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PRESSURE RESPONSIVE SWITCH FOR INDICATORS

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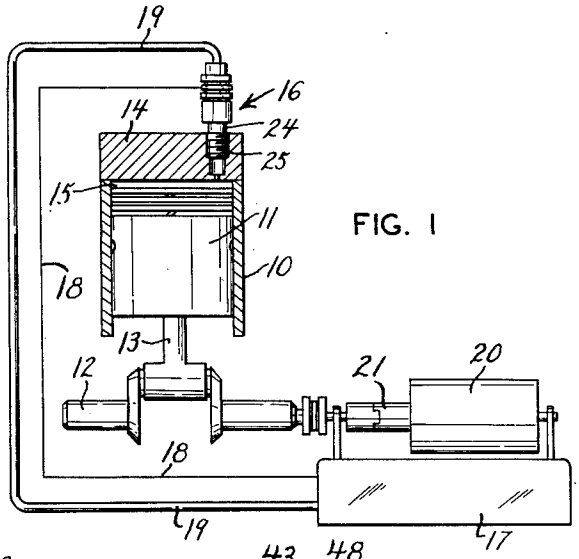

FIG. 1

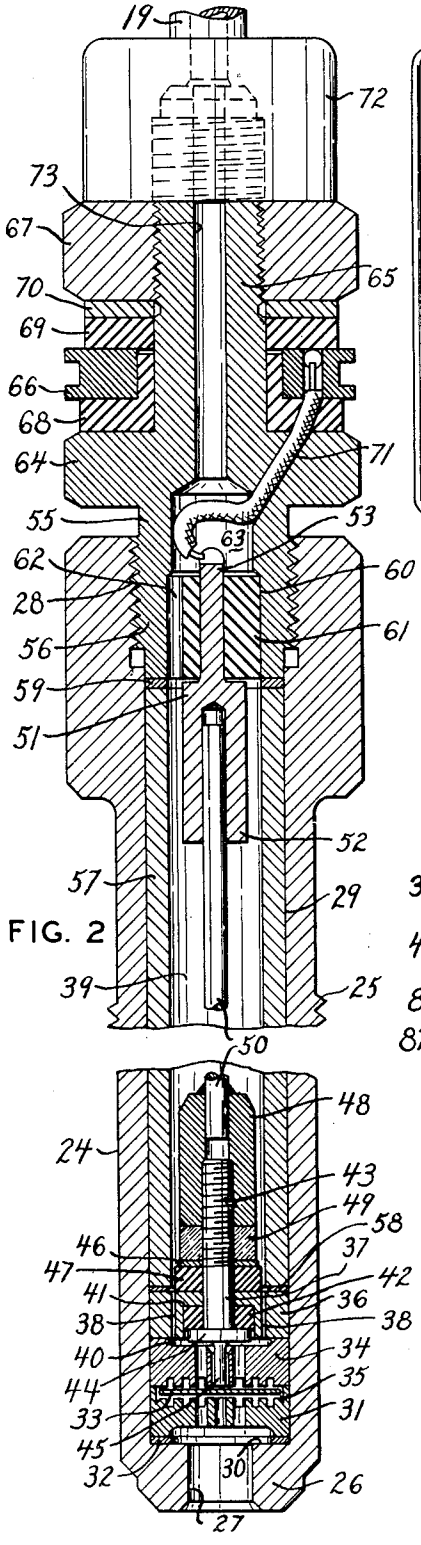

FIG. 2

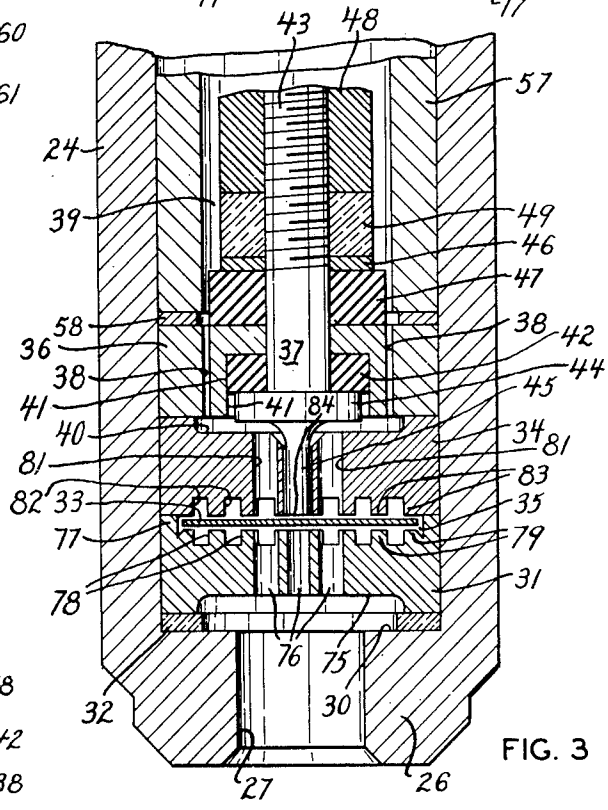

FIG. 3

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PRESSURE RESPONSIVE SWITCH FOR INDICATORS

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7 Claims. (Cl. 200—83)

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This invention is directed to the general class of pressure indicator system for investigating pressure conditions in pumps, internal combustion engines, and the like, it being an important object to improve upon the pressure responsive unit employed with such indicator systems.

The present indicator systems employed for investigative work in connection with the internal conditions in a pressure chamber, such as that of a pump cylinder or internal combustion engine combustion space, usually include a pressure responsive pick up unit which embodies a diaphragm member exposed at one side to the pressure being studied and exposed at its opposite side to the influence of a controllable test pressure. The flexing of such a diaphragm under certain differential pressure conditions is utilized to close an electrical circuit associated with a suitable recording or indicating instrument. Most, if not all, of the pressure units now in use are constructed with the diaphragm member securely clamped at its periphery whereby to effect a positive separation between the diaphragm chamber spaces exposed to the test pressure and the pressure being investigated. The fixed type of diaphragm is, therefore, subjected to destructive fatigue stresses which will eventually develop into permanent deformation of the diaphragm, cause errors in the fidelity of the pressure response, retard the desired rapidity of response, and in other respects cause the introduction of errors materially affecting the true pressure conditions.

Accordingly, it is also an important object of the present invention to design and construct a pressure responsive unit which will not be affected by the above noted objections almost invariably found in the devices currently in use.

It is also an object to simplify the construction of a pressure responsive unit such that the pressurized diaphragm may be entirely unrestricted and freely movable over its full area, securely retained in a closely defined chamber for rapid response to the net effect of opposed pressure from a test source and a source under investigation, and required to have a minimum of movement into or out of a position of contact with an electrode element of the associated electrical indicator circuit.

Other objects and advantages of the present invention will be more fully pointed out in connection with the detailed description of a preferred embodiment hereof as is disclosed in the accompanying drawing.

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In the drawing:

Fig. 1 is a diagrammatic layout of a pressure indicator system serving to show the operative relation of the pressure responsive unit in connection with an internal combustion engine, the latter being shown in schematic and partly sectioned elevation;

Fig. 2 is an enlarged longitudinal sectional elevational view of the improved unit forming the subject of the invention; and

Fig. 3 is a greatly enlarged and fragmentary portion, in section, of the improved unit in which certain details are shown to better advantage.

In the view of Fig. 1, the engine under test is represented by the single cylinder 10, piston 11 and crankshaft 12 to which the piston is operatively connected by the connecting rod 13. The cylinder has the usual head member 14 which cooperates with the cylinder and piston to define a combustion space 15. My improved unit 16 is suitably mounted in the head 14 for communication with the space 15 whereby pressure conditions therein may be investigated. The unit 16 is associated with an engine indicator instrument, shown only generally at 17, through the electrical line 18 and the pressure line 19, each of these lines 18 and 19 having a suitable connection with sources (not shown) of electrical energy and fluid under pressure respectively. It is, of course, understood that the cylinder 10 is grounded to complete the circuit through line 18 and unit 16.

Briefly considered, the instrument 17 carries means for recording the desired cyclic pressure events in space 15 upon a drum means 20 which is rotated in timed relation with crank movement through the clutch connected shaft 21. Thus a record of the combustion pressure conditions may be recorded on drum 20 for any position of the piston 11 as determined by the angular position of the crankshaft 12. The instrument 17, of course, must be adjusted to provide a known pressure in line 19 and when ever the pressure in the space 15 exceeds this test pressure, an electrical circuit through line 18 will be completed for energizing the means (not shown) adapted to mark drum 20. Thus a complete pressure diagram may be obtained in a step-by-step manner.

The improved unit 16 shown in detail in Figs.

2 and 3 comprises a body 24 having external threads 25 by which it may be secured in the cylinder head 14, a lower end having a transverse wall or flange 26 through which port 27 opens to the interior of the body, and an upper and enlarged end having internal threads 28 at the open end zone of the body bore 29. The lower flanged end 26 of the body forms an internal annular seat 30 for receiving a diaphragm block 31 upon a seat gasket 32. The diaphragm element 33 is positioned on the upper recessed surface of block 31 and a second block 34 is positioned thereover to define a restricted chamber 35 within which the diaphragm is confined with a sufficient working clearance so as to permit free bodily movement to a limited extent in the axial direction of the body 24. A holder element 36 for an electrode 37 is positioned adjacent the diaphragm block 34 so that a plurality of apertures 38 in the holder communicate with a space 39 thereabove and a recess 40 formed in the adjacent face of the block 34. Apertures 38 may be located in a circular pattern concentric with the axis of the unit and outwardly of an undercut central recess 41 in the holder for the reception of an insulator element 42.

The electrode 37 is formed with an upper threaded stem 43, a mounting flange 44 and a lower tip 45 of reduced diameter. Flange 44 is positionable in the recess 41 of the holder 36 and is spaced therefrom by the insulator 42 upon positionment of the latter over the stem 43 and against the upper surface of the flange 44. Electrode 37 is clamped to the holder 36 by means of the nut 49 threaded on stem 43 and bearing against a washer 46 and an insulating washer 47, the latter being seated against the holder 36. The upper portion of the threaded stem 43 of electrode 37 engages the threaded socket element 48 of the elongate rod 50. The socket element 48 is formed of an electrical conductive material, and constitutes the circuit connection between the electrode 37 and the rod 50. Rod 50 (Fig. 2) extends toward the upper open end of the body 24 and carries an electrical connector element 51 which is press-fitted thereover by means of the socket portion 52 such that the integrally formed connector post 53 thereof is positioned within the zone of the threads 28 in the body 24.

The parts of the assembly above described are secured in the body 24 by means of the body cap member 55 (Fig. 2) wherein the threaded portion 56 thereof engages in the body threads 28 and serves to press a spacer sleeve 57 positioned in the bore 29 against the electrode holder 36 and, hence, compress the diaphragm blocks 31 and 34 against the sealing gasket 32 upon seat 30 at the lower end 26 of the body 24. Suitable gasket elements 58 and 59 are interposed at opposite ends of the sleeve, 57 as shown. The portion 56 of the cap member 55 is internally recessed to provide a seat 60 for the insulator block 61 which maintains the connector element post 53 in axially concentric position relative to the bore 29 of the body 24. This latter block 61 is formed with a suitable number of radial notches 62 (only one being shown in Fig. 2) which permit communication between the space 39 within sleeve 57 and a pocket 63 provided above the block 61.

Cap member 55 is also formed with an enlarged portion 64 in the nature of a tool engaging nut for effecting threaded positionment thereof in body 24, and a stem portion 65 extending above the boss 64 to provide a mounting surface for the slip ring element 66. The slip ring 66 is held in position by the nut 67 threaded on stem 65, and is fully insulated therefrom by means of the sleeved insulator 68 and the annular insulator 69. Nut 67 bears on washer 70 to protect the insulator 69 from damage by the rotation of the nut. An electrical lead 71 extends from its soldered connection at post 53 through suitable apertures in the boss 64 and insulator to a soldered connection in the slip ring 66, all as indicated in Fig. 2. The ring 66 is suitably formed of an electrically conductive material, such as copper.

Connection of the pressure line 19 to the unit 16 is effected by means of the threaded fitting 72 engaging the upper end of the stem 65 above nut 67 so that the line 19 opens to the axial bore 73 of the member 55 for communication with the pocket 63 and thence through notches 62 in the insulator block 61 to the space 39. At the lower end of the body 24, the space 39 communicates with the upper face of the diaphragm 33 by way of the annular space around the insulator 47, the annular ring of apertures 38 in the holder 36, recess 40 of the upper diaphragm block 34 and the several axially directed apertures formed in the latter block. The electrical circuit for this indicator 16 includes the body 24 and block 34 on one side of the diaphragm 33, and the electrode 37, socket 48, rod 50, connector 51, lead 71, slip ring 66 and external lead wire 18 for the opposite side of the diaphragm. This circuit is completed upon contact of the diaphragm with the electrode tip face 84.

With particular reference to Fig. 3, it will be seen that the diaphragm block 31 is formed with a plain surface recess 75 in the bottom of which are formed a plurality of axially directed apertures 76. The upper side of this block is recessed to provide an axially directed, peripheral rim 77 extended above the general facial plane thereof, and this plane is further milled out to form a series of annular and concentric notches or grooves 78 separated by similar lands 79 of a co-planar character. Thus the diaphragm 33 is adapted to be supported on the lands 79 with a small working clearance at the rim 77. In a similar manner, the upper block 34 is provided with a plurality of axially directed apertures 81 leading from the recess 40 to the diaphragm chamber 35. The lower face of this block 34 is formed with a series of annular notches or grooves 82 and intervening lands 83 which are in oppositely registering alignment with but spaced from the lands 79 on the lower block 31. The spacing of the two blocks 31 and 34 is determined by the rim 77. Electrode element 37 is positioned, in assembly, with its tip 45 extending into the central one of the apertures 81 with small clearance and such that its diaphragm contact face 84 is substantially flush with the common plane of the lands 83.

In a pressure responsive unit of this character the diaphragm chamber 35 defined by the blocks 31 and 34, is open through apertures 76 and port 27 to the source of pressure to be investigated, and through apertures 81 and recess 40 to the source of pressure under control of the instrument 17 as supplied through line 19 at fitting 72. Diaphragm 33 effectively divides this chamber 35 into sections, and effectively prevents cross flow by its seating contact on either one or the other series of land surfaces depending upon which source of pressure is dominant. A pre-

ferred construction, and one which has proved entirely satisfactory, embodies a diaphragm element 33 having a thickness of substantially .010 inch working in chamber 35 having an axial depth of substantially .011 inch. Thus the diaphragm is movable through a distance of .001 inch from its contact on block 31 to its contact with block 34 and electrode tip face 84. In this same embodiment, the diaphragm was formed of Beryllium bronze for its strength and durability under the high pressure and temperature conditions encountered in internal combustion engine use.

The light weight and tough character of the diaphragm renders it extremely sensitive to pressure variations occuring in the different sections of the chamber 35. A further feature hereof resides in the provision of a minimum amount of movement for the diaphragm, thereby practically eliminating inertia effects and consequent time lag for the electrical make or break action on the tip face 84 of the electrode 37. Moreover, the free mounting of the diaphragm entirely eliminates the introduction of errors due to fatigue of the diaphragm, such as is encountered in the prior units where the diaphragm is peripherally clamped in situ.

Having now fully described my improved pressure responsive unit 16, it will be understood that I do not wish to be limited to the exact features of its construction but intend that all reasonable variants thereof be included within the spirit and scope of the appended claims.

I claim:

1. A pressure responsive unit comprising a body having relatively spaced openings for communication with a periodically pressurized space and a source of known pressure respectively, an electrode element positioned in said body, a diaphragm element operatively mounted in said body adjacent said electrode element, said diaphragm element being freely and bodily movable toward or away from said electrode element under the influence of the differential of pressures from said space and known pressure source, and means in said body for confining said diaphragm to limited movement, said means providing openings at each side of the diaphragm for pressure transmission thereto and said openings being located so as to be closed by diaphragm whereby to prevent cross-communication of the space and pressure source.

2. A pressure responsive unit comprising a body having relatively spaced openings, one of which is adapted to communicate with a periodically pressurized space and the other with a source of known pressure, an electrode element positioned in said body and electrically insulated therefrom, and a diaphragm element operatively mounted in said body adjacent said electrode element and in position effectively to prevent cross flow between the pressurized space and known pressure source, said diaphragm element being freely, bodily movable toward or away from said electrode element under the differential pressure effects from said known pressure source and pressurized space.

3. A pressure responsive unit comprising a body having relatively spaced openings for communication with a pressurized space and a source of known pressure respectively, a pair of elements in said body formed to define a chamber therebetween, said elements each having an aperture therein to permit communication between said chamber and the pressurized space and known source of pressure, and a diaphragm freely movably disposed in said chamber for effecting closure of the apertures in either of said elements under the influence of a pressure differential across the diaphragm.

4. A pressure responsive unit comprising a body having an inwardly flanged end providing a port and an annular seat adjacent thereto, a block element on said seat and having apertures therein and a recess in one face communicating with said port through the apertures, a second block element positioned adjacent the recess in said first block to define a recess chamber therewith, said second block having apertures formed therein, a diaphragm in the recess chamber between said block elements, said diaphragm being freely, bodily movable against either of said block elements to close the apertures therein, and means for communicating a known source of pressure through said second block element and against one face of said diaphragm, said port in the flanged end of said body being adapted for communicating a source of pressure to be investigated through said first mentioned block element and against the opposite faces of said diaphragm.

5. In a pressure responsive unit, an elongate body having a bore therein and a ported flange formed at one end thereof, the flange defining an internal annular seat in said body, an apertured block positioned against said annular seat and having a recess formed in one face to provide a peripheral rim directed axially of the body bore, a second apertured block positioned against the peripheral rim of said first block to define a chamber with the recess of the latter block, a diaphragm element freely, bodily movable in said chamber and adapted to contact either of said blocks in aperture closing relation, and an electrode element carried in the body bore and formed with a tip portion extended through an aperture in said second block for contact by said diaphragm upon movement of the latter into contact with said second block, said diaphragm being movable in response to the difference of pressure on its opposite sides due to disposition of said body between separate sources of pressure.

6. In a pressure responsive unit, a body having an axial bore and a ported flange at one end of the bore to define an internal annular seat, a body cap member engageable at the opposite end of the body bore, and having a passage communicating with said bore, a pair of complementary block elements in said bore formed with a plurality of axially directed apertures and defining a chamber between their adjacent faces, means for securing said block elements against said annular seat upon assembly of said cap member, a diaphragm element disposed in said chamber for free bodily movement between said block elements, an electrode element projecting into an aperture of one block element for contact by said diaphragm upon movement thereof against said one block, electrical connection means carried by said cap member, means for electrically associating said connection means and said electrode element, and means on said cap member adapted to connect the body bore with a source of pressure such that said said diaphragm is urged to a position out of contact with said electrode and in opposition to a source of pressure communicated to said chamber at the opposite side of the diaphragm through said ported flange.

7. A pressure responsive unit comprising a body having relatively spaced openings and a bore communicating said openings, the body

openings being adapted for communication respectively with a pressurized space and a source of known pressure, means in said bore defining a chamber having apertures respectively affording communication of the chamber with the pressurized space and known source of pressure, and a diaphragm element freely, movably disposed in the chamber and acting selectively and under the influence of differential pressures to close certain of said apertures to prevent cross-communication of the pressurized space and known pressure source.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,072,984	Haskins	Mar. 9, 1937
2,085,203	Schlesman et al.	June 29, 1937
2,362,874	Wiley	Nov. 11, 1944