March 21, 1961 C. R. RHODES 2,976,379

WIPING CONTACT ROTARY RELAY

Filed Feb. 6, 1958

FIG. 2.

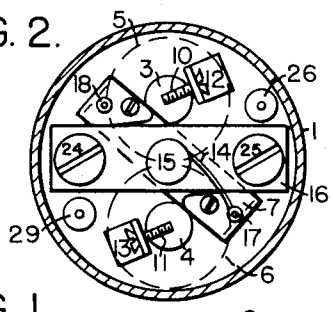


FIG. 1

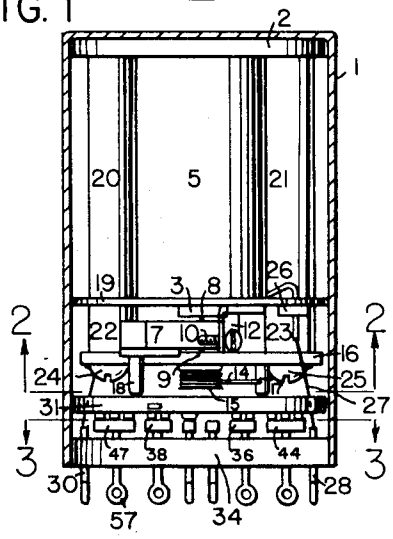


FIG. 3.

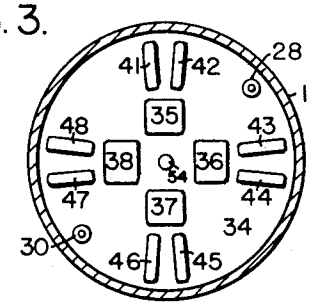


FIG. 4.

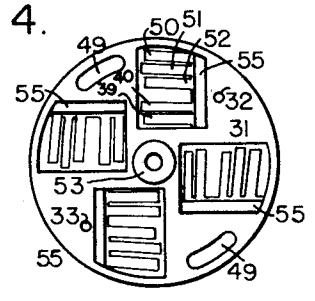


FIG. 5.

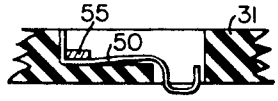


FIG. 6.

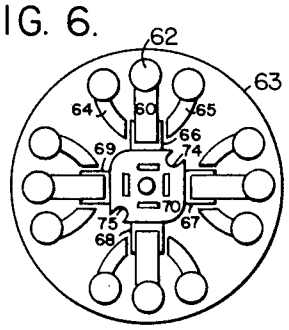


FIG. 7.

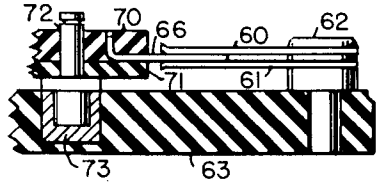
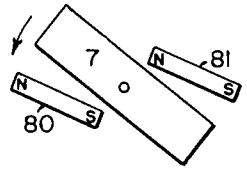


FIG. 8.



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WIPING CONTACT ROTARY RELAY

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17 Claims. (Cl. 200—87)

My invention relates to electromagnetically actuated electrical contacting devices and particularly to a rotary type relay having wiping electrical contacts.

The advances in instrumentation for aircraft, missiles, and for general electronics frequently requires relay switching of electrical energy of low voltage, low current or both. This is known as "dry contact" operation. It is known that the usual butting-contact relay will not give dependable operation under such conditions. The inescapable oxide or equivalent film that forms upon the contact surfaces is sufficient to prevent electrical continuity between contacts when the electrical energy is so feeble.

On the other hand, wiping contacts mechanically scrape such films away with each operation and so are effective in reliably switching feeble electrical energy. Applications where this is required include switching plural relatively low electrical level transducers such as strain gages, pressure indicators and accelerometers to a single amplifier for selective measurement of output. Such measurements may be a part of the operation in air and space vehicles as well as for developmental testing, thus the high performance requirements demanded of components for operation in such vehicles are required of a relay of this type.

I have been able to meet this need by departing from the known type of pull-in butt contact type of relay and also by going beyond the known type rotational relay which as heretofore constituted has employed butt contacts.

Briefly, I form a novel contact construction in which each electrical contact is made by at least two rotative contacts conducting to one stationary contact or vice versa. The contacts are of the fully wiping kind. The proportions are such that one contact element is sufficient to carry the rated load. With the plurality a low resistance electrical contact is certain under all conditions of operation, including vibration, shock and high temperature.

A very short contact "bounce" time is also secured because of the wiping action. This is a highly desirable attribute for precise work and to prevent arcing.

A balanced armature is pivoted for rotation over two pole pieces that are disposed across a diameter. Two coils of wire are wound upon the two pole pieces extended. When energized with an electric current the armature rotates to be more directly over the center of the pole pieces but the air gap between armature and pole pieces does not change.

Friction between contacts is least when those being switched are out of contact, thus and because the rotating force is approximately constant and increase in velocity of rotation is obtained at that time. This gives a rapid break approaching a snap action and so arcing is reduced over prior art relays.

To enhance the feeble electrical energy capability of my relay I place an impermeable diaphram between the magnetomotive force structure and the contact portion

of my relay. Gas fumes are known to evolve from magnet coils at high temperatures and to deposit a film upon contact surfaces that increases contact resistance. The diaphragm prevents such fumes from reaching the contacts.

In a simply altered construction a make before break type of contacting obtained. This is a novel attribute in relays of the so-called military type.

A magnetic rather than spring restoring force upon the armature is also an alternate embodiment.

An object of my invention is to provide a relay capable of reliable contact operation at low electrical energy levels.

Another object is to provide an electrical relay having a very short contact bounce time.

Another object is to provide a relay having multiple wiping contacts.

Another object is to provide a relay having a quick break action.

Another object is to provide a sensitive actuating structure by arranging for maximum torque at the start of the actuating throw.

Another object is to prevent impairment of contact performance by fumes evolved from the magnetomotive structure.

Another object is to provide a make before break contacting military type relay.

Another object is to employ magnetic rather than mechanical armature restoring means.

Other objects of my invention will become apparent upon reading the following detailed specification and upon examining the accompanying drawings, in which:

Fig. 1 shows the interior view of a typical embodiment of my relay in elevation,

Fig. 2 shows a plan view of the same along section 2—2 in Fig. 1, looking upward,

Fig. 3 shows the stationary contact portion of the relay in plan along section 3—3 in Fig. 1 and looking downward,

Fig. 4 shows the rotatable contact wafer portion in plan,

Fig. 5 shows a fragmentary sectional elevation view of enlarged scale of the wiping contact finger construction,

Fig. 6 shows a plan view of an alternate embodiment of the contacts,

Fig. 7 shows a sectional enlarged elevation of the alternate contacts, and

Fig. 8 shows a fragmentary plan view of an alternate restoring torque arrangement.

In Fig. 1 numeral 1 indicates a hollow cylindrical case or housing which alone is shown in section in that figure. This is preferably constructed of metal and may include exterior mounting means.

The upper disk 2 of the magnetomotive force structure is fabricated from soft magnetic iron and carries two coil core and pole piece elements 3, 4, which are also shown in Fig. 2. These are also constructed of soft magnetic iron. Two coils 5 and 6 surround the two cores, each having of the order of 4,000 turns of No. 36 Formvar wire with a total resistance of the order of 500 ohms for 28 volt operation, as an example of one embodiment. Armature 7, also of soft iron, completes the magnetic circuit. It is pivoted top and bottom at its center by stationary pivots 8, 9, which coact within pivot bearings in the armature proper.

It will be noted from Fig. 2 that a tangential force is exerted by pole pieces 3, 4 upon armature 7 when coils 5, 6 are energized with electric current. I have found that this force is a maximum when the armature is slightly closer than tangential to the circular pole pieces in the non-excited position and rotates 22 degrees to the excited

or actuated position. This rotation is terminated by threaded adjustable stops **10, 11**, which are held in angle supports **12, 13**. The latter have slots milled radially with respect to the threads and provide a tight fit for the screws upon the sides of the supports being pressed together. A restoring spring **14** is attached to and wound around capstan **15**, the latter being securely fastened to brass bridge **16**. The free end of spring **14** fastens in a hole in drive pin **17**. This drive pin and another, **18**, which is located at the opposite end of armature **7** impart the movement of the armature to the contact wafer to be described later.

Because of the arrangement of the armature with respect to the pole pieces and the fact that a rotary motion is employed the maximum torque of the system is exerted at the beginning of the stroke. This is quite the opposite to the usual relay functioning, where the armature to pole piece gap is largest at the beginning of the stroke and thus the magnetic force the weakest. The air gap in my relay is constant, of the order of five to ten thousandths of an inch in representative embodiments, and only the opposed area in close magnetic juxtaposition varies as the armature turns. The high starting torque results in my relay being inherently more sensitive than those of the prior art.

Diaphragm **19** is a structural member in the relay and also the means of sealing the magnetomotive portion of the relay from the contacting portion. The diaphragm is attached to upper disk **2** by two non-magnetic rods **20, 21**. These and the diaphragm may be formed from non-magnetic stainless steel, such as type 303, or, of course, from brass. Similarly non-magnetic are spacers **22, 23**, which mount the bridge below the diaphragm as seen in Fig. 1. Screws **24, 25** fasten the above-described parts together, save that the rods are held in the upper disk by a swaged or self-riveted construction. Screws **24, 25** are normally soldered after tightening to enhance permanence under conditions of vibration.

The electrical connections from coils **5** and **6** are brought through the diaphragm by means of insulating ceramic seals. One of these, **26**, may be seen in Fig. 1. A wire **27** connects therefrom to an insulating ceramic seal in the base, terminal **28**. At least one other coil connection is similarly arranged, i.e., **29** in Fig. 2 for the diaphragm lead-through and **30** for the base terminal.

Isolation of the two portions of the relay is accomplished by making the fit between diaphragm **19** and case **1** an accurate and close one. Alternately, the same construction can be hermetically sealed by positioning a thin solder ring at the joint between the diaphragm and the housing and soldering the two together by radio frequency heating of this region by known methods. The solder is placed on the coil side of the diaphragm.

By separating these two portions and employing wiping contacts I am able to switch extremely small amounts of electrical energy over a long relay life. In general, the insulation on magnet wire and other insulation convenient in forming the magnet coils gives off gas and fumes at lower temperatures than cause damage to such insulation. It is desirable that present day relays withstand temperatures one, two or even more times that of boiling water and I enhance this capability by the diaphragm described.

The contacting portion of my relay is shown in elevation at the bottom of Fig. 1, in separated assemblies in Figs. 3 and 4, and in fragmentary detail in Fig. 5.

Insulating wafer **31** (Fig. 4) carries all the rotatable contacts. It is formed of a ceramic-like substance having good structural stability and good electrical insulating properties at all temperatures, such as a glass filled pthalate. It may be formed by machining but for quantity production is preferably molded. The wafer is shaped so that molding is possible.

Two holes **32, 33** are located to take the ends of reduced diameter of drive pins **17, 18**. The wafer is held against the latter by the pressure of the spring contacts which it carries and in this way is uniquely axially positioned.

Coactive with the plurality of contacts on the wafer is a lesser plurality of stationary contacts rigidly embedded in individual glass-like seals in lower header **34**. The relay illustrated is a four pole double throw embodiment. Accordingly, four continuously contacting stationary contacts **35, 36, 37, 38** are positioned around an inner circumference on header **34** at right angles apart. A plurality of spring contacts **39, 40** attached to wafer **31** continuously ride upon contact **35**. That is, contact **35** is in excess of 22 degrees in circumferential width and so the necessary and desirable throw of the armature previously mentioned does not separate the subject movable and stationary contacts. A similar coaction obtains at the other continuously contacting stationary contacts.

The switched stationary contacts are eight in number for this embodiment, i.e., **41** to **48** inclusive. These are less than half as wide circumferentially as the previously described continuous stationary contacts. On the wafer three additional electrically connected spring contact fingers **50, 51, 52** coact with each pair of switched stationary contacts **41, 42**. A much enlarged detail of one such finger **50** is shown in elevation in Fig. 5. The flat part of the finger extending below wafer **31** is the part which contacts either stationary contact **41** or **42** depending upon which extreme position is occupied by the armature at the particular moment. In the non-excited position of the armature contact is made with stationary contact **41** and in the excited position with contact **42**.

It will be noted that when movement of the armature starts from one of its extreme positions all of the five movable contact fingers associated with each pole are in contact with two stationary contacts; i.e., contacts **39, 40** in contact with contact **35** and contacts **50, 51, 52** in contact with contact **41**. As soon as the rotation approaches half way the three contacts **50, 51, 52** leave contact **41** and are not in contact with any solid thing. The friction load upon the magnetomotive system is thus reduced to less than ⅔ that before and so the motion becomes faster. The load is reduced to less than ⅔ because the lever arm of the outer three contacts is considerably more than that because of the two inner contacts remaining in contact. It is thus seen that a quick break action is obtained, reducing the duration of any arc that might form. When wafer contacts **50, 51, 52** reach stationary contact **42** the double throw aspect of the switching has been completed. The four pole aspect is also accomplished by the concurrent action of the four groups of similar contacts.

I have found that by making the several wafer spring contacts of slightly different proportions I am able to obtain superior performance in conditions involving vibration. For example, contact **50** shown in Fig. 5 has a given over-all length. I make companion contact **51** slightly longer, having more of a turned-up portion at the free (right-hand) end. For the same reason contact **52** is made shorter and has less of a turned-up portion. Accordingly, the natural vibrational periods of each are considerably different. As long as one of these contact fingers makes contact with the stationary contact involved the relay operates properly. Under vibration of a given frequency one spring contact may vibrate but the probability is high that the other two will not. Even if all three should vibrate to some degree the phase of the vibratory excursions would be different because of the reasonably different natural periods of vibration. Thus, the probability that at least one contact will be in contact with the stationary contact at every instant is very good.

Wafer **31** is suitably journaled with respect to the stationary contacts by insert **53** located in the center of the wafer and having a downwardly extending tubular extension. Central bearing pin **54** is attached to header

34 and project up into the tubular extension of insert 53. Arcuate slots 49 allow passage of the coil connection wires 27 through the wafer to external contacts 28 and 30.

In numerous relays of the prior art spring contacts have been fastened in place by rivets or equivalent spot fastenings. I have found that such fastening tends to distort the contact elements and that a fully satisfactory structure cannot be attained. By arranging a novel structure in the wafer I am able to completely depart from this practice and to attain superior workmanship in a simpler quantity-production manner than heretofore known. This is accomplished by forming a retaining bar 55.

Each group of finger contacts, as 39, 40, 50, 51, 52 is preferably formed from a single piece of sheet material. As will be noted from Fig. 5 this sheet is folded under bar 55; progressing from left to right first downward vertically from the upper surface of wafer 31, next under the bar horizontally, then raised slightly to give free spring, then downward to form to flat-bottomed hook contacting portion and finally upward at the right to complete the free end. As may be noted in Fig. 4 each sheet progresses from a solid sheet to individual fingers just beyond the portion which is held under the bar. Apertures are provided in wafer 31 at each end of bar 55 through which the latter is slipped. The apertures are formed so that the bar and the contact sheet are held in a tight fit. After insertion each bar is bent slightly at a sharp angle at each extreme end to prevent the bar from subsequently working loose by lengthwise translation.

Silver magnesium nickel is preferably used for each sheet of contacts. This material is cut and formed when soft. Then it is heated at 1450° F. in air for two hours. This oxidizes the magnesium to magnesium oxide and produces a spring material. The bar may be formed from a relatively non-spring material, but one having considerable strength to resist deformation, as bronze.

All stationary contacts, as 35, 41, 42, etc., are preferably formed of fine silver. These are silver soldered to the upper end of the several insulated terminals, as 57. The upper surfaces of all stationary contacts are made to lie in one plane by suitably machining or grinding the assembly as the last step in fabrication.

A very short "bounce" time is secured with my contact structure because of the wiping action. On the contrary, the chatter of butting contacts fosters prolonged arcing and decreases contact life. The bounce of conventional contacts may range from 500 microseconds to 3 milliseconds. Tests with my structure have shown a minimum of no bounce at all and a maximum duration of 40 microseconds. It will be recognized that this is several orders of magnitude improvement and cannot be considered a mere improvement in design.

It will also be noted that the rotating assembly is balanced. This, of course, results in satisfactory performance under conditions of acceleration or shock due to abrupt missile maneuver or equivalent imposed conditions.

How I attain the several desirable characteristics initially mentioned herein is now apparent.

An alternate form of my invention is shown in Figs. 6 and 7.

All of the magnetomotive and general supporting structure is the same as has been previously described. Essentially only the contacting structure is different.

In Figs. 6 and 7 it will be noted that knife blade switch type contacts are provided. In each group of contacts a common stationary one is formed of upper blade 60 and lower blade 61. These blades are held in spaced relation by terminal post 62. The latter also extends through insulating base 63 and allows external connection wires to be soldered into or otherwise connected to the bottom thereof. Closely adjacent to and of equivalent construction is left throw stationary contact 64 and right throw stationary contact 65. These are curved to place the contacting portion close to the common contact 60. All are of sufficient length to have an inherent spring sufficient for long life as a contact. For the four pole double throw relay illustrated there are four groups of three contacts the same as contacts 60, 64, 65.

Coactive with each group is one movable contact 66. As seen in Fig. 6 this switch blade type element is wider than stationary contact but not sufficiently wide to contact all three contacts of the group at once in this embodiment. It does, however, contact either the center contact and the left or the right adjacent stationary contact at any one time save during the transition from one extreme throw position to the other. The switch in Fig. 6 is shown at the instant of midway position between left and right hand contacting. The rest position is either with the movable contact in contact with left stationary contact 64 and center stationary contact 60, or with the movable contact in contact with right stationary contact 65 and the center contact 60. For external connection, the center contact 60 is the "blade" or common connection, while contacts 64 and 65 are the "jaw" or individual throw connections.

Each of the four movable contacts 66, 67, 68, 69 are separately insulated and mounted in a rotor structure composed of upper insulating piece 70, lower insulating piece 71 and shaft 72. Each movable contact, as 66 in Fig. 7, is bent upward at the inner end and firmly fits into a vertical slot in the upper insulating piece. It is held rigidly in place by pieces 70 and 71, being a force fit on the shaft 72 and the pieces being bonded with a suitable adhesive between the two. All of the contacts in this embodiment may be of the silver magnesium nickel alloy previously mentioned.

Shaft 72 is journaled in bearing 73, which latter is cast or forced into the insulating base 63. Upper insulating piece 70 is provided with two notches 74, 75 at opposite ends of a diagonal of the essentially square shape of the piece as shown in Fig. 6. These fit into drive pins the equivalent of 17 and 18 of Figs. 1 and 2, except that the pins are located closer together. The contacting portion of Fig. 6 is then driven by the magnetomotive portion of Fig. 1 as before.

An advantage in manufacture and in repair of either embodiment of my relay is the possibility of fabricating and adjusting the contact assembly of each independent of the magnetomotive structure. With the usual degree of precision of quantity production any motor will operate any contact assembly.

Another alternate embodiment is possible in which the restorative means takes the form of a pair of magnets rather than of spring 14. This alternate is shown in Fig. 8. The ferromagnetic armature 7 is the same as previously shown in Fig. 2. Instead of the spring structure, however, two Alnico 5 permanent bar magnets 80, 81 or the equivalent, are fastened to the stationary structure of the relay in the positions shown. The two magnets induce magnetic poles in the extremities of armature 7 and attract the armature to themselves. In Fig. 8, the armature is shown in the actuated position; i.e., the coils 5, 6 are energized. When this energization ceases the armature rotates counterclockwise as indicated by the arrow until it is in contact or in substantial contact with the magnets. The magnets may act as the stops to mechanically limit the desired 22 degree rotation.

In manufacture the magnets 80, 81 are initially magnetized to the full capability of the magnetic material. The configuration of Fig. 8 is proportioned so that this degree of magnetization is slightly too strong for operation of the relay at a desired minimum electrical input to the actuating coils. The two permanent magnets are then demagnetized slightly by the application of an alternating current yoke of suitable magnetic parameters to reduce the permanent magnetism to the desired degree.

This embodiment has the advantage that mechanical fatigue of spring **14**, Fig. 2, cannot occur and thus failure of the relay for that reason.

A further alternate embodiment of the spring element construction lies in winding two springs **14**, each half as strong as the one shown in Fig. 2, and attaching one as shown and the other to drive pin **18** with the tension such that both forces add. This allows continued operation at reasonably proper characteristics if one spring should fail.

It will also be understood that the use of a double cantilever type strip spring, held by a slot in the central capstan **15** and pressing at one extremity against pin **17** and at the other against pin **18**, may be employed.

The balanced spring and magnetic embodiments have the advantage of a more nearly perfectly balanced structure for the armature assembly. This has significance in high acceleration applications but for usual applications each restorative means functions satisfactorily.

Relays embodied according to my invention meet well known military specifications, as to vibration, shock, contact overload, high and low temperatures and moisture. Embodiments have been tested to operate satisfactorily at 100 *g* shock. From theoretical calculations based on parameter measurements reasonably satisfactory operation at 600 *g* should be expected. Vibration at 30 *g* at frequencies from zero to 2,000 cycles does not affect the operation. Because of the hermetic sealing moisture tests are easily met. In final assembly, of course, header **34** is soldered or brazed to the lower rim of case **1**. As to the internal sealing, long exposure to an ambient temperature of 125° C. does not affect the contacts nor the coil structure. With higher temperature insulation on the wire and around the coils a temperature of 200° C. may be allowed. The embodiments illustrated have a military rating for the contacts of 10 amperes. This corresponds to repeated operation at 80 amperes for allowable overload on test.

In average embodiments 250 milliwatts electrical input to the coils provides reliable operation. The relay then develops three inch ounces torque. This input may be considerably reduced if desired as follows. The airgap between armature and pole pieces is reduced to three thousandths of an inch, the torque of spring **14** is reduced by one third and all sliding contacts are rhodium plated. These combined factors increase the sensitivity eighteen times. Accordingly, the relay will then operate on 14 milliwatts of power, or less than one milliampere at 28 volts.

As to further alternate embodiments, it will be understood that my relay may be constructed with any reasonable number of poles other than the four illustrated. In the order of presumed preference this would be six pole, three pole, two pole and five pole. Balance is still maintained by merely uniformly spacing the poles around the circumference. Single throw embodiments may be constructed by merely omitting one stationary contact from each group of contacts, as **41**, **43**, **45** and **47** in Fig. 3. Further, by omitting contacts **41**, **43**, **46** and **48**, two circuits may be made normally closed while the other two are normally open.

One or more groups of contacts may also be arranged to "make before break" by merely slightly elongating the horizontal portion of the active contact hook (Fig. 5) so that contact is briefly retained at stationary contact **41** after contact has been made at contact **42**, as an example (Fig. 3).

Similarly, in Fig. 6, the rotor contact **66** is very slightly widened so that it remains briefly in contact with stationary contact **64** when contact with stationary contact **65** is first made. Other rotor contacts **67**, **68** and/or **69** may also be widened according to the variety of contact behavior required of a particular relay.

In addition to the construction of the diaphragm and housing previously described the housing may have a machined step at the location of the diaphragm and the means for fastening the interior components within the housing secure the diaphragm to the housing step in a tight fit. A thin gasket may or may not be included.

It will also be appreciated that other inside insulating materials may be used, such as glass-bonded mica for wafer **34**.

I have determined that the range from approximately 20 to 22 degrees represents an allowable range of optimum throw of the armature with respect to the magnetomotive structure, and any desired value within this range may be used for optimum performance.

A preferred size for my relay is half that illustrated in all figures save the doubly enlarged ones, Figs. 5 and 7. Enlarged scales were used throughout the figures for clarity.

A correlated series of specific values and proportions have been given herein in order to most accurately teach my invention. It is to be understood that considerable variation may be taken from these data without departing from the scope of my invention. Variations in the arrangement, size, coactive relation and individual characteristics of elements may be made.

Having thus fully described my invention and the manner in which it is to be practiced, I claim:

1. A rotary relay having wiping contacts comprising a stationary magnetomotive structure having pole pieces, a magnetizable armature, bearings on said armature to allow rotation thereof from a high to a low reluctance position over said pole pieces upon magnetomotive excitation of said structure, restorative means to return said armature to the high reluctance position upon the cessation of said excitation, an insulating wafer mechanically connected to said armature, said wafer having plural radial electrical contacts, three stationary contacts disposed circumferentially adjacent to each of said plural contacts, the center contact of each of said three stationary contacts having a circumferential width only sufficient to remain in wiping contact with one of said plural contacts when said armature is in both the excited and the non-excited rotative positions, another of said stationary contacts differently positioned circumferentially to make wiping contact with said one plural contact when said armature is in the excited position, still another of said stationary contacts oppositely circumferentially removed from said center contact to make wiping contact with said one plural contact when said armature is in the non-excited position; a surrounding case, and a diaphragm in said case adjacent to said pole pieces disposed to separate the contact portion of said relay from the stationary magnetomotive structure of said relay.

2. A rotary relay having wiping contacts comprising a stationary magnetomotive structure having pole pieces, a soft iron armature, a bearing on each side of said armature to allow rotation thereof from a high to a low reluctance circumferential position over said pole pieces upon magnetomotive excitation of said structure, restorative means to return said armature to said high reluctance position upon cessation of said excitation, an insulating wafer having plural radial slots, said wafer connected to said armature, a finger piece having a plurality of spring contact fingers circumferentially mounted in each of said slots, one metal piece radially attached to said wafer in each said slot and bearing upon said finger piece to hold the same, three individual stationary contacts disposed adjacent to each said plurality of spring contact fingers, a central bearing to position said wafer with said fingers in rotary contactable relation to said stationary contacts, said stationary contacts spaced to position one said contact adjacent to said bearing and in contact with at least one of said plurality of fingers in only one of said slots in either the excited or non-excited positions of said armature, another of said stationary contacts positioned to be in wiping contact with at least one of said fingers when said armature is in said excited position, and still another

of said stationary contacts positioned to be in wiping contact with at least one of said fingers when said armature is in said non-excited position, a surrounding case, and a diaphragm in said case adjacent to said pole pieces disposed to separate the contact portion of said relay from the magnetomotive structure of said relay.

3. A rotary relay having wiping contacts comprising a stationary magnetomotive structure having pole pieces, an armature, a bearing on said armature to allow rotation of said armature from a high to a low reluctance circumferential position over said pole pieces upon magnetomotive excitation of said structure, restorative means to return said armature to said high reluctance position upon the cessation of said excitation, an insulating wafer connected to said armature having plural radial electrically separate metal contacts, three stationary contacts disposed adjacent to each of said plural contacts, each said stationary contact having contacting leaves above and below said plural contacts, the center contact of each of said three stationary contacts and each of said plural contacts each having a circumferential width sufficient to remain in contact when said armature is in both the excited and the non-excited rotative positions, another said stationary contact circumferentially removed from said center contact to contact said one plural contact only when said armature is in the excited position, still another stationary contact circumferentially removed from said center contact oppositely to said other contact to contact said one plural contact only when said armature is in the non-excited position; a surrounding case, and a diaphragm in said case adjacent to said pole pieces disposed to separate the contact portion of said relay from the magnetomotive structure of said relay.

4. A rotary relay comprising a magnetomotive structure, an armature, said armature related to said magnetomotive structure to rotate thereover from a position of high to a position of low reluctance in combination with said magnetomotive structure upon the energization of said structure, plural separate electrical contacts insulatingly and mechanically connected for rotation by said armature, each of said plural contacts having plural fingers at different radial distances from the center of said rotation, plural stationary contacts each having plural separate contacting elements disposed in groups adjacent to each of said plural electrical contacts, one of said stationary contact elements in each group in constant wiping electrical contact with one of said plural electrical contacts at one said radial distance, another of said stationary contact elements in each group positioned at another said radial distance to be in wiping contact with said one electrical contact upon said magnetomotive structure being energized, and still another of said stationary contact elements in each group also positioned at said other radial distance to be in wiping contact with said one electrical contact upon said magnetomotive structure not being energized.

5. A relay comprising a magnetic structure having plural pole pieces and an armature, means to allow rotation of said armature to an extreme position over said pole pieces upon excitation of said structure, a wafer, separable means to rotate said wafer by said armature, an electrical contact radially disposed upon said wafer, plural separate stationary contacts disposed to contact said radially disposed contact at plural radial distances, at least one said plural contact having a width sufficient to remain in wiping contact with said radially disposed contact when said armature is in both the excited and in the non-excited positions, and at least another of said stationary contacts lying at another radial distance and positioned to make the only wiping contact to said one radially disposed contact when said armature is in said extreme position.

6. The relay of claim 5 in which said other of said stationary contacts is positioned to make electrical contact with said radially disposed contact only when said armature is rotated oppositely to said extreme position, and said stationary contacts are insulatingly supported to exclusively make mechanical contact with said radially disposed contact.

7. The relay of claim 5 in which an additional stationary contact is positioned to make electrical contact with said one contact of sufficient width through said radially disposed contact only when said armature is rotated oppositely to said extreme position.

8. A relay having only metal-to-metal wiping contacting comprising a magnetic structure having pole pieces, an armature of low retentivity, bearings to allow rotation of said armature circumferentially over said pole pieces from a high to a low magnetic reluctance position upon magnetic excitation of said structure, means to return said armature to said high reluctance position upon the cessation of said excitation, flat multi-fingered electrical contacts insulatingly rotatable by said armature, each finger of said contacts disposed at a different radial distance from the center of rotation of said armature, a separate group of stationary contacts disposed at plural radii and at two different radial distances adjacent to each of said flat contacts, a centrally disposed contact of each said group of contacts having a circumferential width only sufficient to remain in wiping contact with one of said flat contacts when said armature is in both the excited and the non-excited rotative positions, another of said group of stationary contacts at a different radial distance from that of said centrally disposed contact positioned to make wiping contact to said one flat contact when said armature is in said excited position, and still another of said group of stationary contacts oppositely positioned from said center contact to make wiping contact to said one flat contact when said armature is in said non-excited position.

9. The relay of claim 8 in which at least one of said multi-fingered electrical contacts rotatable by said armature has only sufficient circumferential width to make electrical contact with three coactive stationary contacts for a portion of the whole rotation of said rotatable multi-fingered contacts.

10. The relay of claim 8 in which said means to return said armature of low retentivity are a pair of elongated permanent magnets disposed with a pair of unlike poles closely adjacent to said bearings and another pair of unlike poles adjacent to the extremities of said armature to rotate the same.

11. A relay comprising a magnetic structure having pole pieces and an armature, means to allow rotation of said armature between extreme positions with respect to and over said pole pieces upon excitation of said structure, a stop to determine the extreme position of said armature taken upon excitation of said structure, planar insulating means to connect a plurality of electrically separate groups of contact elements to said armature, each said element of one said group disposed at a different radial distance with respect to the center of rotation of said armature, a piece attached to said insulating means to fasten each of said groups thereto, more than two stationary contacts mechanically disposed for wiping contact only by each said group of contact elements, one of said plural stationary contacts positioned at one radial distance to contact at least one said contact element of only one said group in both said extreme positions of said armature, another one of said plural stationary contacts positioned at another radial distance to contact at least one of said contact elements of the same said group upon said armature taking one of said extreme positions.

12. A relay having wiping contacts comprising a stationary magnetomotive structure, an armature of low magnetic retentivity, central means coactive with said armature to allow rotation thereof from a high to a low reluctance position in relation to said magnetomotive structure upon excitation of said structure, means to return

said armature to said high reluctance position upon the cessation of said excitation, a disk-like insulating member connected to said armature and having plural radial slots, a plurality of contact fingers having different circumferential finger lengths and mounted at different radial distances in each of said slots, a piece radially attached to said insulating member in each said slot to secure one end of each of said fingers, a header, plural individual stationary contacts spaced from said header and disposed at different radial distances adjacent to each said plurality of contact fingers, means to position said fingers in rotary contactable relation to said stationary contacts, one of said stationary contacts positioned to be in wiping contact with at least one of said plurality of fingers in one of said slots in either the excited or the non-excited positions of said armature, another of said stationary contacts positioned at another radial distance to be in wiping contact with at least one of said fingers when said armature is in said excited position, and still another of said stationary contacts positioned at said other radial distance to be in wiping contact with at least one of said fingers when said armature is in said non-excited position.

13. The relay of claim 12 in which electrical contact is made through plural fingers of a single contact piece to at least three of said plural individual stationary contacts disposed adjacent to each plurality of spring contact fingers for a part of the rotation between said excited and said non-excited positions of said armature.

14. The relay of claim 12 in which said means to return said armature to said high reluctance position upon the cessation of said excitation are two permanent bar magnets each having a length substantially half the length of said armature, each said magnets disposed with ends closely adjacent to said central means and with opposite ends adjacent to the ends of said armature of low magnetic retentivity to rotate said armature by magnetically attracting the ends of said armature.

15. A relay having wiping contacts comprising a stationary magnetomotive structure, an armature, bearings coactive with said armature to allow rotation thereof from a high to a low reluctance position with respect to said magnetomotive structure upon excitation thereof, means to return said armature to the high reluctance position upon the cessation of said excitation, an insulating disk removably connected to said armature having plural rigidly attached electrically separate radially disposed contacts, a plurality of spring stationary contacts disposed only adjacent to each of said plural contacts and supported at a greater radius than that of said plural contacts for resiliently radially contacting the same, each of said plurality of stationary contacts having a contacting surface above and below said plural contacts, the central contact of each of said plurality of stationary contacts having a width sufficient to remain in wiping contact with one of said plural contacts when said armature is in both the excited and the non-excited rotative positions, another of said plurality of stationary contacts removed from said central contact to wipe said one plural contact when said armature is in the excited position, still another of said plurality of stationary contacts oppositely removed from said other contact to wipe said one plural contact when said armature is in the non-excited position.

16. The relay of claim 15 in which electrical contact is made by one of said plural radially disposed contacts with at least three of said plurality of stationary contacts disposed only adjacent to each of said plural contacts for a part of the rotation of said armature between said excited and said non-excited rotative positions to accomplish a make before break sequence of contacting.

17. The relay of claim 15 in which said means to return said armature to said high reluctance position upon the cessation of said excitation are two permanent bar magnets disposed with ends closely adjacent to said bearings and having a length such that opposite ends of each are adjacent to the ends of said armature, to rotate said armature by inducing magnetism of opposite polarity at opposite ends thereof.

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