April 30, 1957 A. F. HORLACHER 2,790,939

RELAY

Filed June 6, 1951 2 Sheets-Sheet 1

Fig. 1.

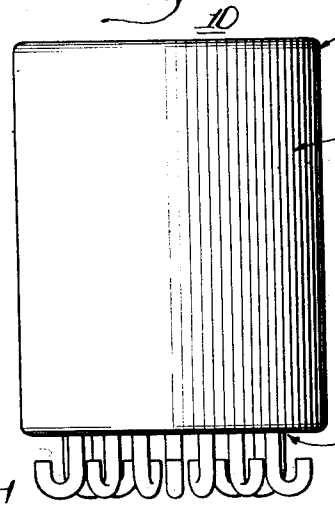


Fig. 2.

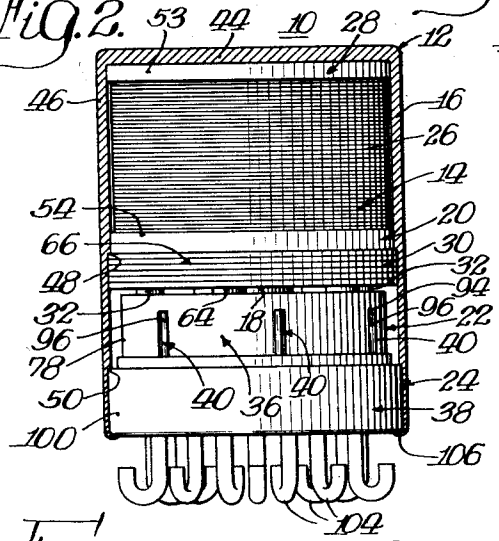


Fig. 3.

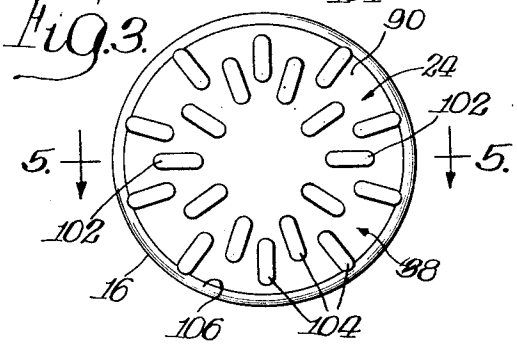
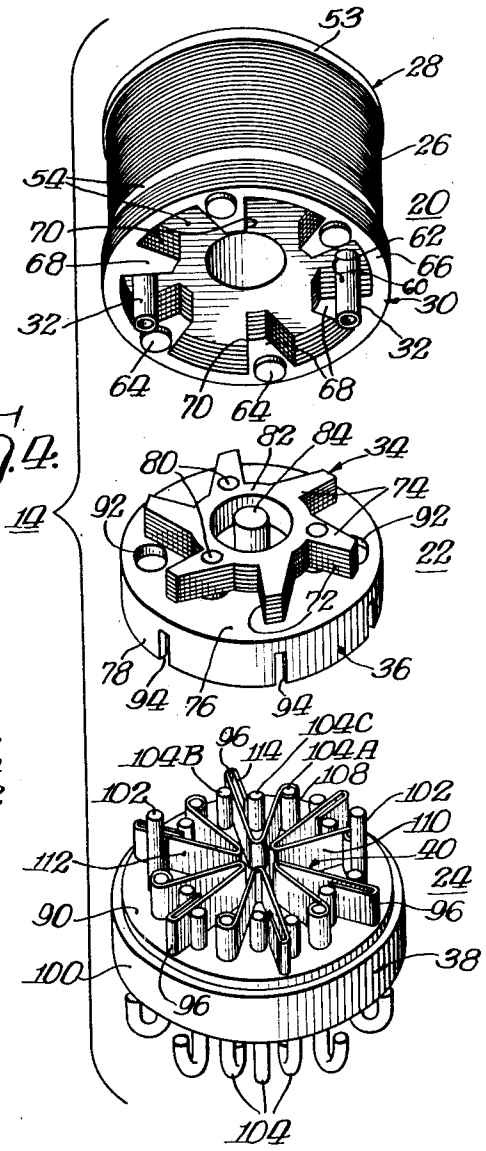


Fig. 4.



INVENTOR.
Albert F. Horlacher,
BY
Mason, Kolehmainen, Rathburn & Wyss Attys.

April 30, 1957 A. F. HORLACHER 2,790,939

RELAY

Filed June 6, 1951 2 Sheets-Sheet 2

Fig. 5.

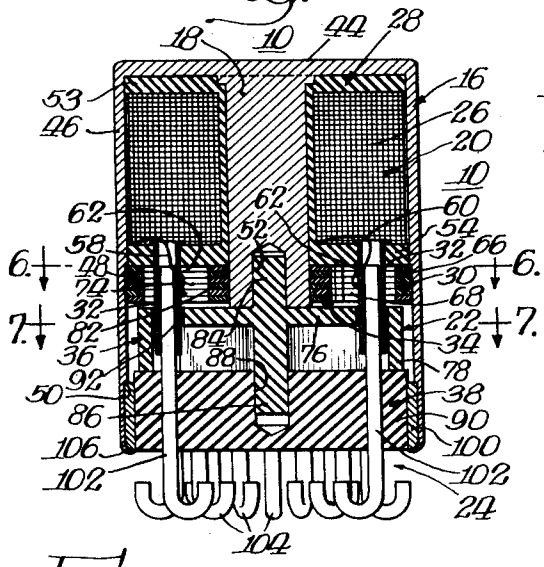


Fig. 8.

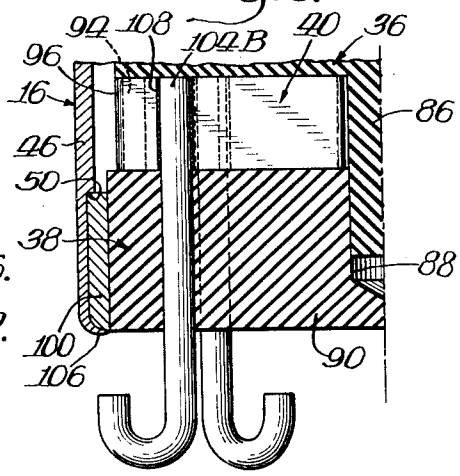


Fig. 6.

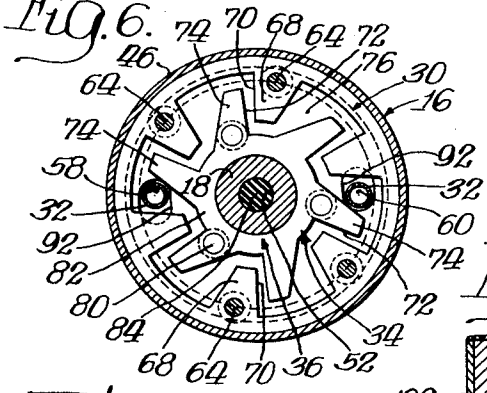


Fig. 9.

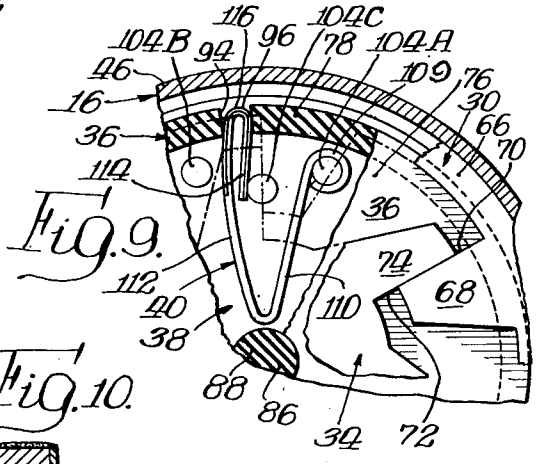


Fig. 7.

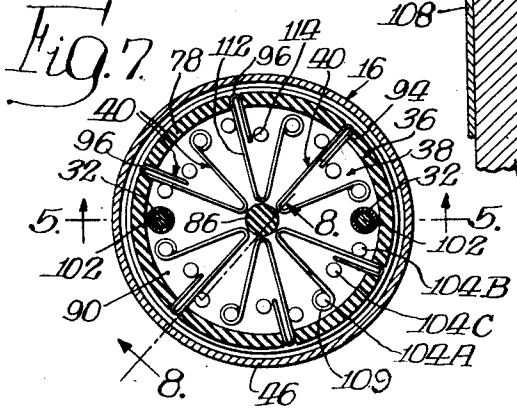
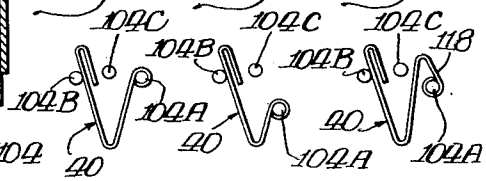


Fig. 10.

Fig. 11. Fig. 12. Fig. 13.



INVENTOR.
Albert F. Horlacher,
BY
Mason, Kolehmainen, Rathburn & Wyss Attys.

United States Patent Office

2,790,939

Patented Apr. 30, 1957

2,790,939

RELAY

Albert F. Horlacher, Palatine, Ill., assignor to C. P. Clare & Co., Chicago, Ill., a corporation of Illinois

Application June 6, 1951, Serial No. 230,169

9 Claims. (Cl. 317—197)

The present invention relates to electric relays and more particularly to an improved relay which is especially suitable for use in applications where the relay is subjected to shock and considerable vibration and may be required to be operated by small currents and over a wide temperature range, but which relay is of such construction that it may be used for other and general purposes.

Many efforts have heretofore been made to devise relays for use in installations in which vibration is prevalent, of which aircraft installations may be considered typical. The results have not been entirely satisfactory because of the complexity of the relays and because, while the relays may have been satisfactory for the purpose for which they were specifically designed, they were not satisfactory for other and more general purposes.

It is an object, therefore, of the present invention to provide a new and improved relay which is simple and economical to construct and assemble, reliable in operation over a wide temperature range including temperatures up to about 200° C. and which is small and compact, but which is substantially insensitive to vibrations and shocks of various sorts.

A further object of the present invention is to provide a relay which can readily be sealed in a container to render it immune to moisture, injurious elements, etc., whereby its field of use is expanded and its operating life is increased.

Another object of the present invention is to provide a new and improved balanced relay which can be placed in practically any desired position and which will operate satisfactorily in response to operating current but which will not operate in response to vibration and shocks.

Another object of the present invention is to provide a new and improved relay of the rotary type which is small, compact, rugged and yet efficient in operation.

A still further object of the present invention is to provide a new and improved relay of what may be termed multi-polar type including a stator element having a plurality of angularly spaced apart polar portions and a rotor or armature having a like number and similarly spaced apart polar portions.

Another object of the present invention is the provision of a new and improved relay of the rotary type including a plurality of circularly arranged circuit controlling movable contacts that are constructed so as to enable a comparatively large number to be located in a small space, and furthermore, wherein said contacts are of unique construction giving them good deflectibility and follow through.

Still another object of the present invention is the provision of a new and improved relay wherein the coil and stator, the armature or rotor, and the movable contacts and associated stationary terminals each constitute a subassembly, which subassemblies can readily be assembled and then inserted into a core supporting housing forming part of the magnetic flux path.

A further object of the present invention is the provision of a new and improved relay of the rotary type having an efficient magnetic circuit and comprising a small, compact structure including a housing of magnetic material, an annular stator fitting closely within the housing and including a plurality of angularly spaced apart polar portions, and a rotor concentrically and movably mounted inside of the stator.

In brief, the relay of the present invention comprises two readily assembled units, one of which includes an axially extending magnetic core and the second includes three subassemblies. The latter are, first, the coil, its bobbin and the stator; second, the rotor and contact actuator; and third, the movable contacts, which are resilient and movable by the actuator, a base adapted hermetically to be sealed relative to the housing, and a plurality of contact pins extending through the base.

The coil has its end portions connected to tubular coil terminals mounted on the bobbin. These terminals are utilized to orientate the base and actuator assembly relative to the stator. The movable contacts are constructed and arranged so that a comparatively large number can be located within a very small space. They are generally V-shaped in configuration, one end of each being fixedly secured to an axially extending contact pin located some distance from the center of the base. The opposite end is reversely bent for cooperative engagement with a normally open contact. The outer portion of each contact extends radially outwardly beyond the stationary contact pins and into slots in the actuator, whereby the actuator is readily operatively connected to the contacts.

The actuator includes oppositely extending shaft portions, one of which fits into a counterbore in the core and the other into a counterbore in the base, whereby effective operation of the moving parts of the relay is insured.

Other objects and advantages of the present invention will become apparent from the ensuing description of an illustrative embodiment thereof, in the course of which reference is had to the accompanying drawings in which,

Fig. 1 is a side elevational view of the relay of the present invention;

Fig. 2 is a side elevation of the relay with the housing shown in axial cross section;

Fig. 3 is an end view showing primarily the terminal ends of the contact pins and the base structure;

Fig. 4 is an exploded perspective view of the three subassemblies constituting all of the relay except the housing and core.

Fig. 5 is an axial cross section through the relay taken along line 5—5 of Figs. 3 and 7;

Fig. 6 is a diametrical cross sectional view taken along the line 6—6 of Fig. 5;

Fig. 7 is a diametrical cross section taken along the line 7—7 of Fig. 5;

Fig. 8 is an enlarged fragmentary axial cross sectional view taken along the broken line 8—8 of Fig. 7;

Fig. 9 is an enlarged fragmentary diametrical cross sectional view illustrating primarily the operation of the contacts and showing their position when the relay is energized or operated;

Fig. 10 is an axial cross section through one of the stationary contacts of the relay;

Figs. 11 to 13 inclusive, are fragmentary somewhat diagrammatic views illustrating other contact arrangements which may be used.

Referring now to the drawings, it may be noted that the relay of the present invention is illustrated in its entirety by the reference character 10. It comprises, as may be best noted from Figs. 1, 2 and 5, two units of construction 12 and 14. Unit 12 consists of a housing 16

and a core 18. Unit 14 consists of the remainder of the relay and includes three subassemblies 20, 22 and 24 as best illustrated in Fig. 4. The construction and arrangement is such that the unit 14 can be assembled and tested prior to insertion into the housing whereby manufacture is considerably expedited.

The subassembly 20 consists of a coil 26 and its bobbin 28, a stator 30 and a pair of diametrically oppositely located tubular coil terminals 32. The subassembly 22 comprises, in the main, an armature or rotor 34 of magnetic material and a contact actuator 36. The subassembly 24 comprises, in the main, a terminal pin-base assembly 38 and a plurality of circuit controlling moveable contact elements 40.

The units and subassemblies, each of which includes novel features, will now be described in detail.

The unit 12 comprising the housing 16 and core 18, may be made from any desired magnetic material. The housing 16 comprises a circular end wall 44 and a tubular side wall 46 having a first internal annular shoulder 48 spaced some distance from the end wall for locating the subassembly 14, and a second internal shoulder 50 located near the open end of the housing for locating the subassembly 38, the location of these two subassemblies being such as to insure freedom of movement for the actuator subassembly 22. The core 18 is located axially of the container and projects a short distance beyond the shoulder 48. The core may be suitably fastened to the end wall, one convenient and effective way of doing so being by projection welding it to the inside of the end wall. The core 18 is provided at its free end with a counterbore 52 for a purpose which will be made clear hereinafter.

The stator-coil-bobbin subassembly 20 is constructed so that it can be slid into place over the core 18. It is dimensioned to fit closely in the housing. The inner rim 53 of the spool is imperforate while the outer rim 54 is secured to the tubular coil terminals 32 to which the ends of the coil, indicated by reference characters 58 and 60 are secured. The securing is accomplished by passing the ends of the coil through the inner ends of the terminals and thence out through small radial openings 62 in the terminals and securing, as by soldering, the exposed coil ends to the exterior of the terminals, as indicated in Figs. 4 and 5. The tubular coil terminals, in accordance with a feature of the present invention, are utilized for locating the parts of the unit 14, as will be brought out hereinafter.

The stator 30 comprising a series of laminations, is secured to the exterior of the rim 54 of bobbin 28 as by rivets 64. The stator has an outer circular rim 66 dimensioned closely to fit inside the housing and also to abut against the shoulder 48, thereby accurately to locate the subassembly 20 in place within the housing. The stator also has a series of angularly spaced apart inwardly projecting teeth or polar portions 68 of suitable configuration, but preferably with flat radial pole faces 70 located adjacent the like radial pole faces 72 on the polar portions 74 of the rotor 34. It may be noted that the coil terminals 32 extend some distance axially beyond the stator and pass through interpolar regions of the latter.

The rotor-actuator assembly 22, best illustrated in Figs. 4, 5 and 6, includes the rotor 34 and the actuator 36. The latter is preferably generally cup shaped with a circular end wall 76 and an axially extending side wall or rim 78. The rotor 34 is also preferably of laminated construction and it is secured to the end wall 76 as by the rivets 80. The polar portions 74 extend radially outwardly from what may be termed a hub portion 82. The dimensions of the stator and rotor are such as to provide an efficient magnetic circuit and the cooperating radially extending pole faces 70 and 72 are dimensioned to give a uniform cross section for the flow of magnetic flux for the particular spatial configuration. An efficient magnetic circuit of small dimensions in thus provided.

The arrangement of the stator, rotor, core and housing is thus such that the rotor is moved a short distance by magnetically efficient means whenever the coil 26 is energized. The flux is distributed uniformly around the housing and to the polar portions and the arrangement of the latter is such as to impart an effective turning torque to the rotor. As will be described hereinafter, the rotation of the rotor is utilized to effect movement of the movable contacts 40.

In order to insure ease of movement of the rotor-actuator subassembly, the latter is provided with oppositely extending shaft portions 84 and 86, the former of which is journaled in the counterbore 52 in the core and the latter of which is journaled in a counterbore 88 at the inside of a terminal carrying end or base plate 90 forming part of the terminal pin-base assembly. Additional to facilitate movement of the actuator, the latter is made of nylon. It will be noted also that the end wall 76 of the actuator is provided with diametrically opposed apertures 92 through which the tubular elements 32 extend. These openings are of a size to enable the actuator to move the requisite distance.

In accordance with another feature of the present invention, the actuator is operatively connected in a novel manner to the relay contacts which also are of a novel construction, providing adequate deflection and follow through of the contacts. The operative connection between the actuator and the contacts includes driving connections on the actuator comprising a series of angularly spaced apart axially extending slots 94 cooperatively associated with contact operating means, which preferably takes the form of reversely bent radially extending end portions 96 of the contacts now about to be described in connection with the subassembly 38.

The terminal pin-base subassembly 38 includes the base 90, a peripheral metallic band 100 secured to it in gas tight manner, a pair of terminal pins 102 adapted to be inserted into the tubular coil terminals 32 and a series of stationary contact pins 104, the contact terminals 102 and 104 passing through the base 90 and being secured therein in gas tight manner. For certain installations the base 90 may be made of Bakelite but if the interior of the relay is to be hermetically sealed it may be made of other materials. For example, it could be made of polymonochlorotrifluoroethylene thermosetting plastic commonly known as Kel F thermosetting plastic. It may, if desired, be made of glass or other available materials. The band 100 is secured to the base 90 and after the relay has been completely assembled the open end 106 of the housing is spun over and soldered or otherwise sealed to the band, see Figs. 2 and 5.

The inner ends of the contact pins 104 project within the interior of the cup-like actuator 36. If desired the contact terminals can be made from some precious or semi-precious contact material or they may be made from base material, such as brass, but the projecting contact ends may be provided with tubular or sleeve contact portions 108, as illustrated in Figs. 8 and 10.

In order to provide adequate deflectibility and follow through of the movable contacts, the latter are constructed and arranged in a novel manner best illustrated in Figs. 4, 7 and 9 to which reference is now had. First of all it may be noted that each of the contacts 40 consists of a relatively wide strip of flexible resilient material and that each has associated with it three of the stationary contact terminals 104. One, indicated by the reference character 104A, constitutes a stationary contact to which the movable contact 40 is secured. The end portion of the contact encircles substantially the entirety of contact 104A, as indicated by the reference character 109. The contact has a first portion 110 extending radially inwardly quite closely to the shaft portion 86 of the actuator. From there it continues with a portion 112 extending radially outwardly beyond the

outermost contacts **104** to form the previously referred to end portion **96** through which the contacts are operatively connected to the actuator. Finally, the movable contact includes a reversed inwardly extending portion **114**. The portion **112** is normally in engagement with an associated stationary contact **104B** and when the coil is energized and the relay operated, this engagement is discontinued and the portion **114** engages the contact **104C**, as best illustrated in Fig. 9.

It will be noted further that the contacts **104C** are positioned radially inwardly of the other contacts, this for the purpose of lengthening the reversely bent portion **114** to give added deflectibility and follow through when contact is made between portions **114** and **104C**. The arrangement furthermore is such that a maximum length of contact is located within the confines of a very small space.

In order to provide a good contact surface on the movable contacts **40** for engagement with the contacts **104B** and **104C**, the free ends of the contacts may be provided with contact surfaces of good contact material. For example, and referring to Fig. 9, the outer end of the contact is provided with a laminar contact defining portion **116** of good contact material.

While the contact arrangement described above is at present preferred, it should be understood that other arrangements can be used. Some of the arrangements that can be used have been illustrated in Figs. 11 to 13 inclusive. The arrangement of Fig. 11 is very much like that already described except that the contact **104C** is located at the same radial distance from the center as contact pin **104A** and contact **104B**. The arrangement of Fig. 12 is like that of Fig. 11 except that the contact pin **104A** is located nearer the center of the device.

The arrangement of Fig. 13 is like that of Fig. 12 except the movable contact is provided with an additional reversely extending portion **118** secured to the contact pin, thereby giving the contact additional length.

From the foregoing detailed description of the relay of the present invention it will be apparent that it can be constructed easily and simply and that it is efficient in operation and rugged in construction. Also the arrangement is such that, if desired, it can be hermetically sealed.

One of the features of the invention, as heretofore indicated, is that it consists of two units, one of which consists of a number of subassemblies, each of which can be easily constructed and all of which can readily be assembled. That the subassemblies **20**, **22** and **24** can readily be made is apparent particularly from Fig. 4. Likewise, they can readily be assembled for insertion into the housing as well as for testing prior to such insertion. In assembling the subassemblies, the actuator-rotor subassembly **22** is mounted on the contact pin-base subassembly **38**. This can be readily done by passing the coil terminal pins **102** through the openings **92** in the actuator, placing the contact end portions **96** into the respective slots **94**, and placing the shaft portion **86** into the counterbore **88** in the base **90**. These can be assembled relative to the stator and coil bobbin by inserting the coil terminal pins **102** into the tubular coil terminals **32**. The electrical connections to the coil are thus effectively made and once made the arrangement is such that the three parts are accurately and correctly assembled relative to each other. The arrangement is furthermore such that once the unit **14** has been assembled it can be readily placed into the housing in any angular position. Once placed into the housing, the end **106** of the housing can be spun over and sealed. Thereafter, the interior of the housing can be evacuated and, if desired, dry air or nitrogen can be inserted into the housing to provide an inert atmosphere therein.

The relay of the present invention is also very efficient and rugged. A low reluctance magnetic path is provided by the arrangement of the core, housing, stator and rotor, and the provision of a plurality of polar portions. Whenever the relay is to be operated, the coil **26** is provided with current and as a result the rotor moves so that the opposed pole faces **70** and **72**, stator and rotor move toward each other with the result that the actuator deflects the end portions **96** of the movable contacts from the normal position illustrated in Fig. 7 to the operated position illustrated in Fig. 9.

The contact construction is such as to provide considerable deflectibility and follow through even though the contacts are confined in a relatively small space. The relay is also operable over a wide temperature range and at relatively high temperatures.

While the present invention has been illustrated and disclosed in connection with the details of illustrative embodiments thereof, it should be understood that those are not intended to be limitative of the invention except as set forth in the accompanying claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A relay comprising structure defining a generally cup shaped housing, core defining structure extending coaxially from the closed end of said structure, stator structure within said housing defining a plurality of angularly spaced apart inwardly extending polar portions within said housing, rotor structure pivotally mounted within and located entirely within said housing for movement about the axis of said core and including a plurality of angularly spaced apart outwardly extending polar portions cooperatively associated with said first mentioned polar portions, a supporting shaft for said rotor, and means for movably supporting said rotor within said housing including a counterbore for one end of said shaft at the end of said core and base structure secured to said housing and having a counterbore for the other end of said shaft.

2. A relay comprising structure defining a generally cup shaped housing of magnetic material, core defining structure extending coaxially from the closed end of said structure, stator structure within said housing defining a plurality of pairs of angularly spaced apart radially inwardly extending stator polar portions in magnetic contact with and encircled by said housing, each of said pairs of stator polar portions including a pair of pole faces lying in a single plane passing through the axis of said core structure and on opposite sides thereof, and rotor structure pivotally mounted within said housing including a plurality of pairs of angularly spaced apart rotor polar portions extending radially outwardly into the stator interpolar region, each of said pairs of rotor polar portions including a pair of pole faces lying in a single plane passing through the axis of said core structure and on opposite sides thereof so as to be adapted to be moved into juxtaposition with the pole faces of a corresponding one of said pairs of stator polar portions.

3. A relay comprising structure defining a generally cup shaped housing, a core defining structure extending coaxially from the closed end of said structure, a stator defining ring mounted inside and including a plurality of pairs of angularly spaced apart inwardly extending stator polar portions, each of said pairs of stator polar portions including a pair of pole faces lying in a single plane passing through the axis of said core structure and on opposite sides thereof, and a rotor including a ring-like hub encircling said core and a plurality of pairs of angularly spaced apart outwardly extending rotor polar portions cooperatively associated with said stator polar portions, each of said pairs of rotor polar portions including a pair of pole faces lying in a single plane passing through the axis of said core structure and on opposite sides thereof so as to be adapted to be moved into juxtaposition with the pole faces of a corresponding one of said pairs of stator polar portions.

4. A relay comprising an axial core structure, a stator concentrically arranged relative to said core and including

a plurality of angularly spaced apart inwardly extending polar portions, a rotor including a plurality of angularly spaced apart outwardly extending polar portions cooperatively associated with said first mentioned polar portions, and means for movably mounting said rotor including a rotor shaft, a counterbore at the end of core into which one end of said shaft extends, and a base structure having a counterbore into which the opposite end of said shaft extends.

5. An armature-contact actuator subassembly, including in combination, a non-magnetic contact actuator element having an axially extending peripheral wall and a circular end wall, said peripheral wall having contact operating means, and a magnetic armature fixedly mounted on said end wall.

6. An armature-contact actuator subassembly, including in combination, magnetic structure having a plurality of angularly spaced apart radially extending polar portions, and a generally cup shaped actuator having end and side wall structures, said magnetic structure being mounted on the end wall structure, and said side wall structure including a series of angularly spaced apart axially extending slots.

7. An armature-contact actuator subassembly, including in combination, magnetic structure having a plurality of angularly spaced apart radially extending polar portions, and a generally cup shaped actuator made of nylon and having end and side wall structures and supporting shaft, said shaft extending axially in opposite directions from said end wall structure and said magnetic structure being mounted on the end wall structure, and said side wall structure including a series of angularly spaced apart axially extending slots.

8. A relay structure including, a coil bobbin having an end wall, and a magnetic stator element carried only by said end wall and having a ringlike peripheral portion and a plurality of spaced apart polar portions, and spaced apart aligning elements carried by said structure and extending axially beyond said stator element.

9. A relay structure including, a coil bobbin having a circular end wall, a stator secured to said end wall and comprising a ring-like peripheral portion and inwardly extending angularly spaced apart polar portions, and coil terminals secured to said end wall in interpolar regions, said terminals extending axially beyond said stator.

References Cited in the file of this patent

UNITED STATES PATENTS

714,607	Potter	Nov. 25, 1902
1,839,377	Daly	Jan. 5, 1932
1,852,232	Buchhold	Apr. 5, 1932
1,920,135	Allen	July 25, 1933
2,082,493	Hartman	June 1, 1937
2,207,292	Hansel et al.	July 9, 1940
2,216,620	List	Oct. 1, 1940
2,216,654	Seubert	Oct. 1, 1940
2,248,584	Reynolds	July 8, 1941
2,289,227	Walker	July 7, 1942
2,310,138	Whittaker	Feb. 2, 1943
2,353,756	Price	July 18, 1944
2,364,656	Price	Dec. 12, 1944
2,499,632	Coake	Mar. 7, 1950
2,519,731	Aust	Aug. 22, 1950
2,531,905	Carpenter	Nov. 28, 1950
2,538,020	Lomhalt	Jan. 16, 1951