March 8, 1966 N. LESSER 3,239,629

CONTACT OPERATOR

Filed Oct. 15, 1963 2 Sheets-Sheet 1

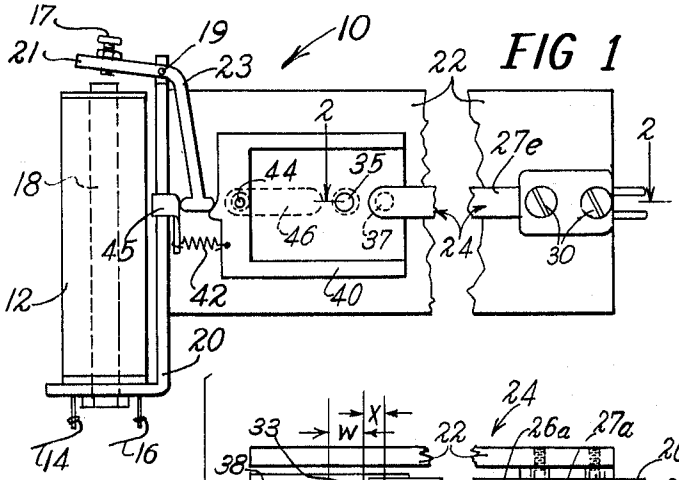



FIG. 1

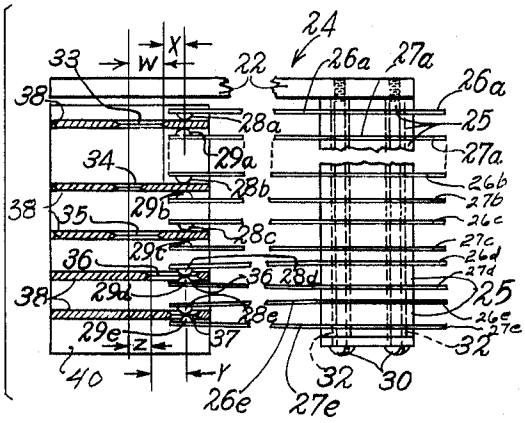



FIG. 2

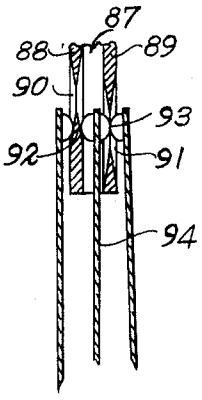



FIG. 5

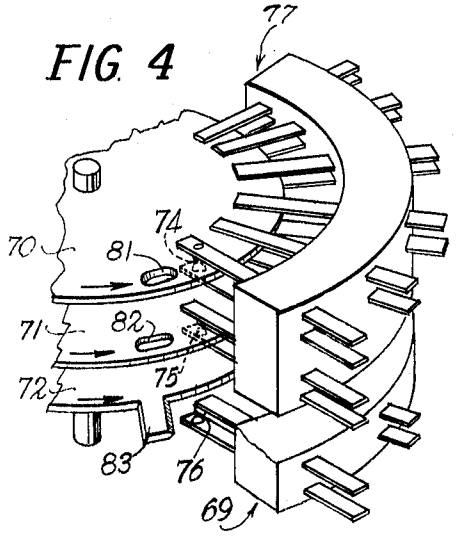



FIG. 4

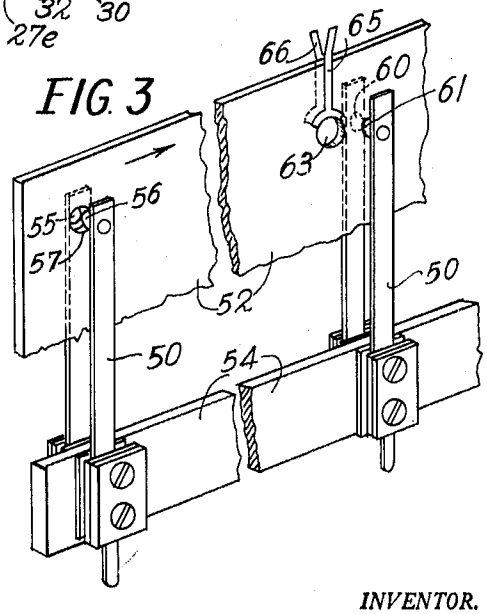



FIG. 3

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FIG. 6

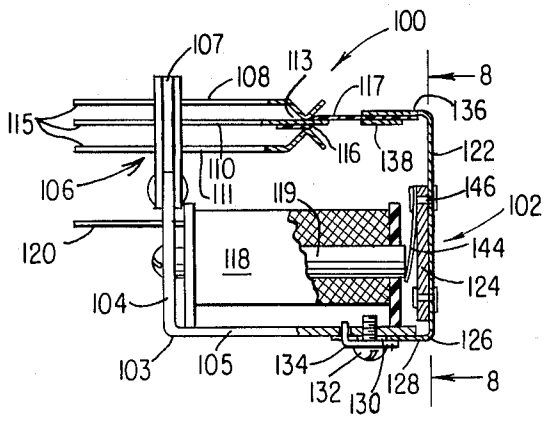



FIG. 7

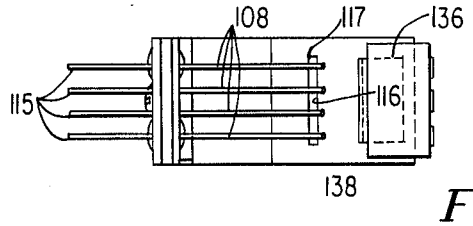
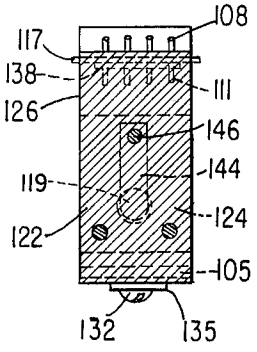



FIG. 8




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United States Patent Office 3,239,629 Patented Mar. 8, 1966



3,239,629

# CONTACT OPERATOR

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Filed Oct. 15, 1963, Ser. No. 317,106
7 Claims. (Cl. 200—104)

This is a continuation in part of application Serial No. 98,699, filed March 27, 1961, now abandoned and pertains to an invention which has evolved from the consideration of a number of problems presented in the construction and operation of electrical contacts, These problems include:

(1) Contact erosion and/or welding.

(2) Power requirements necessary to operate large numbers of contacts.

(3) Securing contact closure and/or opening within required time intervals.

(4) Enabling the sequential opening and/or closing of contacts simultaneously controlled from a common power source.

(5) Contact gap and spring adjustments.

By the use of a simple insulating card or sheet between respective contacts, the severity of the above problems and their economic consequences can be considerably reduced. In its simplest terms consider a pair of break contacts. The springs carrying such contacts are preformed or stressed so that when assembled the contacts are in engagement under a predetermined degree of spring pressure. Now if an insulating card be inserted between the contacts they will be held apart. If an aperture or notch is provided at a predetermined position in the card and the card moved to bring the aperture into alignment with contacts, the contacts close under their own spring pressure. They may therefore be separated by simply moving the card to bring the aperture out of alignment with the contacts. Thus the contacts may be made to serve as either normally open or normally closed contacts depending on the normal position of the aperture. The gap is determined by the thickness of the insulating card and requires no adjustment. With a card between each set of contacts it becomes a simple matter to move all simultaneously so that no special adjustment is required to compensate for the position of the springs in the pile up or other factors. Further by locating each aperture in a desired position in its card and/or controlling the aperture size both the operate and release time of the associated contacts may be easily controlled. Further by the location and size of the aperture the sequence of contact operation may be more easily controlled.

In relays or switches where the total movement of the card is limited to a predetermined small increment during which the card may clear the contacts but fail to clear the springs, a rigid card may prevent engagement between contacts. Thus if a rigid card is misaligned with respect to the plane of the contacts it may fail to disengage from one of the springs and thereby prevent movement of the spring to bring its contact into engagement with the contact of the other spring. This problem becomes more severe where a plurality of contacts are arranged in a common plane in which the rigid insulator must be in the same plane as each of the contacts. Further a rigid card on engaging the projecting surface of the contacts is presented with an obstacle which directly resists its movement and therefore tends to obviate the power gain ordinarily derived from the sliding separation of the contacts.

It is therefore desirable to use a plastic or deformable insulator which yields to some extent to the contact surface and to the spring pressure and thereby avoid rigid engagement with the contact and also permits contact closure even if slightly misaligned. It has however



evidently been heretofore believed that such an insulator would contribute to contact contamination.

To reduce the frictional forces required to move the card especially in the case of intermittently operated devices such as relays or stepping switches, where the card is always slid from a rest position, it is desirable to lubricate the card. Lubrication however, has also evidently been considered as a source of contact contamination in addition to creating maintainence problems.

The present invention however, utilizes an insulator or card of a plastic or deformable character for operating the contacts and further utilizes an insulator having inherent lubricating characteristics derived from materials having an integrally formed lubricating surface such as provided by polytetrafluorethylene, commonly known as Teflon. Such an insulator is particularly valuable since it is easily shaped or worked and provides a low static coefficient of friction with the static coefficient of friction falling with increasing load and does not result in contact contamination.

In many types of relays a stainless steel pin is used for pivotably mounting the armature at the end of the heelpiece with the pin being pivotably held in a yoke adapted to be fastened to the heelpiece. Both the pin and yoke are fabricated to extremely close tolerance and are expensive to manufacture and assemble. In addition the armature is usually provided with a nonmagnetic shim in the area where it engages the coil core to prevent magnetic sticking; and, in many relays using card actuated contacts the armature is returned to its normal position on coil de-energization by a special return spring.

Some attempts have been made in the past to provide an armature which is fixedly mounted on the end of the heelpiece for avoiding the pin and yoke construction referred to above. Such an armature would usually employ a spring material that is flexed on coil energization and whose resiliency would avoid the need for a separate return spring in the case of card actuated contacts. An armature of spring material however has certain disadvantages for example, arising from the stresses set up therein if given a sharp bend adjacent the end of the heelpiece in order to maintain a short magnetic circuit. In addition high operating forces are required if the bend or point of flexure is comparatively close to the coil core.

It is therefore additionally proposed in the present invention to utilize a relay armature of mild or cold rolled steel and preferably of soft iron that is rigidly mounted on the heelpiece and which may be given a sharp bend at the end of the heelpiece in order to maintain a closely coupled magnetic circuit without danger of rupturing on repeated flexing.

A rigidly mounted armature which will flex under normal magnetic fields has to be of very thin cross section and therefore will not carry much flux. In order to render such an armature operable or flexible with a minimum field and to render it sufficiently rigid, it is additionally proposed to increase the cross section of such an armature in the area adjacent the coil core and the end of the heelpiece by attaching thereto a plate of mild steel and preferably soft iron. This increases the flux carried in the critical areas and rigidifies the armature while enabling flexure with a minimum of force.

Under certain circumstances where the armature is required to operate a large number of contacts, magnetic sticking may eventually overcome the normal return forces. To avoid this result the present invention also contemplates a spring of non-magnetic material mounted on the armature and interposed between armature and the core. The non-magnetic spring in this position serves the dual purpose of aiding the return of the armature and as a shim to prevent magnetic sticking.

It is also contemplated in the present invention to use an improved armature of the type just described for carrying an insulator of the type described in the previous paragraphs. For this purpose an improved arrangement for mounting the insulator on the armature is considered among the objects of this invention.

The foregoing having described certain advantages and objects of the present invention, these together with others will become more clearly apparent on reading the following specification, claims and drawings; wherein:

FIG. 1 is an illustration of a relay utilizing the principles of the invention.

FIG. 2 is a view taken along the line **2**—**2** in FIG. 1.

FIG. 3 is a perspective view of another manner of controlling the operation of contacts such as shown in FIG. 1.

FIG. 4 is a view of a bank contact portion of a stepping switch.

FIG. 5 is an illustration of one manner of controlling a make and break spring contact operation.

FIG. 6 is a side elevational view of a relay partially in cross section utilizing the improved armature construction.

FIG. 7 is a top elevational view of the relay shown in FIG. 6; and

FIG. 8 is a sectional view taken along the line **8**—**8** in FIG. 6.

In FIG. 1 a relay construction **10** is illustrated. That relay includes a coil **12** adapted to be energized in any well known manner over the leads **14** and **16**. The coil **12** has a core **18** of appropriate material and is carried by the heelpiece **20**. The bracket **22** is formed on or carried by the heelpiece **20** and in turn supports the contact or spring pile up **24**.

When energized the coil **12** creates a magnetic circuit through the heelpiece **20** and the armature **21** pivotally carried at **19** on one end of the heelpiece to attract the armature **21** to the core **18**. The armature **21** pivots about **19** to move its lever arm **23** counterclockwise. A residual screw **17** is provided on the armature **21**. It limits the armature movement so as to provide an air gap between the armature **21** and core **18** to thereby prevent the armature from being delayed in returning to its normal position on de-energization of the coil **12**.

The spring pile up **24** may comprise a plurality of make and/or break contact sets or various combinations thereof with each contact carried by a respective spring as illustrated in FIG. 2. Thus in FIG. 2 a plurality of contact sets comprising the contacts **28***a* and **29***a*–**28***e* and **29***e* each carried by a respective spring **26***a* and **27***a*–**26***e* and **27***e* are illustrated. One end of each spring is mounted with the insulators **25** therebetween on the bracket **22** by means of the screws **30** which are provided with suitable insulating sleeves **32**. The springs **26***a* and **27***a*–**26***e* and **27***e* are preformed or stressed so that the respective contacts **28***a* and **29***a*–**28***e* and **29***e* would normally be in engagement under a desired degree of pressure, in other words—are formed as break contacts.

An insulating card or sheet **38**, however, is inserted between the respective contacts **28***a* and **29***a*, **28***b* and **29***b* and **28***c* and **29***c* to maintain them normally separated so that they may act as make contacts on energization of the relays **10**. The cards are provided with respective apertures **33**, **34**, **35**, **36** and **37** for the respective contact sets. The apertures **36** and **37** are aligned with respective contacts **28***d* and **29***d* and **28***e* and **29***e* respectively so that these contacts are normally break contacts. The other apertures **33**–**35** when aligned with their respective contacts permit the closure of those contacts under the tension of the respective springs. The cards **38** are supported in any well known manner by an appropriate bracket **40** to eliminate undesirable flexing. The design of the bracket **40** is of course subject to a number of factors so that its configuration and structure may vary over wide limits. Thus each card **38** may be provided with a separate bracket **40** and by suitable guide or stop arrangements each moved in a different manner.



The card **38** may comprise any one of a number of well known types of materials having desired characteristics. Plastics such as, for example, the saturated polyesters one of which is sold under the trade name Mylar: or others such as polytetrafluorethylene sold under the trade name Teflon may be used. Teflon evidently deposits a film on the surface with which it is in engagement and this film serves as a lubricant that provides a very low coefficient of friction. Such materials have excellent dimensional stability, tear or shear resistance, and desirable electrical and fabrication qualities. The rigidity of the sheet depends of course upon the quality of the material, its thickness and the unsupported area thereof. The desired normal separation between respective contacts **28***a* and **29***a*–**28***c* and **29***c* governs the thickness of the material. Normally in telephone circuits utilizing 48 volts, for example, a gap in the neighborhood of .006" would be provided between the contacts, and in other types the gap may be in the neighborhood of twice that amount. However, due to the high insulating qualities of the sheet **38** this may be lowered considerably if desired by simply using a thinner sheet, or if the gap is to be enlarged a thicker sheet is used.

The bracket **40** is movably supported on the bracket **22** by a pin such as **44** engaging a slot **46** in the bracket. The bracket **40** and sheets **38** are biased in one direction against the lever arm **23** by the spring **42**, and the movement in one direction by the lever arm **21**, bracket **40** and sheet **38** is limited by the stop **45**.

The movement of bracket **40** on energization of the coil is guided by the pin **44** in the slot **46** and is limited by the residual screw **17**. When the coil **12** is de-energized the spring **42** simply retracts the sheets **38** from their operated position.

If it is desired to operate the contacts as break contacts instead of make contacts, the position of the aperture is normally aligned with the contacts as shown, for example, at apertures **36** and **37**. The aperture is moved out of alignment with contacts **36** and **37** when the coil is energized so that the card **38** opens the contacts. If the contacts are to be operated as make contacts the card is located between the contacts and on energization of the coil the apertures **33**–**35**, for example, are moved into alignment with the respective contacts and they close under their own tension. If a large number of contact springs are to be operated in the pile up, this permits all springs to be preformed and assembled in the same manner whether operated as break or make contacts, thus minimizing assembly and spring adjustment and problems as to the gap size for each spring combination. It will be noted that the amount of force necessary to operate the springs need only overcome the bias of spring **42** and the inertia of bracket **40** and sheet **38**, the frictional forces of the contacts against the sheet **38** and such force as necessary to initially pry the break contacts apart. The biasing spring in retracting the sheet **40** need only overcome the force involved in the described factors and the mass of the armature and lover arm plus any residual magnetism. Since the mass of the elements and the frictional and prying forces are comparatively nominal, little power is needed either by the biasing spring in overcoming those forces or by the energized coil, thus permitting a large number of springs to be simultaneously controlled by the coil. All springs may be of the same gauge and receive the same prestressing or forming.

The time interval at which the contacts are permitted to operate after the coil is energized is governed by the location or the size of the aperture and the velocity of the card. By locating the aperture at a desired point from the contacts it must travel $x$ distance as shown for aperture **33** after the coil is energized before permitting contact closure between **28***a* and **29***a*. If the contacts are to open a certain time interval after energization the size of

the aperture **36**, for example, is dimensioned so that it travels *y* distance before the card **38** separates contacts **28***d* and **29***d*. Thus a simple expedient is available for governing the operating time of the contacts. The release time of the make contacts may be governed by the size of aperture **33**. Thus by making the aperture large and having the sheet **38** travel some distance after the make contacts are closed the contacts **28***a* and **29***a* are located *w* distance from the aperture edge. Thus on de-energization of the coil **12** that distance must be traversed before the contacts open, thereby governing the release time of the contacts. For break contacts such as **28***d* and **29***d* the procedure for governing the release time after de-energization of the coil is simply reversed. Thus by moving the sheet **38** some distance *z* after the break contacts **28***d* and **29***d* are open, the release time of the break contacts is governed by the time period necessary to return the aperture **36** into alignment with the contacts. One set of contacts may be made to operate several times for one operation of another by simply providing spaced apertures each operating the one set of contacts in a desired sequence while another is operated by a single aperture or hole, for example, or in another sequence.

Inspection of FIG. 2 will also illustrate another facet of the invention. For example, consider the make contacts **28***a* and **29***a*–**28***c* and **29***c*. Since the edges **33**, **34** and **35** are each spaced a different distance from the respective make contacts, those contacts will operate in a respective sequence on energization of coil **12**. Thus the contacts **28***a* and **29***a* operates before contacts **28***b* and **29***b* and **28***c* and **29***c*. Contacts **28***c* and **29***c* operate in a time interval after **28***a* and **29***a* determined by the distance between the respective aperture edges. Contacts **28***b* and **29***b*, of course, operate in another time interval determined by the distance between aperture **34** and contacts **28***b* and **29***b*. With respect to contacts **28***d* and **29***d* and contacts **28***e* and **29***e* it will be noted that contacts **28***e* and **29***e* will operate or break before contacts **28***d* and **29***d* due to the spacing of the back edges of the apertures **36** and **37**. Likewise the spacing of the back edge of aperture **36** with respect to the front edge of apertures **33** and **35**, for example, enables contacts **28***a* and **29***a* and **28***c* and **29***c* to close before contacts **28***d* and **29***d* open. Contacts **28***e* and **29***e*, for example, open before contacts **28***b* and **29***b* close. Thus a large number of desired sequences of contact operation may be easily arranged. It will be noted that the use of an aperture in preference to complete disengagement of the card enables far superior support to be provided to edges disengaging the contacts and prevents buckling

On de-energization of the coil **12** the cards **38** travel back to their original position. The location of the aperture edge with respect to the contacts will now control the time sequence of contact release. Thus contacts **28***b* and **29***b* open before contacts **28***a* and **29***a*. Contacts **28***d* and **29***d* close before contacts **28***e* and **29***e* close or before contacts **28***a* and **29***a* open, for example. The condition of contact release is therefore also easily susceptible to control. In addition if the cards **38** are to be separately guided or moved and/or the apertures given respective configurations and the cards guided accordingly, the time squence of contact operation may be varied in any one of a number of different manners.

The previous discussion has contemplated a spring pile up of a considerable number of springs in a single aligned array with a different sheet **38** between respective contacts. A plurality of such arrays or contact pile ups **50** as shown in FIG. 3 may be also used together with a simple sheet **52** for operating the respective contacts in each pile up. Each pile up **50** is mounted in respective spaced apart locations on a bracket **54** and the single sheet or card is adapted to traverse or engage with one of the contact sets in each pile up. This arrangement permits a plurality of contacts to be disposed laterally and operated simultaneously by a single insulator sheet or card controlled by a relay armature or lever.

The card **52** is moved in any one of a number of well known manners to the right, for example, as shown by the arrow. When this occurs one set of contacts in each pile up is operated. Thus the contacts **55** and **56** open as the aperture **57** moves out of alignment therewith. The contacts **60** and **61** on the other hand close as the aperture **63** moves into alignment therewith. The operative sequence may be controlled as already explained. In addition another feature is illustrated in FIG. 3. This is an additional arrangement for quenching any tendency to arc. Thus a conductive coating **65** and **66** may be applied to respective sides of the sheet **52** adjacent the aperture **63**, for example, and suitable spark supression means connected thereto.

The means for moving the sheet need not be limited to a relay, of course, but instead such devices as stepping switches of cams may also be used. Thus in FIG. 4 a portion of a multiple level switch **69** is shown having a series of sheets **70**, **71** and **72** arranged to be given a rotary or similar movement. The sheets replace the conductive wipers normally used and are arranged to engage the respective bank contacts **74**, **75** and **76** of a multiple level bank **77**, for example. The contacts are arranged as normally closed contacts and the respective sheet maintains control of their position. In this type of operation usually the first contacts in each level are operated when the switch is in position **1**, and the second and succeeding contacts of each level are operated when the switch is in position **2** or respective succeeding positions. The sheets **70**, **71** and **72** are provided with respective apertures **81** and **82** and the ledge **83**. The position of these is changed so that they successively engage the contacts of respective levels in positions **1**, **2** and **3**, etc. Thus as the cards **70**, **71** and **72** rotate to their first position contacts **74** and **75** close while contacts **76** open and the ledge or projection **83** opens contacts **76**. Due to the position of the edge of aperture **82** with respect to aperture **81**, contacts **74** close before contacts **75**. Also due to the position of ledge **83** with respect to aperture **82**, the contacts **75** will close before contacts **76** open. The spacing of the edges may, of course, determine the time of contact operation with respect to card movement.

When the cards **70**–**72** are moved to the succeeding position, contacts **75** open after contacts **74**, and contacts **76** close after contacts **75** open. This, of course, is due to the size of the apertures **81** and **82** and the ledge **83**. Thus a number of control functions similar to those previously described for a relay may also be facily performed in a rotary switch in addition to other described advantages. If desired a common stationary wiper appropriately shaped may be used in place of one spring of each set and the appearance of an aperture between the wiper and spring will permit closure.

In FIG. 5 a simple arrangement for a set of make and/or break contacts is shown. A bracket **87** holding a pair of insulating cards **88** and **89** having a respective aperture **90** and **91** is arranged to control the make contacts **92** and break contacts **93**. Thus movement of the bracket **87** brings the card **89** into alignment with contacts **91** to open those contacts. The aperture **90** being brought into alignment with contacts **92** permits their closure. Spring **94** may be made to normally assume a neutral position with springs **95** and **96** biased towards spring **94**. On the other hand card **88** may be omitted and card **89** can be used to move spring **94** for causing engagement of the contacts **92**.

In FIGS. 6, 7 and 8 one practical version of the insulator described in the previous paragraphs is shown for use with a relay **100** having an improved armature **102** of a character described heretofore. The relay **100** comprises a conventional L shaped heelpiece **103** defining

a vertical arm **104** and a horizontal arm **105**. The arm **104** carried a contact bank **106** at its upper end.

The bank **106** includes an insulating structure **107** in which a plurality of rows of springs **108**, **110** and **111** are fixed. The springs **108** of the upper row and **111** of the lower row engage a respective spring **110** of the center row to define four sets of respective contacts **113** and **114**. The contacts **113** are normally closed to enable the completion of an electrical circuit through terminals **115** while contacts **114** are normally held open by one edge of a slot **116** in a Teflon insulator **117** carried at the upper end of armature **102**.

A coil **118** having a core **119** is mounted on the heelpiece below a contact bank **106**. When the coil is energized by an electrical circuit completed through terminals such as **110**, the armature **102** is adapted to be attracted to the end of the core.

The armature **102** comprises a thin sheet **122** of soft iron carrying a soft iron plate **124** between the sheet and the core. The sheet preferably is less than .02" and should be approximately .01" for long continued non-stick operations with the four form C contacts illustrated in bank **106**, while the plate **124** may be between .025" and .070". The sheet **122** is provided with a sharp bend **126** approximately 90° adjacent its lower end. The bend **126** serves as a point of flexure for the armature when attracted by the core **119**. A horizontal leg **128** extends from the bend. The leg **128** is provided with a slot **130** whereby the armature may be adjustably mounted and fixed on the heelpiece leg **105** by means of a screw **132** and a clamp washer **134**. The bend **126** is approximately .05" from the core while the gap between the plate **124** and the core is approximately .02" to .025" so that a short closely coupled magnetic path is provided.

Since the sheet **122** is quite thin it offers little resistance to flexure while the heavy plate **124** provides sufficient cross section to carry the flux between the heelpiece and core with the minimum distance possible provided between the end of the heelpiece leg **105** and plate **124**. Since the weight of the plate **124** acts primarily along the longitudinal axis of the sheet **122** and transverse to the bend **126** there is little tendency for the sheet **126** to flex about the bend under the influence of the plate, while the plate in turn tends to rigidify the armature in areas other than the bend.

The upper end of the sheet **122** is also provided with a horizontal leg **136** that carries the insulator **117** of the type already described or of the type described in copending application Serial No. 98,699, now abandoned. The leading edge of the slot **116** in the insulator **117** is located between springs **110** and **111** to hold contacts **114** open while the opposite edge of the slot **116** is adapted to be moved between normally engaged contacts **113** for opening the same on attraction of the armature to the core. The leg **136** is provided with a depending tang **138**. The tang **138** is extended through an aperture in the insulator and bent over after the edges of the slot **116** are aligned as desired with the contacts **113** and **114** to clamp the insulator in position. Actually a number of such tangs or tines may be provided and they may simply pierce the insulator and be bent over to clamp the insulator. Additional adjustment may be provided by flexing the sheet **122** between the upper end of plate **124** and the leg **136**. An epoxy may cement the tang to encapsulate the insulator.

It will be noted that backstops are not provided for limiting the return movement of the armature **102**. This is another advantage since repeated blows by the armature against the backstop may throw the armature out of adjustment. In the relay **100** on the other hand, the angle of the bend **126** or any other bend provided in the vertical leg of the armature together with the resiliency of the armature and the pressure of the springs cooperate to return the armature to the same position on each operation.

When the coil **118** is energized the armature **102** is attracted thereto to simultaneously move the leading edge of slot **116** from between the contacts **114** to permit them to engage while the opposite edge of the slot separates contact **113**. On de-energization of the coil, the normal resiliency of the soft iron sheet **122** serves to return the armature and insulator to normal thereby returning the contacts to normal. With the arrangement shown four or five form C contacts are operable on approximately 75 milliwatts. Under certain circumstances such as when more than five contacts **113** and **114** are provided, the normal resiliency of the sheet **122** may be insufficient to return the armature after many cycles of operation.

To overcome this situation an elongate spring **144** approximately .005" thick and of non-magnetic material is provided. One end of the spring is fastened to the plate **124** at rivet **146** and the other end is located between the core **119** and the plate **124** so that when the armature is attracted to the core the spring is placed under tension as the armature approaches the core while the thickness of the spring serves to space the armature from the core to reduce the danger of sticking.

The foregoing is a description of a number of concepts for achieving improved results in the operation of electrical contacts, and whose inventive concepts are believed set forth in the accompanying claims.

What I claim is:

1. A switch construction comprising an electromagnetic actuator, one contact carried by a cantilever spring, another contact carried by a cantilever spring for mating with said one contact under the biasing tension of one of the respective springs, and an insulating member having an integral lubricating surface for sliding between said contacts in response to either the energization or de-energization of said actuator.

2. A spring pile up for use as a switch comprising a plurality of cantilever springs having a support at one end and arranged in pairs with each pair engaging at a respective point lying on an axis transverse to the longitudinal axis of said springs and on a common line having a constant distance from said support and at a substantially irrelevant position with respect to each other for extending a respective electrical circuit therethrough, and an electrically insulating structure of deformable material material mounted for sliding movement between said springs of only a predetermined increment substantially perpendicular to each transverse axis for separating the springs of each pair during said movement.

3. A switch construction in which an electromagnetic actuator is arranged to be successively energized for selecting a different pair of contacts for operation on each successive energization of said actuator, the improvement comprising an arrangement for biasing one contact of each pair towards engagement with the other contact, and a plastic insulating member having an integral lubricating surface arranged to be moved successively a predetermined increment only in response to each energization of said actuator to disengage each pair of contacts successively.

4. For use in a stepping switch wherein a coil is periodically energized for selecting one of a plurality of positions dependent on the order of the energization, a spring individual to each position biased for movement in one direction to engage with another spring, and a plastic deformable sheet insulating member always maintained between the springs at each position and moved only a predetermined increment responsive to each successive energization of said coil, said member arranged to permit one spring in the position corresponding to the order of the energization to engage with the other spring while still maintained between said engaged springs.

5. A relay comprising a coil adapted to be energized by an electrical current, a plurality of spring pairs with the springs of each pair adjusted to normally engage at

a respective point adjacent common plane to form sets of contacts lying along a common straight line transverse to the longitudinal axis of each spring pair, a deformable insulating sheet adapted to be moved in said plane for simultaneously operating all of said spring pairs regardless of the position of said spring pairs with respect to each other, and means for moving said sheet one predetermined increment only for simultaneously operating all of said spring pairs responsive to each energization of said coil.

6. A relay comprising a coil adapted to be energized by an electrical current, a plurality of spring pairs with each pair having a supported end and adjusted to normally engage at a respective point lying along a common straight line equidistant from said supported end of each spring transverse to the longitudinal axis of each pair, and an insulator of polytetrafluorethylene for each pair adapted to be moved a predetermined increment only between said spring pairs and substantially parallel to the longitudinal axis of each pair responsive to the energization of said coil for operating all of said spring pairs irrespective of the position of said spring pairs with respect to each other.

7. A relay comprising an electrically insulating deformable sheet material having an integral lubricating surface and normally held in one position, a coil energized for moving said material from said one position to only one other position on each energization of said coil, and a plurality of contacts each carried by a respective cantilever spring biased to bring said contacts into engagement, said material being always disposed between said springs and moved between said contacts alternatively when said material is either in said one or in said other position.




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