Sept. 20, 1960 A. V. C. DAVIS 2,953,658

PRESSURE SWITCH

Filed May 18, 1959

2 Sheets-Sheet 1

Fig. 2.

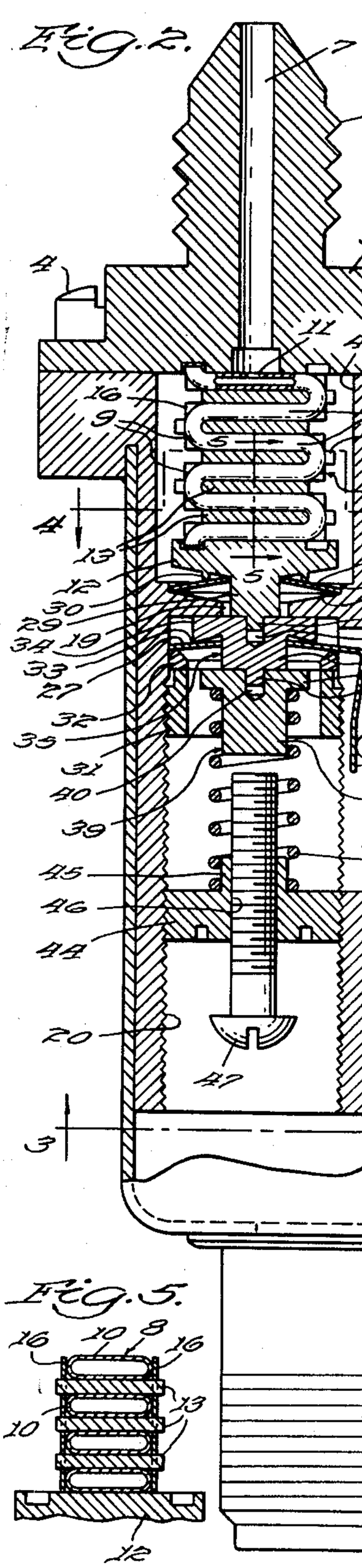

Fig. 6.

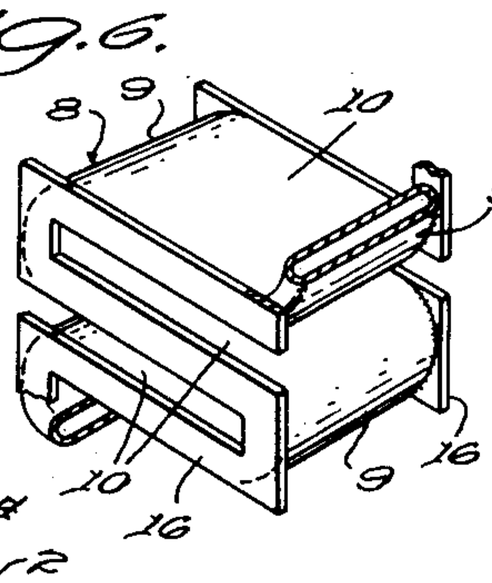

Fig. 1.

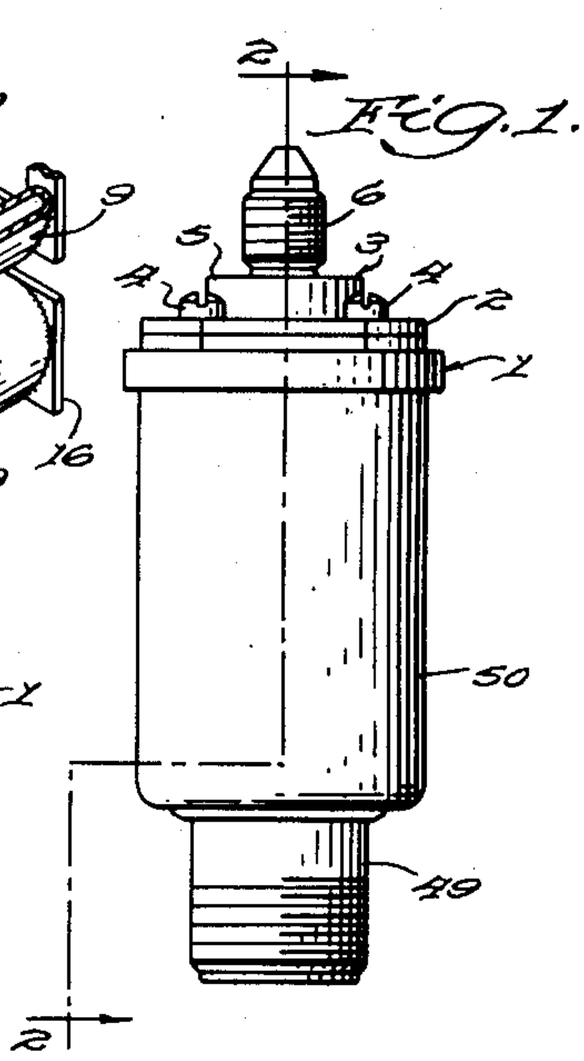

Fig. 3.

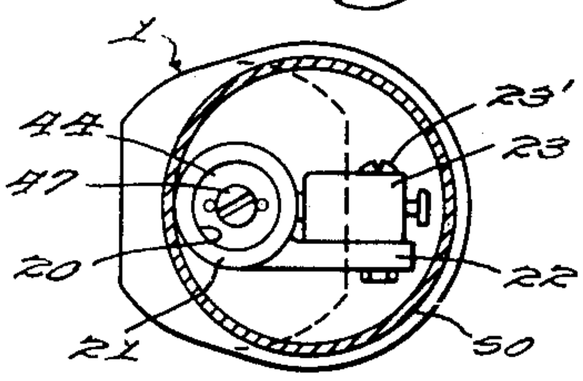

Fig. 4.

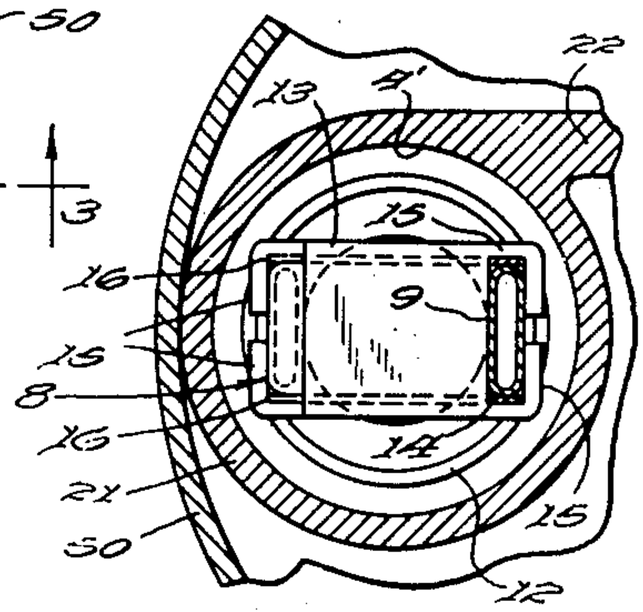

Fig. 5.

Inventor:
Allen V.C. Davis.
By
Harold J. LeVesconte
Atty.

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PRESSURE SWITCH

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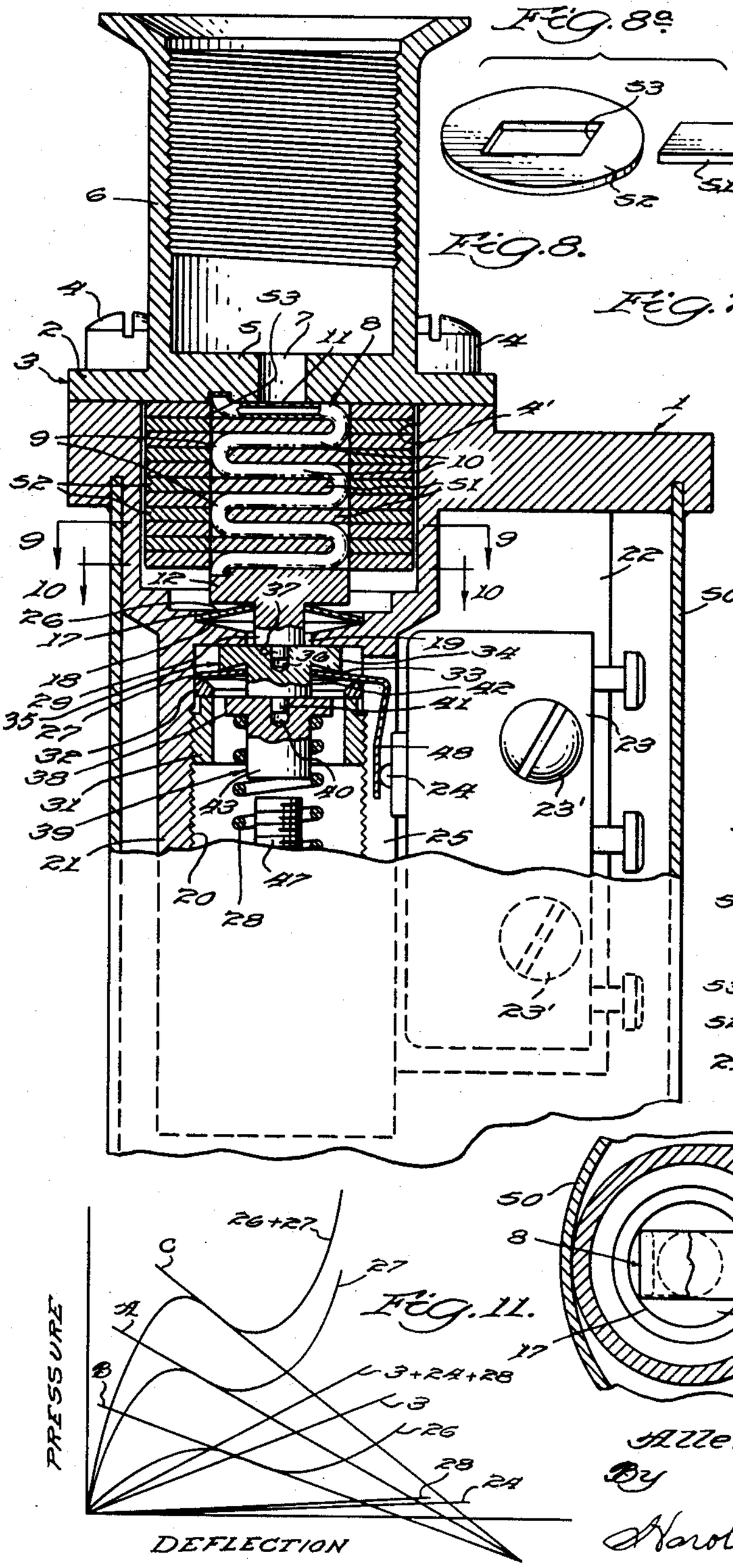

Fig. 8.

Fig. 8a

Fig. 7.

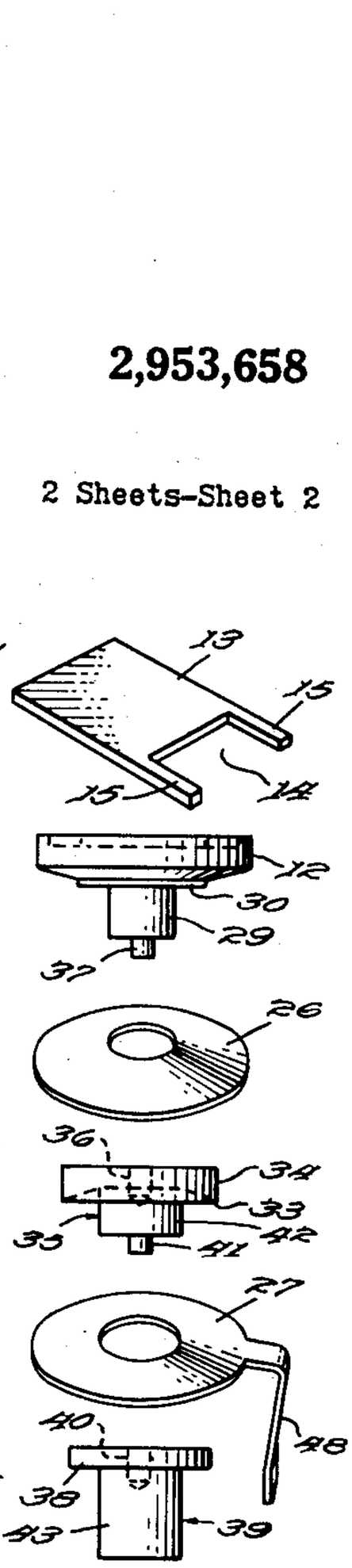

Fig. 9.

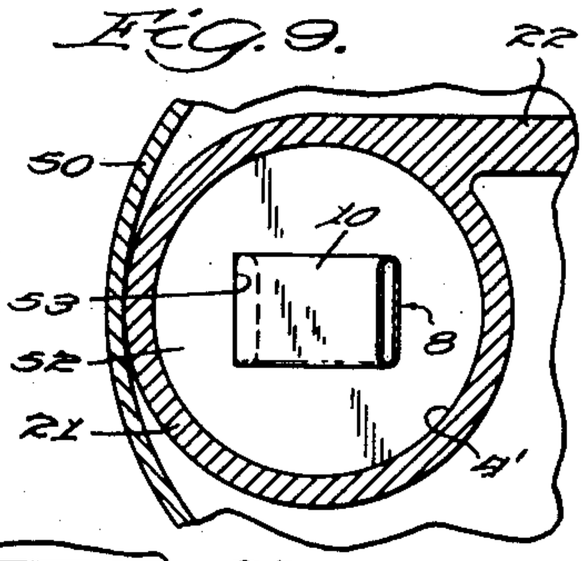

Fig. 10.

Fig. 11.

Inventor:
Allen V. C. Davis
By
Harold J. DeVesconte
Atty.

United States Patent Office

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PRESSURE SWITCH

Allen Van Cleve Davis, 5600 Alta Canyada Road, La Canada, Calif.

Filed May 18, 1959, Ser. No. 813,979

12 Claims. (Cl. 200—81)

This invention relates to pressure switches and more particularly to an improved form thereof especially adapted to respond to very high pressures including an extremely flexible pressure receiving chamber component which is both small in size and light in weight.

The principal object of the invention is to provide a pressure switch including a pressure responsive actuating element capable of withstanding very high pressures such as encountered, for example in the handling of liquified gases with slight amount of movement and arranged to engage and actuate a switch actuating means having movement multiplying capacity and, further, being of extremely small size and light weight.

Another object of the invention is to provide a pressure switch having a pressure responsive, switch actuating element comprising a sinously bent flattened tube having plates interposed between the confronting faces of adjacent runs and having the edges of the runs and the outer faces of the return bends between runs reinforced.

A further object of the invention is to provide a pressure switch having a pressure responsive switch actuating element comprising a sinuously bent flattened tube having plates interposed between the confronting faces of adjacent runs and being surrounded by a stack of plates closely fitting the periphery of the element and serving to reinforce the sharply bent portions of the tubes at the side edges thereof and at the outer faces of the return bends between adjacent runs of the tube.

With the foregoing objects in view, together with such objects and advantages as may subsequently appear, the invention resides in the parts, and in the construction, combination and arrangement of parts described, by way of example, in the following specification of certain presently preferred embodiments of the invention, reference being had to the accompanying drawings which form a part of said specification and in which drawings:

Fig. 1 is a side elevation of a pressure switch embodying the present invention,

Fig. 2 is a greatly enlarged, generally medial sectional view taken on the line 2—2 of Fig. 1,

Fig. 3 is a transverse sectional view taken on the line 3—3 of Fig. 2 but shown in the same scale as Fig. 1,

Figs. 4 and 5 are, respectively, fragmentary sectional views taken, respectively on the lines 4—4 and 5—5 of Fig. 2,

Fig. 6 is a fragmentary perspective view of the pressure responsive element,

Fig. 7 is an exploded view of certain of the parts in the switch actuating train of mehcanism,

Fig. 8 is a transverse sectional view generally similar to Fig. 2 but showing a modified form of pressure responsive cell assembly incorporated therein,

Fig. 8*a* is a perspective view of one each of the tube reinforcing members employed in the said modified form of cell assembly,

Figs. 9 and 10 are transverse sectional views taken on the ines 9—9 and 10—10, respectively, of Fig. 8 but shown in reduced scale, and

Fig. 11 is a graph illustrating the interaction of the spring elements which combine to yieldingly resist the response of the cell assembly to fluid pressure.

Referring first to Figs. 1–7, the illustrated embodiment of the invention comprises a frame member 1 to which the flange 2 of the pressure responsive cell assembly 3 is secured by screws 4, the pressure responsive element of the cell assembly extending into and being housed within a bore 4′ in the frame member 1. The cell assembly includes a body member 5 having a threaded portion 6 affording connection to a source of pressure. A passage 7 extends through said body axially of said threaded portion to the expansible element of the cell assembly, said expansible element comprising a flattened metal tube 8 bent by a series of alternately opposite return bends 9 into a configuration comprising a series of parallel runs 10 spaced from each other. The side of the run comprising one end of the tube is secured to the end face of the body member 5 by soldering or brazing and which incidentally closes that end of the tube and an opening 11 in the side wall of the tube affords communication between the passage 7 and the interior of the tube. The run forming the opposite end of the tube is similarly attached to a pressure plate element 12 with incident closure of that end of the tube. A series of flat plates 13 are disposed one each between the confronting faces of adjacent runs of said tube, said plates each having a notch 14 in which the return bend is received, the notch being sufficiently deep so that the arms 15, 15 at each side thereof may be bent around the edges of the tube at the return bend thereof (see Fig. 4) and thus reinforce the wall of the tube. Additionally, the runs of the tube may be further reinforced by soldering or brazing corresponding sinuously shaped plates 16, 16 to the opposite side edges thereof as best shown in Fig. 6.

It will be obvious that upon the application of fluid pressure through the passage 7 to the interior of the tube the response will be the expansion of the flat parallel side walls of the several runs of the tube, the plates between adjacent runs serving to permit the runs to be disposed parallel to each other without undue sharpness in the return bends. In the illustrated embodiment there are ten such superposed points of expansion and therefore if the effect of the applied pressure is to extend each confronting side wall .001″, the total movement of the pressure plate portion 12 away from the body portion will be .010″. By reason of this stacking up of the various runs of the expansion element, a very considerable switch actuating movement of the pressure plate can be achieved with only a slight amount of stress on the portions of the tube.

The bore 4′ is disposed in the axial line of the passage 7 and terminates in a shallow counterbore 17 and a shallow frusto-conical bottom face 18 having an axially disposed opening 19 communicating with the larger bore 20 disposed coaxially of the bores 4′ and opening 19 and extending through the portion 21 of the frame member 1. The portion 21 is circular in cross section and carries a tangentially disposed longitudinally extending flange 22 on which an electric switch 23 is mounted by screws 23′ with the operating plunger 24 thereof disposed in the outer portion of a longitudinally extending slot 25 formed in the side of the frame portion 21 affording communication with the interior of the bore 20 for engagement with switch actuating means.

Yielding resistance to pressure induced extension of the cell assembly is provided by a series of springs including a first Belleville spring 26, a second Belleville spring 27, and a helical compression spring 28. The Belleville springs ordinarily each a heighth to thickness (h–t) ratio of about 1:1.41 so that, at least, when combined, as hereinafter explained they have a composite negative rate.

In the illustrated embodiment, the spring 26 has its

outer diameter seated on the shoulder formed by the counterbore **17** and the bottom **18** thereof and its inner diameter is slightly larger and consequently is spaced from the neck portion **29** of the pressure plate member **12** which extends therethrough. The adjacent face of the pressure plate member **12** is provided with an integral annular ring **30** disposed coaxially of the neck portion **29** and which engages the spring **26** outwardly of its inner diameter. It will be appreciated that for different pressure ranges, the diameter of this ring **30** can be varied, the larger it is, the greater the resistance the spring **26** can provide. Alternatively, this ring **30** can be dispensed with and the pressure plate allowed to engage the pressure plate closely adjacent the neck portion **27** thereof as shown, by way of example, in Fig. 8.

It will be obvious that as the cell assembly is caused to elongate by the application of pressure in opposition to the bias provided by the spring **26**, the rate of that spring will gradually decrease with the rate thereof approaching zero value at which time it will reach a point which it can move quickly to an opposite conical form (snap action) until stopped by engagement with the bottom surface **18** of the counterbore **17**. The input energy to effect this snap action is supplied by the elasticity of the system, i.e., of the fluid in the system. When used in a system which is compact and has little inherent elasticity, the spring **26** should have more definite inherent snap action. When used in a system including long conduits or other elastic components capable of yielding under system pressure, advantage may be taken of such elasticity to help effect the snap action of the cell assembly at the pressure at which the switch is to be actuated.

The bore **20** is threaded from the outer end thereof to a point adjacent the inner end and this threaded portion carries a nut element **31** disposed adjacent the inner end thereof and which at the face thereof facing the inner end of the bore supports a washer **32** having an annular edge on which the concave side of the Belleville spring **27** is seated. The convex side of said spring is engaged by the annular edge **33** of the head **34** of a presser member **35**, said edge being disposed radially inwardly of the point of engagement with the washer **32**. The opposite face of the head **34** is provided with a socket **36** engaging an axially disposed stud **37** carried by the neck portion **29** of the pressure plate **12** to maintain alignment between the pressure plate **12** and the presser member **35**.

The nut **31** has an axial bore extending therethrough affording clearance for the head **38** of a spring seating member **39**, said member having an axially disposed socket **40** engaged by a stud portion **41** on the distal end of the shank **42** of the presser member **35** which extends through the center of the spring **27**. The member **39** includes an axially disposed shank portion **43** which extends into one end of the spring **28**, the other end of said spring being seated on the confronting face of an adjusting nut **44** threadedly engaging the bore **20** and being secured against lateral displacement by the axially disposed boss **45** on said nut which enters the coils of the spring. The nut **44** is provided with an axially disposed threaded bore **46** in which a stop screw **47** is mounted to extend within the coils of the spring **28** and adjustably limits the extent of movement of the switch actuating means deriving from pressure induced extension of the cell assembly by engagement with the distal end of the shank **43**.

Due to the fact that seemingly identical Belleville springs vary beyond any tolerance acceptable for pressure switches of great accuracy and uniformity, means for compensating for such variation is provided, such means being the adjustable abutment for the spring **27** afforded by adjustment of the nut **31** through which, in assembly of the switch, an approximation of the actuating of the switch at a desired pressure may be obtained, and the final exact adjustment is then achieved by varying the bias imposed on the spring **28** through appropriate adjustment of the nut **44** in the same threaded bore

and of the stop screw **47** in the nut. Following this, the switch terminals are connected with leads (not shown) extending to the socket receptacle **49** fixed to the cover **50** which is then soldered to the base to seal the mechanism contained therein.

The operation of the device is as follows:

Assuming that the device is connected in a system and is subjected to a pressure less than that required to effect actuation thereof, it is in the position of repose illustrated in Fig. 2. Upon pressure increase sufficient to elongate the pressure responsive cell assembly **3**, the springs **26** and **27** pass through an increasing rate and thence a decreasing rate at which time the elasticity of the system causes it to snap through to the opposite position. The spring **27** is formed with an integral arm **48** extending generally at right angles to the disk portion thereof and disposed in the slot **25**, the distal end of the arm being positioned to contact the switch actuating plunger **24**. Thus, as the spring **27** is caused to partake of snap action by extension of the cell assembly, the end of the arm **48** will swing to the right as viewed in Fig. 2 depressing the plunger **24** and causing actuation of the switch **23**. When the pressure decreases by a predetermined amount, the springs **26** and **27** aided by the spring rates of the tube **8** and the spring **28** will snap back to their position of repose with incident return of the switch to its normal position. The switch illustrated is a single pole, double switch as indicated by the three terminals thereon, but it will be appreciated that any snap type switch which is spring biased to normally maintain one position may be substituted whether it be single or multiple pole or single or double throw.

Referring finally to the embodiment of the invention shown in Figs. 8, 9 and 10, all similar parts have been given the same identifying numbers as in the first embodiment, it being noted that the pressure connection is internally threaded by way of showing that either type of connection may be employed. The sinuous, resilient tube **8** of the pressure cell assembly is also the same as that employed in the first embodiment of the invention. The difference between the two embodiments being in the mode of reinforcement of this sinuous tube.

Plates **51** are placed between adjacent runs of the tube, said plates being rectangular in plan and each having a rounded end edge **51'** at the end thereof which engages the inside of the bend in the tube. The opposite ends of the plates are substantially in the plane of the outer surfaces of the bends and the side edges thereof are flush with the planes of the sides of the tube. The thickness of each plate **51** is equal to the thickness of the tube and to the distance between the confronting sides of adjacent runs of the tubes.

Surrounding the tube and the inserted plates is a stack of washers **52** each having a rectangular hole **53** formed therein. The outer periphery of the washers is only slightly smaller than the bore **4'** and the thickness of the washers are the same as the thickness of the plate **51** or of the tube. The holes **53** are of a size which closely fit the plan dimensions of the runs **9** and of the plate **51** plus the thickness of the tube at the rounded end of the plate.

When the tube is distended by the application of pressure, the tube tightly grips each individual washer. Alternate washers are gripped by the side edges of the runs of the tube and by the distention of the return bend reacting against the plate disposed within each return bend as most clearly shown in Fig. 8. When the tube **8** is elongated by the application of pressure, each individual washer moves with the portion of the tube contacted thereby and thus this stack of washers provided a flexible reinforcing means which contacts every external, closely rounded edge of the thin wall of the tube (the wall thickness usually being less than .010") to prevent it from being ruptured by the applied internal high pressure. At the same time no resistance is offered

by this reinforcing means to the endwise extension of the pressure cell constituting the sinuous tube. Consequently, this second form of pressure cell has a lower inherent spring rate than the first embodiment in that the spring rate is that only of the resilient tube itself and not of the reinforcing means which engages the side edges thereof. While both embodiments of the invention are especially useful for pressures, say, of the order of 300 p.s.i. to as much as 20,000 p.s.i., the pressure cell of the second embodiment is preferable for the lower pressures in the indicated range. The switch actuating means operated by the extension of the pressure responsive cell assembly is identical in both embodiments and the description need not be repeated, it being noted that by way of illustration the annular ring **30** on the pressure plate **12** is omitted in Fig. 8 and that the Belleville spring **26** consequently engages the shoulder between the shank **29** and the body or head portion of the pressure plate **12**. This, it will be appreciated, is in keeping with the statement above that the first embodiment of the invention is particularly adapted for the higher ranges of pressures and consequently the bearing on the Belleville spring **26** in that form is applied outwardly from the inner diameter of the spring.

The principle of operation of the switch actuating means of the second embodiment of the invention is illustrated by the load-deflecting diagram of Fig. 11. The spring rates of the cell assembly **3**, the switch plunger **24** and the helical spring **28** are indicated by lines bearing those numbers and extending diagonally upward to the right from a zero position. The sum of these rates is indicated by the corresponding line designated **3** plus **24** plus **28**.

The rates of the Belleville springs **26** and **27** are indicated by the curves indicated by those numbers, said curves generally having decreasing rate portions indicated, respectively, by the lines A and B extending diagonally downwardly to the right, the sum of said curves being indicated by the curve designated **26** plus **27** and including a decreasing rate portion indicated by the line C extending diagonally downward to the right.

Now so long as line C is disposed at a greater angle with respect to the horizontal than is the line designated **3** plus **28**, the cell assembly and the train of switch actuating means interposed between it and the switch actuating plunger **24** will move with snap action when the pressure for which the switch is intended is applied to the cell assembly. The said train of switch actuating mechanism and the switch will, of course, then reactuate to their positions of repose upon a predetermined decrease in the applied pressure.

While in the foregoing specification there have been described certain presently preferred embodiments of the invention by way of example, it will be understood that the invention is not to be deemed to be limited to the exact embodiments thus disclosed, and it will be understood that the invention includes as well all such changes and modifications in the parts, and in the construction, combination and arrangement of parts as shall come within the purview of the appended claims.

I claim:

1. In a pressure switch, a fluid pressure extensible assembly including a flattened tube having means closing one end thereof and means affording the connection of the other end of the tube with a source of fluid pressure; said tube between its ends being bent by alternately opposite return bends into a plurality of spaced, parallel runs with adjacent runs having spaced parallel, confronting faces, means engaging and reinforcing the side edges of said tube, other means reinforcing and engaging the outer surfaces of said return bends, and a plurality of plates disposed one each between and engaging said parallel confronting side surfaces of one each of each pair of adjacent runs effective to cause the pressure induced extension of said assembly to be that of the sum of the amounts of distension of said side surfaces reacting against said plates, an electric switch including a spring biased actuator, devices yieldingly opposing pressure induced extension of said assembly, and a member forming a part of said devices operatively engaging said switch actuator.

2. In a pressure switch, a fluid pressure extensible cell assembly comprising a closed end, flattened tube, means for connecting the interior of said tube at the other end thereof with a source of fluid pressure; said tube, between its ends, being bent by a series of alternately opposite return bends into a plurality of spaced parallel runs with adjacent runs having spaced, parallel, confronting faces, and reinforcing means engaging each of the side edges of said tube, the inner and outer surfaces of said return bends and said parallel confronting faces of adjacent runs; said assembly and reinforcing means, when subjected to the effect of fluid pressure internally of said tube, being extensible in a direction normal to the planes of said parallel confronting faces the amount of pressure induced extension of said assembly being the sum of the amounts of distension of said confronting faces reacting against adjacent portions of said reinforcing means, an electric switch including a spring biased actuator, devices including at least one spring having a negative rate yieldingly opposing pressure induced extension of said cell assembly, and a member forming a part of said devices operatively engaging said switch actuator.

3. In a pressure switch, a fluid pressure extensible cell assembly comprising a closed end, flattened tube, means for connecting the interior of said tube at the other end thereof with a source of fluid pressure; said tube, between its ends, being bent by a series of alternately opposite return bends into a plurality of spaced, parallel runs with adjacent runs having spaced, parallel, confronting faces, means secured to and reinforcing the side edges of said tube, other means interposed between said parallel confronting faces of said parallel runs and reinforcing the inner and outer surfaces of said return bends; said assembly, including said reinforcing means, being extensible in a direction normal to the planes of said parallel confronting faces the amount of pressure induced extension of said assembly being the sum of the amounts of distension of said confronting faces reacting against adjacent portions of said reinforcing means when subjected to the effect of fluid pressure internally of said tube, and an electric switch including a spring biased actuator, devices yieldingly opposing pressure induced extension of said cell assembly including at least one spring having a negative rate, and a member forming a part of said devices operatively engaging said switch actuator.

4. In a pressure switch, a fluid pressure extensible cell assembly comprising a closed end, flattened tube, means for connecting the interior of said tube at the other end thereof with a source of fluid pressure; said tube, between its ends, being bend by a series of alternately opposite return bends into a plurality of spaced, parallel runs with adjacent runs having spaced, parallel, confronting faces, means engaging and reinforcing the side edges of said tube, other means engaging and reinforcing the outer surfaces of said return bends, and a plurality of plates disposed one each between and engaging said parallel confronting side surfaces of one each of each pair of adjacent runs, the amount of pressure induced extension of said assembly being the sum of the amounts of distention of the confronting side surfaces of said runs reacting against the adjacent side surfaces of said plates, an electric switch including a spring biased actuator, devices yieldingly opposing pressure induced extension of said cell assembly including at least one spring having a negative rate and a member forming a part of said devices operatively engaging said switch actuator.

5. In a pressure switch, a fluid pressure extensible cell assembly comprising a closed end, flattened tube, means for connecting the interior of said tube at the other end

thereof with a source of fluid pressure; said tube, between its ends, being bent by a series of alternately opposite return bends into a plurality of spaced, parallel runs with adjacent runs having spaced, parallel confronting faces and reinforcing means engaging each of the side edges of said tube, the inner and outer surfaces of said return bends and said parallel confronting faces of adjacent runs, said assembly when subjected to the effect of fluid pressure internally of said tube being extensible in a direction normal to the planes of said parallel confronting faces, the amount of pressure induced extension of said assembly being the sum of the amounts of distension of said confronting faces reacting against adjacent portions of said reinforcing means, an electric switch including a spring biased actuator, devices yieldingly opposing pressure induced extension of said cell assembly including a spring having a negative rate, means for adjusting the initial loading of said negative rate spring, a helical compression spring, means for adjusting the initial loading of said helical spring, and a member forming a part of said devices operatively engaging said spring actuator.

6. In a pressure switch, a pressure responsive cell assembly comprising a closed end, flattened tube, means for connecting the interior of said tube with a source of fluid pressure; said tube being bent by a series of alternately opposite return bends into a plurality of spaced, parallel runs, a first reinforcing means comprising a pair of members each having the same configuration as the side edges of said bent, flattened tube, one each of said members being secured to one each of the sides of said tube, and a second reinforcing means comprising a plurality of flat plates disposed one each between the confronting faces of adjacent runs of said tube, each of said plates having a notch formed in one end thereof in which the return bend joining the adjacent runs between which the plate is positioned is received and the extensions of said plate forming said notch being bent over the outer periphery of the return bend to reinforce that portion of the tube, an electric switch including a spring biased actuator, devices yieldingly opposing pressure induced extension of said assembly including two springs each having a negative rate and a helical compression spring, and a member formed as a laterally extending arm comprising an integral portion of one of said negative rate springs operatively engaging said switch actuator.

7. In a pressure switch, a pressure responsive cell assembly comprising a closed end, flattened tube, means connecting the interior of said tube with a source of fluid pressure, said tube being bent by a series of alternately opposite return bends into a plurality of spaced, parallel runs, reinforcing means engaging the side edges of said tube, the inner and outer surfaces of said return bends and the confronting faces of adjacent runs; said reinforcing means comprising a series of plates disposed one each between each pair of confronting faces of adjacent runs, the ends of said plates engaging the return bend connecting the confronting faces between which it is disposed being rounded to conform to the surface of the return bend and the outer end of the plate being disposed in a plane containing the outer extension of the opposite return bends of said tube, the width of said plates being equal to the width of the tube, and a plurality of washers each having a rectangular opening therein adapted to fit respectively the sides of the runs of said tube and the sides and exposed end of said plates and the outer ends of the return bends, said washers being gripped by the expansion of said tube incident to the introduction of fluid pressure therein and forming a reinforcement for the side edges of said runs of said tube and for the outer ends of said return bends, said plates serving to reinforce the flat portions of the runs of the tube and the inner faces of the return bends thereof, said reinforcing means being capable of extension with said tube as it is extended by the application of pressure therein, an electric switch including a spring biased actuator, devices yieldingly opposing pressure induced extension of said assembly, and a member forming a part of said devices operatively engaging said switch actuator.

8. In a pressure switch, a pressure responsive cell assembly comprising a closed end, flattened tube, means connecting the interior of said tube with a source of fluid pressure, said tube being bent by a series of alternately opposite return bends into a plurality of spaced, parallel runs, reinforcing means engaging the side edges of said tube, the inner and outer surfaces of said return bends and the confronting faces of adjacent runs; said reinforcing means comprising a series of plates disposed one each between each pair of confronting faces of adjacent runs, the ends of each of said plates engaging the return bend connecting the confronting faces between which it is disposed being rounded to conform to the surface of the return bend and the outer end of the plate being disposed in a plane containing the outer extension of the opposite return bends of said tube, the thickness of said plates being equal to the thickness of the tube, and a plurality of washers of the same thickness as said plates and the holes in alternate washers each being rectangular and adapted to have a light press fit engagement with, respectively, the sides of the runs of said tube and the sides and exposed end of said plates and the outer ends of the return bends, the said light press fit of said washers forming a reinforcement for the side edges of said runs of said tube and for the outer ends of said return bends, said plates serving to reinforce the flat portions of the runs of the tube and the inner faces of the return bends thereof, said reinforcing means being capable of extension with said tube as it is extended by the application of pressure therein, an electric switch including a spring biased actuator, devices yieldingly opposing pressure induced extension of said assembly, including a pair of springs each having a negative rate, and a member forming a part of one of said negative rate springs operatively engaging said spring actuator.

9. In a pressure switch, a pressure responsive cell assembly comprising a closed end, flattened tube, means connecting the interior of said tube with a source of fluid pressure, said tube being bent by a series of alternately opposite return bends into a plurality of spaced, parallel runs, reinforcing means engaging each of the side edges of said tube, the inner and outer surfaces of said return bends and the confronting faces of adjacent runs; said reinforcing means comprising a series of plates disposed one each between each pair of confronting faces of adjacent runs, the ends of said plates engaging the return bends connecting the confronting faces between which it is disposed being rounded to conform to the surface of the return bend and the outer end of the plate being disposed in a plane containing the outer extension of the opposite return bends of said tube, the thickness of said plates being equal to the thickness of the tube, and a plurality of washers each of the same thickness as each of the plates and each having a rectangular opening therein adapted to engage, respectively, the sides of the runs of said tube and the sides and exposed end of said plates and the outer ends of the return bends, with a light press fit and alternate ones of said washers forming a reinforcement for the side edges of said runs of said tube and the others thereof reinforcing the outer ends of said return bends, said plates serving to reinforce the flat portions of the runs of the tube and the inner faces of the return bends thereof, said reinforcing means being capable of extension with said tube as it is extended by the application of pressure therein, an electric switch including a spring biased actuator, devices yieldingly opposing pressure induced extension of said assembly, including a pair of springs each having a negative rate and a helical compression spring, separate means for adjusting the initial loading of one of said negative rate springs

and said helical spring, and a member forming an integral part of one of said helical springs operatively engaging said spring actuator.

10. In a pressure switch, a frame, a pressure responsive cell assembly comprising a closed end, flattened tube, means for mounting the other end of said tube on said frame including means for connecting the interior of said tube with a source of fluid pressure; said tube, between its ends, being bent by a series of alternately opposite return bends into a plurality of spaced, parallel runs with adjacent runs having spaced, parallel, confronting faces, reinforcing means engaging each of the side edges of said tube, other reinforcing means engaging the inner and outer surfaces of said return bends and said parallel confronting faces of adjacent runs, said assembly when subjected to the effect of fluid pressure internally of said tube being extensible in a direction normal to the planes of said parallel confronting faces, the amount of pressure induced extension of said assembly being the sum of the amounts of distension of said confronting faces reacting against adjacent portions of said reinforcing means, an electric switch mounted on said frame and including a spring biased actuator, devices carried by said frame yieldingly opposing pressure induced extension of said assembly, and a member forming a part of said devices operatively engaging said switch actuator.

11. In a pressure switch, a frame, a fluid pressure extensible cell assembly comprising a closed end, flattened tube, means for mounting the other end of said tube on said frame including means for connecting the interior of said tube with a source of fluid pressure; said tube, between its ends, being bent by a series of alternately opposite return bends into a plurality of spaced, parallel runs with adjacent runs having spaced, parallel confronting faces, reinforcing means engaging the side edges of said tube, other reinforcing means engaging the inner and outer surfaces of said return bends and said parallel confronting faces of adjacent runs, said assembly when subjected to the effect of fluid pressure internally of said tube being extensible in a direction normal to the planes of said parallel confronting faces, the amount of pressure induced extension of said assembly being the sum of the amounts of distension of said confronting faces reacting against adjacent portions of said reinforcing means, an electric switch mounted on said frame and including a spring biased actuator, devices carried by said frame yieldingly opposing pressure induced extension of said assembly, including a Belleville spring, and a member forming an integral part of said Belleville spring operatively engaging said switch actuator.

12. In a pressure switch, a frame, a pressure responsive cell assembly comprising a closed end, flattened tube, means for mounting the other end of said tube on said frame including means for connecting the interior of said tube with a source of fluid pressure; said tube between its ends, being bent by a series of alternately opposite return bends into a plurality of spaced, parallel runs with adjacent runs having spaced, parallel, confronting faces, reinforcing means engaging the side edges of said tube, other reinforcing means engaging the inner and outer surfaces of said return bends and said parallel confronting faces of adjacent runs, said assembly when subjected to the effect of fluid pressure internally of said tube being extensible in a direction normal to the planes of said parallel confronting faces, the amount of pressure induced extension of said assembly being the sum of the amounts of distension of said confronting faces reacting against adjacent portions of said reinforcing means, an electric switch mounted on said frame and including a spring biased actuator, devices carried by said frame yieldingly opposing pressure induced extension of said assembly including a Belleville spring, and a member forming an integral part of said Belleville spring operatively engaging said switch actuator and means for adjusting the initial loading of said Belleville spring.

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