Aug. 25, 1942. F. A. ZUPA 2,294,327

ELECTROMAGNETIC RELAY

Filed May 17, 1940

FIG. 1

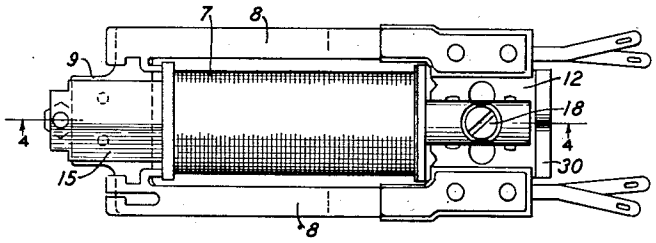


FIG. 2

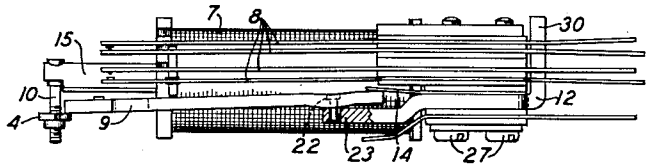


FIG. 3

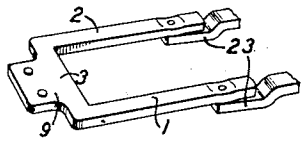


FIG. 4

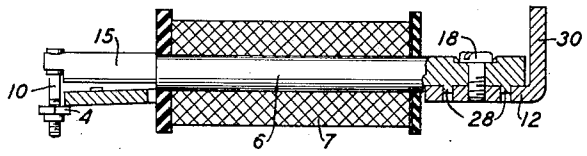


FIG. 5

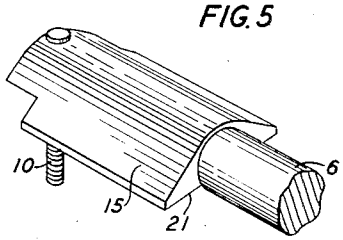
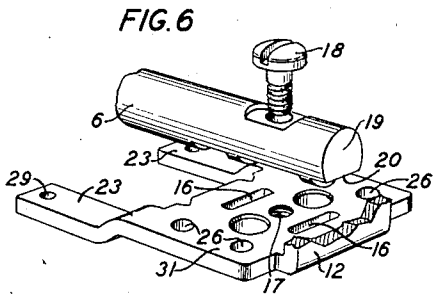


FIG. 6



INVENTOR
F. A. ZUPA

BY
P. C. Smith

ATTORNEY

Patented Aug. 25, 1942

2,294,327

UNITED STATES PATENT OFFICE

2,294,327

ELECTROMAGNETIC RELAY

Frank A. Zupa, New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 17, 1940, Serial No. 335,723

1 Claim. (Cl. 175—336)

This invention relates to electromagnetic switching devices and particularly to electromagnetic relays that have a high magnetic efficiency in order to secure positive operation on small power input and a low magnetic retentivity in order to insure positive release on a high percentage of the operating power.

In electric circuits generally and in telephone circuits particularly, the electromagnetic relay is extensively employed, and in such circuits the functions it performs are numerous and varied. Since the advent of automatic telephony and the consequent increase in the multiplicity and complexity of switching circuits, contact spring loads for relays have been progressively increasing to provide for the operation of a larger number of interrelated circuit networks which, in turn, have necessitated a relay structure with a degree of mechanical perfection and magnetic efficiency capable of functioning the heavy spring loads that such circuits require, said increased load resulting from an increase in the number of contact springs on the relay and also from an increase in the contact pressure on individual springs to insure greater contact reliability.

It is the object of this invention to provide an electromagnetic relay of sturdy mechanical structure and improved magnetic design that will permit it to be used in different types of circuits as, for instance, a straight switching relay in which a high magnetic efficiency is required to permit operation on lower current values relative to spring loads than heretofore, and, as a supervisory relay, in which a low magnetic retentivity is required to insure release against higher current values usually present in supervisory circuits. In other words, the object of the invention is to produce a relay which, in relation to its load, is efficient in both operation and release.

The invention will be readily understood from the following detailed description made with reference to the accompanying drawing, in which:

Fig. 1 is a top plan view of a relay structure embodying the features of this invention;

Fig. 2 is a side elevation of the relay shown in Fig. 1;

Fig. 3 is a perspective elevation of the relay armature and the supporting portions of the supporting bracket therefor;

Fig. 4 is a cross-sectional side elevation of the relay shown in Fig. 1 taken along the line 4—4 without the contact carrying springs;

Fig. 5 is a perspective view of the pole face end of the core; while

Fig. 6 shows the end portion of the core in relation to its disposition upon the armature bracket.

The relay disclosed in the drawing consists of the well-known essential parts, namely, a core 6 preferably of cylindrical cross-section, an energizing coil 7 mounted thereon, spring pile-ups 8, a U-shaped armature 9, a cooperating U-shaped mounting bracket 12, and the armature backstop adjusting device 10. The core 6 has a rear end portion 19 provided with a flat bottom surface 20 from which two suitably spaced tapered ridges 28 extend and between which is an aperture to receive the screw 18. The tapered ridges fit tightly into corresponding slots 16 in the mounting bracket.

The pole-piece 15, disposed at the opposite end of the core, may be integral with the rest of the core or it may be a separate piece which may be produced independently of the core and subsequently welded or otherwise secured thereto. The pole-piece may be arcuately shaped with an end portion of its under-side cut away to provide space for the adjusting device 10, and a pole face 21 of substantially rectangular configuration having a width substantially two and a half times the diameter of the core and a length of about a quarter the length of said core. These dimensions are given by way of example only to stress the fact that in the relay of my invention the pole face is large relative to the pole face obtained on the usual flat type relay structure. As said before, the pole-piece 15 may be made integrally with or separately from the rest of the core and in the latter event, suitably secured to it in any known manner so as to form a path of very low magnetic reluctance at the juncture.

The bracket 12 is substantially U-shaped, having an end portion 30 which is provided with suitable apertures (not shown) for receiving screws by which the relay structure may be secured to a relay rack, a cross-reach 31 and two offset legs 23. Perpendicular to the longitudinal axis of the bracket are two rectangular slots 16 and the threaded aperture 17 disposed therebetween. The slots 16 are for the reception of the tapered ridges 28 of the core and the aperture 17 is for the reception of the holding screw 18. When the core is fitted upon the supporting bracket 12, the two ridges 28 are inserted into the slots 16 with which they make a tight fit, and the screw 18 is driven securely through the aperture 17. On either side of the slots 16 and in alignment with the offset leg portions 23 are

two apertures 26 through which pass clamping screws 27 to secure the spring pile-ups 8. At each end of the two offset leg portions 23 are apertures 29 which are provided for the reception of a pin 22 on each leg of the armature as hereinafter set forth.

The armature 9 is substantially a U-shaped structure having the two legs 1 and 2 joined by the rectangular cross-piece 3 which has an area slightly in excess of that necessary to cover the pole face area 21 of the pole-piece, the front end being adapted, when the armature is in position, to move freely within space provided by the adjusting device 10 and to rest, when in a released condition, against the nut 4 thereof. Near the end of each of the two armature legs 1 and 2 are the pins 22 which are adapted to fit loosely in the apertures 29 of the bracket legs 23.

The armature rests upon the bracket 12, being loosely secured thereto by the pins 22 which are firmly attached to each leg of the armature and fit into apertures 29 provided for the reception of the same in each of the offset legs 23 of the bracket 12. Clamped over each leg of the supporting bracket, between the spring pile-up 8 and the upper face of each of said legs, is a spring reed 14 of magnetic material the free end of which engages with and rests upon the end of the armature leg. Each spring reed holds the armature flexibly secure in its position of rest against the bracket leg and partially prevents the armature from being lifted from said legs by the momentum acquired in its motion of operating or releasing. The reason for the application of this partial spring brake against the rear end motion of the armature, some of which it must have to prevent a chattering of the contact points as set forth in Patent 2,178,656 granted to Paul W. Swenson on November 7, 1939, appears hereinafter in the description of the operation of the relay.

The relay carries two sets of spring assemblies 8, one on each side of the core, each assembly, with suitable insulating spacers, being clamped by screws 27 passing through the threaded holes 26 on each side of the bracket 12.

Having thus described the physical elements of my improved relay, I will now consider those aspects of the design of its various parts which are effective in producing a relay that has a high magnetic efficiency on operation and a low magnetic retentivity on release.

In respect to high magnetic efficiency, it is necessary, of course, to provide a magnetic circuit of low magnetic reluctance, and to this end all unnecessary air-gaps have been avoided and all leakage paths have been reduced to a minimum. Thus the spring reeds 14, besides counter-balancing some of the spring load against the armature when the relay is in an unoperated position, further maintain closed gaps between the legs of armature 9 and the bracket legs 23, thereby avoiding any break in the continuity of the magnetic path therebetween and contributing thereby to higher operating efficiency. The magnetic reluctance is further reduced by the large pole face area 21 at the working gap which, in combination with the large area of the pole face of the armature provides a large flux path at the area of contact while the arcuate shaping of the pole-piece 15 provides a minimum surface outside of the pole gap through which flux can leak off. Thus the amount of useful flux at the pole gap is increased while the amount of leakage flux is reduced.

In the fully operated position of the armature, the large pole face acts to lower the holding efficiency because the total flux in the magnetic circuit at the point of release results in a lower flux density at the pole gap. Since the pull at the pole faces varies directly as the square of the flux density in the pole gap, the above reduction in flux density more than offsets the gain in flux in the magnetic circuit due to the lower reluctance of the pole gap. This relation obtains because the reluctance of the pole gap in the operated position is small compared to the total reluctance of relay magnetic circuit. The poorer holding efficiency, therefore, results in the higher release condition which is desired.

It is evident, therefore, that the larger pole face results in more pull at the higher open gaps and less pull at the lower air-gaps. This represents a very desirable condition because, from a circuit standpoint, a relay should operate on as low a current as possible and release on as high a current as possible.

The operating load of the contact springs against the armature is partially neutralized by the reed springs 14. On relays designed to operate on low current, the forces against the armature must necessarily be made as small as possible. Reliable contact performance, however, requires greater forces. The reed springs provide both.

What is claimed is:

In a relay, the combination of a core, a pole-piece having a substantially triangular cross section and a rectangular pole face having a length and width both of the order of twice the diameter of said core, said pole-piece affixed to the forward end of said core, a U-shaped bracket secured to the rearward end of said core having a pair of legs constituting fulcrum bearing surfaces for the legs of an armature, relatively long springs mounted on the ends of said bracket over the legs thereof, a U-shaped armature having a pole face corresponding in size to the said pole face of said core and a pair of legs each embossed near its free extremity with a rocker-like formation constituting a fulcrum for cooperation with the corresponding leg of said bracket, said armature near the pole face thereof having bearing surfaces on the legs thereof for operating the said relatively long springs, and a relatively short reed spring supported on each leg of said bracket underneath each of said relatively long springs and bearing with its free end against the free end of the corresponding leg of said armature, the pressure points of said relatively long springs and said relatively short springs being located at opposite sides of said fulcrum points, the pressures being additively applied in a direction to provide positive magnetic contact between the legs of said bracket and the legs of said armature, but differentially opposed to the operation of the said armature upon the energization of the magnet.

FRANK A. ZUPA.