

[54] **AIR PRESSURE RESPONSIVE SWITCH FOR VEHICLE TIRE AND THE LIKE WITH HINGED CONTACT AND DIAPHRAGM**

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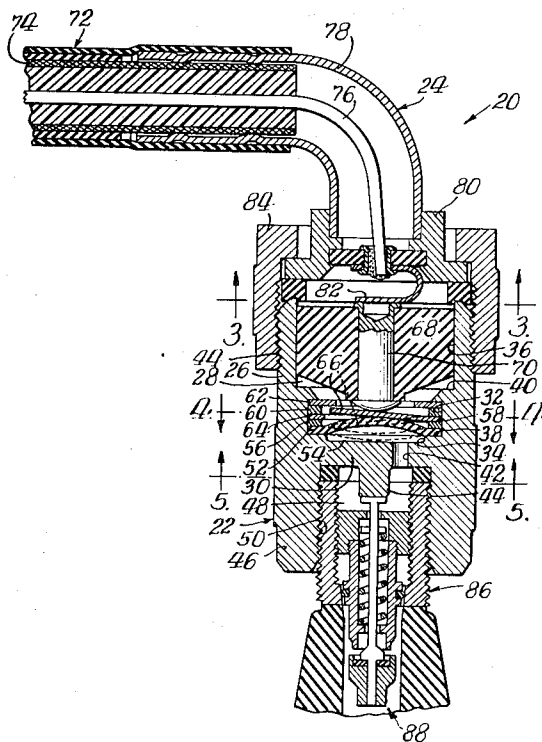
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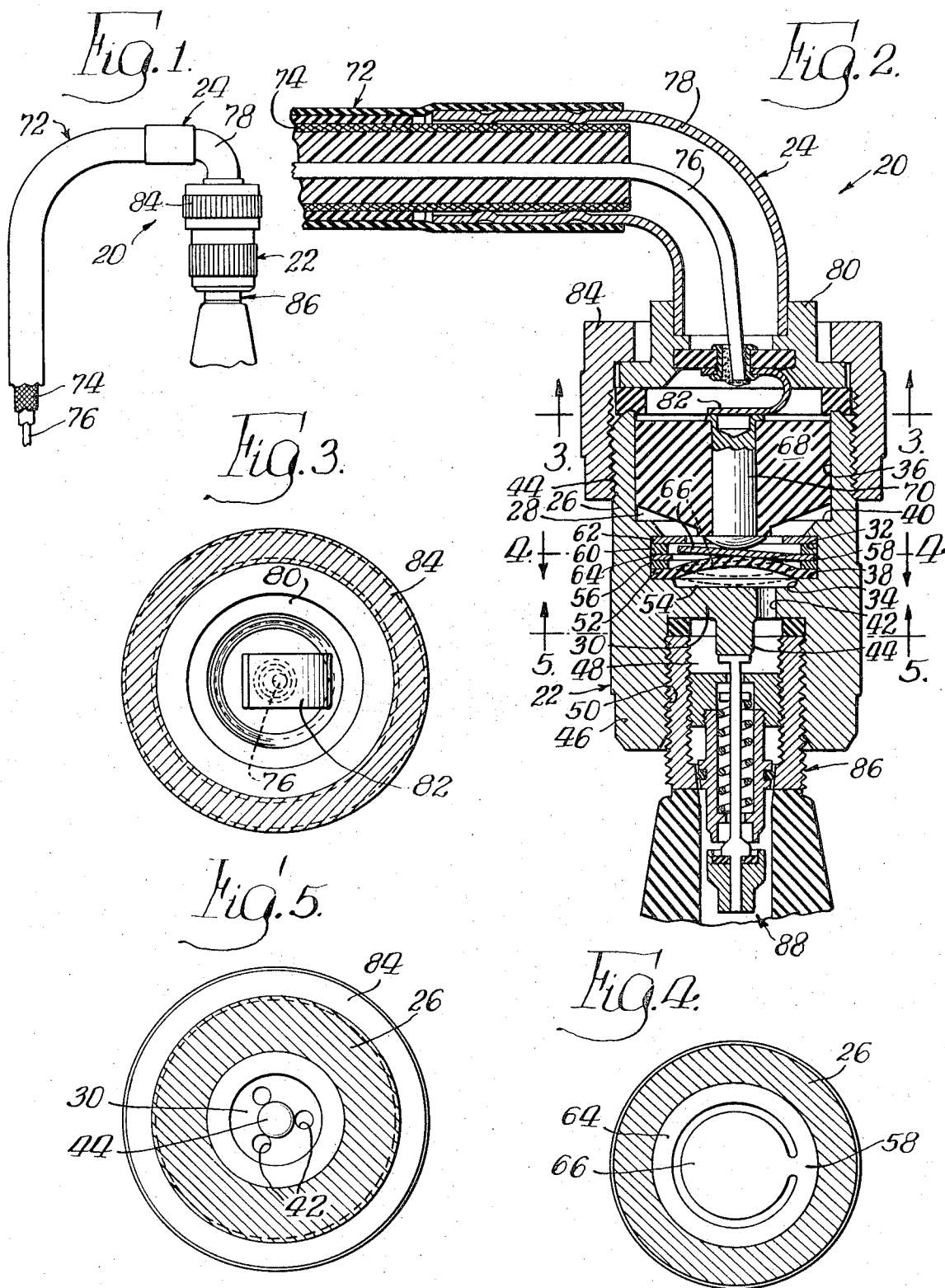
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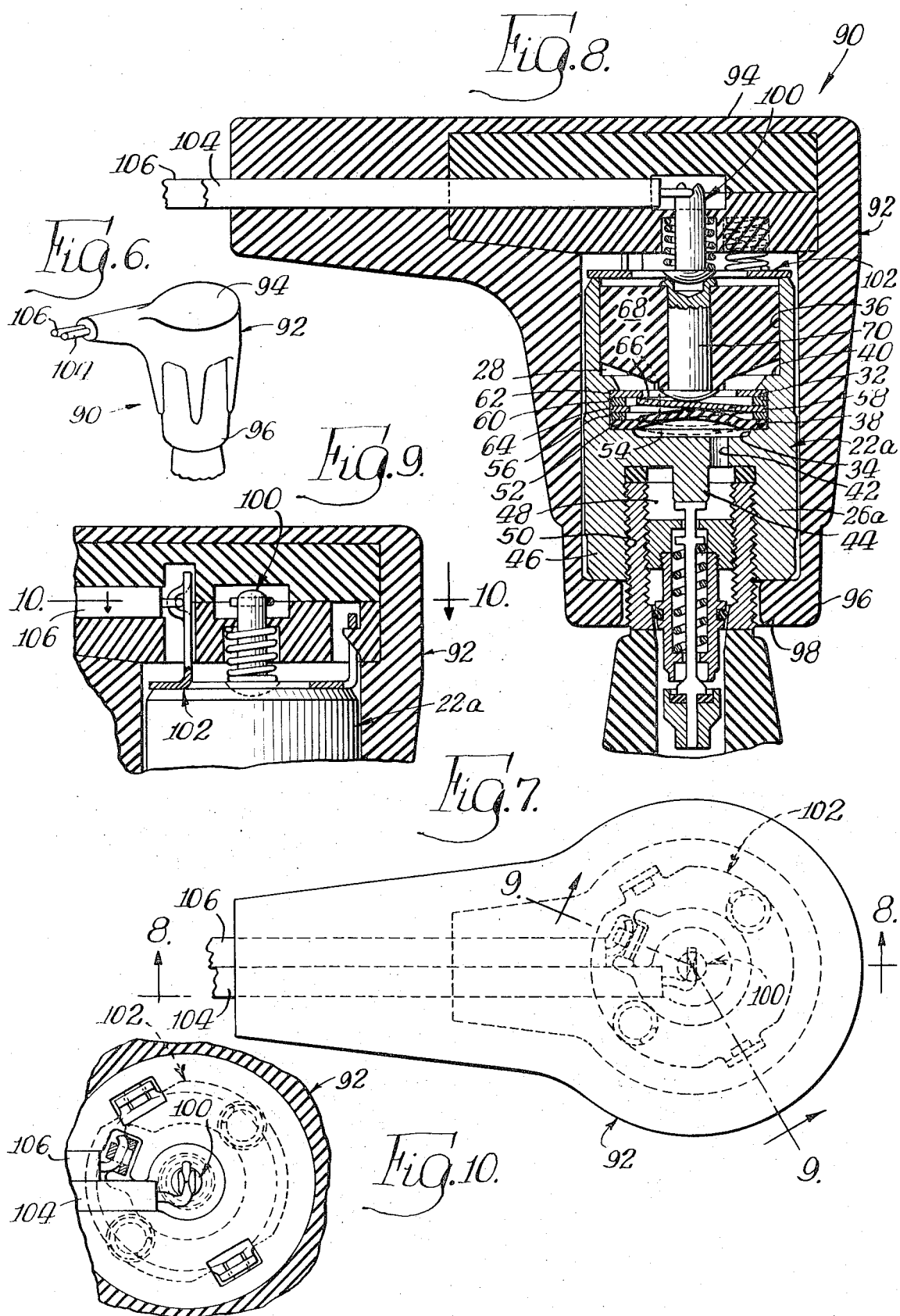
ABSTRACT

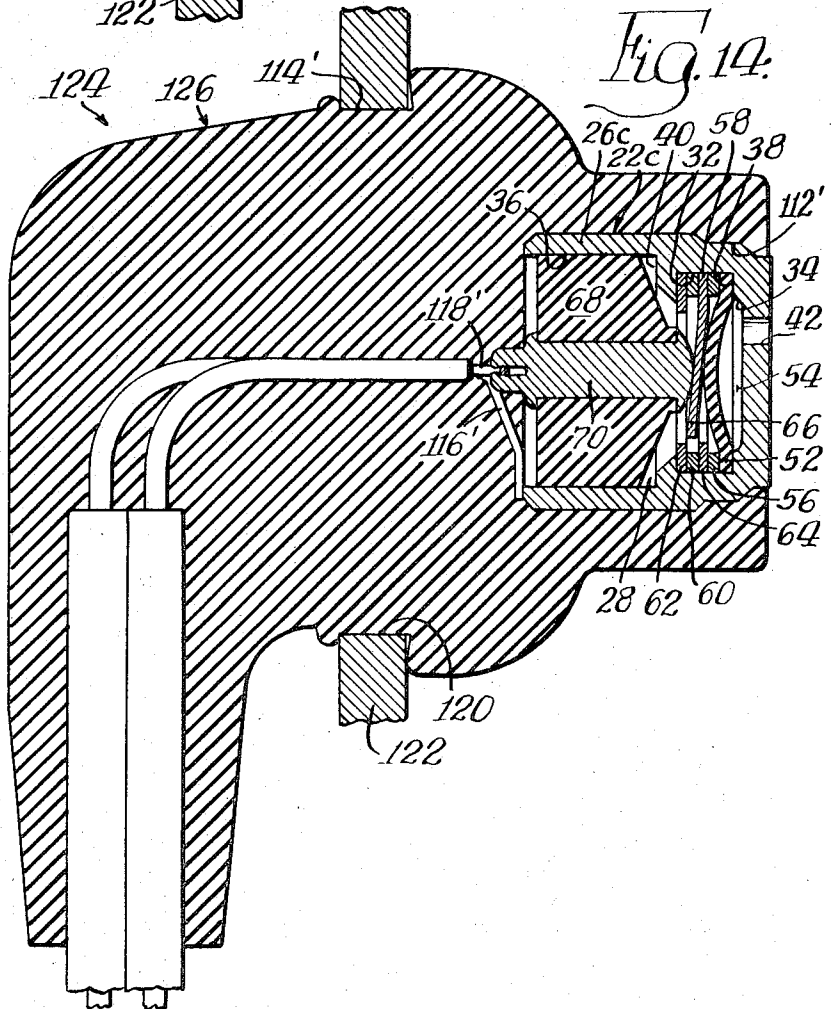
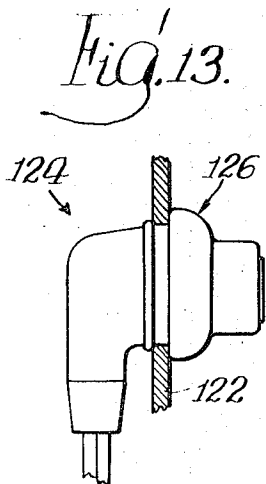
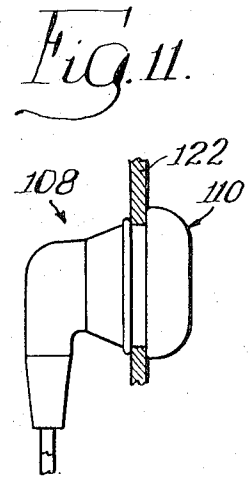
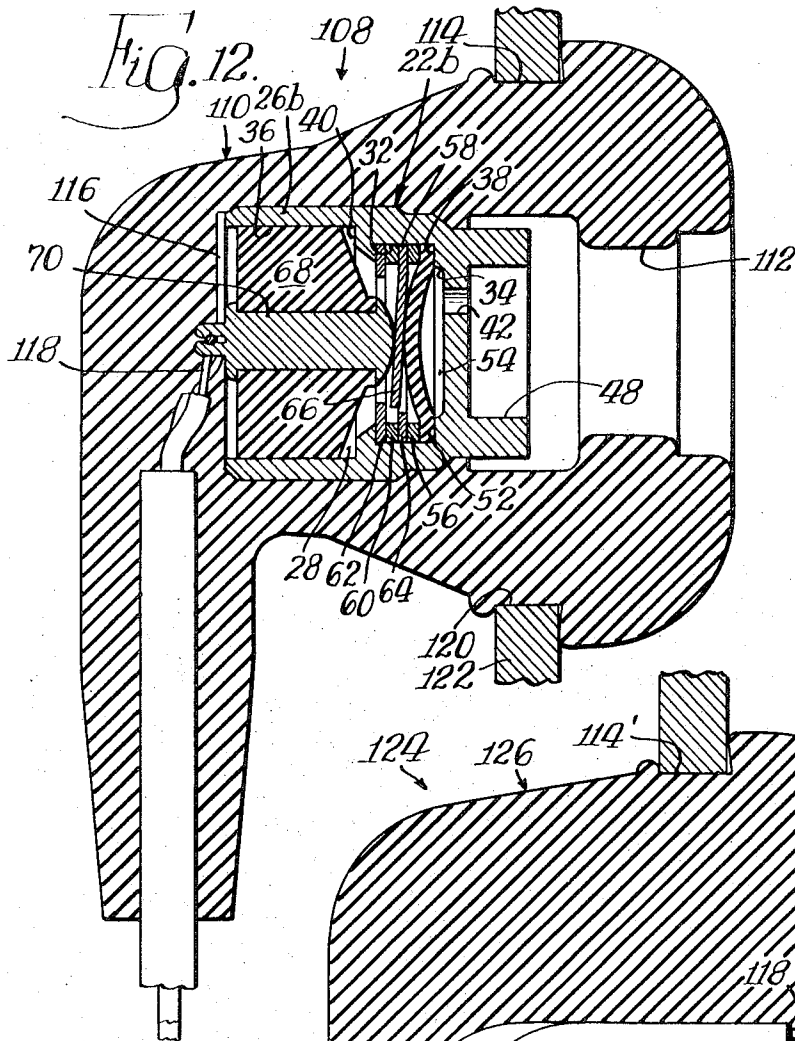
The switch body has an axial opening in one end thereof and a transverse apertured wall at the inner end of the opening. A transverse resilient diaphragm is mounted adjacent to and spaced from the transverse wall whereby to define therewith a chamber. A first electrical contact member is spaced from the diaphragm in opposed relation to the transverse wall, and a second electrical contact member comprising an annular ring portion and an integrally hinged central contact portion is mounted intermediate the diaphragm and the first contact member. The central contact portion of the second contact member is movable with the diaphragm into and out of engagement with the first contact member in response to the air pressure in the chamber.

15 Claims, 14 Drawing Figures









AIR PRESSURE RESPONSIVE SWITCH FOR VEHICLE TIRE AND THE LIKE WITH HINGED CONTACT AND DIAPHRAGM

FIELD OF THE INVENTION

The present invention relates generally to an air pressure responsive switch and more particularly to a switch that is adapted for example to be associated with a vehicle tire for sensing the pressure therein.

SUMMARY OF THE INVENTION

For reasons of safety and tire life, it is desirable that the air pressure of vehicle tires be maintained at or above a predetermined value. The present invention contemplates the provision of air pressure responsive switches which are associated with the vehicle tires and which have connection with a remote visual or audible indicator mounted for example on the vehicle dashboard. When the air pressure of one or more tires falls below the predetermined value, the circuit to the indicator is actuated and the vehicle operator is thereby alerted to the undesirable condition.

The switch of the present invention in brief comprises a first contact, a diaphragm that flexes in response to air pressure, and a second contact that is movable with the diaphragm into and out of engagement with the first contact. By reason of the few moving parts, and the absence of coil springs, the switch, as will be explained in detail hereinafter, affords excellent operational stability, sensitivity and efficiency throughout a wide range of pressures and temperatures and the full range of humidity. With minor design variations, the switch may be attached to a conventional tire valve stem or may be mounted directly to a tire wheel rim, and the switch may have connected thereto a conventional cable assembly or may be housed in a casing providing the necessary electrical connections.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view, approximately full scale, of one embodiment of air pressure responsive switch assembly incorporating the principles of the present invention;

FIG. 2 is a longitudinal median sectional view, on an enlarged scale, of the assembly of FIG. 1;

FIG. 3 is a transverse sectional view taken substantially along the line 3—3 in FIG. 2 looking in the direction indicated by the arrows;

FIG. 4 is a transverse sectional view taken substantially along the line 4—4 in FIG. 2 looking in the direction indicated by the arrows;

FIG. 5 is a transverse sectional view taken substantially along the line 5—5 in FIG. 2 looking in the direction indicated by the arrows;

FIG. 6 is a perspective view, approximately full scale, of another embodiment of air pressure responsive switch assembly incorporating the principles of the present invention;

FIG. 7 is a top view, on an enlarged scale, of the assembly of FIG. 6;

FIG. 8 is a longitudinal sectional view taken substantially along the line 8—8 in FIG. 7 looking in the direction indicated by the arrows;

FIG. 9 is a partial longitudinal sectional view taken substantially along the line 9—9 in FIG. 7 looking in the direction indicated by the arrows;

FIG. 10 is a transverse sectional view taken substantially along the line 10—10 in FIG. 9 looking in the direction indicated by the arrows;

FIG. 11 is a side elevational view, approximately full scale, of a further embodiment of air pressure responsive switch assembly incorporating the principles of the present invention;

FIG. 12 is a longitudinal median sectional view, on an enlarged scale, of the assembly of FIG. 11;

FIG. 13 is a side elevational view, approximately full scale, of a still further embodiment of air pressure responsive switch assembly incorporating the principles of the present invention; and

FIG. 14 is a longitudinal median sectional view, on an enlarged scale, of the assembly of FIG. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1-5, there is shown one embodiment of air pressure responsive switch assembly 20 incorporating the principles of the present invention. The assembly 20 includes an air pressure responsive switch 22 and a cable unit 24 connected thereto.

The air pressure responsive switch 22 comprises a switch body 26 having an axial opening 28 in one end thereof and a transverse wall 30 at the inner end of the opening 28. The opening 28 is defined by a first or intermediate axial bore 32, a second or inner axial bore 34, and a third or outer axial bore 36. The second bore 34 is of lesser diameter than the first bore 32 whereby an annular seat 38 is defined therebetween, while the third bore 36 is of greater diameter than the first bore 32 whereby an annular shoulder 40 is defined therebetween. The transverse wall 30 is formed with axial apertures 42 therethrough and with a central axial projection 44. The switch body 26 is further provided with external threads 44 concentric of the third bore 36, and includes an extension portion 46 having an axial opening 48 into which the wall projection 44 extends. The opening 48 communicates with the second bore 34 through the apertures 42, and is formed with internal threads 50. At least a portion of the switch body 26, and preferably the entire body, is fabricated of an electrically conductive material such as metal.

A transverse resilient diaphragm 52 is disposed in the first bore 32 and seated against the annular seat 38 whereby the second bore 34 serves as a chamber 54. Also disposed in the first bore 32 are a first annular spacer 56, an electrical contact member 58, a second annular spacer 60, and an annular retainer 62. The annular shoulder 40 is ring staked radially inwardly to retain the indicated members within the first bore 32. The contact member 58 is a transversely disposed disc comprising an annular ring portion 64 and an integrally hinged central contact portion 66. The ring portion 64 is engaged with the switch body 26, while the central contact portion 66 is prestressed out of the plane of the ring portion 64, biased against the diaphragm 52 and normally disposed in the dotted line position shown in FIG. 2. In certain applications, the second spacer 60 may not be required. Press fitted in the third bore 36 is an insulator body 68 in which is mounted an elongated axial electrical contact member 70. If desired, the contact member 70 may be threaded for axial adjustment relative to the insulator body 68. The head portion of the contact member 70 is located adjacent the first bore 32 and the annular retainer 62.

The cable unit 24 includes a cable 72 having a ground sheath 74 and a conductor wire 76, a connector tube 78 with a ferrule 80 in which is mounted a contact spring 82 to which the conductor wire 76 is secured, and a clamp nut 84. The cable unit 24 is removably connected to the switch 22, with the contact spring 82 engaging the tail end of the contact member 70, by means of the clamp nut 84 threaded on the threads 44 of the switch body 26. The cable 72 extends to and is electrically connected with a suitable indicator located for example on the dashboard of an automobile. The switch body 26 is removably threaded on a conventional valve stem 86 which is mounted either in an inner tube of a tire or in the rim flange of a wheel supporting a tubeless tire and which includes a valve 88.

When the switch 22 is to be put into use, it is first threaded on the valve stem 86, and then the cable unit 24 is connected to the switch 22. Operationally, the wall projection 44 depresses the valve 88 and the switch chamber 54 is placed in communication with the interior of the tire or tube. In general, the diaphragm 52 is flexed toward and away from the contact member 70 in response to the air pressure in the chamber 54, and the contact portion 66 of the contact member 58 is movable with the diaphragm 52. When the air pressure in the chamber 54 is at or above a predetermined value, the diaphragm 52 effects engagement of the contact portion 66 with the contact member 70 as shown in FIG. 2, thereby closing the electrical circuit of the remote indicator. Also, the annular retainer 62 is engageable by the contact portion 66 when the latter is moved against the contact member 70 by the diaphragm 52 whereby to limit flexure of the contact portion 66 (within its elastic limit) and of the diaphragm 52 and thereby protect the same against possible permanent distortion or rupture due to overload air pressure. When the air pressure in the chamber 54 drops below the predetermined value, the diaphragm 52 returns toward its normal rest position, and the contact portion 66 is disengaged from the contact member 70 and permitted to return toward the position shown in dotted lines in FIG. 2, whereupon the electrical circuit of the remote indicator is opened. The cable unit 24 may be easily removed from the switch 22, and the switch 22 may be easily removed from the valve stem 86, whenever air is to be added to the tire.

The diaphragm 52 is very thin—in the order of 0.015–0.030 inch thick—and the contact member 58 is likewise very thin—in the order of 0.010–0.030 inch thick. As a consequence, the force absorbed by the diaphragm 52, and the mass of the moving diaphragm 52 and contact portion 66, are insignificant. The volume of the chamber 54 is less than 0.0008 cubic inch when the diaphragm 52 is in its prestressed inactive position. The small volume of the chamber 54, coupled with the small amount of air that passes through the small ports 42, minimizes internal condensation. The pressure setting of the switch 22 may be adjusted at the time of assembly in the approximate range of 2–150 pounds per square inch by altering the axial position of the insulator body 68 within the bore 36 or by changing the axial position of the contact member 70 within the body 68 and by changing the degree of prestress imposed on the contact portion 66. The latter permissive change, coupled with the provision of the chamber 54, affords control of the diaphragm 52 and hence promotes calibration stability. Finally, the switch 22 retains excellent

operating stability within a wide pressure range, within a temperature range between -60° and 240°F. , and within a humidity range of 0–100 percent.

Referring now to FIGS. 6–10, there is shown another embodiment of air pressure responsive switch assembly 90 incorporating the principles of the present invention. The assembly 90 includes an air pressure responsive switch 22a and a hollow casing 92 associated therewith. Except for a change in form of the switch body 26a, the switch 22a is substantially identical in construction and operation to the switch 22; and like reference numerals have been used to identify the same or similar parts. The casing 92, which is fabricated of a yieldable material, has a rear closed end 94 and a forward open end 96 with a radially inwardly directed flange portion 98. Mounted inside the casing 92 adjacent the closed end thereof are a spring biased center axial contact pin 100 and a spring biased coaxial contact ring 102. Electrical conductors 104 and 106 are respectively connected to the pin 100 and ring 102 and extend to and are connected with a suitable remote indicator. When the switch 22a is to be put into use, it is first threaded on the valve stem 86, and then the casing 92 is pushed over the switch 22a. The flange portion 98 is yieldable to accommodate movement of the switch 22a into and out of the casing 92. In assembled relation, the switch body 26a is retained in the casing 92 between the flange portion 98 and the contact ring 102 with the contact member 70 engaging the contact pin 100.

Referring now to FIGS. 11 and 12, there is shown a further embodiment of air pressure responsive switch assembly 108 incorporating the principles of the present invention. The assembly 108 includes an air pressure responsive switch 22b and a casing 110 associated therewith. Except for a change in form of the switch body 26b and specifically the elimination of an axial wall projection, the switch 22b is substantially identical in construction and operation to the switch 22; and like reference numerals have been used to identify the same or similar parts. The casing 110, which is fabricated of a yieldable material, has a forward end with an axial opening 112 therein, and an exterior annular recess 114 located intermediate of the length of the opening 112. The switch 22b is mounted in the opening 112 with the transverse wall 30 being disposed rearwardly of the recess 114. Electrical conductors 116 and 118 are respectively connected to the switch body 26b and contact member 70 and extend to and are connected with a suitable remote indicator. The casing 110 is yieldable to accommodate insertion of the forward end thereof through the aperture 120 of a tire wheel rim 122 with the recess 114 being engaged about the edge of the aperture 120. As thus mounted, the switch chamber 54 is placed in communication through the wall apertures 42 with the interior of a tire supported on the wheel rim 122, and the switch 22b is operationally responsive to the air pressure within the tire.

Referring now to FIGS. 13 and 14, there is shown a still further embodiment of air pressure responsive switch assembly 124 incorporating the principles of the present invention. The assembly 124 includes an air pressure responsive switch 22c and a casing 126 associated therewith. Except for a change in form of the switch body 26c and specifically the elimination of an axial wall projection and a body extension portion, the switch 22c is substantially identical in construction and

operation to the switch 22; and like reference numerals have been used to identify the same or similar parts. The casing 126 is similar to the casing 110; and prime reference numerals have been used to identify the corresponding parts. Differentially, the opening 112' is not as deep as the opening 112, the recess 114' is located rearwardly of the opening 112', and the switch 22c is mounted in the opening 112' with the transverse wall 30 being disposed at the forward end of the casing 126; and the switch 22c is arranged to be positioned interiorly of a tire, while the switch 22b is arranged to be positioned exteriorly of a tire.

While there has been shown and described preferred embodiments of the present invention, it will be understood by those skilled in the art that various rearrangements and modifications may be made therein without departing from the spirit and scope of the invention.

The invention claimed is:

1. An air pressure responsive switch having a switch body with an axial opening in one end thereof and a transverse wall at the inner end of said opening, a transverse resilient diaphragm mounted in said opening adjacent said transverse wall, said transverse wall being formed with axial aperture means therethrough, a first electrical contact member mounted in said opening coaxially thereof and spaced from said diaphragm in opposed relation to said transverse wall, and a second electrical contact member mounted in said opening intermediate said diaphragm and said first contact member and having at least a portion thereof being engaged and movable with said diaphragm into and out of engagement with said first contact member in response to the air pressure on the side of said diaphragm facing said transverse wall, the improvement wherein said second contact member is a transversely disposed disc comprising an annular ring portion and a central circular contact portion interconnected by an integral narrow radial hinge portion.

2. The improvement of claim 1 wherein an annular spacer is disposed intermediate of said ring portion of said second contact member and said diaphragm, and said central portion of said second contact member is prestressed out of the plane of said ring portion and biased against said diaphragm.

3. The improvement of claim 2 wherein a transverse annular retainer is disposed adjacent said second contact member in opposed relation to said diaphragm and is engageable by said central contact portion of said second contact member when the latter is moved against said first contact member by said diaphragm whereby to limit flexure of said central contact portion and said diaphragm and thereby protect the same against overload air pressure.

4. An air pressure responsive switch comprising: a switch body having a first axial bore, a second axial bore adjacent said first axial bore and being of lesser diameter than the latter whereby an annular seat is defined therebetween, and a transverse wall at the inner end of said second axial bore and being formed with axial aperture means therethrough; a transverse resilient diaphragm mounted in said first bore and seated against said annular seat whereby said second bore serves as a chamber; a first stationary electrical contact member adjacent said first bore coaxially thereof; a second electrical contact member mounted in said first bore intermediate said diaphragm and said first contact member; said second contact member being a trans-

versely disposed disc comprising an annular ring portion and a central circular contact portion interconnected by an integral narrow radial hinge portion; said central contact portion of said second contact member being movable by said diaphragm; said central contact portion of said second contact member being engaged with said first contact member when said diaphragm is flexed in the direction of the latter in response to air pressure in said chamber at or above a predetermined value, and said central contact portion of said second contact member being disengaged from said first contact member when the air pressure in said chamber drops below said predetermined value and said diaphragm returns towards its normal rest position.

5. The air pressure responsive switch of claim 4 wherein an annular spacer is disposed intermediate of said ring portion of said second contact member and said diaphragm, and said central contact portion of said second contact member is prestressed out of the plane of said ring portion and biased against said diaphragm.

6. The air pressure responsive switch of claim 5 wherein a transverse annular retainer is disposed adjacent said second contact member in opposed relation to said diaphragm and is engageable by said central contact portion of said second contact member when the latter is moved against said first contact member by said diaphragm whereby to limit flexure of said central contact portion and said diaphragm and thereby protect the same against overload air pressure.

7. The air pressure responsive switch of claim 6 wherein said switch body has a third axial bore adjacent said first axial bore and of greater diameter than the latter whereby an annular shoulder is defined therebetween, and said annular shoulder is ring staked radially inwardly to retain said diaphragm and said second contact member and said annular spacer and said annular retainer within said first bore.

8. In combination with the air pressure responsive switch of claim 4, a casing of yieldable material having a forward end with an axial opening therein and said switch being mounted in said opening with said transverse wall facing said forward end of said casing.

9. The combination of claim 8 wherein said casing has a radially inwardly directed flange portion at said forward end, said flange portion is yieldable to accommodate insertion of said switch into said casing, and said switch is retained in said casing by said flange portion.

10. The combination of claim 8 wherein said casing has an exterior annular recess coaxial of said axial opening, and said casing is yieldable to accommodate insertion of said forward end of said casing through the aperture of a tire wheel rim with said recess being engaged about the edge of the aperture.

11. The combination of claim 10 wherein said annular recess is located intermediate of the length of said axial opening, and said transverse wall is disposed rearwardly of said recess.

12. The combination of claim 10 wherein said annular recess is located rearwardly of said axial opening, and said transverse wall is disposed at said forward end of said casing.

13. The air pressure responsive switch of claim 4 wherein at least a portion of said switch body is electrically conductive, said first contact member is insulated from said electrically conductive portion of said switch body, and said second contact member is engaged with

said electrically conductive portion of said switch body.

14. In combination, an air pressure responsive switch and a casing assembly--said switch comprising: a switch body having a first axial bore, a second axial bore adjacent said first axial bore and being of lesser diameter than the latter whereby an annular seat is defined therebetween, and a transverse wall at the inner end of said second axial bore and being formed with axial aperture means therethrough; at least a portion of said switch body being electrically conductive; a transverse resilient diaphragm mounted in said first bore and seated against said annular seat whereby said second bore serves as a chamber; a first stationary electrical contact member adjacent said first bore coaxially thereof; said first contact member being insulated from said electrically conductive portion of said switch body; a second electrical contact member mounted in said first bore intermediate said diaphragm and said first contact member and having at least a portion thereof being movable by said diaphragm; said second contact member being engaged with said electrically conductive portion of said switch body; said second contact member being engaged with said first contact member when said diaphragm is flexed in the direction of the latter in response to air pressure in said chamber at or above a predetermined value, and said second contact member being disengaged from said first contact member when the air pressure in said chamber drops below said predetermined value and said diaphragm returns toward its normal rest position--and said casing assembly comprising: a hollow casing of yieldable material having a closed end and an open end with a radially inwardly directed flange portion, a spring biased center axial contact pin mounted inside said casing adjacent the closed end thereof, a spring biased coaxial contact ring mounted inside said casing adjacent the closed end thereof, said flange portion being yieldable to accommodate movement of said switch into and out of said

casing, and said switch body being normally retained in said casing between said flange portion and said contact ring with said electrically conductive portion engaging the latter and with said first contact member engaging said contact pin.

15. For use with an air pressure responsive switch having a switch body with at least a portion thereof being electrically conductive and an axial opening in one end thereof and a transverse wall at the inner end of said opening, a transverse resilient diaphragm mounted in said opening adjacent said transverse wall, said transverse wall being formed with axial aperture means therethrough, a first electrical contact member mounted in said opening coaxially thereof and spaced from said diaphragm in opposed relation to said transverse wall, and a second electrical contact member engaged with said electrically conductive portion of said switch body and mounted in said opening intermediate said diaphragm and said first contact member and having at least a portion thereof being movable by said diaphragm into and out of engagement with said first contact member in response to the air pressure on the side of said diaphragm facing said transverse wall, the combination of a hollow casing of yieldable material having a closed end and an open end with a radially inwardly directed flange portion, a spring biased center axial contact pin mounted inside said casing adjacent the closed end thereof, a spring biased coaxial contact ring mounted inside said casing adjacent the closed end thereof, said flange portion being yieldable to accommodate movement of said switch into and out of said casing, and said switch body being normally retained in said casing between said flange portion and said contact ring with said electrically conductive portion engaging the latter and with said first contact member engaging said contact pin.

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