or notches 21 and 22 formed in the bar.

These notches 21 and 22 are provided to receive two pressed out protuberances 23 (Figs. 1 and 5) formed on the lower side of a supporting

plate member 24 made of magnet iron which is secured to the lower side of the armature 10 as by screws 25 and forms a part of the armature. Preferably the plate 24 is formed in a suitable die with two laterally spaced apart V-shaped notches 26 and 27 (Fig. 4) in its upper surface, the metal being pressed out thereby forming the complementary protuberances 23 opposite the notches 26 and 27 and on the opposite side of the plate 24. These protuberances 23 fit loosely in the notches 21 and 22 and hold the plate 24 against lateral displacement on the bar 16. Also, as shown, the plate 24 is formed with a laterally extending portion 24a at its upper end extending at an angle somewhat greater than 90 degrees with the lower portion of the plate so that when the armature is in its unattracted position, as shown in Fig. 1, this portion 24a is parallel with the bar 16.

The bend between the upper portion 24a and the lower portion on the under side, as seen in the drawing, is formed with precision with a sharply defined straight junction or line bearing seat 24b between the two parts thereby to form a V-shaped bearing which fits on the knife-edge bearing 20 on the bar 16 so that when the member 24 is pressed on the bar 16, the two parts are held by these bearings in a precise pivotal positional relation with each other. Furthermore, the V-shaped bearings 26 and 27 have the junctions of their sides, i. e., their bottom line bearing seats, sharply defined so as to form seats for spring pressed knife-edge bearings 28 and 29 on the ends of spring members 30 and 31. Also, as shown in Figs. 1 and 4, the sides of each of the bearings 26 and 27 are substantially at right angles with each other, although this is not indispensable.

An important feature of the V-shaped knife-edge bearings 26 and 27 is that their line bearing seats or bottoms are in alignment with each other, and with the line bearing 24b, and also coincident with the pivot axis of knife-edge bearing 20. Consequently, the spring force applied to the knife-edge bearings 28 and 29 thereby to hold the plate 24 on the knife-edge bearing 20 does not apply any appreciable biasing force to the armature 10. Thus the plate 24 and the armature 10 carried by it are held securely by spring pressure on the knife-edge bearing 20, but without any impediment by this spring pressure to their pivotal movement. If a slight clearance is permissible between the knife edges 23 and 29 and the seats 26 and 27, the members 30 and 31 may be rigid and not apply pressure to the seats 26 and 27.

As shown, the spring members 30 and 31 are secured to extensions 33 on a formed bracket 32 in turn secured to the core member 15. For greater strength the opposite sides of the bracket 32 are turned downward on opposite sides of the core member. The armature 10 moves freely between the sides of the bracket 32. The spring members 30 and 31 are secured to the extensions 33 as by screws 24 (only one of which is shown). It will be observed that the spring members are bent into substantially inverted U shapes. Also, relatively short portions on their free ends, on which the knife-edge bearings 28 and 29 are formed, are of decreased width and extend through notches 35 and 36 in the armature into the bearing slots 26 and 27. These spring members are shaped so as to apply spring pressures on the bottoms of the slots 26 and 27 in the direction substantially bisecting the substantially 90-degree angle of the knife-edge bearing 20 when the contactor is open, as shown in Fig. 1. The slots 35 and 36 in the

armature are wide enough to provide for freedom of movement of the armature without engaging the spring members.

It should be noted that the springs 30 and 31 apply a minimum force at right angles to their forces applied to the bottoms of the slots 26 and 27. For the purpose of minimizing still further this right angle force, the springs may be hinged at their middle bends. Also, helical springs (not shown) could be used to apply forces to the V-shaped bearings 26 and 27.

It will be understood that various structural features of the contactor, which are conventional, have been omitted, for example, the panel support or other mounting for the stationary contact 37 and for the movable contact 11 and operating coil.

The movable contact 11, as shown, is held when it is in its open circuit position against a bracket 38 secured to the armature by means of a helical spring 39, the lower end 40 of the contact pivotally bearing against the bracket 38. When the armature is moved to its attracted position, shown in Fig. 2, by energization of the magnet coil, the movable contact is moved about its lower end as a pivot away from the bracket 38, the spring 39 being compressed. A flexible connecting lead 41 of electrically conducting material is secured by screw 42 to the movable contact and extends downward inside the bracket 32 to a point below the armature where it is secured by a bolt 42' to an arm 43 provided for it on the bracket 32. A metal arcing horn or arc runner member 43' is provided adjacent the movable contact.

In the event of wear, the bearings can be renewed by replacing the parts 16 and 24 with new parts. These parts are preferably case hardened to resist wear.

For the purpose of avoiding interference by deposits of dust and dirt, the knife edge 20 is extended upward somewhat above the upper surface of the bar 16 so that when the contactor is in its open position the portion 24a is spaced somewhat above the bar 16.

A bumper member 44 is provided on the core member 15 for the armature 10 to rest on when the armature is in its unattracted position.

Another feature of my invention is the use of magnetic iron for part or all of the bumper member 44 thereby to form an initial magnetic holding or restraining force for the armature 10. The purpose of this holding force is to prevent partial closing of the breaker under low voltage conditions. Without the use of magnetic material in bumper 44, or equivalent restraining means, in the event that the operating coil of the contactor is energized to close the contactor under substantial low voltage conditions, such as 75 per cent of normal voltage or less, the magnetic attractive force of the coil on the armature will be sufficient to move the armature and movable contact toward their closed circuit positions until the movable contact has engaged the stationary contact. At that point the armature is opposed by the additional contact spring pressure, i. e., the pressure of the spring 39, and must overcome this pressure in moving the movable contact and wiping it over the stationary contact to its final closed circuit position. When the closing movement thus stops upon initial engagement of the contacts, the electrical contact between them is unsatisfactory and may produce welding of the contacts together.

The object of this part of my invention, therefore, is to provide an initial restraining force which is great enough to prevent movement of

the armature toward its attracted position when the voltage applied to the operating coil is less than a predetermined voltage, such as 75 per cent of full voltage, but which holding force under normal voltage conditions drops to zero soon after the start of movement of the armature and, therefore, does not under normal voltage conditions appreciably affect closing operation of the contactor.

The strap of magnetic material formed by the bumper 44 provides a shunt magnetic path for the core member 15 when the armature is in its unattracted position, as shown in Fig. 1, this shunt path being from the right-hand end of the core member 15 directly through the strap of magnetic material 44 to the right-hand end of the armature 10 and thence through the armature and across the air gap to the end of the core member 13. This flux path results in a magnetic attraction between the bumper member and the armature which, for certain predetermined low voltages, is greater than the oppositely directed magnetic force exerted on the other end of the armature.

The bumper 44 is so arranged by suitably selecting its magnetic properties as by means of a non-magnetic shim (not shown), or by regulating its cross-sectional area, that as long as the voltage applied to the coil 12 during the closing movement is, for example, 75 per cent of normal voltage or more, the armature will be pulled away from the bumper 44 by the attractive force between its other end and the core 13, and then moved to its full attracted and closed circuit position. This holding force of the bumper is, of course, regulated to correspond with the additional force required to move the contactor to its fully closed position after first engagement of the contacts. Thus, under the conditions assumed, it was found in a typical contactor that 75 per cent or more voltage fully closed the contactor.

It will be understood that at some predetermined voltage applied to the coil 12 which gives a predetermined current in the coil and a corresponding magnetic flux value, the magnetic metal of the bumper 44 becomes saturated magnetically and consequently the magnetic restraining force of the bumper on the armature 10 is a maximum value. With higher voltages applied to the coil and resulting higher currents in the coil and greater magnetic flux generated by the coil, the restraining pull of the bumper remains substantially unchanged at substantially the predetermined maximum value while the magnetic flux in the other of the two parallel flux paths increases and applies an increasing pull on the lower left-hand end of the armature in a direction to move the armature to its attracted position. At the predetermined pickup voltage of, for example, 75 per cent of normal voltage, the armature is pulled to its attracted position against the restraining force of the bumper 45.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electromagnet comprising an armature, an operating coil for said armature, said armature being provided with a pair of V-shaped slots on opposite sides of said armature, said slots

being laterally disposed with respect to each other with their bottoms coincident with a pivot axis for said armature, a knife-edge bearing member for said armature extending into the one of said slots on the lower side of said armature thereby pivotally to support said armature, and a spring arm having a knife-edge bearing at its end extending into the other of said slots thereby to hold said armature on said first knife-edge bearing.

2. An electromagnet comprising an L-shaped armature, said armature being provided with a V bearing at the inner side of its bend, an operating coil for said armature, a bearing plate provided with a knife-edge bearing fitting into said V bearing thereby pivotally to support said armature, said bearing plate being provided with a slot intersecting said knife-edge bearing, a V-shaped bearing slot in the opposite or outer side of said armature at its bend with a complementary protuberance on the inner side of said armature fitting into said slot in said bearing plate, said outer V-shaped slot having its bottom pivot axis coincident with the bottom pivot axis of said first V bearing on the inner side of said armature, and a spring member having a knife-edge bearing on its end extending into said outer V-shaped slot and bearing on the bottom pivot axis of said slot.

3. An electromagnet comprising an L-shaped armature, said armature being provided with a V bearing at the inner side of its bend, an operating coil for said armature, a U-shaped magnet core for said coil having one leg extending through said coil, a bearing plate on the other end of said core provided with a knife-edge bearing fitting into said V bearing thereby pivotally to support said armature, said bearing plate being provided with two slots spaced apart and intersecting said knife-edge bearing, two spaced apart V-shaped bearings in the opposite or outer side of said armature at its bend with complementary protuberances on the inner side of said armature fitting into said slots in said bearing plate, said two outer V-shaped bearings having their bottom pivot axes coincident with the bottom pivot axis of said first V bearing on the inner side of said armature, two spring pressed members having knife-edge bearings on their ends extending respectively into said two outer V-shaped slots and bearing on the bottom pivot axis of said slots, and resilient means for applying forces to said spring pressed members in directions to hold said armature on said bearing plate and in a direction substantially bisecting the angle of the knife-edge bearing on said bearing plate.

4. An electromagnet comprising an armature, a first bearing plate armature member provided with an inner V-shaped bearing seat secured to the inner side of said armature, an operating coil for said armature, a magnet core for said coil having one leg extending through said coil, a second bearing plate secured to the other end of said core provided with a knife-edge bearing fitting into said inner V-shaped bearing thereby pivotally to support said armature, said second bearing plate being provided with a notch intersecting said knife-edge bearing, an outer V-shaped bearing in the outer side of said first plate with a complementary protuberance on the inner side of said first plate fitting into said notch in said second bearing plate, said outer V-shaped bearing having its bottom pivot axis coincident with the bottom pivot axis of said inner V-shaped bearing, an opening in said armature opposite

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said outer V-shaped bearing, a spring having a knife-edge bearing on its end extending through said opening in said armature into said outer V-shaped bearing with its knife-edge bearing engaging the bottom pivot axis of said outer V-shaped bearing, said spring applying a force to said outer V-shaped bearing to hold said first bearing plate and said armature on said second bearing plate and in a direction substantially bisecting the angle of the knife-edge bearing on said second bearing plate.

5. An electromagnet comprising an armature, an operating coil for said armature, said armature being provided with a V-shaped bearing on

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each of two opposite sides of said armature, said bearings being in alinement with each other with their bottom bearings coincident with a pivot axis for said armature, two knife-edge bearing members for said armature positioned on said opposite sides of said armature and extending into said V-shaped bearings thereby pivotally to support said armature for movement about said pivot axis, and a spring supporting one of said knife-edge bearings biasing said one knife-edge bearing against its bottom bearing thereby to hold said armature resiliently on the other of said knife-edge bearings.

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