Aug. 7, 1951 H. E. SCHLEICHER 2,563,495

ELECTROMAGNETIC OPERATING MEANS FOR ROTARY ELECTRIC SWITCHES AND OTHER DEVICES

Original Filed Nov. 26, 1943 3 Sheets-Sheet 1

FIG. 1.

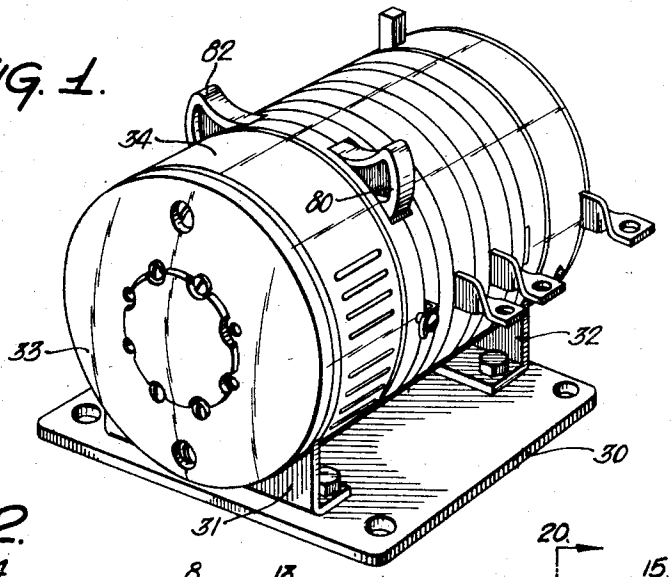
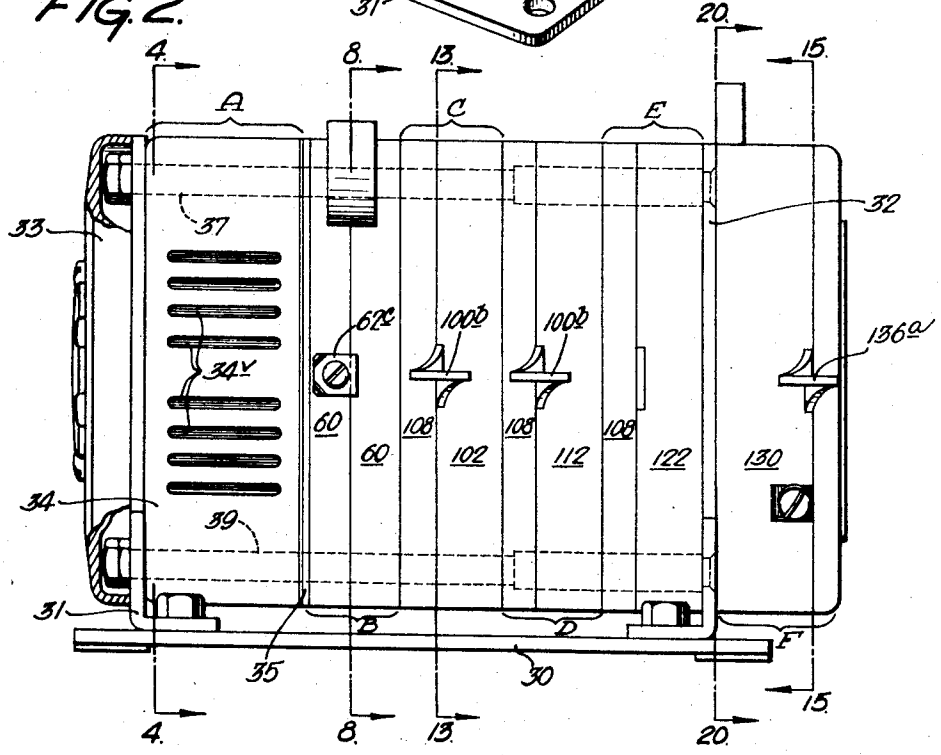


FIG. 2.



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FIG. 3.

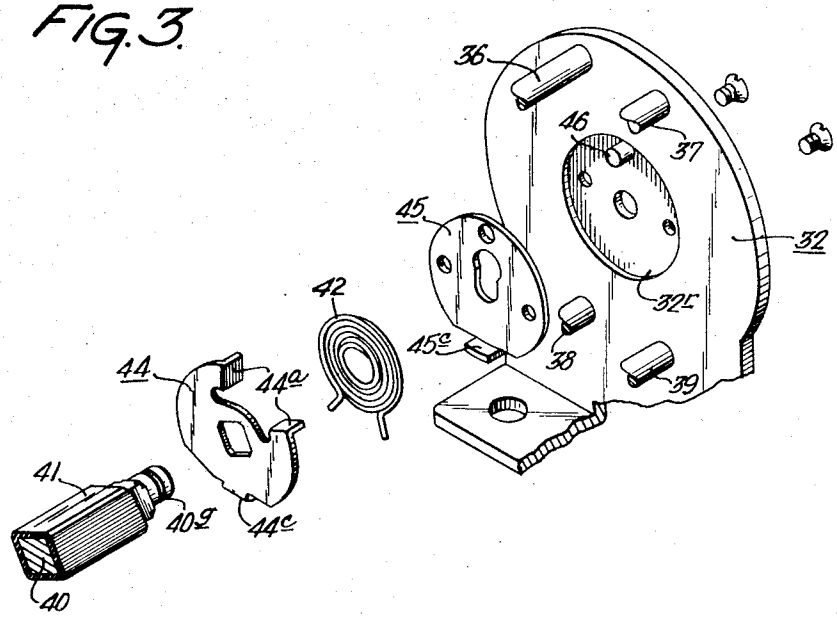
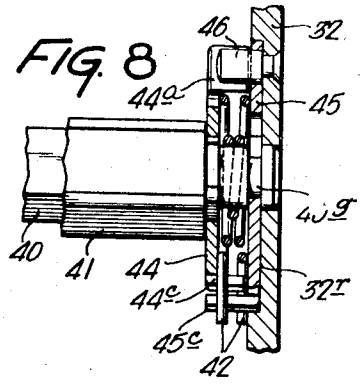


FIG. 8



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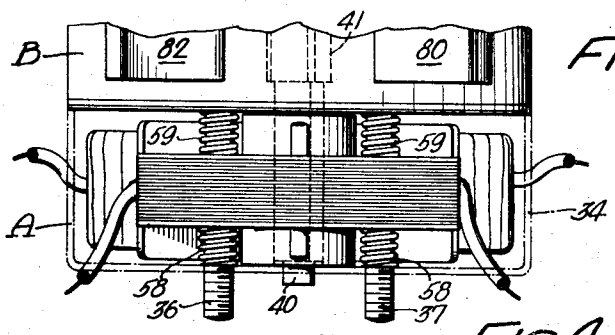


FIG. 5.

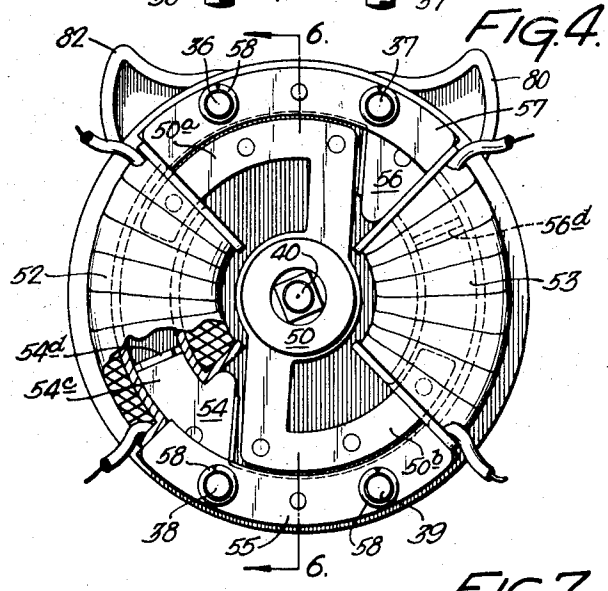


FIG. 4.

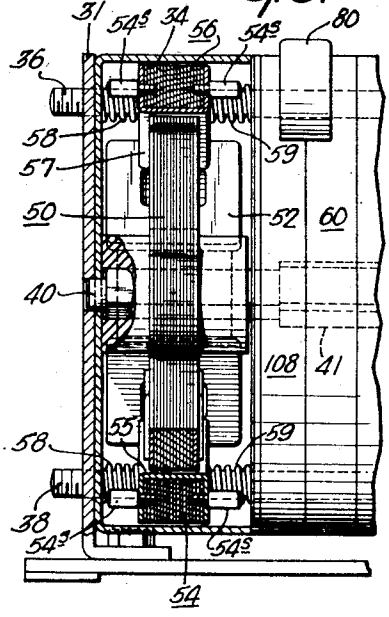
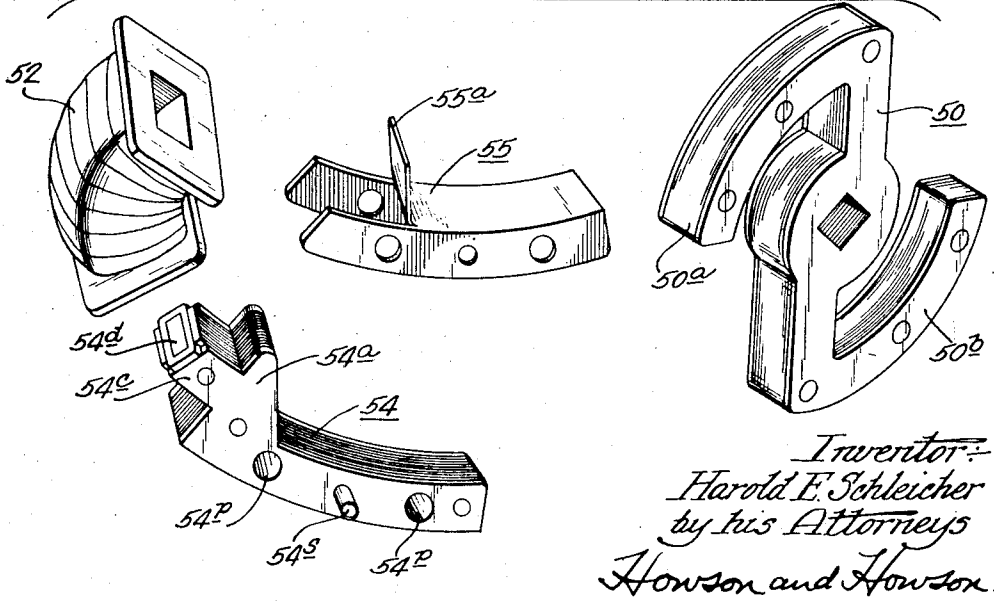


FIG. 6.

FIG. 7.



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UNITED STATES PATENT OFFICE

2,563,495

ELECTROMAGNETIC OPERATING MEANS FOR ROTARY ELECTRIC SWITCHES AND OTHER DEVICES

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Original application November 26, 1943, Serial No. 511,855. Divided and this application September 18, 1950, Serial No. 185,422

14 Claims. (Cl. 175—336)

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This invention relates to electromagnetic operating means for electromagnetically operated circuit makers and breakers and other uses, capable of operation locally, or by remote control if desired.

Modern battle conditions require electrical control apparatus to withstand high impact shocks, the shock test requirements having recently been increased more than tenfold. Attempts heretofore to meet the test requirements involved the addition of counterweights, inertia hammers, special brush-type contacts, etc. to existing conventional commercial structures. These have proved unsatisfactory under the new requirements. A new approach to the problem was needed to produce a scientifically designed device in which the movable parts would be dynamically and statically balanced.

It is an object of the present invention to provide an electromagnetic operating means for a circuit maker and breaker, and other devices, designed to withstand high impact tests by providing for dynamic and static balance of its movable parts. A related object is to provide an improved design of electromagnetic operating means requiring a minimum amount of energy to produce initial and succeeding movement and to maintain the mechanism in closed position.

Another object is to provide improved electromagnetic operating means for an electric switch or other device which can be mounted in any position without entailing increased energy consumption in its operation to overcome gravity, heavy biasing springs, or the like, and which requires less energy under any conditions than prior devices for similar usage.

Another object is to provide an electromagnetic operating means for a switch or other device which will have a more uniform pull on its armature, a higher sealing pull, with quieter operation and less wattage loss in alternating current use.

Another object is to provide an electromagnetic operating means for a switch or other device for the use of dual magnet coils to enable, optionally, the use of the device on different voltages.

Other objects of the invention will become apparent as the invention is described in connection with the drawings.

This application is a division of my co-pending application, Serial No. 511,855, filed November 26, 1943, entitled "Rotary Magnetic Switch," Patent 2,540,294.

Although useful in circuit interrupters and in military fields because of its peculiar advantages, the invention is nevertheless useful in a wide variety of other domestic situations.

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In the drawings:

Fig. 1 is a perspective view of a device embodying the invention;

Fig. 2 is a side elevation view of the device of Fig. 1;

Fig. 3 is an exploded perspective view of certain parts employed in the device of Figs. 1 and 2;

Fig. 4 is an elevational section view taken along line 4—4 of Fig. 2;

Fig. 5 is a plan view of the electromagnetic structure which is located within the forward end of the device in Fig. 1, the housing being removed;

Fig. 6 is a vertical section view taken along line 6—6 of Fig. 4;

Fig. 7 is an exploded perspective view of certain parts of the electromagnetic structure;

Fig. 8 is a section view of the spring biasing structure for the main shaft.

Referring to the drawings, the main switch contacts, certain control circuit contacts and electromagnetic operating mechanism therefor are housed within a cylindrical sectional casing, built up from molded insulating discs, 60, 102, 108, 112, 122, 130 and a metal shell 34, all of which are ultimately supported from a base plate 30 by means of the mounting plates 31 and 32 bolted on said base plate and extending at right angles to the face thereof. The immediate support for the casing sections is four spaced parallel rods 36, 37, 38, 39 (Figs. 2, 3 and others) running between and supported by mounting plates 31, 32. Holes are formed in each of the parts that make up the casing so they may be slid on the rods.

The device may be conveniently considered as comprising a number of sections or units. Referring to Fig. 2, in the section A at the left end is the electromagnetic operating means, the electric terminal connections for which extend through the left end cover or cap plate 33, which may conveniently be made of molded insulating material and secured against the face of the mounting plate 31 by screw bolts.

In the section B are a switch and its manual operating means for local control of operation of the device.

In the sections C, D and E are the main circuit making and breaking contacts for the three lines of a three-wire power system. However, the invention is applicable equally to the making and breaking of any number of lines, the three line form having been chosen for illustration as a

preferred embodiment because of its common usage. Each section includes a pair of fixed contacts and a movable bridging contact structure, hereinafter more fully described.

In section F are located the overload protective devices.

The movable bridging contact structure and the movable portion of the electromagnetic operating mechanism are mounted upon a main shaft 40 (Figs. 3, 4, 6) whose axis is the main axis of the device. The main shaft 40 has its end journalled in and supported by the mounting plates 31 and 32.

The electromagnetic operating means

The parts of the electromagnetic operating means are protected by and located within a two-part magnetic sheet metal housing (Figs. 1, 2, 6). One part 34 has a cylindrical wall and an integral end wall. The other part 35 is a sheet metal disc completely covering the open end of the part 34. The end wall of part 34 lies against the mounting plate 31 and both the end wall and cover plate 35 are apertured centrally for passage of the main shaft. Louvers 34*v* for ventilation may be formed in the cylindrical wall of part 34. As will presently appear, the housing 34, 35 completely surrounds the electromagnetic parts and is in close proximity thereto, providing a flux path around the coil sides.

Referring particularly to Figs. 3, 4 and 7, it will be observed that the laminated armature 50 of the electromagnet is substantially of Z-shape, with the oppositely directed ends of its arms 50*a*, 50*b* made arcuate. A square passageway is formed through the central portion of the armature to enable it to be slid upon and to turn with the mainshaft 40, which, also, is square in section. The nature of the armature structure is such that the armature is dynamically balanced upon the main shaft so that it possesses dynamic and static equilibrium at all times, eliminating, for all practical considerations, tendency for the armature and shaft to turn, unless acted on by a force such as an electromagnetism.

The curved end portions 50*a*, 50*b* of the armature are adapted to move in and out of the hollow circumferential cores of toroidal solenoid coils 52, 53 positioned diametrically opposite each other about the main shaft 40. These coils may be connected electrically either in series or in parallel. In case of use, for example, on a 220 volt 3-wire line, if the coils are each 110 volt coils, they may be connected in series across the 220-volt lines; or they may be connected in parallel between the neutral and one outside line, supplying 110 volts. Alternatively, the coils may have dual windings, each winding comprising a 110-volt coil which may be connected in series or in parallel with its neighbor, in a manner similar to that just described, and in series or parallel with the opposite dual coil. In any case, the electromagnetic effect of the coils will be cumulative, creating a greater force and a more uniform pull on the armature than a single coil.

Cooperating with the coils 52 and 53 are pole pieces (designated as a whole by 54 and 56) made up of laminated magnetic material. These pole pieces are identical and are generally arcuate in form, being enlarged near one end as at 54*a* and having an arcuate extension such as 54*c* concentric with but of less radius than the main portion of the pole piece. The extension 54*c* and 56*c* extend into one end of each of the coils 52 and 53, while the main portions of the pole pieces

bridge the air gap between the ends of the coils 52 and 53, said portions lying just beyond but closely adjacent the paths of movement of the arcuate portions 50*a* and 50*b* of the armature. Lying against the inner face of the pole pieces are non-magnetic shield or liner members 55 and 57. These shield members are channelled in shape and arcuate in form to fit around the inner and side faces of the pole piece which they shield. They may be affixed to the pole pieces by riveting. A tongue, such as 55*a*, is bent inwardly toward the axis of the armature adjacent one end of each shield member, so as to lie along the inclined surface of the enlargement 54*a* of the pole piece. When the armature is returned to inactive position by a spring, as hereinafter described, upon deenergization of the coil of the magnet the back side of its radial arms will abut the tongue 55*a*, preventing the armature from sticking to the pole piece. The liners also provide a momentary time delay while the flux field is building up to strength needed for moving the armature. This and the non-sticking feature insure that the initial pull on the armature will be unopposed by the armature itself.

To fix the pole pieces and the coil in position resiliently, circular apertures, such as 54*p*, are provided in the arcuate portions of the pole pieces to enable the pole pieces to be mounted on the mounting rods 36—39, inclusive. As illustrated, the pole piece 56 is mounted upon the rods 36 and 37. To position or space the pole pieces, small coiled compression springs 58 are mounted on the rods, between the pole pieces and the inner surface of that portion of the housing which lies against the plate 31; and on the opposite side of the pole piece, similar small compression springs 58 (also mounted upon the mounting rods) lie between the pole pieces and the next adjacent section B.

To allow limited, but to prevent excessive side thrust of the pole pieces, stud pins such as 54*s* are attached to the opposite side faces thereof and are engageable with the side walls of the enclosure in which the magnet is housed.

From the foregoing it may be observed that as the coils are energized a magnetic field will be set up and will be concentrated at the ends of the coils in the pole pieces and concentrated in the oscillatory path of the armature, reducing losses to a minimum. The force of the magnetic field will draw the arcuate portion of the armature into the coil and against the faces 54*d*, 56*d* of the extension 54*c*, 56*c*. (These faces may conveniently be provided with shading coils in the conventional manner.) Upon deenergization of the coils, the armature will be retracted to its original position by spring means hereinafter to be described. The oscillatory movement of the armature is communicated to the main shaft of the device because the shaft is of the square section. An insulating sleeve 41 is provided to insulate the shaft from all the parts it carries.

To return the shaft 40 to the position normally occupied when the electromagnet is deenergized, a flat coil spring 42 (Fig. 3) is placed around the end of the shaft near mounting plate 32, between a spring-tension and stop member 44 and an anchor member 45. The stop and spring tensioning member is a small sheet metal stamping of irregular shape (see Fig. 3) with a square aperture for the square main shaft 40 and spaced, laterally bent, radially extending stop lugs 44*a* which are adapted to butt against a circular stud

or pin 46 extending from the mounting plate 32 as the shaft 40 oscillates. On the opposite side of the member at its periphery is a spring tensioning lug 44c bent normal to the member and embraced by the ends of the coil spring 42. Also embraced by these coil spring ends is a similar lug 45c on the stationary anchor member 45. The anchor member 45 is a small sheet metal disc-shaped stamping with a keyhole aperture which interengages with a circumferential groove 40g in the end of the shaft 40 to hold the shaft against axial movement but permit its rotation when the anchor member is fixedly secured within a countersunk recess 32r in the mounting plate 32.

The stop plate or member 44 has its travel limited in both open and closed contact positions. The stoppage in the closed position enables the armature and magnets to align themselves freely; otherwise the magnets would be forced against the mounting rods and prevented from assuming natural adjustment.

In considering the functions, advantages and novel features, the following should be noted:

Long angular rotation of the armature is one of the factors desirable for securing a high interrupting gap of the contacts for direct current ratings without resorting to condensors or blow out coils. In the present invention the air gap of the armature can be regulated to any intermediate position to suit various interrupting characteristics by governing the location of the stop-plate lugs 44a. On maximum stroke the armature moves within that portion of the solenoid that produces the maximum constant magnetic force value with a minimum of inrush current.

Being totally enclosed the movable parts are protected against tampering, atmospheric conditions, and the like.

From the foregoing it will be observed that all movable parts are in balanced condition in both open and closed positions. Since the return spring 42 which normally would move the parts to open position, is overcome by the electromagnet while the latter is energized, there is no tendency by weight, bias, or location of the movable parts, to move when the whole device is suddenly subjected to shock or violent motion. The balance of the parts and condition of equilibrium avoids such tendency. At the same time it provides a more easily operable device, requiring less power with better holding qualifications.

Many modifications within the scope of the invention will occur to those skilled in the art. Therefore I do not limit the invention to the embodiment disclosed.

I claim:

1. An electromagnet comprising a rotary armature, circumferentially curved arms thereon, oppositely positioned pole pieces having circumferentially curved portions adjacent said curved arms, oppositely positioned electromagnet coils having arcuate hollow cores to receive said arms, said pole pieces having extensions entering the ends of said coils, and said pole pieces extending between the ends of the opposite coils to concentrate the magnetic force and completing a substantially circular flux path.

2. An electromagnet comprising a rotary armature, oppositely located arcuate arms on said armature, arcuate magnetic pole pieces lying outside the arc of movement of said arms but adjacent thereto, arcuate electromagnet coils oppositely located having hollow circumferential cores, said pole pieces lying between the ends of opposite coils completing a substantially circular flux path, each pole piece having an extension entering the end of a coil.

3. An electromagnet comprising a rotary armature, oppositely located arcuate arms on said armature, arcuate magnetic pole pieces lying outside the arc of movement of said arms but adjacent thereto, arcuate electromagnet coils oppositely located, said pole pieces lying between the ends of opposite coils completing a substantially circular flux path, each pole piece having an extension entering the end of a coil, and means to resiliently mount said pole pieces and permitting limited lateral movement for adjustment of the faces of said arms and pole pieces.

4. An electromagnet comprising a rotary armature dynamically and statically balanced for the purpose of avoiding a tendency to move from a given position when the electromagnet is subjected to shock or motion, said armature having oppositely extending counterbalancing arms with circumferentially curved end portions, electromagnet coils having arcuate open end cores to receive said arms, magnetic pole pieces adjacent the arcs of travel of said arms and positioned between the ends of opposite coils and completing a substantially circular flux path.

5. An electromagnet comprising a rotary armature dynamically and statically balanced for the purpose of avoiding a tendency to move from a given position when the electromagnet is subjected to shock or motion, said armature having oppositely extending counterbalancing arms with circumferentially curved end portions, electromagnet coils having arcuate open-end cores to receive said arms, magnetic pole pieces adjacent the arcs of travel of said arms and positioned between the ends of opposite coils, and non-magnetic channel shaped metallic pole piece liners each having an extending portion forming an abutment for said armature to prevent sticking to said pole pieces.

6. An electromagnet comprising a rotary armature dynamically and statically balanced for the purpose of avoiding a tendency to move from a given position when the electromagnet is subjected to shock or motion, said armature having oppositely extending counterbalancing arms with circumferentially curved end portions, electromagnet coils having arcuate open-end cores to receive said arms, magnetic pole pieces adjacent the arcs of travel of said arms and positioned between the ends of opposite coils, and means to resiliently and floatingly mount said pole pieces in a predetermined position to permit limited lateral movement for self-adjustment between the faces of the pole pieces and the armature.

7. An electromagnet comprising a rotary armature dynamically and statically balanced for the purpose of avoiding a tendency to move from a given position when the electromagnet is subjected to shock or motion, said armature having oppositely extending counterbalancing arms with circumferentially curved end portions, electromagnet coils having arcuate open-end cores to receive said arms, magnetic pole pieces adjacent the arcs of travel of said arms and positioned between the ends of opposite coils, non-magnetic pole piece liners each having an extending portion forming an abutment for said armature to prevent sticking to said pole pieces, and means to resiliently and floatingly mount said pole pieces in a predetermined position to permit limited lateral movement for self-adjustment be-

tween the faces of the pole pieces and the armature.

8. An electromagnet comprising a rotary armature dynamically and statically balanced for the purpose of avoiding a tendency to move from a given position when the electromagnet is subjected to shock or motion, said armature having oppositely extending counterbalancing arms with circumferentially curved portions, electromagnet coils having arcuate open-end cores to receive said arms, magnetic pole pieces adjacent the arcs of travel of said arms and positioned between the ends of opposite coils, and channel shaped, non-magnetic channel shaped metallic liners on each pole piece partially enclosing each, and an abutment extending from each pole piece forming a stop and preventing sticking of the armature to said pole pieces.

9. An electromagnet comprising a rotary armature dynamically and statically balanced for the purpose of avoiding a tendency to move from a given position when the electromagnet is subjected to shock or motion, said armature having oppositely extending counterbalancing arms with circumferentially curved end portions, electromagnet coils having arcuate open end cores to receive said arms, magnetic pole pieces adjacent the arcs of travel of said arms and positioned between the ends of opposite coils, a plurality of parallel rods for supporting said pole pieces and coils, and resilient means holding said pole pieces in predetermined positions on said rods.

10. An electromagnet comprising a rotary armature dynamically and statically balanced for the purpose of avoiding a tendency to move from a given position when the electromagnet is subjected to shock or motion, said armature having oppositely extending counterbalancing arms with circumferentially curved end portions, electromagnet coils having arcuate open-end cores to receive said arms, magnetic pole pieces adjacent the arcs of travel of said arms and positioned between the ends of opposite coils, a plurality of parallel rods for supporting said pole pieces and coils, resilient means holding said pole pieces in predetermined positions on said rods, and means to limit the movement permitted of said pole pieces on said rods beyond the requirement for self-adjustment of the faces of said pole pieces and armature arms.

11. An electromagnet comprising a rotary shaft, field pieces, a rotary armature mounted on said shaft adapted to abut said field pieces to provide a sealing type of electromagnet, toroidal electromagnet coils having hollow circumferential cores, arms on said armature adapted to enter said coils on energization thereof, said energization causing rotary motion of said armature and shaft, and said field pieces being located adjacent the arcs of movement of said arms, and together with said arms forming a substantially complete circular pattern of magnetic metal for the magnetic flux in energized position of said armature.

12. An electromagnet comprising a rotary shaft, a rotary armature mounted on said shaft, toroidal

hollow electromagnet coils, arms on said armature adapted to enter said coils on energization thereof, said energization causing rotary motion of said armature and shaft, and magnetic pole pieces adjacent the arcs of movement of said arms and positioned between the ends of opposite coils to concentrate the magnetic flux and complete a substantially circular flux path, and means to resiliently mount said pole pieces permitting self-adjustment of the faces of the pole pieces and armature.

13. In an electromagnet, a rotary armature having radial arms with arcuate end portions, arcuate field pieces concentric with said arcuate end portions, toroidal coils into which said end portions enter when said coils are energized, said toroidal coils having hollow circumferential cores, said end portions and said field pieces forming a substantially continuous path through magnetic metal in energized position of said armature, and said coils, armature ends and field pieces being arranged in a continuous circular pattern and mutually contributing to the flux structure of one another.

14. In an electromagnet, a unitary rotary armature, arcuate coil and field piece means, and means for non-rigidly mounting said field piece means with relation to said armature enabling self-adjustment between them, said armature means having arcuate portions which in deenergized position cooperate with said field piece means and with said coils forming a complete circular flux path, said arcuate arm portions and said field piece means forming a substantially complete circular path through magnetic metal in energized position.

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