

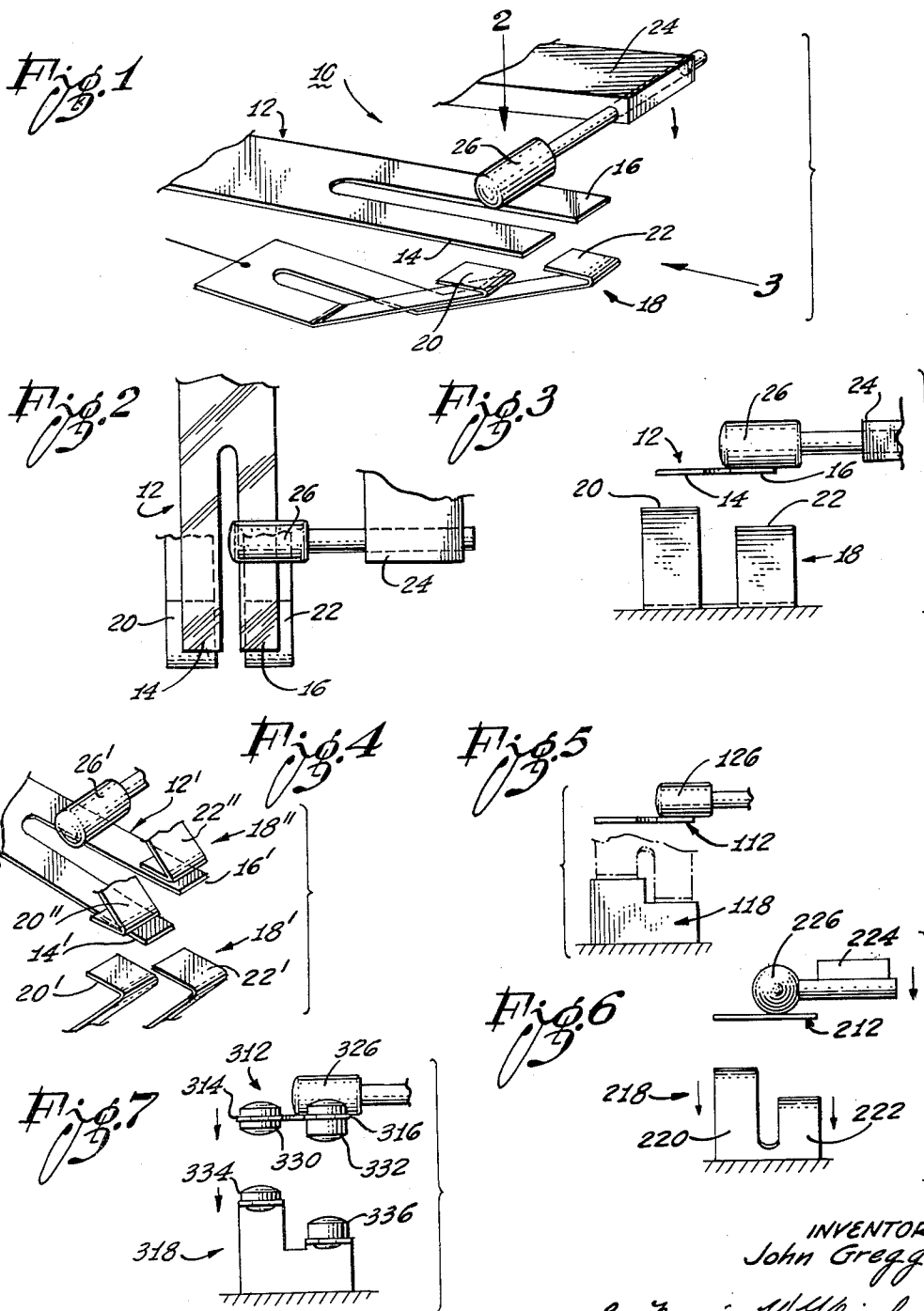
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J. GREGG

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DRY CIRCUIT SWITCH

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DRY CIRCUIT SWITCH

John Gregg, Los Angeles, Calif., assignor to Litten

Systems, Inc., Beverly Hills, Calif.

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This invention relates to switching devices and more particularly to an improved combination of movable and stationary switch contacts in a configuration having special application in low level signal or so-called "dry circuit" applications.

In recent years, the requirements of sophisticated computer and control systems have required the transmission of extremely low level signals from remote sensors or transducers into circuits devised to utilize these signals. Frequently, these signals, in the form of currents in the microampere range operating under millivolt difference in potential, represent physical parameters such as temperature, pressure, acceleration, or velocity which are used in analog or digital computation. Slight variations in the voltage or current, introduced by non-negligible impedances in the switching circuits, can completely invalidate the computations.

Conventional switches, such as are found in commercially available relays, are fully adequate at their rated voltage and current levels, nominally amperes and volts, but frequently exhibit an intolerably high impedance to low level signals in the dry circuit range. For example, a relay switch designed to carry a rated load of 2 amperes at 15 volts presents negligible resistive impedance when used in such a circuit. However, the same relay switch used in a low level, dry circuit application may exhibit resistive impedances on the order of several hundred ohms, which may be many times the impedance of the dry circuit itself.

In the prior art, special, noble metal relay contacts have been provided such as gold alloys, platinum alloys, and others which do not tarnish readily, and which normally exhibit extremely low contact resistance throughout the life of the switch. Further, these contacts can be subjected to normal rated volt-ampere loads without damage and without adversely affecting their performance under low level conditions. However, such contacts can be expensive compared to the total cost of the relay, and, where many hundreds of switch contacts are required in a system, the increased cost is appreciable.

In order to avoid the high cost of noble metal contacts, attempts have been made to plate or flash a noble metal film over a base metal contact to gain the benefits of decreased contact resistance to low level signals and lowered incidence of tarnishing films. Although these contacts are satisfactory for low-level use exclusively, they are certain to be rendered useless if subjected to the larger, rated current or voltage loads. For example, the inadvertent testing of such a relay at its normal rated voltage of, for example, 2 amperes and 15 volts, causes a physical alteration of the surface due to arcing and evaporation of the plating among other things and, although the relay is satisfactory for normal, rated power switching duties, it is ruined insofar as further dry circuit use is concerned. More important, should such a relay be installed in a dry circuit, and, as the result of the failure of a component in the system, the contacts receive a voltage and current load that is substantially greater than the dry circuit range, then the relay will no longer function satisfactorily under dry circuit conditions and will require replacement.

According to the present invention, relay contacts are so arranged to take advantage of the high conductance and low tarnishing of precious or noble metals and the

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cost advantages of base metals to provide a switch contact which is useful in low level or dry circuit applications and which is not damaged by occasional, intentional or inadvertent surges of current in the normal, rated range. The configuration of the stationary member relative to the movable member is such that two separate contacts are formed, one of which makes first and breaks last while the other makes last and breaks first, somewhat in the manner of prior art circuit breaker devices. It will be clear, however, that the special problems involved with low level circuits prevent the direct adoption of conventional circuit breakers of the prior art.

In a preferred embodiment of the present invention, the movable blade of the switch is bifurcated and is normally biased out of engagement with the stationary contact elements. One of the two contact ends is termed the power contact while the other is termed the signal contact. A lever arm connected to a relay armature is used to drive the moving contact against its normal spring bias. When the relay is energized and the armature is pulled, the lever arm moves the entire blade towards the stationary contacts. The blade power contact engages a corresponding stationary power contact to establish or "make" the circuit. The lever arm continues to drive the signal contact portion of the movable blade into engagement with the corresponding stationary signal contact. When the relay is fully energized, both the signal and power contacts of the movable blade are conductively engaged with their corresponding stationary contacts. The additional travel necessary to engage the signal contacts after the power contact is made causing a wiping action on the power contact, and, in the preferred embodiment, sufficient over-travel is provided to cause a wiping of the signal contacts, as well. As the relay is deenergized the armature is released and the spring bias of the movable blade initially disengages the signal contacts after which the power contacts separate. The design parameters of the contact assembly are carefully controlled to assure this breaking sequence on deenergization and any arcing or welding that might take place is confined solely to the power contacts.

In continuing operation, if all signals are of the low level type, no arcing or heating will ever occur at the power contacts and therefore both power and signal contacts are useful for low level or dry circuit signals. However, should a signal of greater power such as the volt-ampere signal that is normally within with relay's rated voltage and current be applied either due to testing or component failure, any arcing or welding action is limited to the power contacts. Inasmuch as a noble metal flashing or plating is adversely affected by the arcing or welding action at power levels, it follows that the power contacts are rendered unfit for future dry circuit signals but the relay as a unit does not lose its suitability, inasmuch as the signal contacts are not affected and continue to remain useful for low level signal applications.

In an alternative embodiment of the present invention, a second pair of stationary contacts are provided for the normal single pole double throw operation whereby in one relay state, one set of power and signal contacts are engaged and in the other state, the other set of contacts are energized. In this arrangement, too, the stationary contacts are staggered so that the power contacts are always first to make and last to break and the signal contacts are last to make and first to break.

The expressions "low level" or "dry circuit" refer specifically to electrical currents of less than 100 microamperes and differences of potential less than 100 millivolts. These limits have been used, for example, in the published annual proceedings of the National Conference on Electromagnetic Relays, sponsored by the Na-

tional Association of Relay Manufacturers and Oklahoma State University.

Accordingly, it is an object of the invention to provide a novel relay contact configuration for reliably connecting low level circuits.

It is an additional object of the invention to provide a highly reliable relay switch for low level circuits whose operation is unimpaired by voltage and current overloads.

It is a further object of invention to provide a base metal relay switch contact having a noble metal flashing or plating that will operate reliably in low level circuits in spite of power loads far in excess of the low level circuit range.

It is still another object of the invention to provide a novel relay switch contact arrangement of increased reliability and lower cost that is alternatively operable at low level circuit or at power circuit conditions.

It is yet another object of invention to provide a low level or dry circuit switch of high conductance which includes two sets of contacts that operate in a predetermined make-break sequence.

The novel features which are believed to be characteristic of the invention, both as to its organization and method operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawings in which several embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention.

FIGURE 1 is a perspective view of a switch according to the present invention, which includes a movable, bifurcated blade and a pair of resilient, stationary contacts;

FIGURE 2 is a top view of the switch of FIGURE 1 taken along line 2 in the direction of the arrow;

FIGURE 3 is an end view of the switch of FIGURE 1 taken along line 3 in the direction of the arrow;

FIGURE 4 is a perspective view of an alternative embodiment of the switch of FIGURE 1 which includes a second pair of stationary contacts for single pole, double throw operation;

FIGURE 5 is an end view of another switch according to the present invention, which includes a movable bifurcated blade and a pair of rigid, stationary contacts;

FIGURE 6 is an end view of still another configuration of the switch of the present invention which includes a non-bifurcated movable blade and a pair of resilient, stationary contacts; and

FIGURE 7 is an end view of yet another embodiment according to the present invention which employs contact buttons of different thickness on a movable bifurcated blade which engage fixed, stationary contacts.

Turning now to the figures, there is shown in FIGURES 1, 2 and 3 several views of a preferred embodiment of the present invention which is illustrated as a single pole, single-throw switch 10. To simplify the description of the present invention, the details of the relay coil and armature assembly have been omitted from the drawing as being well-known to those skilled in the art. The switch 10 includes a movable blade 12 of a rectangular shape. The movable blade 12 is made of a resilient material and is mounted in cantilever fashion to the frame of the relay structure (not shown). The blade 12 is bifurcated at its free end into a power contact portion 14 and a signal contact portion 16 which are co-planar. A permanent resilient bias is imposed to normally bias the blade away from a corresponding stationary contact 18 which is also divided into two separately engageable portions, including a power contact element 20 and a signal contact element 22.

These elements of the stationary contact 18 are commonly connected electrically, and are spaced in a stag-

gered relation with respect to each other, the power contact element 20 being positioned in advance of the signal element 22, relative to the movable blade 12. The stationary contact elements are also of a resilient material to increase the available contact pressure and to assure a wiping action when engaged by the movable blade 12. As is clearly seen in the end view (FIG. 3), the movable blade portions are normally aligned and the stationary elements are stepped to facilitate the early engagement and late disengagement of the power contact pair.

A portion of relay armature 24 is shown, from which extends a lever arm 26 terminating in a glass bead. The techniques and details of armature and lever arm construction are well-known in the art and therefore, to simplify the presentation, only the portion is shown here. The lever arm 26 is positioned adjacent the signal contact portion 16 of the movable blade 12 and, in the normally open position with the relay in the deenergized state, the arm 26 is spaced away from the blade 12. As shown in the figures, however, the relay is assumed to be partially energized and the armature is shown after a small amount of travel. With the relay fully energized and the armature 24 at its corresponding pulled position, both the power and signal contacts are engaged and a slight amount of overtravel of the armature 24 and lever arm 26 has been permitted to enable a wiping of the sets of contacts to assure a highly conductive circuit. The wiping action tends to prevent the formation or retention of tarnish films by a polishing process and otherwise improves the conductivity at the area of contact.

All of the contact elements, such as the bifurcated blade 12 and the power and signal contact elements 20, 22 are preferably made of a relatively inexpensive, resilient, base metal such as phosphor-bronze, copper, or nickel which tend to tarnish and thereby increase surface contact resistance to low level signals. To prevent this, according to techniques well-known in the art, a noble metal such as gold, platinum, or a noble metal alloy, is flashed or plated on to provide a noble metal contact surface at a nominal cost. The noble metals exhibit not only higher conductivity, but also a greater resistance to tarnishing and the formation of organic films. Further, due to the great ductility of the noble metals, rubbing or wiping contact of noble metal surfaces does not result in an appreciable wearing away of the noble metal, but rather the noble metal virtually flows into the grain structure of the base metal, impregnating the surface layers beneath to provide at all times, a noble metal contact surface.

In operation at the extremely low power levels of the so-called "dry circuit" range, the difference in potential existing between the moving and the stationary portions of the switch is on the order of millivolts. As the power contacts approach each other, conduction is initiated in the circuit approximately at the instant of physical impact. The lever arm 26 continues its travel, making the signal contacts without affecting the character of the transmitted signal. However, due to malfunction of circuit elements or such inadvertence, as for example, an incorrect test procedure, a difference in potential exists within the so-called "normal range" which includes signals on the order of watts, and, as the power contacts make, an arc forms, heating the point of contact. Any tendency of the contacts to weld together is minimized by the wiping action, but at the instant before physical impact there is certainly some melting and evaporation of the plating or flashing at that point. Once the power contacts have made, a complete circuit exists and, since the signal contacts are at the same potential, their engagement does not give rise to any destructive electrical action.

When the lever arm 26 is released by deenergization of the relay, the normal bias of the movable blade 12 provides the motion necessary to break the contacts,

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The signal contacts 16, 22 are the first to break, partly because of the relative location of the signal and power contact elements 22, 20 and partly because of the additional increased tension on the blade's signal portion 16 brought by the lever arm 26 when the circuit is fully made. At a finite time interval later, the power contacts 14, 20 also break, opening the circuit. Under dry circuit conditions, the interruption of the circuit produces no deleterious effects upon the contact elements. In the case of the inadvertent watt-power signal involving a several volt difference in potential, however, breaking of the circuit also produces arcing and heating at the opposing surfaces which causes evaporation and melting of the flashing or plating of the power contacts.

It may be seen that all damage is confined to the surface of the power contacts alone, and, even after damage occurs, the switch is still effective to transmit low level, dry circuit signals through the signal contacts. Subsequent operation of the relay at the low signal levels produces little or no transmitted signal at the power contacts because of the higher surface resistance of the damaged contacting surfaces which quickly tarnish and film. However, closure of the signal contacts does complete the circuit. At the lower power levels associated with dry circuit operations, the damage caused by initiation of conduction is negligible. Further, continued imposition of the higher power signals will not damage the signal contacts since the power contacts remain highly conductive to signals in the volt-ampere range.

It will be understood by those skilled in the art that commercially available relays are normally rated in terms of the maximum voltage and current that the contacts can safely and reliably handle. The dry circuit requirements are a relatively recent innovation in the relay art and impose the additional condition that the contact resistance of the switch at the extremely low power levels encountered, such as, for example, microampere currents at millivolt potentials, be substantially less than 1,000 ohms. This condition can be satisfied either by the costly expedient of noble metal contacts or by the relatively inexpensive plating or flashing of base metal contacts, which then must be carefully protected from "normal," volt ampere loads. The present invention, however, eliminates the need for this careful protection.

The switch of FIGURES 1, 2 and 3 is easily modified for double throw operation by the addition of a second, stationary contact 18'' as shown in FIGURE 4 which increases the versatility of the relay within the scope of the present invention. As shown, reference numerals of the elements of the switch of FIGURES 1, 2 and 3 are used here with a prime added to indicate corresponding elements. The movable blade 12' is bifurcated into a power contact portion 14' and a signal contact 16'. The first set of stationary contacts 18' includes the power contact 20' and the signal contact 22'. A second set of stationary contacts 18'' is provided, including a power contact 20'' and a signal contact 22''. The power contact 20'' is positioned in advance of the signal contact 22'' and is nearer the opposite set of contacts 18'. As before, a relay having an armature 24' with a lever arm 26' connected to it moves the blade 12'.

In the normal, deenergized state, the lever arm 26' is positioned slightly away from the movable blade 12', which is normally biased into contact with the second set of stationary contacts 18''. The second set of contacts may therefore be termed the normally closed (NC) set. On full energization of the relay, lever arm 26', bearing upon the signal contact portion of the 16' movable blade 12', drives the blade 12' into engagement with the first set of stationary contacts 18', which may be termed the normally open (NO) set. After energization, therefore, the state of the switch is as described above in connection with the embodiment of FIGURES 1, 2 and 3.

It will be recognized that the choice of resilient materials, the amount of normal spring bias, the relative

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dimensions of the power and signal portions 14', 16' of the movable blade 12' are all parameters which may be varied to determine the contact pressures available and the time interval between the breaking of a signal contact and the breaking of a power contact and the subsequent making of the opposite power contact and the making of the opposite signal contact. Those skilled in the art will readily determine the proper combination for optimum performance when the lever arm 26' is released. A similar sequence follows on deenergizing of the relay. The normal bias of the movable blade 12', and the added force on the signal contact portion 16' breaks the signal contact first and then the power contact. As the blade 12' moves to its rest position, the power contact portion 14' makes first and the normal bias of the blade causes the signal contact portion 16' to make with the normally opened (NO) set of stationary contacts 18'' also.

An alternative embodiment of the invention is shown in FIGURE 5 and includes a bifurcated movable blade 112 of resilient base metal, cantilevered from a mounting (not shown) and which is normally biased away from a fixed stationary contact 118 also of a base metal. As above, one of the blade portions is a power contact portion 114 and the other is a signal contact portion 116. The stationary contact 118 in this embodiment is a pair of stepped or staggered contact surfaces on a common, rigid member. A power contact surface 120 is positioned in advance of a signal contact surface 122 with respect to the approaching movable blade 112. Both contact elements are plated or flashed with a noble metal to increase the surface conductivity.

Attached to a relay armature 124 is a lever arm 126 which is shown in the partially energized state, adjacent the one of the portions of the bifurcated blade 112 corresponding to the signal contact portion 116. As before, when fully deenergized, the lever arm rests apart from the blade and when energized, the lever arm exerts by a force against the signal contact portion of the blade, to move the entire blade against the stationary contact 118. The power contact portion 114 makes with the stationary power contact surface 120 and the lever arm 126 continues to drive the blade at the signal contact portion 116 until it, too, makes with the signal contact surface 122 of the stationary member 118.

When the relay is deenergized and the lever arm 126 returns to its rest position, the internal forces of the resilient signal portion 116 of the blade 112 causes it to break first, quickly followed by the power portion 114. The normal resilient bias of the movable blade maintains the sets of contacts in the open state. It will be readily appreciated that the spacing between the power and signal contact surfaces 120, 122 is determined by many factors, including the resilience of the blade member 112 and the desired speed of make and break of the contacts. A second stationary contact set may be positioned to be normally closed when the relay is deenergized and therefore this embodiment, too, can function as a single pole, double throw switch, as shown in FIGURE 4 above.

Still another configuration according to the present invention is shown in the embodiment of FIGURE 6. The relay is substantially similar to that of the earlier embodiments and employs a pair of stationary contacts 218 comparable to those of the device of FIGURE 1. These stationary contacts 218 are resilient and one of them, designated the power contact 220, is, as in the device of FIGURE 1 above, positioned in advance of the other, designated the signal contact 220, with respect to a movable blade 212. In this embodiment, a non-bifurcated movable blade 212 is used and the desired make-break sequence of operation is effected by the movement of the blade into engagement first, with the resilient power contact 220 which is elastically deformed until contact is made with the signal contact 222 as well. A relay armature 224 carries a lever arm, 226 to drive the movable blade 212. When the relay is energized,

the blade is driven as described above and deenergization of the relay releases the armature 224 and the lever arm 226. The blade 212 springs away from the contacts under the combined forces of its own normal resilient bias and the added spring force of the deformed stationary contacts.

A second set of stationary contacts (not shown) can be added as in the embodiment of FIGURE 4 above, to enable single pole, double throw, operation with the contact sequence maintained as described above, and such modification is well within the skill of the art.

For certain applications, it is preferred to have a pair of so-called contact "buttons" as the contacting surfaces and these are carried by both the moving blade and the stationary contact. Contact buttons can be made of special materials of high conductivity or long wear or a combination of these properties and may be plated or flashed without the necessity of plating or flashing the entire blade and stationary contact assembly. Depending upon the usage envisioned, the buttons can be planar or curved. The curved buttons exert a much higher contact pressure since, ideally, touching spheres meet at a point. At the normal spring pressures used in relay switches, the contact pressure at a point can be substantial, resulting in some elastic deformation at the point of contact which materially aids in "self-cleaning" of the contact surfaces by fracturing and flaking off contaminant films.

One such switch embodiment 310 having contact buttons on a bifurcated movable blade 312 and on the stationary contacts 318 is shown in FIGURE 7. Buttons 330, 332 of different thicknesses are mounted to the portions corresponding to the power and signal portions 314, 316 of the movable blade 312. The stationary contact 318 consists of a pair of respectively corresponding buttons 324, 336 fastened to rigid mounts 320, 322. The power contact button 334 is positioned in advance of the signal contact 336 button as in earlier embodiments described above. The spacing between the buttons 324, 326 is partially determined by the relative thickness of the buttons and partially depends on the other parameters of the system, such as resilience of the blade 312 and relative size of the signal and power portions 314, 316. Upon energization of the relay the farther extending or power contact button 334 is made first and the blade 312 is elastically deformed until contact is made with the signal button 336. A slight overtravel can be provided to assure positive contact with both buttons and, upon release of the relay, the break of the signal contacts 332, 336 precedes the break of the power contacts 330, 334.

Other combinations of switches utilizing button contacts on resilient stationary contact members and a non-bifurcated blade will be obvious to those skilled in the art. In all variations, through the physical placement of the components, the power contact always makes before the signal contact and, on deenergization of the relay, the signal contact breaks before the power contact.

It will also be recognized by those skilled in the art, that, in each of these embodiments, the power contact should be physically displaced with respect to the signal contact to assure early making and late breaking of the power contact and, that at least one contact should be resilient.

It will also be readily apparent to those familiar with relay circuit design that, in every instance, a second set of stationary contacts, identical to the first, may be provided to cooperate with the movable blade to extend the versatility of the switch to include double throw operation. In such configurations, the movable blade is normally biased into engagement with one pair of contacts, the normally closed set (NC) and, upon energization of the relay, the blade makes with the other, or normally open (NO) pair.

Other configurations of the relay are also possible, such

as those wherein the armature is centrally mounted on a pivot to operate two movable blades in a double-throw, double pole arrangement, first connecting one diagonally opposed set of contacts and then, alternatively, connecting the other diagonal set. Still other relay configurations provide a plurality of movable blades, which are driven by a single relay armature, and it will be appreciated that every blade and contact set can be arranged according to the principles of the present invention.

What is claimed as new is:

1. A switching device for providing a low impedance circuit between a first and a second terminal to signals in the dry circuit range, said device comprising: movable contacting means including coplanar first and second resilient members having a noble metal plating for increased surface conductivity and being adapted to be commonly connected to the first terminal; stationary contacting means including a corresponding pair of contact members, positioned one in advance of the other with respect to said movable means, for mechanically and electrically engaging said first and second resilient members, respectively, said pair of members having a noble metal plating for increased surface conductivity and being adapted to be commonly connected to the second terminal; and driving means energizable to contact said movable contact means to bring said movable contact means into engagement with said stationary contact means in an ordered sequence, said driving means when deenergized moving out of contact with said contact means to release said movable contact means from engagement with said stationary contact means in the reversed sequence, whereby signals of voltage and currents exceeding the dry circuit range are incapable of damaging at least said other contact member and the resilient member cooperating therewith.

2. In a relay having first and second states, including a switch portion to interconnect elements of a low level circuit and having means for maintaining the low level capability of said switch after the application of higher level signals, said means comprising: a movable blade member of a resilient base metal having a noble metal plating to provide a highly conductive contacting area, said blade being mounted for cantilever operation and having a normal resilient bias; a bifurcated stationary contact of base metal having first and second contact bifurcations commonly connected electrically, said contact being positioned in the path of movement of said blade member with said first bifurcation being positioned in advance of said second bifurcation relative to said blade member, said contact bifurcations having a noble metal plating to provide a highly conductive contacting area; and driving means operable in response to the first state of the relay to engage said blade for moving said blade member against the normal bias into touching engagement with said first and second conductive bifurcations in order, said driving means being responsive to the second state of the relay to disengage said blade for releasing said blade member, said blade member under the force of the normal bias, first disengaging said second contact bifurcation to confine detrimental electrical activity to said first bifurcation on both make and break of the switch, whereby the low level signal conductivity of said second bifurcation is maintained substantially unimpaired.

3. In a low level signal switching device, a combination for prolonging the operating life of said device, the combination comprising: movable switch means of a base metal having a noble metal flashing including a first resilient member having a first contact and a second resilient member having a second contact, coplanar therewith; stationary contact means of a base metal having a noble metal flashing including a third contact positioned in the path of said first contact and fourth contact positioned in the path of said second contact in a staggered alignment, one of said contacts being positioned nearer said movable switch means; and driving means energizable for engaging first and second contacts to move

said contacts into electrical and mechanical contact with said third and fourth contacts, respectively, in sequential order, and said driving means when deenergized, disengaging said contacts to break contact in reverse sequential order, whereby the contact pair first to close is the last to open, and whereby voltage differences and current flow tending to destroy the noble metal flashing are confined to said contact pair first to close and last to open, thereby maintaining the low level signal capabilities of the contact pair last to close and first to open.

4. In a relay switch including base metal contact elements and a noble metal plating to provide highly conductive contact surfaces for low level signals, a combination for maintaining the low level capability of said switch after application of high level signals of magnitudes sufficient to damage the noble metal plating at the area of surface contact, said combination comprising: first and second contact arms movable relative to each other for conductive engagement, one of said contact arms being bifurcated at a free end; a first pair of contacts respectively located on each bifurcation and facing the other of said contact arms; a second pair of contacts on the other of said contact arms, respectively positioned to conductively engage said first pair of contacts, one contact of one of said pairs being positioned in advance of the other contact of said one of said pairs relative to said other of said pairs; and means for contacting said arms to move said arms relative to each other for establishing conduction between corresponding contacts of said pairs in a predetermined order and for disengaging said arms to break break conduction in reverse order, whereby at least one set of corresponding contacts maintains a highly conductive contacting surface for conducting low level signals after application of high level signals across said first and second contact arms.

5. In a relay switch having base metal contact elements with a noble metal plating to provide highly conductive contact surfaces for low level signals in the dry circuit range, a combination for maintaining low level circuit capability after application of signals of electrical magnitude sufficient to damage the noble metal plating, the combination comprising: first and second contact members movable relative to each other having noble metal plated contact surfaces and respectively adapted to establish a low level circuit in the dry circuit range; a pair of resilient contact projections extending from said first member and having noble metal plated contact surfaces, one of said pair being closer to said second contact member than the other of said pair; and means contacting said members to impart movement to said contact members for first establishing conduction between said second member and said one of said pair of projections and then establishing con-

duction between said second member and said other of said pair of projections, whereby application of signals of magnitude sufficient to damage the noble metal contact surface adversely affects only the contact area between said second member and said one of said pair of contacting projections.

6. A switching device adapted for inclusion in a dry circuit for maintaining the dry circuit capability of said device after application of signals of magnitude greater than dry circuit signals, said switching device comprising the combination of: moving switch means including a bifurcated element of a base metal having a noble metal contact surface commonly connected to a first terminal with a pair of contact members respectively located on each bifurcation, said bifurcations being resiliently coupled together for limited independent movement; first stationary contact means of a base metal having a noble metal contact surface including a pair of first stationary contacts respectively positioned to make first with one of said pair and then the other of said pair of contact members; second stationary contact means including a pair of second stationary contacts respectively positioned opposite said first stationary contact means to make first with said one of said pair and then said other of said pair of contact members, said moving switch means being normally biased into engagement with said first stationary contact means; and driving means energizable to overcome said switch means bias for disengaging said moving switch means from said first stationary contact means to break the respective connection and to engage said moving switch means with said second stationary contact means for making the respective connections, said one of said pair of contact members always making first and breaking last with the corresponding stationary contacts and the other of said pair of contact members always making last and breaking first with the corresponding stationary contacts, whereby damage caused by voltages and currents of magnitudes greater than the dry circuit range is confined to said one of said pair of contact members, and said other of said pair of contact members maintain its dry circuit capabilities.

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