This invention relates to electromagnetically operated devices, and more particularly to industrial contactors, or relays, used in electric systems of control, wherein the magnetic circuit includes a laminated armature and a multi-lag laminated core member, and wherein the contact assembly includes a plurality of movable contact members and a plurality of coaxing stationary contact members.

In most industrial applications compactness of the contactor is of great value and the useful life is of great value. It is a broad object of this invention to provide a contactor which is both compact and has a long useful life.

It is a more specific object of this invention to provide a control relay of minimum size but having a maximum number of bridge contacts of suitable current interrupting capacity, wherein the terminal connectors of the stationary contacts are so arranged as to be readily accessible in their assembled positions.

Another object of this invention is to provide a contactor which lends itself to many applications, particularly in control systems, that is, to provide a type of contactor which permits one and the same contactor to be used both as a normal control device with terminal screws and mounted in a base, and also as an interchangeable element by utilizing, for example, plug-in connected bars, with a simultaneous reversal of the mounting position.

The invention contains the objects thus far expressed by constructing a contact chamber unit including the contact bridge carrier and the magnet armature, to form an interchangeable structural unit such that contact chambers having one bank of contacts as well as contact chambers having two banks of contacts can be selectively mounted, regardless of the type and number of terminal connectors employed and regardless of the mounting position the contactor takes on a suitable base.

The wear resistance of an industrial contactor often called upon to operate thousands of times a day, must be great if a useful life worthwhile is to be attained. Therefore, the builder of such contactors must give particular attention to the mounting and guiding of the pull magnets used.

In switching apparatus of conventional prior art type, the magnets of a contactor are guided therein. However, these guides, particularly with respect to the core, are quite rigid with respect to the longitudinal guiding direction so that the core cannot adapt itself to normal swings and deflections of the armature. This results in impact forces acting only toward one side and thus results in a premature destruction of the magnet pole surfaces.

It is also an object of this invention to provide mounting means for the magnetic core of a contactor which is both rigid enough to positively guide the core and resiliently movable enough to permit an adaptation of the position of the core to all the normal tilts and deflections the armature may undergo.

It is also an object of this invention to utilize for the purposes thereof the known method of shock absorption of the core acting in a direction opposite the attraction of the core with respect to the armature. These last recited objects of this invention are attained by using supporting means including a lever extending through the laminated core in a direction perpendicular to the direction of movement of the armature, said lever being held in balanced position by means of springs cooperating with the ends of the lever at opposite sides of the laminated core, and abutting against some suitable stationary member as the coil frame.

The objects recited are merely illustrative. Other objects and advantages will become more apparent from a study of the following specification and the accompanying drawings, in which:

FIGS. 1 and 2, with parts in section, show front and side elevations, respectively, of the simplest embodiment of this invention;

FIGS. 3 and 4, with parts in section, shown front and side elevations, respectively, of a more complex embodiment of this invention;

FIGS. 5 and 6 are showings similar to FIGS. 3 and 4 of the further embodiment of this invention;

FIG. 7 shows a plan view of a cover such as may be used with the embodiment shown in FIGS. 5 and 6, and

FIG. 8 is an enlarged view of a detail of this invention.

The operating parts of the contactor are disposed in a housing having the general shape of a right parallelepiped and comprising a bottom part 2 and a cap or top part 3, which parts are held firmly together as a unit by the bolts disposed at diagonal corners of the housing.

An E-shaped main magnet, or core, 5 of laminations is disposed in the bottom part 2 with the legs of the E projecting upward. A magnetizing winding, or coil, 6, disposed on a suitable spool 7 of insulating material, is disposed over the middle leg of the core 5. Near the bottom of the core, 5, that is, near the midportion of the inner bottom part of the 2 when the magnet is in position, a relatively small rectangular hole or opening, 10, is provided transversely of the core. A relatively narrow and thin but quite stiff rectangular bar 11 is disposed in the opening 10. The bar 11 has a downwardly directed bowed portion 12 near its midportion to engage with a line contact the middle of the upwardly facing surface forming the bottom boundary of the hole 10.

The upwardly facing surface at the bottom of part 2 is provided longitudinally thereof with an arcuate ridge 13 in the shape of a relatively small segment of a cylinder. A flat rectangular strip 14 of waxed paper, hard rubber, hard neoprene, or other somewhat pliable, or resilient, material fits snugly in the part 2 against the arcuate ridge 13 to engage this ridge with a line contact parallel to the axis of the ridge, or cylindrical segment 13. It will be noted that this line contact is parallel to the line contact made at the bottom of slot 10 by the downwardly directed bowed portion 12 on bar 11 and that the two line contacts are spaced but a short distance apart.

The downwardly facing flat surface of the magnet longitudinally engages the strip 14. The strip 14 is not of absolutely necessary part of this invention. If the strip 14 is not used then the magnet itself engages the arcuate ridge in a line longitudinally of the back of the magnet.

The coil spool 7 is provided with shallow downwardly directed cup-shaped regions for receiving the upper ends of the springs 15 and 16. These springs are rather stiff, and with their lower ends rest on the ends of the bar 11. When the bolts 4 are positioned to firmly hold the parts 2 and 3 together, the magnet 5 is firmly biased downwardly against the arcuate ridge.

The upper end of the coil spool engages the top part 3 telescopically but against suitable shoulders so that the coil is firmly held against upward movement into the part 3 housing the contact assembly. The terminals for the coil are indicated at 17 and 18. The terminals are set in recesses and thus do not protrude beyond the general outline of the contactor.

The upper part 3 houses the contact assembly, the
contact-bridge carrier 19 and the armature 20 which may be a flat laminated bar but preferably is \( E \)-shaped with the \( E \) having relatively short legs. The legs are directed downwardly to engage the upwardly directed relatively longer legs of the core 5. A through-bolt 21 fitting not too snugly pivotally mounts the armature on the contact-bridge carrier 19 so that the armature 20, within certain limits, has freedom of rotation in the plane of the paper, as seen in Fig. 2.

From the foregoing disclosure of the mounting of the core 5, in relation to the bottom part, the coil, and the armature, it is apparent that the core 5 may, when necessary, perform tilting movements relative to the coil and the housing as well as with respect to the armature, which tilting movements thus adjust themselves to the movement of the armature. Further, since the core 5 is biased downwardly by the springs 15 and 16 and is not actually rigidly mounted in the housing, it actually, upon energization of the coil has some slightly transient upward movement. The armature and magnet so to speak meet in mid-air and the impact is cushioned both by the movements and the strip 14. Also further since the arcuate ridge 13 contacts the core 5 in a line and the tilting required is small the magnet after the first impact with the armature remains in its desired tilted position. There is thus on successive operations no edge impact between the armature and magnet and premature destruction of the magnet pole surfaces is eliminated. The contactor is thus less noisy and has a very much lengthened useful life.

Furthermore, it is not only possible to mount the core 5 so as to permit it to perform certain tilting movement relative to the coil and housing by means of the bar 11 and associated parts and the arcuate ridge, but it is also possible to support the coil spool relative to the top part of the housing by means of suitably positioned extensions having the shape of rounded fins. For example, by so disposing the rounded fins on the supporting surface that the longitudinal axis thereof extends perpendicular to the longitudinal dimension of the magnet, said coil, and thus the magnet may also tilt in a direction perpendicular to the direction of tilt resulting from the bar 11 and associated parts and the arcuate ridge 13. In other words, in this case said coil and magnet would be tiltable in the housing toward both sides because the mounting is like a Cardan mounting.

The contact-bridge carrier 19 is provided longitudinally thereof with an upwardly directed rectangularly shaped projection 22 provided with substantially rectangular window-like transverse openings 23 for receiving the contact bridges 24, which are to coat with the stationary contacts 25.

The window-like openings 23 have recessed shoulders at each outer vertical edge for receiving the guiding ears 28 of the U-shaped holders 27. A spring 29 is disposed between the facing bights of each of two of the U-shaped holders to urge them upwardly and downwardly, respectively to hold the contact bridges disposed between the holders 27 and the top and bottom ends of the openings. Since the projecting ears on the holders retain the holders against transverse movement in the window-like openings 23 it is apparent that the contact bridges may be readily removed and re-inserted. This removal is readily effected by merely pulling the contact bridge out. For insertion the contact bridge is merely pushed in position. The insertion may be so made that any particular contact bridge may be a make contact or a break contact.

The stationary contacts 25 are provided with the ears 30 and 31 at each edge for engaging a pair of facing grooves, as groove 32, formed at the region of the stationary contacts in the facing side walls of the housing for the contact assembly. These ears thus provide firm lateral stability for the stationary contacts.

A hexagonal nut 33 is disposed in a retainer seat in the housing. The crimped portion 34 on the contact 25 acts as a keeper for the nut 33. The bolt 35, passing through a hole in the contact 25 is threaded into the nut 33 and below the nut extends, without any material play, or looseness, into a smooth cylindrical well or opening 36 to thus retain all parts associated with contact 25 in position. There is thus no chance of accidental loss of any of the parts.

The resetting of the armature and therefore the contact-bridge carrier is effected by diagonally displaced springs 37 and 38 which abut against the coil spool and the contact-bridge carrier.

FIGS. 3 and 4 are front and side elevations, respectively, of a contactor built according to the invention, wherein a contact member having two superimposed rows of contacts is employed instead of the single-row contact chamber with the associated contact-bridge carrier illustrated in FIGS. 1 and 2. In FIGS. 3 and 4 there can be seen the connecting means 4 between the magnetic housing 2 and housing 3 mounted thereto as well as the fastening means 39 provided on the base. The contact chamber 3 is extended toward the side remote from the magnet core, and accommodates a second row of contacts comprising the stationary contacts 40, the associated contact bridges 41, and the stationary terminal connectors 42. From FIG. 4 it can be seen that, by way of comparison with the arrangement in FIGS. 1 and 2, the stationary contacts 42 of the lower row are arranged so as to cooperate with reversed contact bridges 43 to form break contacts instead of the make contacts illustrated in FIG. 2. It can also be seen that the stationary terminal connectors 42 are displaced toward the inside of the contact chambers with respect to the terminal connectors 25, which arrangement makes the terminals easily accessible.

FIGS. 5 and 6 show a further embodiment of the contactor according to the invention, wherein the stationary contacts with the clamping type terminals have been replaced by knife-type contact studs 41 disposed in the same housing portion. FIGS. 5 and 6 further show the connection of the contactor, provided with contact studs, with a terminal board 42. It will be noted that the position of the assembly has been reversed with respect to the base-type mounting, previously described, on account of the arrangement of the fixed contacts on the terminal board 42. The contactor is secured to the terminal board 42 which is provided with resilient clamps 43. These clamps ensure a proper and firm mounting of the contactor on the base support. FIGS. 5 and 6 further show that the contact chamber region is provided with a cover 44 having openings 44' therein for guiding and holding the contact studs 41.

In order to prevent the contact studs from being inadvertently interchanged with respect to said cover, and the contacting from being incorrectly attached to the terminal strip, the housing portion 3, the cover 44, and the terminal board 42 are provided with projections and recesses associated therewith, said projections and recesses being asymmetrically disposed with respect to each other in a manner known per se. The same is true with respect to the magnet housing 2 and the housing portion 3. The stationary clamping-type terminals and the plug-in type terminal studs are so constructed that they can be interchanged, utilizing the same housing portion 3.

FIG. 7 is a plan view of said cover 44 which preferably is made of transparent plastic. Since additional knife contacts are needed for the trip current that the current is switched in the housing, a short wire connection 45 is provided between the terminal connector 17 and one of said stationary contacts. It will be noted that, by using knife contacts with a contactor constructed according to the invention, there may be used a maximum of only seven closing contacts or four closing
contacts and three opening contacts, respectively, instead of the eight closing contacts or four closing contacts and four opening contacts, respectively, if possible. It is to be understood that various modifications are possible with respect to the design of the magnet, the use of multi-legged magnets, the construction of the core body, and, if desired, the configuration of said scale-beam shaped lever as well as with respect to the arrangement of these elements, without departing from the scope of the invention.

I claim as my invention:

1. In an electromagnetically operable device, in combination, a base, a magnetic circuit comprising a core member and a movable armature, said core member having projecting means projecting toward the armature to coat with the armature and having a transverse slot near the edge of the core remote from said projecting means, said base having a well for receiving the core and an arcurate ridge at the bottom of the well, said core being supported by said ridge, coil means mounted in fixed relation in said well for magnetizing the magnetic circuit to cause actuation of said core here, core retaining means for retaining the core against the arcurate ridge in the bottom of the well in the base, said core retaining means comprising a relatively thin and relatively stiff generally straight elongated bar having an arcurate or bowed, mid region disposed in said slot so that the bowed region engages the bottom of the slot by a line contact and the ends of the bar project from each side of the core, a spring disposed between one end of the bar and the coil means, said springs thus biasing the core for some pivotal movement against said arcurate ridge to thus retain the core in the well in the base.

2. In an electromagnetically operable device, in combination, a hollowed-out base, an arcurate ridge in the bottom of the base, a cap for the base, a magnetic circuit comprising a core disposed in the base and a movable armature disposed to coat with said core, said core having upwardly directed projecting means having armature engaging surfaces, coil means operatively disposed with respect to said magnetic circuit, means coacting with said cap for holding the coil means in fixed relation to said base, said armature having surfaces for engaging the armature engaging surfaces on said core and said armature being moveable by the energization of said coil means toward said projecting means, said core being provided with a transverse slot near its bottom surface, core retaining means comprising a bar, having a downwardly directed bowed portion near its middle, disposed in said slot so that the bowed portion engages the bottom of the slot and the ends project beyond the core at each side of the core, a spring disposed between the coil means and one end of the bar, and a second spring disposed between the coil means and the other end of the bar, whereby the core bottom is biased against the arcurate ridge and thus has some freedom of pivotal adjusting movement and is retained in the base.

3. In an electromagnetically operable device, in combination, a base hollowed-out to provide a well, a cover for said well, an elongated upwardly directed convex ridge in the bottom of the well, a magnetic circuit comprising a core, disposed in the well of the base to rest on said ridge to make line contact with said ridge, and a movable armature disposed to coat with said core, said core having upwardly directed projecting means having armature engaging surfaces, coil means operatively disposed with respect to said magnetic circuit, means coacting with said cover for holding the coil means substantially in fixed relation to said base, said armature being mounted for pivotal movement about an axis above said ridge transverse of the ridge and for translational movement toward said projections upon energization of said coil means, said core being provided with a transverse slot near its bottom surface, core retaining means comprising a bar, having a downwardly directed bowed portion near its middle, disposed in said slot so that the bowed portion engages the bottom of the slot and the ends project beyond the core at each side of the core, a second spring disposed between the coil means and the other end of the bar whereby the core bottom is biased against the arcurate ridge and thus has some freedom of pivotal adjusting movement on the ridge and is retained in the well of the base.

4. In an electromagnetically operable device, in combination, a base hollowed-out to provide a well, a cover for said well, an elongated upwardly directed convex ridge in the bottom of the well, a covering of somewhat elastic material for said ridge, a magnetic circuit comprising a core, disposed in the well of the base to rest through said covering on said ridge to make line contact with said ridge, and a movable armature disposed to coat with said core, said core having upwardly directed projecting means having armature engaging surfaces, coil means operatively disposed with respect to said magnetic circuit, means coacting with said cover for holding the coil means substantially in fixed relation to said base, said armature being mounted for pivotal movement about an axis above said ridge transverse of the ridge and for translational movement toward said projections upon energization of said coil means, said core being provided with a transverse slot near its bottom surface, core retaining means comprising a bar, having a downwardly directed bowed portion near its middle, disposed in said slot so that the bowed portion engages the bottom of the slot and the ends project beyond the core at each side of the core, a spring disposed between the coil means and one end of the bar, and a second spring disposed between the coil means and the other end of the bar whereby the core bottom is biased against the arcurate ridge and thus has some freedom of pivotal adjusting movement on the ridge and is retained in the well of the base.

5. In an electromagnetically operable device, in combination, a base, a magnetic circuit comprising a core member and a movable armature, said core member having projecting means projecting toward the armature to coat with the armature and having a transverse slot near the edge of the core remote from said projecting means, said base having a well for receiving the core and an arcurate ridge at the bottom of the well, said core being supported by said ridge, coil means mounted in fixed relation in said well for magnetizing the magnetic circuit to cause actuation of said armature, core retaining means for retaining the core against the arcurate ridge in the bottom of the well in the base, said core retaining means comprising a relatively thin and relatively stiff generally straight elongated bar having an arcurate or bowed, mid region disposed in said slot so that the bowed region engages the bottom of the slot and the ends project beyond the core at each side of the core, a spring disposed between the coil means and one end of the bar, and a second spring disposed between the coil means and the other end of the bar whereby the core bottom is biased against the arcurate ridge and thus has some freedom of pivotal adjusting movement on the ridge and is retained in the well of the base.

6. In an electromagnetically operable device, in combination, a base, a magnetic circuit comprising a core member and a movable armature, said core member having projecting means projecting toward the armature to coat with the armature and having a transverse slot near the edge of the core remote from said projecting means, said base having a well for receiving the core and an arcurate ridge at the bottom of the well, said core being supported by said ridge, coil means mounted in fixed relation in said well for magnetizing the magnetic circuit to cause actuation of said armature, core retaining means for retaining the core against the arcurate ridge in the bottom of the well in the base, said core retaining means comprising a relatively thin and relatively stiff generally straight elongated bar having an arcurate, or bowed, mid region disposed in said slot so that the bowed region engages the bottom of the slot by a line contact and the ends of the bar project from each side of the core, a spring disposed between one end of the bar and one spring back-up means and a second spring disposed between the other end of the bar and the other spring back-up means, said springs thus biasing the core against said arcurate ridge to thus pivotally retain the core in the well in the base.

6. An electric control device comprising, in combination, a housing, an electromagnet disposed within said housing and comprising a core member and an armature movable toward and away from said core member, said core member having an opening therethrough, an elongated member disposed in said opening such that the two opposite ends thereof protrude out from said opening, resilient means biasing said ends in the same direction to bias said core member away from said armature, and
means limiting movement of said core member away from said armature whereby said core member is supported for limited movement within said housing.

7. An electric control device comprising, in combination, a housing, an electromagnet disposed in said housing and comprising a core member having an opening therethrough, an elongated member disposed in said opening such that the two opposite ends thereof protrude from said opening, said elongated member comprising a bowed portion intermediate its ends and positioned within said opening, the spring at each of said ends, said springs biasing said elongated member to bias said core member in a direction away from said armature, and means limiting movement of said core member away from said armature.

8. An electric control device comprising, in combination, a housing comprising an insulating base and an insulating cover, said base comprising a bottom portion and sidewalls extending from said bottom portion, a core member having an opening therethrough, an elongated member slideable into and out of said opening and being disposed in said opening with the two opposite ends of said member protruding from opposite ends of said opening, resilient means biasing said ends to bias said core member toward said bottom portion whereby said core member is supported for limited movement within said base, and an armature cooperable with said core member and supported for limited movement on said cover.

9. An electric control device comprising, in combination, a housing comprising an insulating base and an insulating cover, said base comprising a bottom portion and sidewalls extending from said bottom portion, and an E-shaped core member mounted within said base with the legs thereof extending away from said bottom portion, core means disposed over the center leg of said E-shaped core member, said E-shaped core member having an opening extending therethrough in a direction generally normal to the direction of extension of the legs of said member, an elongated flat member disposed in said opening such that the opposite ends of said member extend out from said opening, said elongated member having a bowed portion intermediate its ends and disposed in said opening, spring means engaging said opposite ends and biasing said elongated member to bias said core member toward said bottom portion, and an E-shaped armature movably supported within said housing to cooperate with said core member.

References Cited in the file of this patent
UNITED STATES PATENTS
2,544,491 Davis ------------------ Mar. 6, 1951
2,786,164 Carpenter ---------------- Mar. 19, 1957
2,811,617 Townsend ---------------- Oct. 29, 1957
2,822,450 Goudy et al. -------------- Feb. 4, 1958
2,848,663 Kelto et al. ------------- Aug. 19, 1958
2,897,311 Schleicher ------------- July 28, 1959
2,919,327 Kuhn et al. ------------ Dec. 29, 1959