

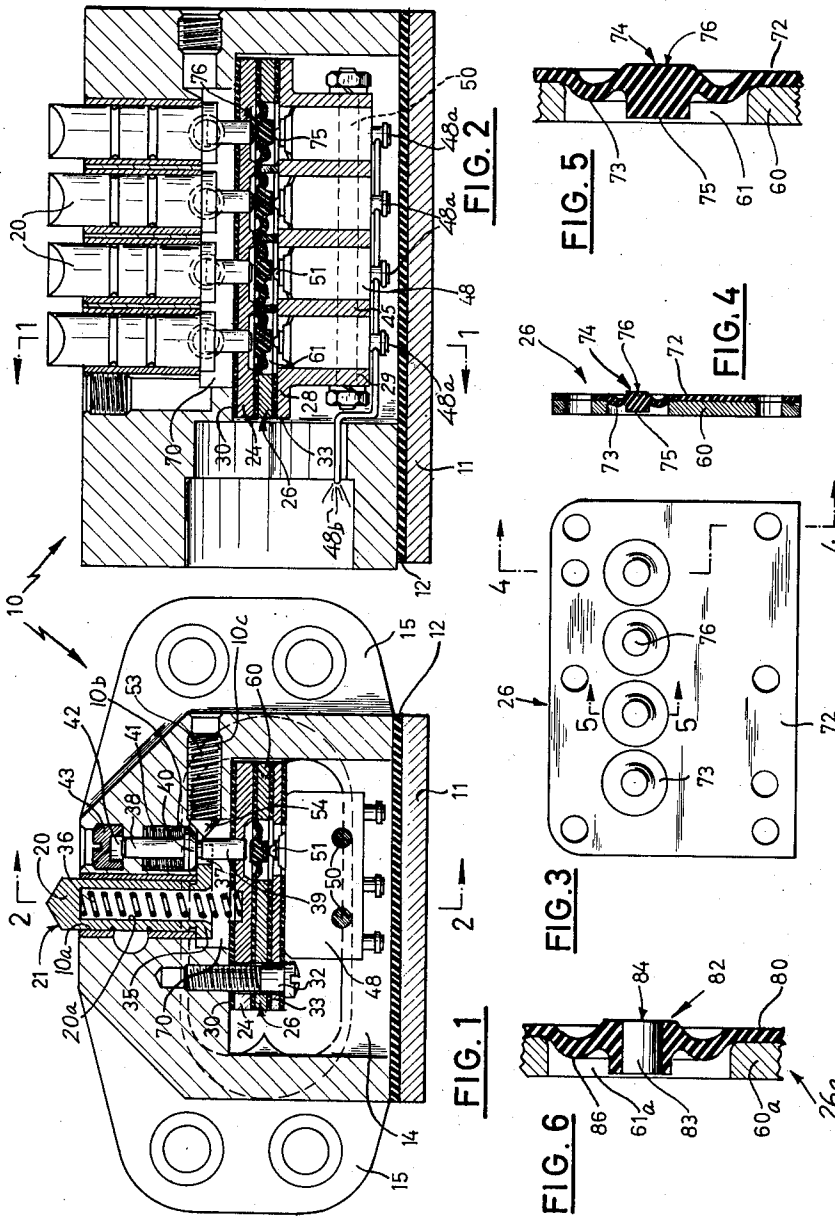
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ELECTRIC SWITCH AND SEALING ELEMENT THEREFOR

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ELECTRIC SWITCH AND SEALING ELEMENT THEREFOR

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The present invention relates to improvements in electric switches, and more particularly to devices of the type known as limit switches. The invention also relates to a novel sealing element for use in such switches.

It is already known to utilize limit switches with one or more actuating elements which are operated from the outside, for example, by movable component parts of machine tools or the like. The movable part or parts of the machine tool would act against and axially displace the spring biased actuating element or elements of the limit switch whereupon each actuating element operates an electric switching unit built into the housing of the limit switch and comprising fixed and movable contact members of known construction. The movable contact member of each switching unit and the respective actuating element are preferably separated by a sealing plate of elastic material whose peripheral zones are rigidly held in the housing of the limit switch. The elastic plate is subjected to considerable deformation during each movement of the actuating element or elements and, being positively held solely along its peripheral zone, the major portion of its body follows the movements of respective actuating elements when the operation of one or more switching units is desired.

It has been found that, due to such mounting, the elastic sealing plates in known limit switches are rapidly subjected to more or less permanent deformation and, consequently, do not return into exact neutral or idle positions after comparatively short periods of use. This is due to the fact that relatively large areas of the sealing plate are caused to move whenever the respective actuating element is displaced. As a consequence, the operation of limit switches utilizing such sealing plates becomes unreliable after comparatively short periods of actual use. In addition, as the relatively large outer or exposed surface of each movable portion in such sealing plates is often subjected to detrimental effects of moisture, lubricating oil, raw oil or dust, such foreign substances further accelerate the dislocation, permanent deformation and destruction of the sealing plate, which, in turn, further increases the likelihood of faulty and unreliable operation and may even cause permanent damage to the limit switch.

An important object of the present invention is to provide an electric switch which fully overcomes the aforementioned drawbacks of prior switching devices in that it positively prevents entry of foreign matter into the compartment in which the switching unit or units are mounted; which is reliable in operation over prolonged periods of actual use; which is of very simple construction; and which may be utilized as a single or as a multiple switch.

Another object of the invention is to provide a limit switch embodying a novel sealing element which is so constructed as to return into neutral or idle position after each deformation occurring whenever the switch is put to use; which cannot become distorted when the switch is actuated; which cannot be removed from sealing engagement with other component parts of the switch during actual use; and which may be simultaneously utilized as a sealing means for two or more switching units.

A further object of the instant invention is to provide a limit switch of the above outlined character which is so

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constructed that the force with which its actuating element or elements bear against the aforementioned sealing element may be adjusted within any desired range.

A still further object of the invention is to provide a limit switch embodying a novel sealing element of the above described type which is particularly suitable for use in connection with machine tools, and which is capable of being put to use in a number of different positions.

A yet further object of the invention is to provide an electric switch for use as a limit switch whose sealing element for the switching unit or units may be readily inserted into or removed from the housing of the switch, and whose switching unit or units may be actuated directly or indirectly over suitable motion and pressure transferring members.

The above and certain other objects of the invention are attained by the provision of an electric switch, preferably of the type known as limit switch, which comprises a housing formed with a suitable chamber for reception of at least one switching unit of known construction, i.e. comprising a fixed and a movable contact member which latter extends therefrom and, upon depression thereof, operates the switching unit to establish or break the electric circuit in which the unit is installed. The housing also supports actuating means for each switching unit, each actuating means comprising a spring biased push-button which may be so installed in the housing as to directly operate the movable contact member of the respective switching unit, or may be operatively connected with a second actuating element in the form of a stud or the like which latter is caused to engage a movable contact member whenever the push-button associated therewith is moved in a direction to extend further into the housing.

The novel sealing element which separates each actuating means from each switching unit comprises a rigid plate-like carrier, preferably made of a suitable metallic material and formed with one or more preferably circular apertures, one for each movable contact member, the apertures being located in surrounding relationship about the respective movable contact members. The carrier is securely fixed into the housing and is in face-to-face contact with the second component of the sealing element which consists of an elastic foil or sheet, preferably made of rubber, of an elastic synthetic plastic, or of a highly elastic metallic sheet material. The foil seals each aperture in the carrier and is rigidly secured thereto, e.g. by means of an adhesive or in any other suitable way. That portion of the foil which seals an aperture in the carrier constitutes a flexible diaphragm which is formed with an endless, preferably circular, corrugation or bead surrounding a preferably reinforced portion of the foil there-within, this reinforced portion serving as a means for transmitting motion to the movable contact member of a selected switching unit when the respective push-button is depressed in a direction to extend further into the housing.

The motion transmitting portion of each diaphragm may be of circular shape and may extend at least slightly into the respective aperture in the carrier. If desired, a preferably metallic insert of cylindrical or other shape may be embedded, e.g. vulcanized, into the motion transmitting portion to directly engage with the adjacent movable contact member when it is directly or indirectly displaced by the push-button of respective actuating means.

The housing of the switch may comprise two or more switching units and an equal number of push-buttons which may be arranged in a single row or in pairs, depending upon the intended use of the apparatus. The novel sealing element constitutes an air- and water-tight sealing means between the actuating means and the

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switching units and, as the diaphragms may be of comparatively small diameters, their exposed surfaces are not likely to be rapidly destroyed by moisture, oil, dust or other foreign matter. In addition, the novel sealing element, too, may be separated from atmosphere by suitable cover plates and sealing rings which latter, however, are then formed with adequate openings to permit reciprocating movements of certain components of the actuating means into contact with the diaphragm or diaphragms of the above described foil which forms part of the novel sealing element.

Adjusting means may be provided for controlling the extent to which the movable element or elements of actuating means may displace the respective diaphragm or diaphragms, i.e. to control the extent to which the respective movable contact member or members are depressed when a switching unit is operated. The foil may consist of a single homogeneous body of elastic material, or it may consist of several smaller units individually secured to the carrier.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of two specific embodiments when read in connection with the accompanying drawing, in which:

FIG. 1 is a transverse section through a limit switch embodying my invention, the section being taken on line 1—1 of FIG. 2, as seen in the direction of arrows;

FIG. 2 is a section through the limit switch taken on line 2—2 of FIG. 1, as seen in the direction of arrows;

FIG. 3 is top plan view of a plate-like sealing element constituting a component part of the limit switch shown in FIGS. 1 and 2;

FIG. 4 is a transverse section taken substantially along the line 4—4 of FIG. 3, as seen in the direction of arrows;

FIG. 5 is a greatly enlarged fragmentary sectional view illustrating a detail of the sealing element, the section being taken on line 5—5 of FIG. 3; and

FIG. 6 is a similar fragmentary sectional view showing a detail of a modified sealing element.

Referring now in greater detail to the drawing, and first to the electric switch shown in FIGS. 1 and 2, the device therein shown is a so-called multiple limit switch consisting of four individual switch assemblies which are arranged in a single row. The multiple switch comprises a housing or casing 10 whose open lower end is closed in actual use by a cover or lid 11 with a packing in the form of a sealing plate 12 interposed between parts 10 and 11. Adjacent to the inner side of sealing plate 12, the housing 10 defines a space or chamber 14. Flanges 15, connected to and extending from the outer sides of housing 10, facilitate connection of the multiple switch at any point of desired use, for example, to a machine tool or the like.

Since the four individual switch assemblies which constitute the multiple switch of FIGS. 1 and 2 are of identical construction, only one will be described in full detail hereinafter. The terms "upper," "lower," "lateral" etc. which will be utilized in the following part of this description, of course, refer to the parts so positioned only when the multiple switch is in the position of FIGS. 1 and 2, it being understood that the switch will operate in identical fashion when turned through any desired angle from the position shown in said figures.

The individual switch assembly shown in full detail in FIG. 1 comprises an actuating element or push-button 20 whose upper end extends beyond the housing 10 and is bounded by a pair of inclined surfaces 21. The main body portion of actuating element 20 is reciprocally received for axial movements in a vertical bore 10a formed in housing 10, and has a coaxial blind bore 20a receiving a helical expansion spring 36. The lower end of actuat-

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ing element 20 terminates in an external collar 35 which is normally urged by resilient element 36 against a shoulder at the lower end of bore 10a in which the main body portion of element 20 is received. The right-hand side of collar 35 is formed with a bifurcated extension or stop 37.

Adjacent to the upper end wall of chamber 14 in housing 10, there is provided a cover plate 24 and adjacent thereto a sealing element 26. The flange 28 at the upper end of a holder 29 is adjacent to the underside of sealing element 26 which latter is shown in greater detail in FIGS. 3 to 5. A sealing ring 30 is disposed between the upper end wall of chamber 14 and the upper side of cover plate 24, and a similar sealing ring 33 is inserted between the underside of sealing element 26 and the upper side of flange 28. Parts 24, 26, 28—29, 30 and 33 are fixed to the housing or casing 10 by one or more screws 32. The lower end of aforementioned expansion spring 36 extends through an opening in sealing ring 30 and is received in a shallow groove formed in the upper side of plate 24. Thus, spring 36 constantly urges the upper end of actuating element 20 in a direction away from housing 10 to the extent determined by collar 35 which then abuts against the upper end wall of a recess or cavity 70 separated from chamber 14 therebelow by sealing ring 30.

A bolt 38 is installed in the bore 10b of housing or casing 10 and is preferably parallel with the axis of push-button or actuating element 20. At its lower end, the second actuating element or bolt 38 is formed with an annulus 40 whose frustoconical lower half tapers inwardly and downwardly and is connected to or integral with a downwardly extending cylindrical stud 39. The bifurcated portion 37 of external collar 35 at the lower end of push-button 20 engages with the underside of annulus 40 and thus determines the extent to which the bolt 38 can move in downward direction under the action of a helical expansion spring 41 which latter operates between the upper end wall of bore 10b and the annular member 40. Spring 41 is weaker than the first-mentioned spring 36 in the bore 20a of actuating element 20. The upper end of the second actuating element or bolt 38 extends into the bore 42 of a terminal screw 43 which latter is retained in the switch housing 10.

The holder 29 comprises a series of spaced vertical webs or walls 45 (see FIG. 2) defining a series of recesses for reception of switching boxes or units 48 fixed to webs 45 by anchor bolts 50. Each unit 48 comprises an upwardly extending contact pin 51, and opposite thereto terminals 48a are provided to which wires 48b are attached as by soldering.

An adjusting screw 53 is threaded into a tapped horizontal bore 10c formed in the casing 10. This screw is formed with a conical end portion 54 which cooperates with the frusto-conical lower half of annulus 40 at the lower end of bolt 38.

The sealing element 26 is shown in full detail in FIGS. 3 to 5. It comprises a plate or carrier 60 made preferably of a metallic material, e.g. steel, and a homogeneous sealing sheet or foil 72 which is in face-to-face sealing contact with member 60, e.g. it may be glued, vulcanized or otherwise securely connected thereto. Carrier or plate 60 is formed with circular cutouts or apertures 61, one for each cylindrical stud 39, enabling the latter to act against the contact pins 51 of respective switching units 48. The circular zones of foil 72 which cover the apertures 61 constitute four diaphragms 74 each of which is formed with a reinforced median portion 75 whose purpose is to transfer pressure and motion from respective stud 39 to adjacent contact pin 51. The (in FIGS. 4 and 5) left-hand ends of pressure and motion transmitting members or portions 75 project to a certain extent into the respective cutouts 61 in carrier 60. The ends of cylindrical studs 39 are adapted to engage with the outer end faces 76 of respective members 75. Each

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relatively small and preferably, though not necessarily, circular membrane 74 comprises an endless annular corrugation or bead 73 which surrounds the respective pressure transmitting member 75.

The material of which the sheet or foil 72 is made may be rubber, an elastic synthetic plastic, or a highly elastic metallic substance. It is equally possible to utilize a number of individual foils each of which then covers one of apertures 61 in carrier 60 and has its peripheral zone rigidly fastened to the latter. However, a homogeneous, unitary foil is preferred because its material is less likely to show signs of fatigue or breakdown and, consequently, remains operative during a practically unlimited number of switching operations even under very unfavorable operating conditions. This is particularly important when the novel switch is utilized in expensive machine tools.

The multiple switch operates as follows:

When a push-button 20 is depressed against the force of constantly acting resilient means 36 in its blind bore 20a, the collar 35 and forked portion or stop 37 move in downward direction to release the second actuating element or bolt 38 which latter is then set in motion under the influence of its spring 41 in the respective bore 10b of the housing 10 until the annulus 40 comes into abutting contact with the conical end 54 of adjusting screw 53. The cylindrical stud 39 is pressed against the end surface 76 of the member 75 forming part of respective diaphragm or membrane 74 which latter is subjected to elastic deformation thus enabling its member 75 to displace the contact pin 51 of the respective switching unit 48. The corrugation 73 allows for practically unrestricted movements of the central portion of diaphragm 74 in response to movements of stud 39 thereagainst.

As is shown in FIGS. 1 and 2, the recess 70 is practically perfectly sealed from chamber 14 therebelow by ring 30, cover plate 24 and by the cylindrical studs 39 which latter are snugly received in openings provided therefor in member 24. An additional and even more perfect seal between chamber 14 and recess 70 is provided by the sealing element 26 whose continuous foil 72 is tightly pressed against the underside of cover plate 24 by screws 32. As before stated, the lower end of chamber 14 is completely sealed from atmosphere by the packing 12 and lid 11; thus, the switching units 48 are fully protected from dust, moisture, or any other foreign matter.

FIG. 6 illustrates a modified sealing element 26a consisting of a carrier or plate 60a which is identical with member 26, and of a slightly different sealing foil 80. The latter comprises at least one diaphragm 82 which seals the respective cutout or aperture 61a in plate-like carrier 60a, the diaphragm being formed with a reinforced median portion 84 surrounded by an endless annular corrugation or bead 86. The pressure and motion transferring portion or member 84 coaxially receives a preferably metallic insert 83 of cylindrical contour which is securely embedded therein. Thus, if the diaphragm 82 consists of rubber or an elastic synthetic plastic substance, the rigid insert 83 may be vulcanized or glued into its reinforced portion 84. The function of this combined sealing and pressure transferring element 26a is identical with that of composite member 26.

Another important advantage of foil 72 or 80 is in that, due to the provision of corrugations 73, 86, respectively, only the reinforced median portion 75 or 84 performs movements when a stud 39 abuts thereagainst, while the peripheral zone of each membrane which is glued or otherwise sealingly connected to respective carrier 60, 60a is not subjected to any stresses. Consequently, the sealing connection between the foil 72 or 80 and carrier 60 or 60a, respectively, is not affected by the movements of studs 39 and of diaphragm zones within

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corrugations 73, 86, respectively. Any stresses which, in prior switch assemblies, are transmitted to the peripheral zones of diaphragms are taken up and neutralized by aforementioned corrugations or beads, thus insuring longer useful life of the novel switch assembly and lesser wear and tear on its sealing element. Moreover, the corrugations maintain the pressure and motion transferring members 75 or 83 in proper position, i.e. centrally in respective apertures 61, 61a, and thus prevent any malfunctioning of switching units 48.

It will also be understood that the push-buttons 20 may be formed with extensions similar to studs 39 and so installed in housing 10 as to act directly against members 75 or 83, in which case the bolts 38 may be omitted together with springs 41 and annuli 40.

Without further analysis the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An electric limit switch comprising, in combination: a housing; at least one actuating means each including a spring biased push-button reciprocally installed in said housing and constantly urged in a direction to extend from the housing, a spring biased bolt reciprocally received in said housing and parallel with the respective push-button, each bolt comprising an annulus and a stud, stop means connected with each push button and engageable with the annulus of respective bolt, and spring means for constantly urging the annulus of each bolt into engagement with the respective stop means; a switching unit for each actuating means received in said housing, each switching unit including a movable contact member operable by the respective stud when the push-button associated therewith is displaced in a direction to extend further into said housing and the stop means connected therewith is displaced; and a sealing element installed in said housing for separating each stud from each contact member, said sealing element comprising a plate-like carrier of metallic material having an aperture for and adjacent to the contact member of each switching unit, and a foil of elastic material connected and in permanent surface-to-surface sealing contact with said carrier, said foil constituting diaphragm means for sealing each aperture in the carrier and comprising a circular corrugation surrounding each contact member and a reinforced motion transferring portion disposed concentrically within each corrugation, each actuating means adapted to actuate the contact member of the respective switching unit through the respective motion transferring portion and through the respective stud when the push button associated with the latter is displaced to extend further into said housing.

2. An electric limit switch comprising, in combination: a housing; at least one actuating means each including a spring biased push-button reciprocally installed in said housing and constantly urged in a direction to extend from the housing, a spring biased bolt reciprocally received in said housing and parallel with the respective push-button, each bolt comprising an annulus and a stud, stop means connected with each push button and engageable with the annulus of respective bolt, and spring means for constantly urging the annulus of each bolt into engagement with the respective stop means; adjusting means comprising a member located in the path of each annulus for controlling the extent to which the respective bolt is movable by said spring means; a switching unit for each actuating means received in said housing, each switching unit including a movable contact member operable by the re-

spective stud when the push-button associated therewith is displaced in a direction to extend further into said housing and the stop means connected therewith is displaced; and a sealing element installed in said housing for separating each stud from each contact member, said sealing element comprising a plate-like carrier of metallic material having an aperture for and adjacent to the contact member of each switching unit, and a foil of elastic material connected to and in permanent surface sealing contact with said carrier, said foil constituting diaphragm means for sealing each aperture in the carrier and comprising a circular corrugation surrounding each contact member and a reinforced motion transferring portion disposed concentrically within each corrugation, each actuating means adapted to actuate the contact member of the respective switching unit through the respective motion transferring portion and through the respective stud when the push button associated with the latter is displaced to extend further into said housing.

3. For use in an electric switch including a plurality of switch actuating means and a plurality of switching units each arranged opposite to and spaced from a corresponding actuating means; a sealing element comprising a rigid flat carrier member adapted to be arranged between said actuating means and said switching units and having a plurality of apertures passing therethrough and each adapted to be located between one of said actuating means and the corresponding switching unit, said rigid flat carrier having on one side thereof a surface including a plurality of surface portions each surrounding one of said apertures; and a foil of elastic material covering said surface of said rigid carrier permanently sealed at least to said surface portions thereof along said apertures, said foil thus forming over each of said apertures a diaphragm covering the respective aperture, said foil including an annular corrugation in each of said diaphragms whereby the portion of each diaphragm surrounded by the respective annular corrugation is movable relative to said rigid flat carrier member by the corresponding actuating means, while due to the sealing of said foil of elastic material to said surface portions surrounding said apertures the action of each actuating means is positively limited to the corresponding switching unit.

4. A sealing element as set forth in claim 3, wherein the thickness of said corrugations equals the thickness of such portions of said foil which are sealed to said carrier.

5. For use in an electric switch including a plurality of switch actuating means and a plurality of switching units each arranged opposite to and spaced from a corresponding actuating means: a sealing element comprising a rigid flat carrier member adapted to be arranged between said actuating means and said switching units and having a plurality of aligned apertures passing therethrough and each adapted to be located between one of said actuating means and the corresponding switching unit, said rigid flat carrier having on one side thereof a surface surrounding said aligned apertures; and a foil of elastic material covering said surface of said rigid carrier permanently sealed thereto, said foil thus forming over each of said aligned apertures a diaphragm covering the respective aperture, said foil including an annular corrugation in each of said diaphragms whereby the portion of each diaphragm surrounded by the respective annular corrugation is movable relative to said rigid flat carrier member by the corresponding actuating means, while due to the sealing of said foil of elastic material to said surface surrounding said aligned apertures the action of each actuating means is positively limited to the corresponding switching unit.

6. An electric switch comprising in combination, a housing; a plurality of actuating means arranged within said housing side by side and reciprocally relative to said housing; a plurality of switching units arranged also in said housing side by side, each of said switching units including a movable contact member located opposite one

of said actuating means and adapted to be moved by the latter; and a sealing element arranged in said housing for separating said plurality of actuating means from said plurality of switching units, said sealing element comprising a rigid flat carrier member arranged within said housing with said plurality of actuating means located on one side of said rigid flat carrier member and with said plurality of switching units located on the other side of said rigid flat carrier member separated from said plurality of actuating means by said rigid flat carrier member, said rigid flat carrier member having a plurality of apertures, each located between one of said actuating means and the corresponding switching unit and each having an area substantially greater than the area of the actuating means adapted to engage the movable contact member of the corresponding switching unit, said rigid flat carrier member having on one side thereof a surface including a plurality of surface portions each surrounding one of said apertures, and foil means of elastic material located on said surface and sealed at least to said surface portions surrounding said apertures, said foil means forming within each of said apertures a diaphragm and including within each of said diaphragms an endless corrugation substantially along the periphery of the respective aperture and a motion transferring portion located within said corrugation, whereby said actuating means are adapted to engage said motion transferring portion of said diaphragm and to move the same relative to the portion of said foil means sealed to said surface portions into contact with the movable contact member of the corresponding switching unit, while sealing of said foil of elastic material to said surrounding surface portions will prevent any influence of operation of one of said operating means on the other switching elements.

7. An electric switch comprising in combination, a housing; a plurality of actuating means arranged within said housing side by side and reciprocally relative to said housing; a plurality of switching units arranged also in said housing side by side, each of said switching units including a movable contact member located opposite one of said actuating means and adapted to be moved by the latter; and a sealing element arranged in said housing for separating said plurality of actuating means from said plurality of switching units, said sealing element comprising a rigid flat carrier member arranged within said housing with said plurality of actuating means located on one side of said rigid flat carrier member and with said plurality of switching units located on the other side of said rigid flat carrier member separated from said plurality of actuating means by said rigid flat carrier member, said rigid flat carrier member having a plurality of apertures, each located between one of said actuating means and the corresponding switching unit and each having an area substantially greater than the area of the actuating means adapted to engage the movable contact member of the corresponding switching unit, said rigid flat carrier member having on one side thereof a surface including a plurality of surface portions each surrounding one of said apertures, and foil means of elastic material located on said surface and sealed at least to said surface portions surrounding said apertures, said foil means forming within each of said apertures a diaphragm and including within each of said diaphragms a resilient annular portion substantially along the periphery of the respective aperture and a motion transferring portion located within said annular portion, whereby said actuating means are adapted to engage said motion transferring portion of said diaphragm and to move the same relative to the portion of said foil means sealed to said surface portions into contact with the movable contact member of the corresponding switching unit, while sealing of said foil of elastic material to said surrounding surface portions will prevent any influence of operation of one of said operating means on the other switching elements.

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