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(54) FLUID PRESSURE SWITCH

(71) We, GAMBRO AB, a Swedish Company of Fack S-220 10 Lund, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

The present invention relates to a pressure switch for the monitoring of fluid pressure and especially, but not necessarily, for the tripping of an electric signal, e.g. an alarm, when the pressure passes a certain predetermined limit value.

The pressure switch in accordance with the invention is intended primarily for the monitoring of the pressure of the blood supplied to a dialysis system of the type described for example in UK Patent Application Nos. 38759/77 (Serial No. 1 587 137) and 38760/77 (Serial No. 1 587 138). It will be obvious, however, to those versed in the art that the invention can also be applied to many other cases where a signal is desired when a pressure exceeds a certain value or remains below the same.

The pressure switch in accordance with the invention is characterised in that the force exerted by the fluid can be transmitted via a spring device which is arranged so that it can assume two different operating positions, which are separated by a dead-centre position, the one operating position bringing about a direct transmission of the force exerted by the monitored pressure to an actuating element to move said element between first and second positions thereof, whilst the other operating position maintains said actuating element in its first position without any pressure being monitored.

Thanks to this construction the monitored line can easily be made to by-pass the pressure switch, when the latter is not required, e.g. in the event of manual monitoring, whilst the pressure switch can be adapted so that it can be automatically restored when the by-passing is cancelled.

A very simple arrangement is obtained if a plate spring is chosen as the said spring device.

In a preferred embodiment of the invention the pressure switch has an outer housing into which a compressible tube can be introduced against the action of a sensing element, the position of which influences the actuating element via the spring device. This sensing element may be manually adjustable on a pressure transmission shaft, so that it can be set for tripping at different pressures in the monitored line. The sensing element preferably consists of a threaded wheel which can readily be gripped and with the help of which the position of the spring device can be altered manually from its pressure-monitoring position to its position where it is unaffected by the pressure in the line.

Appropriately the actuating element is a spring-loaded actuating element of a microswitch and is arranged so that, in the pressure-monitoring position of the spring device, it is affected solely by the pressure in the monitored line, that is to say independently of any pressure in the spring device, whilst in the position of the spring device where it does not monitor pressure in the line said actuating element is adapted so that it picks up solely the pressure of the spring device.

The monitored tube is preferably connected or connectable to a normally graduated, that is to say readable, pressure gauge with the help of which the tripping pressure can be set through adjustment of the position of the sensing element.

A practical construction is obtained if the spring device includes a plate spring and the opposed ends of the spring are arranged to be fixed to the side pieces of a U-shaped bracket which is adapted so that it is movable together with the sensing element and, if present, the said pressure transmission shaft between a position wherein all these components jointly are freely movable for the transmission of the force exerted by the monitored pressure, and a second position wherein the bracket is pressed against some fixed component in the construction to absorb the force which the plate spring exercises upon the actuating element.

According to a preferred embodiment of

the present invention there is provided a pressure switch for monitoring fluid pressure in a compressible tube, which switch comprises locating means for releasably receiving the tube; a sensing element adapted to bear against the tube when received in the locating means for movement to a signal position in response to change of fluid pressure in the tube beyond a predetermined pressure; an over-centre spring device biassed into and movable between first and second operative conditions and an actuating element operatively associated with said spring device for movement between first and second positions, the arrangement being such that, in its first operative condition, the spring device transmits the movement of the sensing element to its signal position to the actuating element to move the latter to its second position whilst, in its second operative condition, the spring device maintains the actuating element in its first position.

Usually, but not necessarily, the sensing element moves to its signal position when pressure in the tube falls below the said predetermined pressure.

In its first operative condition, the spring device can bias the sensing element into contact with the tube when received in the locating means. The position of the sensing element relative to the locating means preferably is adjustable to adjust the signal position and hence the said predetermined pressure monitored by the switch. Suitably, the sensing element is adjustably carried by a pressure transmission shaft which transmits to the spring device the movement of the sensing element to its signal position. The pressure transmission shaft can be externally threaded and the sensing element can be an internally threaded wheel threadably received thereon.

Advantageously, the spring device can only adopt its second operative condition when the tube is not received in the locating means. It is also preferred that the spring device is movable between its first and second operative conditions by manual movement of the sensing element. Said movement can be facilitated by securing the pressure transmission shaft to the spring device.

It is particularly preferred that the spring device comprises a leaf spring which can be secured between the limbs of a "U" shaped bracket for movement between first and second attitudes relative thereto corresponding respectively to the said first and second conditions and the bracket is movable with the sensing element when the leaf spring is in its first attitude but abuts a fixed support member when the leaf spring is in its second attitude.

A pressure gauge can be provided to measure the fluid pressure in the tube when received in the locating means at which the sensing element moves to its signal position.

Conveniently an electrical switch is actuated by movement of the actuating element, especially an electrical switch in an alarm circuit. Said electrical switch suitably makes an electrical contact when the actuating element is in its second position and breaks that contact when the actuating element is in its first position. The electrical switch can have an actuating arm which is spring biassed to urge the actuating element to its second position and can be arranged so that in the first operative condition of the spring device the actuating arm is operated independently of spring pressure in said device whilst in the second operative condition it is operated on solely by the spring pressure in said device.

A further aspect of the present invention provides a dialysis system comprising a dialyser, means for conducting fluid to be dialysed through the dialyser, and a pressure switch of the invention wherein said switch monitors the pressure of said fluid in said means.

Another aspect of the invention provides a method of monitoring fluid pressure which comprises passing the fluid through a compressible tube received in locating means of a pressure switch in accordance with the aforementioned preferred embodiment of the invention.

The invention will be described in detail in the following description with reference to the accompanying drawings, wherein by way of an example a preferred embodiment of the invention is shown. In the drawings:–

Figure 1 shows the pressure switch in a position where a pressure detected in a line is transmitted to a microswitch, and

Figure 2 shows the same pressure switch in a position where the microswitch is influenced instead by a spring pressure.

In Figure 1 the pressure switch shown as an example is arranged so that it monitors the pressure in a line 1 which may be constituted for example of a blood tube. To facilitate the monitoring, the line is provided with a flexible monitoring pad 2. To this monitoring pad 2 is connected a further line 3 which is intended for the calibration of the pressure switch shown. This line 3 is connected or connectable therefore to a conventional pressure gauge which indicates the actual pressure in the line 1.

When the pressure switch is to be utilized for the detecting or monitoring of the pressure in the line 1, the line 1 with the pad 2 and the connecting line 3 are introduced into a housing 4 which contains an internal sensing element 5. In the embodiment shown this sensing element has the form of a wheel which is manually adjustable in relation to a transmission shaft 6. This adjusta-

bility is achieved in any suitable manner, not shown on the drawing, e.g. in that the wheel is threaded on or in the transmission shaft 6. The shaft 6 passes through a bush 7 which is permanently fixed to the housing 4.

The housing 4 together with a bracket 8 is attached to a fixed machine element 9 which may consist for example of the wall of a control unit. At its extreme end the transmission shaft 6 carries a movable bracket 10. This bracket is U-shaped and carries between the ends of its side pieces a plate spring 11. This plate spring in turn carries a pressure transmission element 12 which is adapted so that it acts upon the movable spring-loaded actuating element 13 of a conventional microswitch 14.

Since the microswitch 14 may be of any suitable type, its inner mechanical construction is not shown. It is important only that its actuating element 13 should be pressed in against the action of a spring force. In a diagrammatic representation is shown, however, how the microswitch 14 can act via a line 15 upon an alarm lamp 16 and how it obtains its energy from a source of current 17. Naturally, the signal obtained can also be used for purposes other than for lighting an alarm lamp. Thus, for example, the signal, beside raising an alarm, may also bring about some kind of adjustment of the pressure in the line 1, e.g. by acting upon some pump or valve in this line. The microswitch 14 is fixed to the bracket 8 with the help of a fixed stud 18 and nuts 19 and 20. Thus, in the position shown the pressure is transmitted from the pad 2 via the pressure transmission shaft 6, the plate spring 11, and the pressure transmission element 12 to the movable actuating element 13 of the microswitch. The spring pressure in the plate spring 11 here does not affect the loading of the actuating element 13.

If the pressure switch is to be by-passed, the tube 1, its pad 2 and its connecting line 3 are removed from the housing 4, as shown in Fig. 2. Subsequently the wheel of sensing element 5 is moved out manually to the position shown in Fig. 2. When this happens the plate spring 11 passes through a dead centre position and snaps over to the position shown in Fig. 2. In this position the movable bracket 10 is pressed against the fixed bush 7 at the same time as the pressure transmission element 12 is pressed against the actuating part 13, overcoming the internal spring force of the microswitch 14. This prevents any signal from being emitted from the circuit 15, 16, 17. Since the tubes have been removed from the housing 1, the position as shown in Fig. 2 cannot give rise to any misunderstanding where a person might think that the pressure switch is in operation. When the tubes are reintroduced into the housing 4, the system is automatically returned to the position shown in Fig. 1 and activated so that the circuit 15, 16, 17 is closed if the pressure in the line 1 drops below a predetermined value which can be set by means of the wheel 5.

Naturally the invention is not limited exclusively to the embodiment described above, but can be varied within the scope of the following claims. It will be obvious for example to those versed in the art, that the plate spring shown can be substituted by other spring devices which are moved between different operating positions via a dead-centre position overcoming a spring force. Such a system may be constructed for example with the help of a lever mechanism and optional springs. It will probably be found, however, that the simple plate spring shown represents the most convenient arrangement.

WHAT WE CLAIM IS:–

1. A pressure switch for monitoring fluid pressure wherein the force exerted by the fluid can be transmitted via a spring device which is arranged so that it can assume two different operating positions which are separated by a dead-centre position, the one operating position bringing about a direct transmission of the force exerted by the monitored pressure to an actuating element to move said element between first and second positions thereof whilst the other operating position maintains said actuating element in its first position without any pressure being monitored.

2. A pressure switch as claimed in Claim 1 wherein the spring device comprises a plate spring.

3. A pressure switch as claimed in Claim 1 or Claim 2 wherein an outer housing is provided into which a compressible tube can be introduced against the action of a sensing element, the position of which influences the actuating element via the spring device.

4. A pressure switch as claimed in Claim 3 wherein the said sensing element is adapted so that it can be adjusted manually on a pressure transmission shaft to be set for tripping at different pressures in the monitored tube.

5. A pressure switch as claimed in Claim 4, wherein the sensing element comprises a wheel threaded onto the extreme end of the pressure transmission shaft, which wheel can readily be gripped and by means of which the position of the spring device can be altered manually from its pressure-monitoring position to its position where it is unaffected by the pressure.

6. A pressure switch as claimed in Claim 4 or Claim 5 wherein the compressible tube is connected to a readable pressure gauge with the help of which the tripping pressure can be set through adjustment of the position of the sensing element.

7. A pressure switch as claimed in any one of Claims 3 to 6 wherein the spring device includes a plate spring and the opposed ends of said plate spring are fixed to the side pieces of a U-shaped bracket which is arranged to be movable together with the sensing element and, if present, the said pressure transmission shaft between a position wherein all these components jointly are freely movable for the transmission of the force exerted by the monitored pressure and a second position wherein the bracket is pressed against a fixed component in the construction to absorb the force which the plate spring exercises upon the actuating element.

8. A pressure switch as claimed in any one of the preceding Claims wherein the actuating element is a spring-loaded actuating element of a microswitch.

9. A pressure switch as claimed in Claim 8 wherein in the pressure-monitoring position of the spring device said microswitch actuating element is adapted so as to be affected solely by the force exerted by the monitored fluid pressure, i.e. independently of any pressure in the spring device, whilst in the position of the spring device where it does not monitor the fluid pressure said actuating element is adapted so as to pick up solely the force of the spring device.

10. A pressure switch for monitoring fluid pressure in a compressible tube, which switch comprises:–

locating means for releasably receiving the tube;

a sensing element adapted to bear against the tube when received in the locating means for movement to a signal position in response to change of fluid pressure in the tube beyond a predetermined pressure;

an over-centre spring device biassed into and movable between first and second operative conditions; and

an actuating element operatively associated with said spring device for movement between first and second positions.

the arrangement being such that, in its first operative condition, the spring device transmits the movement of the sensing element to its signal position to the actuating element to move the latter to its second position whilst, in its second operative condition, the spring device maintains the actuating element in its first position.

11. A pressure switch as claimed in Claim 10 wherein, the sensing element moves to its signal position when pressure in the tube falls below the said predetermined pressure.

12. A pressure switch as claimed in Claim 10 or Claim 11 wherein, in its first operative condition, the spring device biasses the sensing element into contact with the tube when received in the locating means.

13. A pressure switch as claimed in any one of Claims 10 to 11 wherein the position of the sensing element relative to the locating means is adjustable to adjust the signal position and hence the said predetermined pressure monitored by the switch.

14. A pressure switch as claimed in Claim 13 wherein the sensing element is adjustably carried by a pressure transmission shaft which transmits the movement of the sensing element to its signal position to the spring device.

15. A pressure switch as claimed in Claim 14 wherein the pressure transmission shaft is externally threaded and the sensing element is an internally threaded wheel threadably received thereon.

16. A pressure switch as claimed in any one of the Claims 10 to 15 wherein the spring device can only adopt its second operative condition when the tube is not received in the locating means.

17. A pressure switch as claimed in any one of Claims 10 to 16 wherein the spring device is movable between its first and second operative conditions by manual movement of the sensing element.

18. A pressure switch as claimed in Claim 16 when appendent to Claim 14 or Claim 15 wherein the pressure transmission shaft is secured to the spring device to permit of said movement of the spring device.

19. A pressure switch as claimed in any one of Claims 10 to 18 wherein the spring device comprises a leaf spring.

20. A pressure switch as claimed in Claim 19 wherein the leaf spring is secured between the limbs of a "U" shaped bracket for movement between first and second attitudes relative thereto corresponding respectively to the said first and second conditions and the bracket is movable with the sensing element when the leaf spring is in its first attitude but abuts a fixed support member when the leaf spring is in its second attitude.

21. A pressure switch as claimed in any one of Claims 10 to 20 adapted for connection of a pressure gauge to measure the fluid pressure in the tube when received in the locating means at which the sensing element moves to its signal position.

22. A pressure switch as claimed in any one of Claims 10 to 21 including an electrical switch actuated by movement of the actuating element.

23. A pressure switch as claimed in Claim 22 wherein said electrical switch makes an electrical contact when the actuating element is in its second position and breaks that contact when the actuating element is in its first position.

24. A pressure switch as claimed in Claim 23 wherein said electrical switch is in an alarm circuit.

25. A pressure switch as claimed in any one of Claims 22 to 24 wherein the said switch has an actuating arm which is spring biassed to urge the actuating element to its second position.

26. A pressure switch as claimed in Claim 25 wherein said electrical switch is arranged so that in the first operative condition of the spring device the actuating arm is operated independently of spring pressure in said device whilst in the second operative condition it is operated on solely by the spring pressure in said device.

27. A pressure switch substantially as hereinbefore described with reference to and as shown in Figures 1 and 2 of the accompanying drawings.

28. A dialysis system comprising a dialyser, means for conducting fluid to be dialysed through the dialyser, and a pressure switch as claimed in any one of the preceding Claims wherein said switch monitors the pressure of said fluid in said means.

29. A method of monitoring fluid pressure which comprises passing the fluid through a compressible tube received in locating means of a pressure switch as claimed in any one of Claims 10 to 27.

For the Applicants:
W. H. BECK, GREENER & CO.,
Chartered Patent Agents,
7 Stone Buildings,
Lincoln's Inn,
London WC2A 3SZ.

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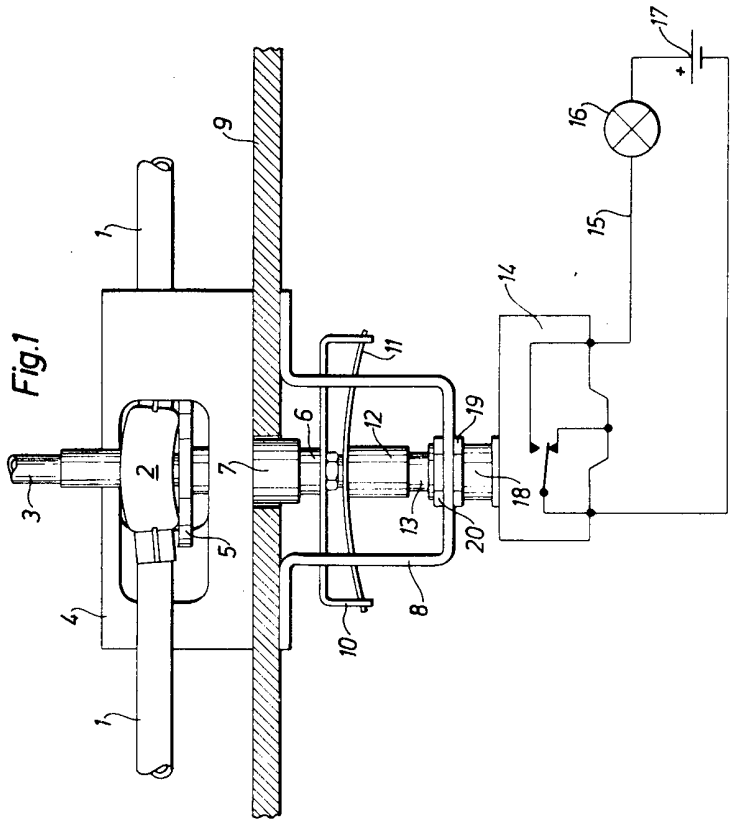
Sheet 1



1587640 COMPLETE SPECIFICATION
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Sheet 2

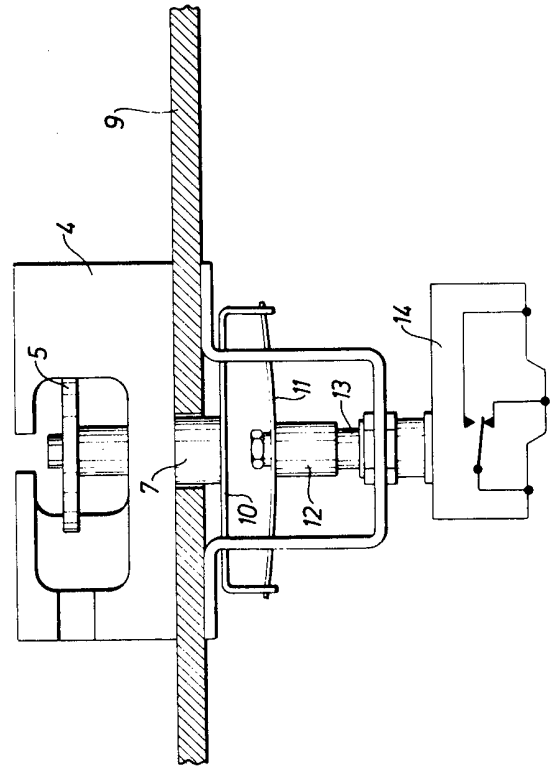

Fig.2