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[54] **PRESSURE OPERATED ELECTRIC SWITCHES WITH FLEXIBLE HELICAL BRIDGING CONTACT**

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[51] **Int. Cl.**..... **H01h 35/38,** H01h 1/20

[58] **Field of Search** ..... 200/166 BA, 16 A, 200/5 C, 159 R, 82 R, 83 J, 81 R

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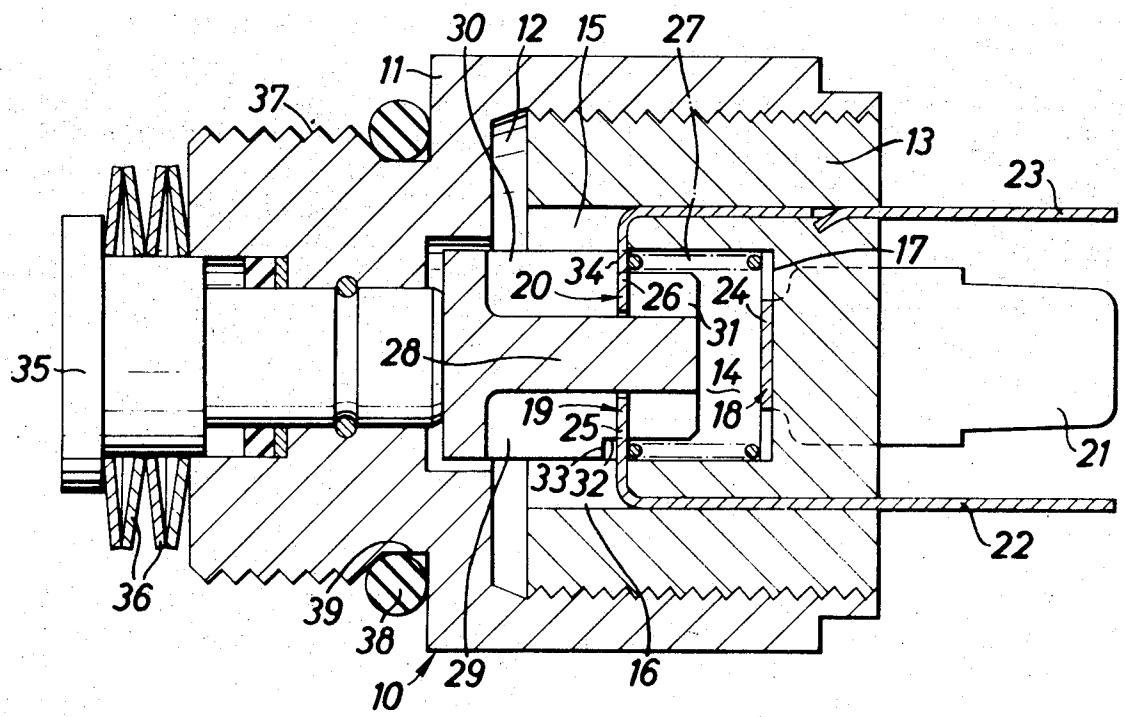
[57] **ABSTRACT**

A pressure operated electric switch having two sets of contacts operated at different pressures acting on the switch, comprises a helical conductor in permanent contact with a first fixed contact and normally held out of engagement with a second and a third fixed contact by a plunger which is responsive to the operating fluid pressure. Movement of the plunger following a suitable reduction in the operating fluid pressure first brings the helical conductor into engagement with the second fixed contact and subsequently with the third fixed contact. The plunger may be arranged to disengage from the helical conductor when the latter is engaged with both the second and the third fixed contacts, or the plunger may be arranged to make part of the circuit between the first and second fixed contacts.

8 Claims, 2 Drawing Figures



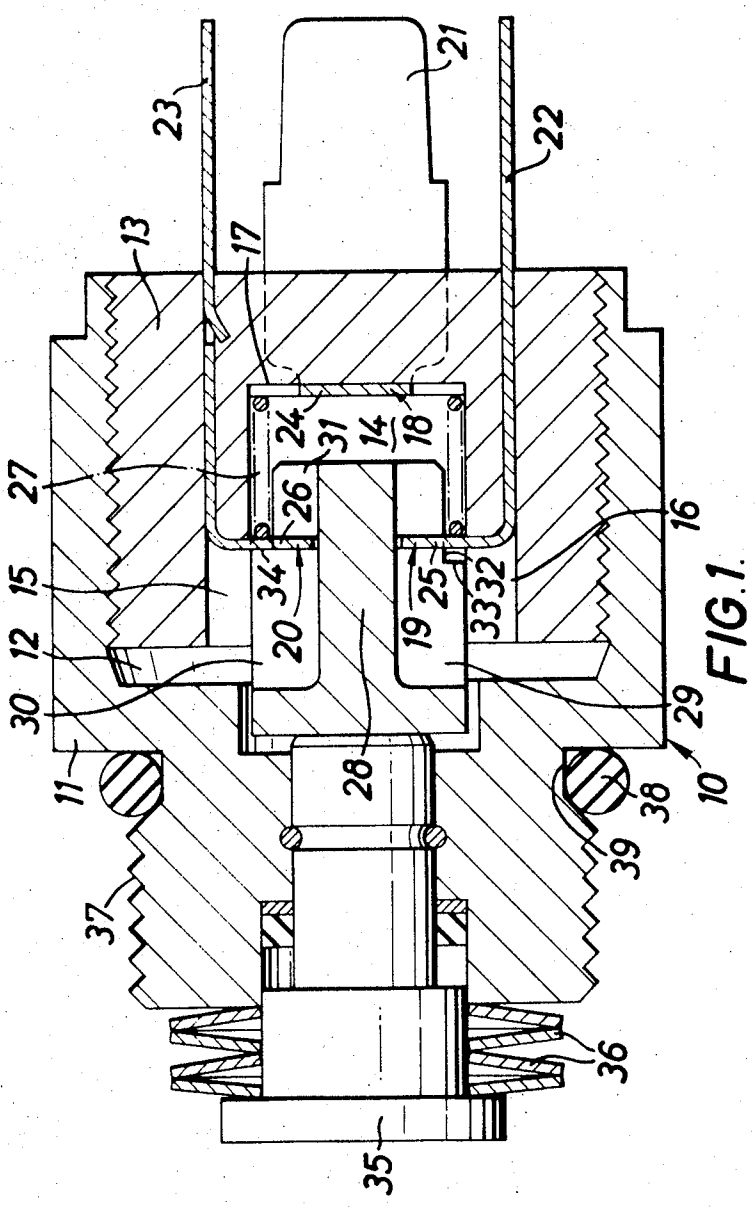

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FIG. 1.

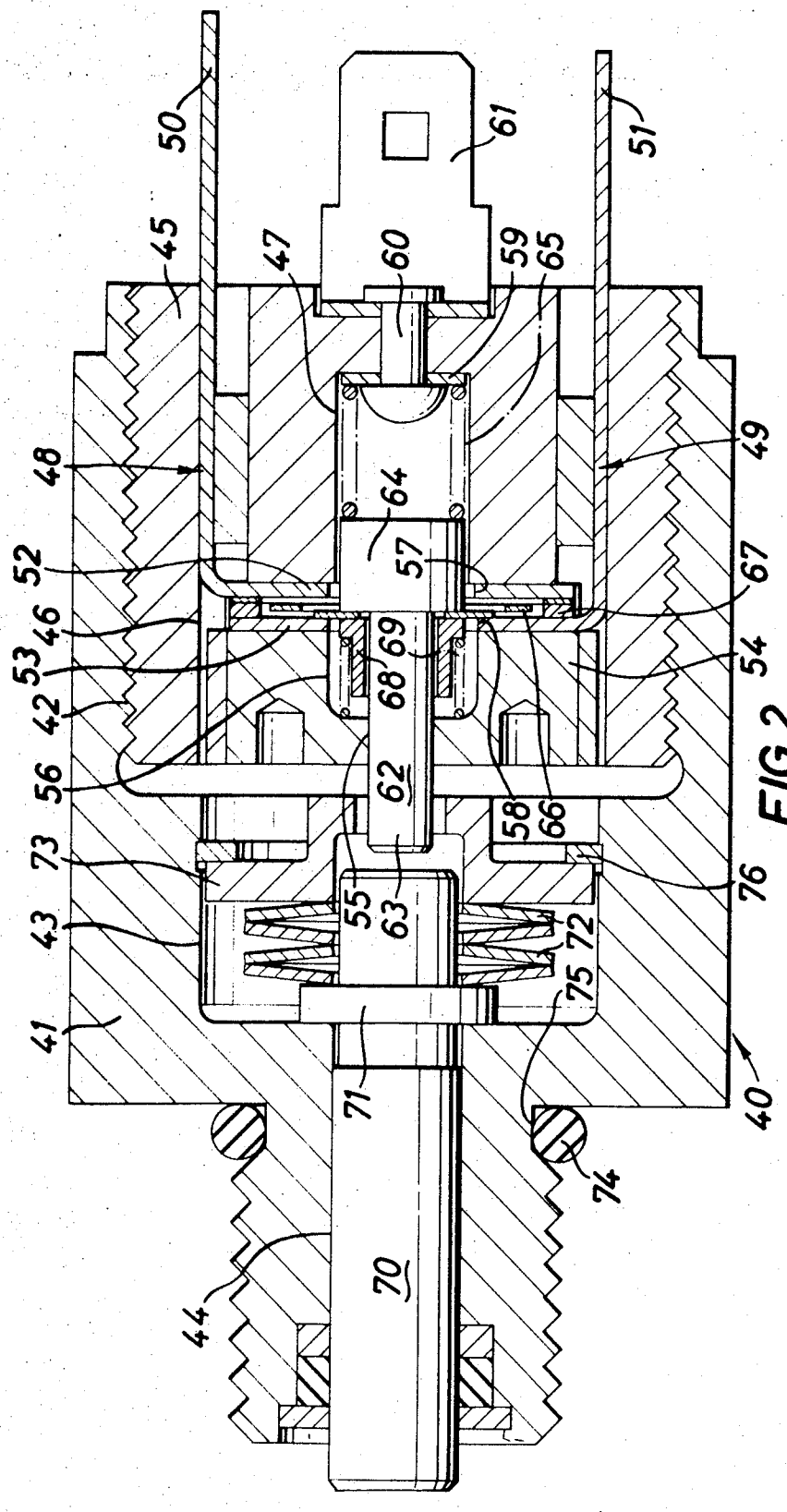
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FIG. 2.

PRESSURE OPERATED ELECTRIC SWITCHES WITH FLEXIBLE HELICAL BRIDGING CONTACT

This invention relates to pressure operated electric switches and has for its object to provide a switch having two sets of contacts operated at different pressures acting on the switch.

According to this invention there is provided a pressure operated electric switch comprising a plunger adapted to be subjected to an operating fluid pressure, resilient means acting on said plunger to oppose the said operating fluid pressure, first, second and third fixed contact members, a flexible bridging contact member in permanent contact with the first fixed contact member and associated with said plunger so that movement of the plunger in one direction from a position in which the flexible bridging contact member engages only said first fixed contact member first completes an electrical connection between said first and second fixed contact members via said flexible bridging contact member and subsequently completes an electrical connection between said first and third contact members via said flexible bridging contact member.

Preferably the electrical connection between the first fixed contact member and the second fixed contact member via the flexible bridging contact member is maintained during subsequent movement of the plunger in said one direction so that said first fixed contact member is connected to both said second and said third contact members via said bridging contact member once the electrical connection to said third contact member has been completed.

The flexible bridging contact member may be a helical conductor which may be coaxial with said plunger and connected to the first fixed contact member by one of the end turns.

According to one embodiment of this invention two spaced portions of the end turn of the helical conductor remote from the first fixed contact member co-operate respectively with the second and third fixed contact members, the resilient loading of the helical conductor being sufficient to hold each said spaced portion in electrical contact with the respective one of the second and third fixed contact members, and means define spaced abutments which are movable axially with movement of the plunger, the arrangement being such that each said spaced portion can be engaged by a respective one of the spaced abutments and held spaced from the respective one of the second and third fixed contact members against the resilient loading of the helical conductor.

The two spaced portions of said end turn of the helical conductor may be arranged to co-operate with axially aligned radially extending portions of the second and third fixed contact members, the spaced abutments comprising spaced portions of a shoulder defined by a contact control member which is movable axially with movement of the plunger, the shoulder being stepped, or inclined to the axis, so that the spaced shoulder portion which is adapted to hold the respective end turn of the helical conductor spaced from the third fixed contact member is nearer the first fixed contact member than is the spaced shoulder portion which is adapted to hold the respective end turn portion of the helical conductor spaced from the second fixed contact member.

According to another embodiment of this invention the diameter of one end turn of the helical conductor

is greater than the diameter of the other end turn. Conveniently the helical conductor is connected to the first fixed contact member by the larger diameter end turn and the first fixed contact member is located between and is spaced axially from the second fixed contact member and third fixed contact member.

Preferably, when the helical conductor is connected only to the first fixed contact member, the fluid pressure operated plunger is arranged to hold a coaxial secondary plunger against the loading of a spring by which the coaxial secondary plunger is connected electrically with the second fixed contact member, and thus to hold the secondary plunger spaced from the smaller diameter end turn of the helical conductor with which it is adapted to co-operate, the arrangement being such that movement of the secondary plunger with movement of the fluid pressure operated plunger in said one direction first brings the secondary plunger into electrical contact with the smaller diameter turn of the helical conductor so as to complete the electrical connection between the first and second fixed contact members, and then moves the smaller diameter turn of the helical conductor axially into electrical contact with the third fixed contact member so as to complete the electrical connection between the first and third fixed contact members. Conveniently a separate spring acts to urge the smaller diameter end turn of the helical conductor away from the third fixed contact member and said separate spring may hold the smaller diameter turn of the helical spring in contact with the first fixed contact member when the helical conductor is connected only to said first fixed contact member.

The fluid pressure operated plunger may be arranged to move in said one direction when said operating fluid pressure is reduced.

Two embodiments of this invention will be described now by way of example only with reference to the accompanying drawings, of which :

FIG. 1 is a longitudinal sectional view of a pressure operated electric switch according to one embodiment of this invention; and

FIG. 2 is a longitudinal sectional view of a pressure operated electric switch according to a second embodiment of this invention.

Referring to FIG. 1, the switch **10** comprises a tubular body **11**. One end of the bore of the tubular body **11** defines a cavity **12**. A block **13** of electrically insulated material is screwed into the cavity **12** and has a coaxial recess **14** at its inner end. Two diametrically opposite longitudinal grooves **15** and **16** are formed in the axially extending wall of the recess **14**. The grooves **15** and **16** extend from the open end of the recess **14** and terminate short of the closed end wall **17** of the recess **14**.

Three fixed metal contacts **18, 19** and **20** are embedded in the block **13**. Each fixed contact **18, 19** and **20** has a respective tag **21, 22** and **23** projecting through the outer end of the block **13** for the connection to a respective electrical circuit conductor. The fixed contact **18**, hereinafter called the first fixed contact, has a flat plate portion **24** lying against the closed end wall **17** of the recess **14**. The fixed contact **19**, hereinafter called the second fixed contact, has a limb **25** which extends radially inwardly from the inner end of the longitudinal groove **15** into the recess **14**. The fixed contact **20**, hereinafter called the third fixed contact, has a limb **26** extending radially inwardly from the inner end of

the longitudinal groove 16 into the recess 14. A coiled compression spring 27 is located coaxially within the recess 14 and has its end nearer the closed end wall 17 connected electrically, e.g. by welding or brazing, to the contact plate 24 of the first fixed contact.

A cylindrical contact control member 28 of electrically insulating material is mounted slidably in the recess 14 and has diametrically opposed longitudinal grooves 29 and 30 which each receive the inwardly projecting limb 25 or 26 of a respective one of the second and third fixed contacts 19 and 20. The contact control member 28 has a reduced diameter end portion 31 at its end nearer to the closed end wall 17 of the recess 14. The shoulder 32 defined between the end portion 31 and the remainder of the member 28 is shown as being inclined to the axis of the member 28 so that the shoulder portion 33 adjacent the groove 29 is further from the closed end wall 17 than is the shoulder portion 34 adjacent the groove 30. The shoulder 32 may be stepped instead of being inclined to the axis providing the shoulder portion 33 is further from the closed end wall 17 than is the shoulder portion 34.

A plunger 35 is mounted slidably in the bore of the tubular body 11. The plunger 35 projects from the end of the bore remote from the block 13 and is urged outwardly away from the block 13 by a stack of Belleville washers 36. The outer surface of the end of the body 11 from which the plunger 35 projects is screw threaded at 37 so that the body 11 can be mounted in an opening in the wall of a component (not shown) of a fluid pressure system. Packing means 38 are retained in an annular groove 39 in the outer surface of the body 11, the packing means 38 being provided to prevent leakage of fluid around the body 11 or between the plunger 35 and the body 11 when the body is so mounted.

In use, the switch 10 is mounted in an opening in the wall of a component of a fluid pressure system. When pressure in the system exceeds a predetermined value, dependent on the load exerted by the stack of Belleville washers 36, the contact control member 28 is held in a position such that the whole of the shoulder 32 is between the limbs 25 and 26 and the plate 24. The end of the coiled compression spring 27 further from the contact plate 24 is engaged by the shoulder 32 and is held spaced from both the limbs 25 and 26. If the pressure in the fluid pressure system decreases, the contact control member 28 moves away from the contact plate 24, and, when the pressure falls to a predetermined value, the shoulder portion 33 adjacent the second fixed contact 19 passes the limb 25 so that the end of the spring 27 remote from the contact plate 24 engages the limb 25 and completes an electrical circuit through the first and second fixed contacts 18 and 19. Being a helical conductor, the spring 17 acts as a flexible bridging contact. If the pressure continues to fall, the shoulder portion 34 adjacent the third fixed contact 20 passes the limb 26 so that the end of the spring 27 remote from the contact plate 24 engages the limb 26 to complete an electrical circuit through the first and third fixed contacts 18 and 20. Thus first one circuit and then the other circuit is completed. The circuits may include warning lights or other warning devices which provide a two stage indication or pressure drop.

Referring now to FIG. 2, the switch 40 comprises a tubular body 41. The bore of the tubular body 41 is stepped and comprises a largest diameter bore portion 42, an intermediate diameter bore portion 43 and a smallest diameter bore portion 44, the intermediate diameter bore portion 43 being between the largest diameter portion 42 and the smallest diameter portion 44. A block 45 of electrically insulating material is screwed into the largest diameter bore portion 42 from the open end thereof. The block 45 has a coaxial recess 46 which opens into its end nearer the intermediate diameter bore portion 43. A closed ended coaxial bore 47 opens into the base of the recess 46.

Two diametrically opposite fixed contacts 48 and 49 extend from the recess 46 through the block 45 away from the intermediate diameter bore portion 43. Each fixed contact 48 and 49 has a respective tag 50, 51 outside the switch housing 41, the tags being for connection to electrical circuit conductors. The fixed contact 48, hereinafter referred to as the first fixed contact, has a limb 52 which extends radially across the recess 46 and abuts the radial face of the block 45 which forms the base of the recess 46. The fixed contact 49, hereinafter called the second fixed contact, has a limb 53 which extends across the recess 46, the limb 53 being spaced axially from the limb 52 and being nearer to the intermediate diameter bore portion 43 than is the limb 52.

The limb 53 carries an annular disc 54 on the side thereof remote from the limb 52. The annular disc 54 is formed of electrically insulating material. The central aperture of the annular disc 54 comprises a smaller diameter aperture portion 55 and a larger diameter aperture portion 56, the smaller diameter aperture portion 55 being further from the closed ended coaxial bore 47 than is the larger diameter aperture portion 56. The diameter of the closed ended coaxial bore 47 is greater than that of the smaller diameter aperture portion 55 and is less than that of the larger diameter aperture portion 56. Coaxial apertures 57 and 58 are formed respectively in the limbs 52 and 53, the diameter of each aperture 57 and 58 being substantially the same as the diameter of the larger diameter aperture portion 56.

A metal disc 59 mounted at the closed end of the closed ended coaxial bore 47 constitutes a third fixed contact and is connected electrically by a rivet 60 to a tag 61 outside the tubular body 41.

A metal plunger 62 has a stem portion 63 and an enlarged head portion 64. The stem portion 63 is engaged slidably in the smaller diameter aperture portion 55 and the head portion 64 slides in the coaxial bore 47. A coiled compression spring 65 is engaged at one end with the disc 59 and at the other end with the head portion 64.

A spirally wound helical conductor 66 has its larger diameter end turn held in electrical contact with the limb 52 by a ring 67 of electrically insulating material which is trapped between the larger diameter end turn of the conductor 66 and the limb 53.

A sleeve 68 of insulating material is mounted slidably upon the stem 62 within the larger diameter aperture portion 56. A coiled compression spring 69 acts between the shoulder defined by the two aperture portions 55 and 56 and a radial flange on the sleeve 68 to urge the sleeve 68 towards the head portion 64 of the plunger 62. The smaller diameter end turn of the helical conductor 66 is located between the sleeve 68 and the head portion 64 of the plunger 62, the radial dimension of the material which forms the smaller diameter end turn of the helical conductor 66, being sufficient to

ensure the smaller diameter end turn can be brought into electrical contact either with the limb **52** or the limb **53**, and with the head portion **64**.

The outer surface of the end portion of the tubular body **41** remote from the block **45** is screw threaded externally for mounting in an opening in the wall of a component of a fluid pressure system, a packing ring **74** being provided in an annular groove **75** to prevent leakage of fluid along the screw thread. An actuating plunger **70** is slidable in the smallest diameter bore portion **44** of the tubular body **41**, and has a radial flange **71** within the intermediate diameter bore portion **43**, the diameter of the radial flange **71** being greater than the diameter of the smallest diameter bore portion **44**. A stack of Belleville washers **72** within the intermediate diameter bore portion **43** act between an annular member **73** and the radial flange **71** to urge the radial flange **71** towards the smaller diameter bore portion **44**, the annular member **73** being held against movement away from the smallest diameter bore portion **44** by a circlip **76** mounted in the intermediate diameter bore portion **43**.

In use of the switch **40**, the switch body **41** is screwed into an opening in the wall of a component of a fluid pressure system so that the fluid pressure in that fluid pressure system acts on the end of the actuating plunger **70** which projects out of the switch body **41**. When the fluid pressure acting on the actuating plunger **70** exceeds a first predetermined value, the actuating plunger **70** is moved inwardly against the load of the stack of Belleville washers **72**. Such inward movement of the actuating plunger **70** is transmitted to the plunger **62**, the head portion **64** of the plunger **62** being moved sufficiently into the closed ended coaxial bore **47** to allow the inner turn of the helical conductor **66** to be held in contact with the limb **52** by the action of the compression spring **69** acting through the sleeve **68**, the head portion **64** being spaced from the inner turn of the helical conductor **66**. Thus the helical conductor **66** engages only the first fixed contact member and there is no electrical connection between that first fixed contact member **48** and either the second fixed contact member **49** or the third fixed contact member **59**.

If the pressure acting on the actuating plunger **70** falls to a first lower value, the actuating plunger **70** is moved outwardly by the stack of Belleville washers **72** until the head portion **64** of the plunger **62** contacts the inner turn of the helical conductor **66**. Thus the helical conductor **66** acts as a bridging contact member which makes an electrical connection between the first fixed contact **52** and the head portion **64** so that the first fixed contact **52** is connected to the third fixed contact **59** by the helical conductor **66**, the head portion **64** and the compression spring **65** which also functions as a helical conductor. If the pressure acting on the actuating plunger **70** falls to a second lower value, the actuating plunger **70** is moved further outwardly until the smaller diameter end turn of the helical conductor **66** is moved into contact with the limb **53** of the second fixed contact **49** and all three fixed contacts **48, 49** and **59** are connected electrcially together by the compression spring **65**, the head portion **64** and the helical conductor **66**. Thus two electrical circuits, which may each include a separate warning light or other warning device, may be closed one after the other as the pressure falls.

We claim:

1. A pressure operated electric switch comprising a plunger adapted to be subjected to an operating fluid pressure, resilient means acting on said plunger to oppose the said operating fluid pressure, first, second and third fixed contact members, a flexible helical conductor bridging contact member having one of its end turns in permanent contact with said first contact member and associated with said plunger so that movement of said plunger in one direction from a position in which said flexible bridging contact member engages only said first fixed contact member, first completes an electrical connection between said first and second fixed contact members through said flexible bridging contact member, and subsequently completes an electrical connection between said first and third contact members through said flexible bridging contact member, said electrical connection between said first fixed contact member and said second fixed conteact member through flexible bridging contact member being maintained during subsequent movement of said plunger in said one direction so said first fixed contact member is connected to both said second and said third fixed contact members through said flexible bridging contact member once the electrical connection to said third fixed contact member has been completed.

2. The pressure operated electric switch of claim **1**, wherein two spaced portions of the end turn of the helical conductor remote from the first fixed contact member co-operate respectively with the second and third fixed contact members, the resilient loading of the helical conductor being sufficient to hold each said spaced portion in electrical contact with the respective one of the second and third fixed contact members, and means define spaced abutments which are moveable axially with movement of the plunger, the arrangement being such that each said spaced portion can be engaged by a respective one of the spaced abutments and held spaced from the respective one of the second and third contact members against the resilient loading of the helical conductor.

3. The pressure operated electric switch of claim **2**, wherein the two spaced portions of said end turn of the helical conductor co-operate with axially aligned radially extending portions of the second and third fixed contact members, the spaced abutments comprising spaced portions of a shoulder defined by a contact control member which is moveable axially with movement of the plunger, the shoulder being stepped so that the spaced shoulder portion which is adapted to hold the respective end turn portion of the helical conductor spaced from the third fixed contact member is nearer the first fixed contact member than is the spaced shoulder portion which is adapted to hold the respective end turn portion of the helical conductor spaced from the second fixed contact member.

4. The pressure operated electric switch of claim **2**, wherein the two spaced portions of said end turn of the helical conductor co-operate with axially aligned radially extending portions of the second and third fixed contact members, the spaced abutments comprising spaced portions of a shoulder defined by a contact control member which is movable axially with movement of the plunger, the shoulder being inclined to the axis, so that the spaced shoulder portion which is adapted to hold the respective end turn portion of the helical conductor spaced from the third fixed contact member is nearer the first fixed contact member than is the spaced

shoulder portion which is adapted to hold the respective end turn portion of the helical conductor spaced from the second fixed contact member.

5. The pressure operated electric switch of claim **4**, wherein the diameter of one end turn of the helical conductor is greater than the diameter of the other end turn.

6. The pressure operated electric switch of claim **5**, wherein the helical conductor is connected to the first fixed contact member by the large diameter end turn, the first fixed contact member being located between and being spaced axially from the second fixed contact member and the third fixed contact member.

7. The pressure operated electric switch of claim **6**, wherein when the helical conductor is connected only to the first fixed contact member the fluid pressure operated plunger is arranged to hold a coaxial secondary plunger against the loading of a spring by which the coaxial secondary plunger is connected electrically with the second fixed contact member, and thus to hold the secondary plunger spaced from the smaller diameter and turn of the helical conductor with which it is adapted to co-operate, the arrangement being such that movement of the secondary plunger with movement of the fluid pressure operated plunger in said one direction first brings the secondary plunger into electrical contact with the smaller diameter turn of the helical conductor so as to complete the electrical connection between the first and second fixed contact members and then moves the smaller diameter turn of the helical conductor axially into electrical contact with the third fixed contact member so as to complete the electrical connection between the first and third fixed contact members.

8. The pressure operated electric switch of claim **7**, wherein a separate spring acts to urge the smaller diameter end turn of the helical conductor away from the third fixed contact member and to hold the smaller diameter turn of the helical spring in contact with the first fixed contact member when the helical conductor is connected only to said first fixed contact member.

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