

[54] **PRESSURE-TO-ELECTRIC TRANSDUCER**[76] Inventor: **Paul Patrick Rice**, R.R. No. 3, Box 411, Elkhart, Ind. 46514[22] Filed: **Feb. 24, 1972**[21] Appl. No.: **229,123**[52] U.S. Cl. **338/42, 73/398 AR**[51] Int. Cl. **H01c 13/00**[58] Field of Search **338/42, 41, 2, 4, 338/5, 36; 73/269, 398 AR**[56] **References Cited****UNITED STATES PATENTS**

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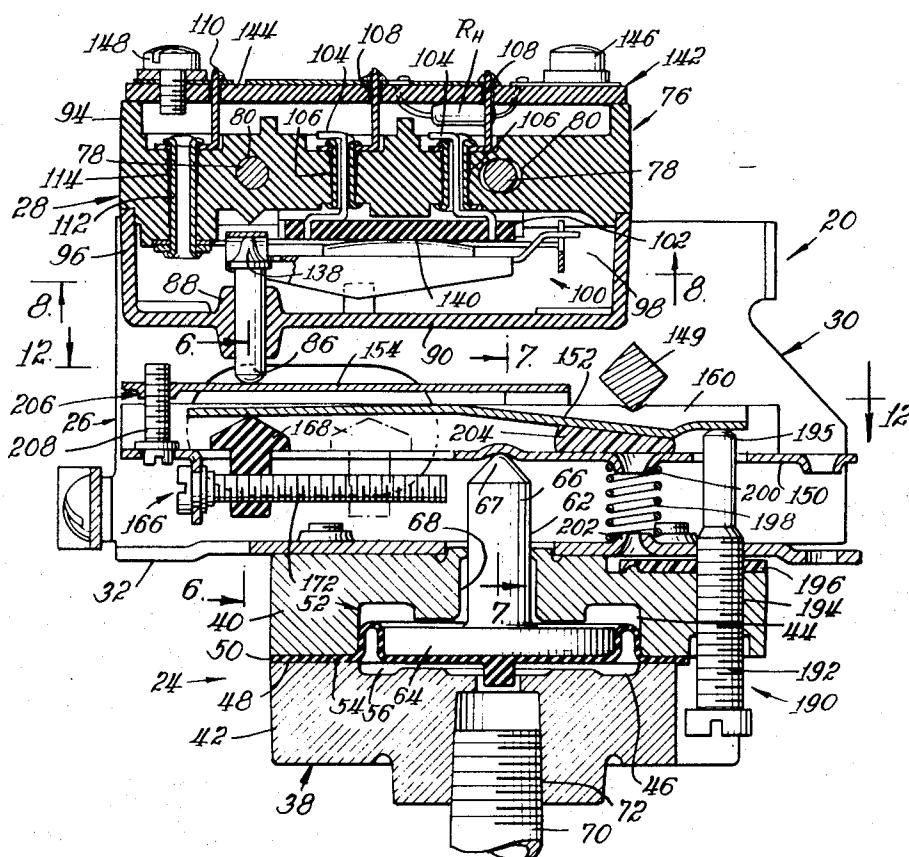
Primary Examiner—C. L. Albritton

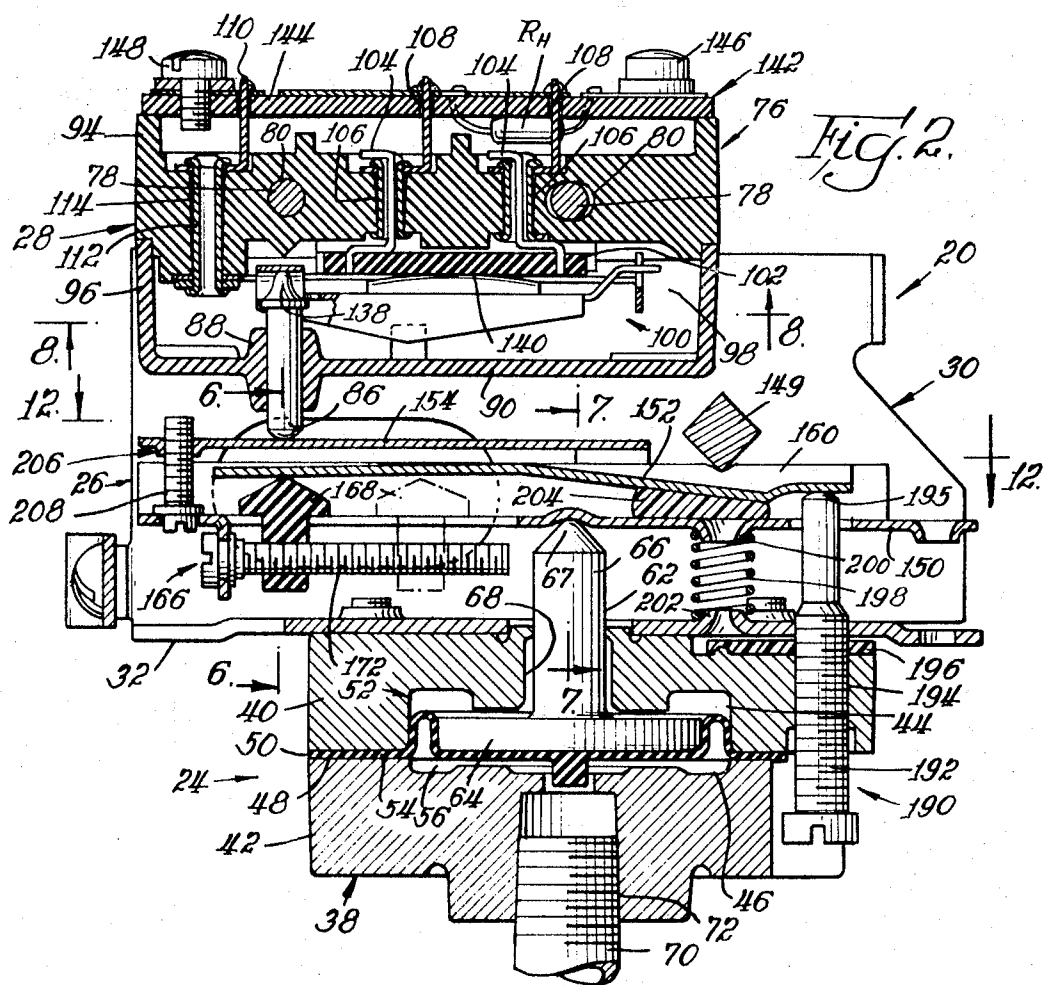
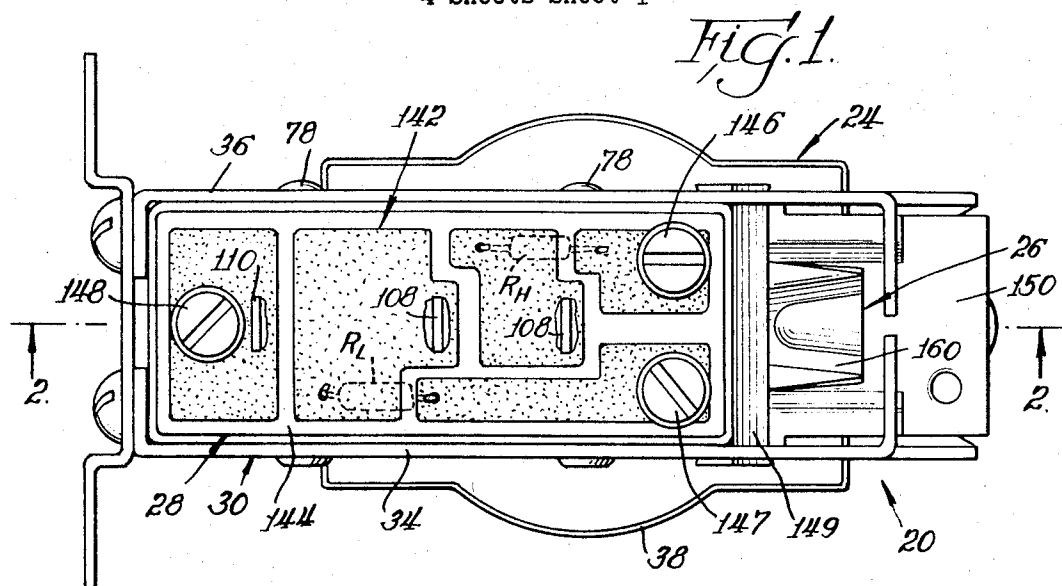
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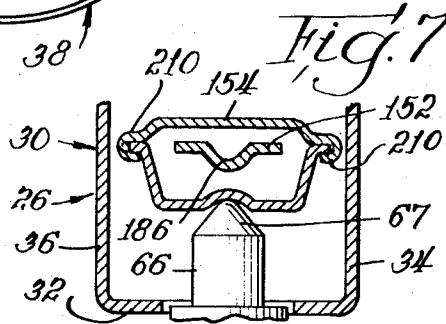
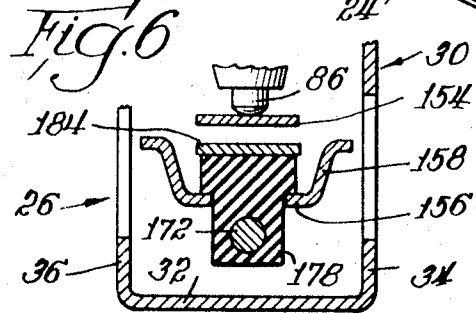
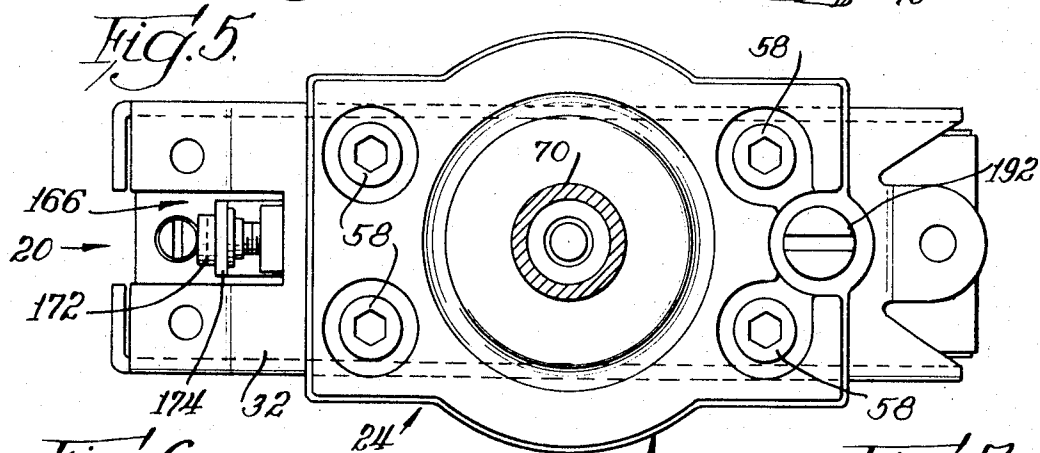
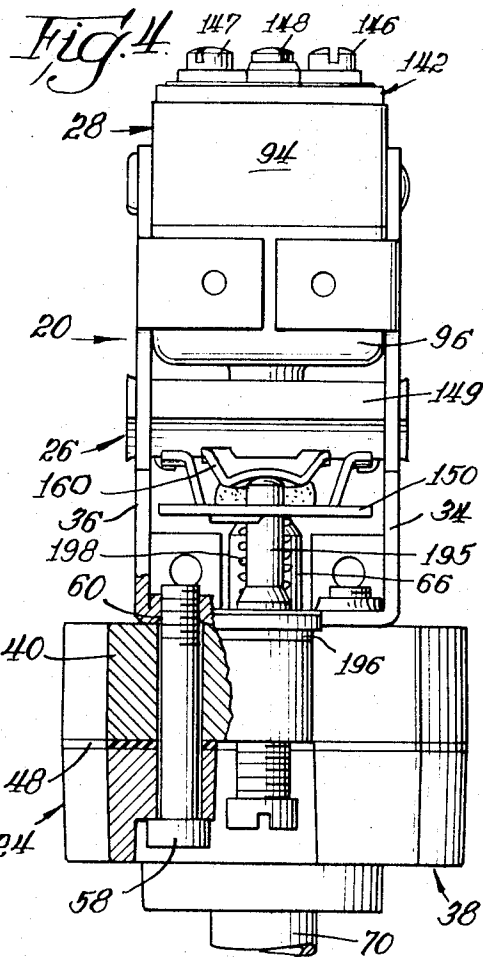
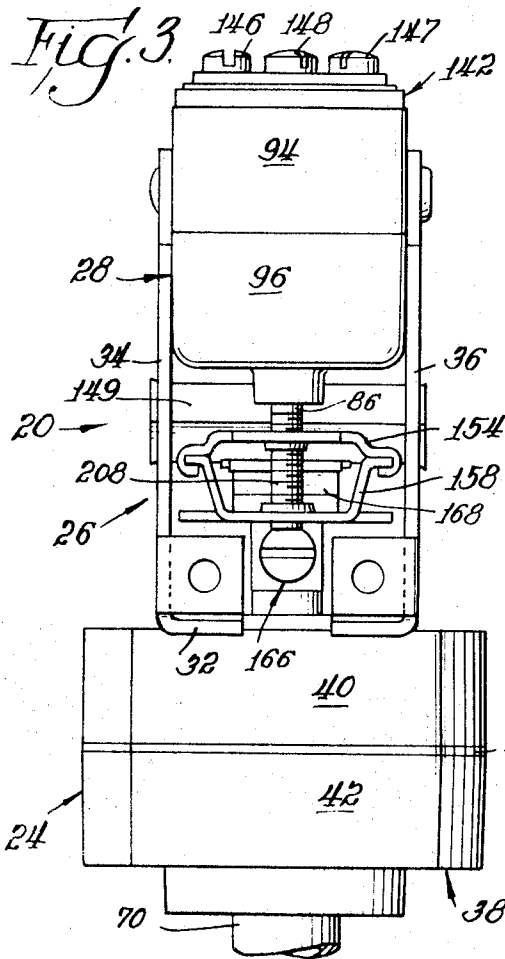
[57] **ABSTRACT**

A transducer for providing an electrical output voltage

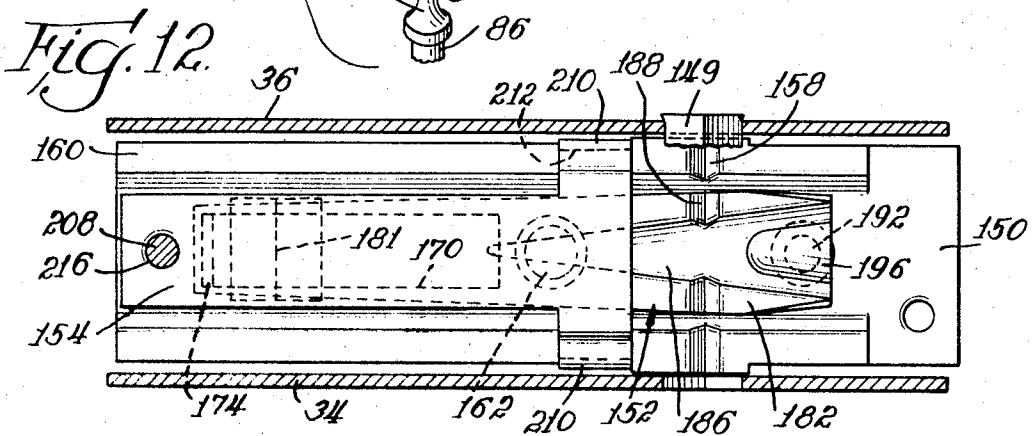
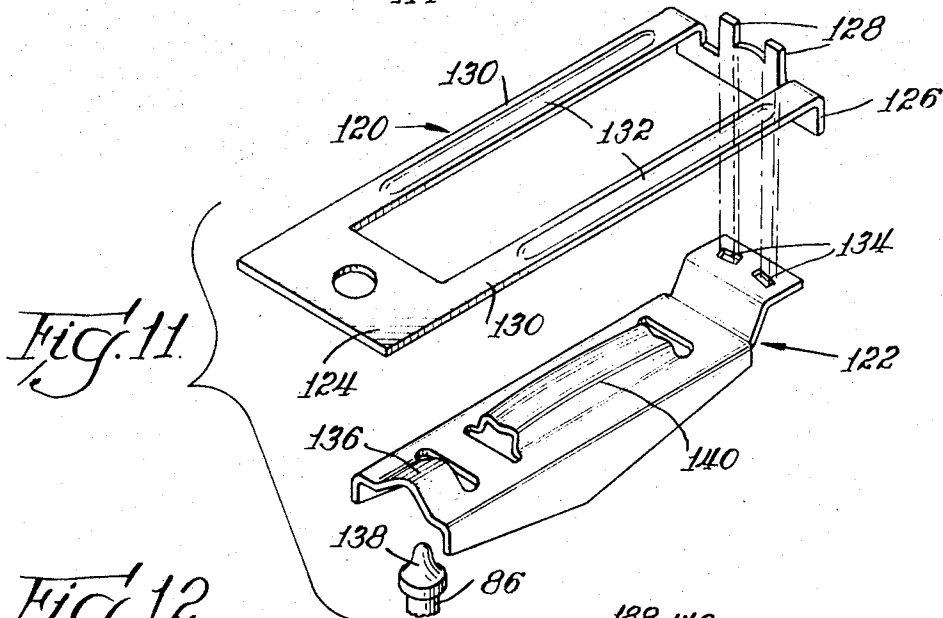
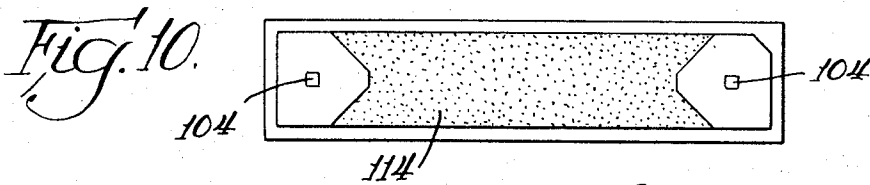
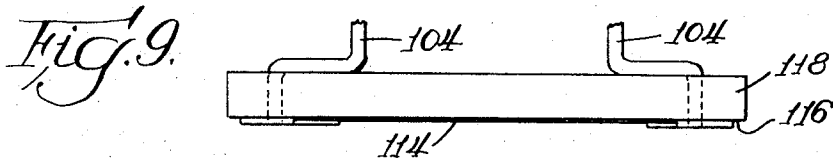
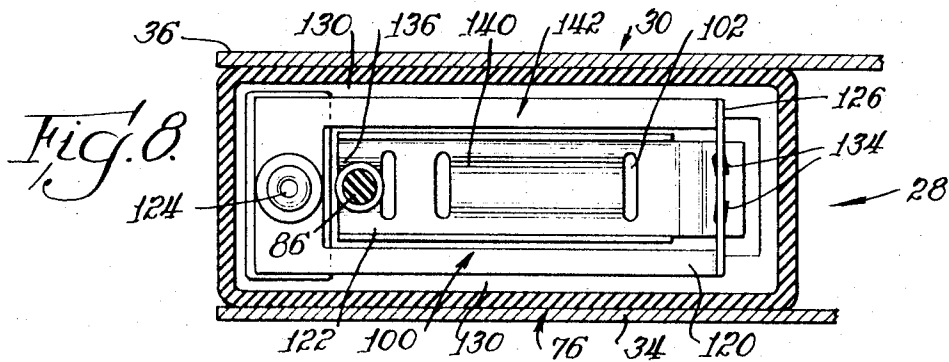
linearly proportional to an input pressure is assembled on a frame having a bottom wall and a pair of sidewalls. A pressure diaphragm housing is supported below the bottom wall of the frame and includes a central passageway and an intersecting cavity. A diaphragm member is disposed across said cavity crosswise to the central passageway to define an expandable and collapsible pressure chamber with the lower portion of the cavity. A force transfer member is slidably supported in the upper portion of the central passageway with its lower end abutting against the diaphragm member and its upper end extending above said bottom wall. A pivot member extends between the frame sidewalls and a main lever is supported between the pivot member and the upper end of the force transfer member with a spring means constantly urging the lever towards the force transfer member. Variable resistance means are actuated by the arcuate movement of the main lever to provide an electrical output signal directly proportional to the displacement of the force transfer member in response to changes in the pressure in the pressure chamber.

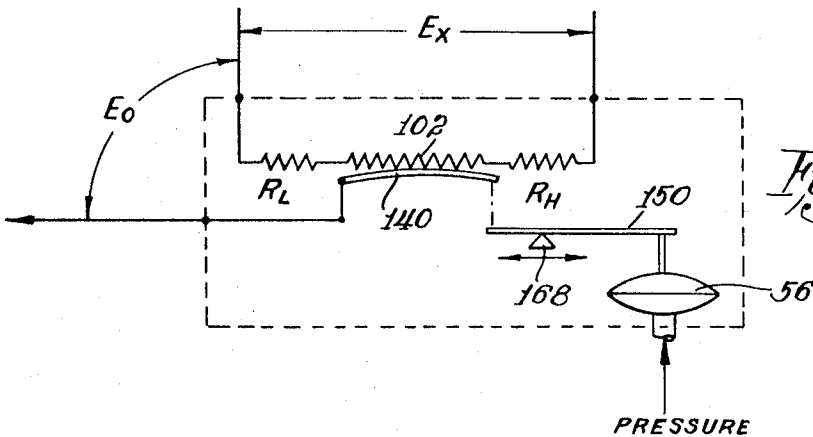
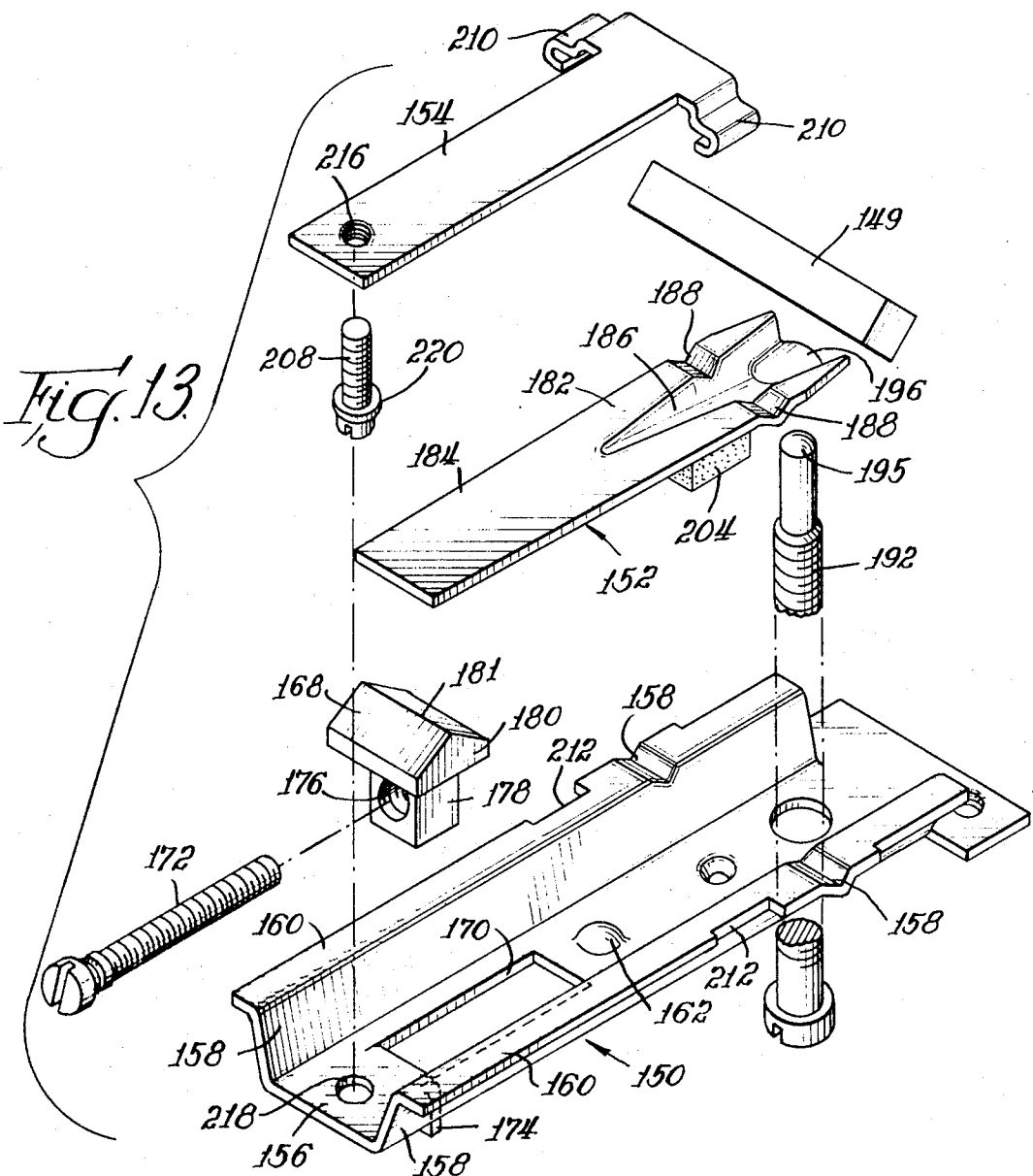
17 Claims, 14 Drawing Figures





4 Sheets-Sheet 3





PRESSURE-TO-ELECTRIC TRANSDUCER

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for providing an electrical output signal indicative of the presence of a predetermined input pressure, and more particularly to a transducer apparatus for providing an electrical output voltage linearly proportional to an input pressure.

In the prior art, there are a number of transducer apparatus designed to provide an electrical signal responsive to an input pressure. In order to produce an output voltage which is linearly proportional to the input pressure, these prior art devices have quite complicated constructions which are expensive to manufacture and subject to high repair costs.

One object of this invention is to provide a transducer apparatus capable of producing an electrical output voltage linearly proportional to an input pressure, which is inexpensive to manufacture and easy to calibrate.

A further object of this invention is to provide a transducer apparatus capable of producing an electrical output voltage linearly proportional to an input pressure in which the range of operation can be readily varied.

A further object of this invention is to provide a transducer apparatus capable of producing an electrical output voltage linearly proportional to an input pressure in which the point of the initial pick-up of the apparatus can be varied to selectively adjust the point at which the pressure will actuate a variable resistance means to provide an electrical output signal directly proportional to the change in input pressure.

SUMMARY OF THE INVENTION

A transducer for providing an electrical output voltage linearly proportional to an input pressure comprising an expandable and collapsible pressure chamber having a fluid inlet means, a main lever pivotally supported adjacent the chamber, force transfer means for moving the main lever in one direction about its pivot in direct response to increases of pressure in the chamber with spring means biasing the lever against such movement, and variable resistance means for providing an electrical output signal directly proportional to the movement of said main lever about its pivot. The variable resistance means is constructed as an elongated resistive element having voltage input terminals, a conductive rocker member having an arcuate contact portion disposed lengthwise adjacent to the resistive element, voltage output terminals electrically connected between the rocker member and one of the input terminals, and translational means operatively connected between the main lever and the rocker member to convert the arcuate motion of the main lever to a translational force which is directed against one end of the rocker member causing the contact portion to roll along said resistive element in direct proportion to the change in pressure of the pressure chamber.

The spring means used to bias the main lever is an elongated member disposed in space relation transversely to the main lever with one end portion rigidly supported at the pivot member and the other end portion extending beyond the point of contact of force transfer means and main lever. The other end portion is resiliently urged against the main lever. A differential

range adjust means is provided for selectively varying the point of contact in a lengthwise direction between resilient end portion of the elongated spring member and the main lever to thereby vary its effective spring rate, and a set point means is used for varying the transverse angle between said resilient end portion and the main lever to selectively adjust the point at which the pressure will actuate the variable resistance means.

DESCRIPTION OF DRAWINGS

For a better understanding of this invention reference may be made to the accompanying drawings in which:

FIG. 1 is a top plan view of a transducer apparatus embodying the principles of my invention;

FIG. 2 is a cross sectional view taken along the lines 2—2 of FIG. 1 and looking in the direction of the arrow;

FIG. 3 is an end view of FIG. 1 taken from the left side thereof;

FIG. 4 is an end view of FIG. 1 taken from the right side thereof;

FIG. 5 is a bottom view of the transducer apparatus of FIG. 1;

FIG. 6 is a cross sectional view taken along the line 6—6 of FIG. 2 and looking in the direction of the arrow;

FIG. 7 is a cross sectional view taken along the line 7—7 of FIG. 2 and looking in the direction of the arrow;

FIG. 8 is a view taken along the line 8—8 of FIG. 2 and looking in the direction of the arrows showing the operating components of the potentiometer assembly;

FIGS. 9 and 10 illustrate, respectively, the side and bottom view of a resistor element used in the potentiometer assembly;

FIG. 11 is a perspective exploded view of the actuator used in the potentiometer assembly;

FIG. 12 is a top plan view of the main lever assembly taken along the line 12—12 of FIG. 2 and looking in the direction of the arrows;

FIG. 13 is an exploded perspective view of the main lever assembly; and

FIG. 14 is an electrical schematic diagram of the transducer apparatus embodying the principles of my invention.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to FIGS. 1 through 5, there is shown a pressure-to-electric transducer apparatus embodying the principles of my invention and generally designated by the reference numeral 20. The pressure - electric transducer 20 has three operating assemblies: pressure diaphragm assembly 24, main lever assembly 26 and potentiometer assembly 28. The components of the pressure-electric transducer 20 are supported by elongated U-shaped frame 30 having a bight portion 32 and a pair of parallel arm portions 34 and 36.

Housing 38 for the pressure diaphragm assembly 24 is supported on the outside surface of the bight portion 32 of U-shaped frame 30 and comprises upper and lower mating blocks 40 and 42. Upper and lower blocks 40 and 42, respectively, are provided with recesses 44 and 46 in their lower and upper surfaces 48 and 50, respectively, which when assembled together define an enclosed cavity 52. A diaphragm member 54 is sandwiched between the upper and lower blocks 40

and 42 and extends across the cavity 52 to define an expandable and collapsible pressure chamber 56 with the lower recess 46. The upper and lower blocks 42 and the diaphragm member 54 are assembled together as an integral unit and are mounted on the bight portion 32 of the U-shaped frame 30 by means of four mounting bolts 58, which extend through the upper and lower blocks and diaphragm member 54 and are screwed into threaded apertures 60 (FIG. 4) in the bight portion 32.

The diaphragm member 54 is preferably a pre-convoluted type containing a constant net effective area through its displacement. When supported in the manner shown in the drawings, the convolution produces lower lateral stress per p.s.i. to allow high overpressure without rupture. Diaphragm 54 drives force transfer member 62 in response to changes in pressure in the pressure chamber 56. Force transfer member 62 has a T-shape with a head portion 64 disposed within upper recess 44 in abutting relationship with the central area of the diaphragm 54. Stem portion 66 of force transfer member 62 is disposed in sliding relationship with a central passageway 68 formed through the center of upper block 40. Stem portion 66 extends beyond the limits of the passageway 68 and its upper pointed end 67 engages the main lever assembly 26. The fluid whose pressure is to be sensed by the transducer 20 is introduced into the chamber 56 through a fluid inlet means in the form of fitting or hose coupling 70 which fastens into the lower end of central passageway 72 formed through lower block 42.

Potentiometer assembly 28 has an enclosed box-shaped housing 76 which is mounted between the outer ends of the arm portions 34, 36 of U-shaped frame 30 by means of two rivets 78 inserted through apertures in the arm portions 34, 36 and through circular openings 80 extending between the sidewalls 84 of housing 76. A plunger element 86 is slidably mounted in a sleeve 88 formed in the bottom wall 90 of the housing 76. Plunger element 86 is repositioned by the main lever assembly 26 in response to changes in the pressure of pressure chamber 56.

The housing 76 for the potentiometer assembly 28 has an upper block section 94 and a lower block section 96. Lower block section 96 has a pan shaped configuration which mates with upper block section 94 to present a cavity 98. A contact rocker device 100 is disposed within cavity 98 and interconnects the plunger element 86 to a resistor element 102. Voltage input terminals 104 of elongated resistive element 102 extend through a pair of passageways 106 formed in the upper block section 94 and are electrically connected to a pair of output terminal blades 108. A third terminal blade 110 is connected to the contact rocker device 100 by means of a conductive element 112 extending through a third passageway 114 formed in the upper block section 94.

Referring to FIGS. 9 and 10, resistive element 102 comprises a resistive coating 114 covering the bottom surface 116 of an insulative block 118. Contact rocker device 100 (FIG. 11) comprises spring element 120 and conductive rocker member 122. The spring element 120 has an elongated rectangular shape with an open midsection and is fixed at one end 124 to the conductive element 110. Its opposite free end 126 is upturned and has a pair of downwardly extending tabs 128 used for coupling the rocker lever 122. A pair of spaced parallel legs 130 connect the two ends 124, 126

and have rib portions 132 for strengthening purposes.

Rocker lever 122 has an elongated shape having one end formed with a pair of apertures 134 into which tabs 128 of spring member 120 project to interconnect the two elements. The free end of rocker lever 122 is provided with a crown portion 136 into which the pointed head of plunger element 86 seats. An arcuate contact portion 140 is integrally formed intermediate the two ends and is held against the resistive element 102 by virtue of the spring force of spring element 120, and is adapted to form rolling contact with approximately 80 percent of the resistive coating 114. The outer end portions of resistive coating are not linear in resistance so the two end portions are not used.

Referring to FIG. 2, it can be seen that the translational displacement of plunger element 86 determines the point of contact between arcuate portion 140 of the rocker lever 122 and the resistive coating 114. By virtue of this relationship, the potentiometer assembly 28 acts as a variable resistance means which provides an electrical output signal directly proportional to the arcuate movement of main lever 150.

The preferred embodiment is shown to include the use of a range select panel 142 which snaps over the terminal blades 108, 110. The purpose of this range select panel is to select the transducer's range by adding resistors R_H and R_L as schematically depicted in FIG. 14. Range select panel 142 comprises a printed circuit board 144 with resistors R_H and R_L attached across its bottom portion and electrically connected between terminal blades 108 and terminal posts 146, 149 by etched conductive strips. The third terminal post 149 is electrically connected to the third terminal blade 110. Thus R_L and R_H are connected in series with variable resistor 102, as depicted in FIG. 14.

The main lever assembly 26 is disposed within the U-shaped frame 30 between the pressure diaphragm assembly 24 and the potentiometer assembly 28 and pivots about fulcrum or pivot member 149, which is secured between arms 34 and 36. Main lever assembly comprises a main lever 150, a spring member 152 and an alignment bar 154. Referring to FIG. 13, the main lever 150 has an elongated configuration with a bottom wall 156, a pair of diverging upstanding sidewalls 158 that terminate as outturned flange portions 160. A dimple 162 is provided in the bottom wall 156 for receiving the pointed upper end 67 of stem portion 66. A pair of V-grooves 158 are formed crosswise to the main lever 150 in its pair of flange portions 160 for seating against the lower pointed edge of the square-shaped pivot member 149 (FIG. 2).

The main lever assembly 26 includes a differential range adjustment device 166 to vary the effective spring rate of spring member 152 and thereby provide a means to vary the sensitivity of the pressure-electric transducer apparatus 20. Differential range adjustment device 166 (FIG. 2) comprises a sliding block 168 (FIG. 3) projecting through an elongated opening 170 in main lever 150. To selectively vary the position of sliding block 168, a differential range adjusting screw 172 is rotatably mounted in a downturned flange 174 of main lever 150 and is in threaded engagement with a threaded bore 176 formed through the stem portion 178 of the sliding block 168. The spacer portion 180 of the sliding block 168 is substantially larger in cross section than the width of the elongated opening 170 to support block 168 on bottom wall 156 and the upper

pointed edge 181 of spacer portion 180 engages the outer end portion of spring member 152.

Spring member 152 (FIG. 13) is formed as a one-piece elongated element having a rigid portion 182 and a resilient portion 184. The rigid portion 182 includes a V-shaped stiffening rib 186 extending lengthwise, and a pair of V-grooves 188 formed crosswise to its length inwardly of its opposite lateral edges for seating against the lower corner of fulcrum member 149. The resilient portion 184 is flattened and tapers inwardly in a lengthwise direction towards its outer end to provide a decreasing spring resistance. It will thus be appreciated that as the sliding block 168 is moved toward the right as viewed in FIG. 2, the biasing force of spring member 152 increases.

The pressure in chamber 56 at which initial displacement of plunger 86 occurs is determined by the position of set point device 190 (FIG. 2). Set point device 190 comprises a threaded bolt 192 extending through bore 194 in the upper block section 94 and having its upper pointed end 195 in engaging relationship with the dimpled portion 196 at the end of rigid portion 184 of spring biasing member 152. By selectively turning range adjust bolt 192 the transverse angle between the resilient portion 184 and main lever 150 is varied to thereby change the pick-up point at which the pressure will actuate the potentiometer 28. A torque gasket 196 (FIG. 2) locks the range adjust bolt 192 in position once the desired setting of spring biasing member 152 is determined.

A spring 198 (FIG. 2) is disposed between boss 200 on main lever 150 and complementary boss 202 projecting upwardly from bight portion 32 of U-frame 30 to prevent misalignment of the main lever assembly 26 during either shipment or backing off range screw 192 too far. Similarly, a resilient piece 204, such as a piece of foam rubber, is disposed between main lever 150 and spring bias member 152 to prevent the spring member from dropping out during the shipment or in the event the range screw 192 is backed off too far.

An alignment device 206 (FIG. 2) is provided between the contact rocker device 100 and the main lever assembly 26, and comprises alignment bar 154 and alignment screw 208. Alignment bar 154 (FIG. 13) has a T-shape with the head portion formed with a pair of inwardly turned clamping fingers 210 which fit into a pair of complementary notches 212 in the flange portions 160 of the main lever 150 and are fastened in place to secure the right end of alignment lever 154 (as viewed in FIG. 2). The other end of alignment lever 154 has a threaded aperture 216 through which is screwed alignment screw 208. Alignment screw 208 has a circular stop 220 formed at its head of a diameter larger than opening 218 in main lever 150. Thus it can be seen that by turning alignment screw 208, the initial contact point with potentiometer plunger 86 can be set.

It will be apparent that modifications and variations may be made in the disclosed embodiment without departing from the scope of the novel concepts of the present invention. It is accordingly my intention that the scope of the invention be limited solely by that of the hereinafter appended claims.

I claim:

1. A transducer apparatus for providing an electrical output voltage linearly proportional to an input pressure comprising an expandable and collapsible pressure chamber having a fluid inlet means, a main lever pivot-

ally supported adjacent said chamber, force transfer means for moving said main lever in one direction about its pivot in direct response to increases of pressure in said chamber, an elongated spring member disposed in space relation along said main lever having one end fixed at said pivot and the other end disposed in resilient engagement with said main lever to urge said main lever against said force transfer means, variable resistance means for providing an electrical output signal directly proportional to the movement of said main lever about its pivot and set point means for varying the transverse angle between said other end portion of said spring member and said main lever to selectively adjust the point at which the pressure will actuate said variable resistance means.

2. A transducer apparatus for providing an electrical output voltage linearly proportional to an input pressure comprising an expandable and collapsible pressure chamber having a fluid inlet means, a main lever pivotally supported adjacent said chamber, force transfer means for moving said main lever in one direction about its pivot in direct response to increases of pressure in said chamber, spring means biasing said lever against movement in said one direction, and variable resistance means for providing an electrical output signal directly proportional to the movement of said main lever about its pivot, said variable resistance means including an elongated resistive element, voltage input terminals electrically connected across said resistive element, a conductive rocker member having an arcuate contact portion disposed lengthwise of said resistive element, voltage output terminals electrically connected between said rocker member and one of said voltage input terminals, and translational means operatively connected between said main lever and said rocker member to convert the arcuate motion of said main lever to a translational force which is directed against one end of said rocker member causing said contact portion to roll along said resistive element in direct proportion to the change in pressure in said pressure chamber.

3. A transducer apparatus for providing an electrical output voltage linearly proportional to an input pressure comprising an expandable and collapsible pressure chamber having a fluid inlet means, a main lever pivotally supported adjacent said chamber, force transfer means for moving said main lever in one direction about its pivot in direct response to increases of pressure in said chamber, spring means biasing said lever against movement in said one direction, said spring means including an elongated member disposed in space relation along said main lever and having one end portion rigidly supported at said pivot and the other end portion extending beyond the point of contact of said force transfer means with said main lever, said other end portion having resilient characteristics and disposed in engaging relation with said main lever to urge said main lever against said force transfer means, and variable resistance means for providing an electrical output signal directly proportional to the movement of said main lever about its pivot.

4. A transducer apparatus as defined in claim 3, further comprising a differential range adjust means for selectively varying the point of contact in a lengthwise direction between said resilient end portion of said elongated spring member and said main lever to thereby vary its effective spring rate.

5. A transducer apparatus as defined in claim 4, wherein said differential range adjust means comprises a block member slidably mounted on said main lever and having a spacer portion sandwiched between said outer end portion of said spring member and said main lever, and an adjustment screw rotatably mounted on said main lever in a lengthwise direction and in threaded engagement with a threaded bore in said block member.

6. A transducer apparatus as defined in claim 3, further comprising set point means for varying the transverse angle between said resilient end portion of said spring member and said main lever to selectively adjust the point at which the pressure will actuate said variable resistance means.

7. A transducer apparatus for providing an electrical output voltage linearly proportional to an input pressure comprising a frame having a bottom wall and a pair of sidewalls, an enclosed housing supported below said bottom wall and having a central passageway formed therethrough in alignment with an opening in said bottom wall, a cavity formed within said housing intersecting said central passageway, a diaphragm member disposed across said cavity crosswise to said central passageway to define an expandable and collapsible pressure chamber with the lower portion of said cavity, a force transfer member slidably supported in the upper portion of said central passageway with its lower end abutting against said diaphragm member and its upper end extending above said bottom wall, a pivot member extending between said sidewalls above and to one side of said force transfer member, a main lever extending lengthwise between said sidewalls and supported between said pivot member and the upper end of said force transfer member, spring means biasing said lever towards said force transfer member, and variable resistance means for providing an electrical output signal directly proportional to the movement of said main lever above said pivot member caused by the displacement of said force transfer member in response to changes in the pressure of said pressure chamber.

8. A transducer apparatus as defined in claim 7, wherein said variable resistance means comprises an elongated housing mounted between said side walls above said main lever, said elongated housing having an enclosed elongated cavity, three terminal members projecting above the upper surface and extending through three spaced passageways in said elongated housing between said cavity and said upper surface, a flat resistive element electrically connected to two of said terminal members in said cavity and having a resistive coating facing downwardly, a conductive rocker member having an arcuate contact portion disposed in rolling relation with said resistive coating, the third of said terminal members electrically connected to said conductive rocker member, a plunger element slidably disposed through a sleeve provided crosswise through the bottom wall of said elongated housing, the upper end of said plunger element in engaging relation with one end of said rocker member and its lower end operatively connected with said main lever such that the arcuate motion of said main lever about said pivot member causes a translational movement of said plunger element, and second spring means for biasing said rocker member to follow the translational movements of said plunger element.

9. A transducer apparatus as defined in claim 8, further comprising a range select panel which snaps over the upper ends of said three terminal members, said range select panel including a printed circuit board with openings to fit over said three terminal members, three terminal posts extending upwardly from the upper surface of said circuit board, first and second resistors, first and second conductive means for electrically connecting, respectively, said first and second resistors between first and second of said three terminal posts and said two of said terminal members, and third conductive means for electrically connecting the third terminal member to the third terminal post.

10. A transducer apparatus as defined in claim 8, further comprising an alignment bar supported by said main lever above its base plate below said plunger element and screw means for selectively varying the distance of said alignment bar from said base plate at its point of contact with said plunger element.

11. A transducer apparatus as defined in claim 7, wherein said spring means comprises an elongated member disposed in space relation along said main lever and having one end portion rigidly supported at said pivot member and the other end portion extending beyond the point of contact of said force transfer member with said main lever, said other end portion having resilient characteristics and disposed in engaging relation with said main lever to urge said main lever against said force transfer member.

12. A transducer apparatus as defined in claim 11, further comprising a differential range adjust means for selectively varying the point of contact in a lengthwise direction between said resilient end portion of said elongated spring member and said main lever to thereby vary its effective spring rate.

13. A transducer apparatus as defined in claim 12, wherein said differential range adjust means comprises a block member slidably mounted on said main lever and having a spacer portion between said resilient end portion of said spring member and said main lever, and an adjustment screw rotatably mounted on said main lever in a lengthwise direction and in threaded engagement with a threaded bore in said block member.

14. A transducer apparatus as defined in claim 11, further comprising set point means for varying the transverse angle between said other end portion of said spring member and said main lever to selectively adjust the point at which the pressure in said pressure chamber will actuate said variable resistance means.

15. A transducer apparatus as defined in claim 14, wherein said set point means comprises a set screw in threaded relation with an aperture in said bottom wall of said frame with its upper end engaging the outer end of said one end portion of said elongated spring member, where the turning of said set screw changes the transverse angle between said resilient end portion of said spring member and said main lever.

16. An apparatus for providing an electrical output signal to indicate the presence of a predetermined input pressure comprising an expandable and collapsible pressure chamber having a fluid inlet means, a main lever pivotally supported adjacent said chamber, force transfer means for moving said main lever in one direction about its pivot in direct response to increases of pressure in said chamber, spring means biasing said lever against movement in said one direction, said spring means including an elongated member disposed

in space relation along said main lever and having one end portion rigidly supported at said pivot and the other end portion extending beyond the point of contact of said force transfer means with said main lever, said other end portion having resilient characteristics and disposed in engaging relation with said main lever to urge said main lever against said force transfer means and electrical responsive means actuated after a determined amount of movement of said main lever

in said one direction to provide said electrical output signal.

17. An apparatus as defined in claim 16, further comprising set point means for varying the transverse angle between said resilient end portion of said spring member and said main lever to selectively adjust the point at which the pressure will actuate said electrical responsive means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,753,199 Dated August 14, 1973

Inventor(s) Paul Patrick Rice

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Preamble, after the name of the inventor insert --

Assignee: Johnson Service Company, Milwaukee, Wisconsin --

Signed and sealed this 5th day of February 1974.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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