May 7, 1968 P. J. KVISTAD 3,382,470

LEVER OPERATED PRESSURE TRANSDUCER

Filed Sept. 21, 1966 3 Sheets-Sheet 1

Fig. 2.

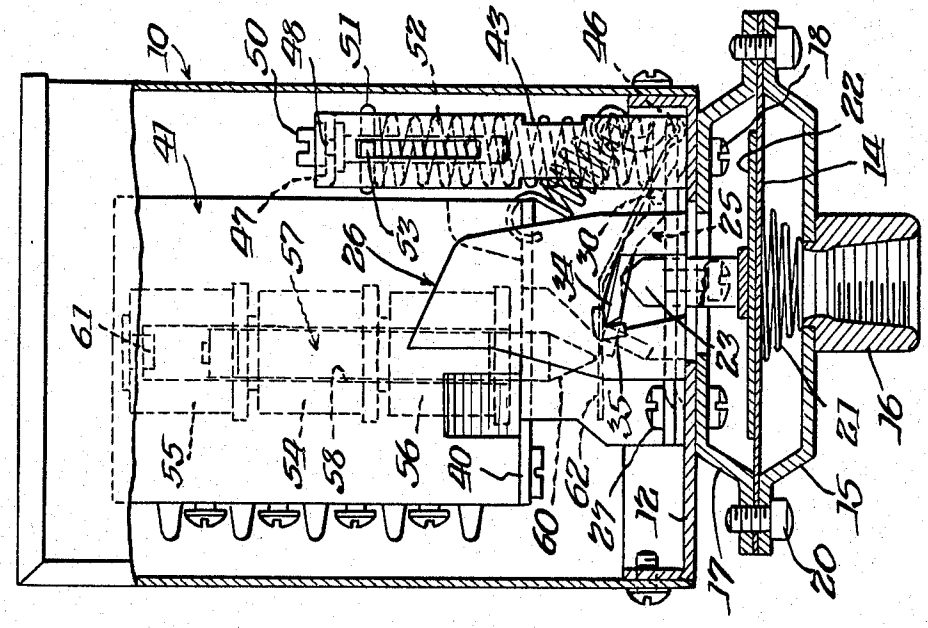


Fig. 1.

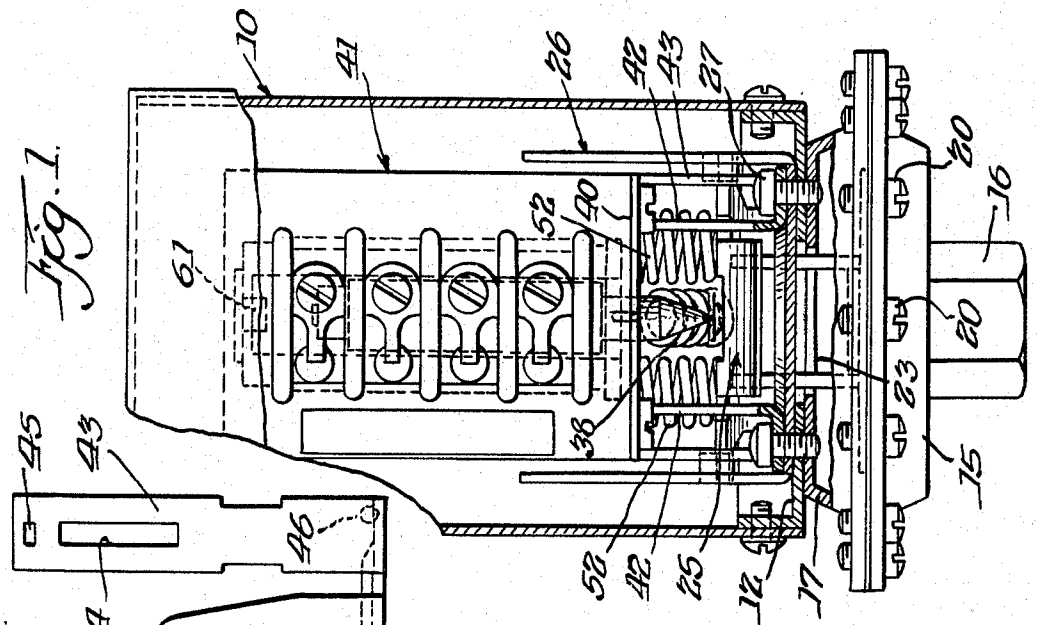


Fig. 6

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May 7, 1968 P. J. KVISTAD 3,382,470

LEVER OPERATED PRESSURE TRANSDUCER

Filed Sept. 21, 1966 3 Sheets-Sheet 2

Fig. 4.

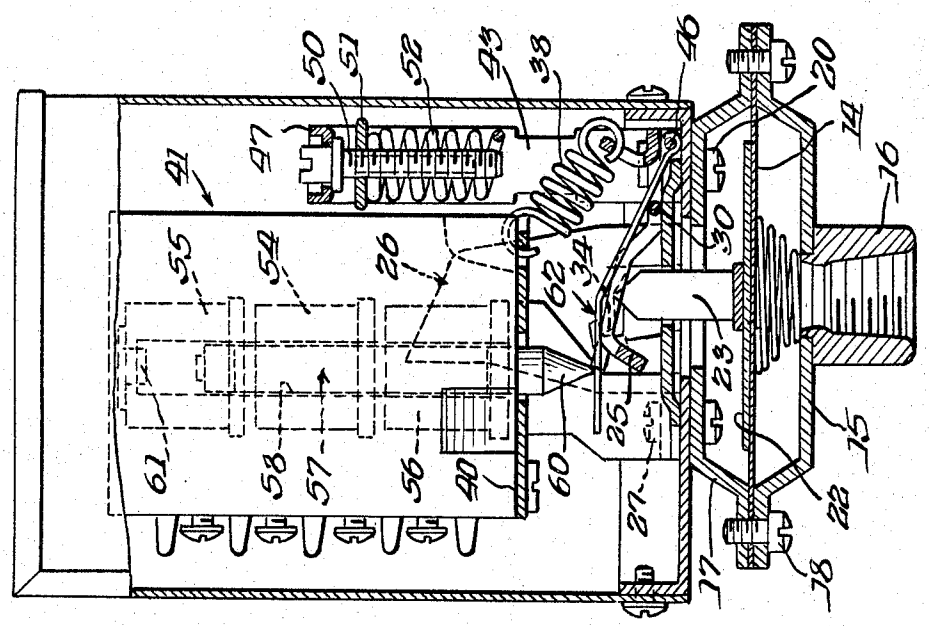
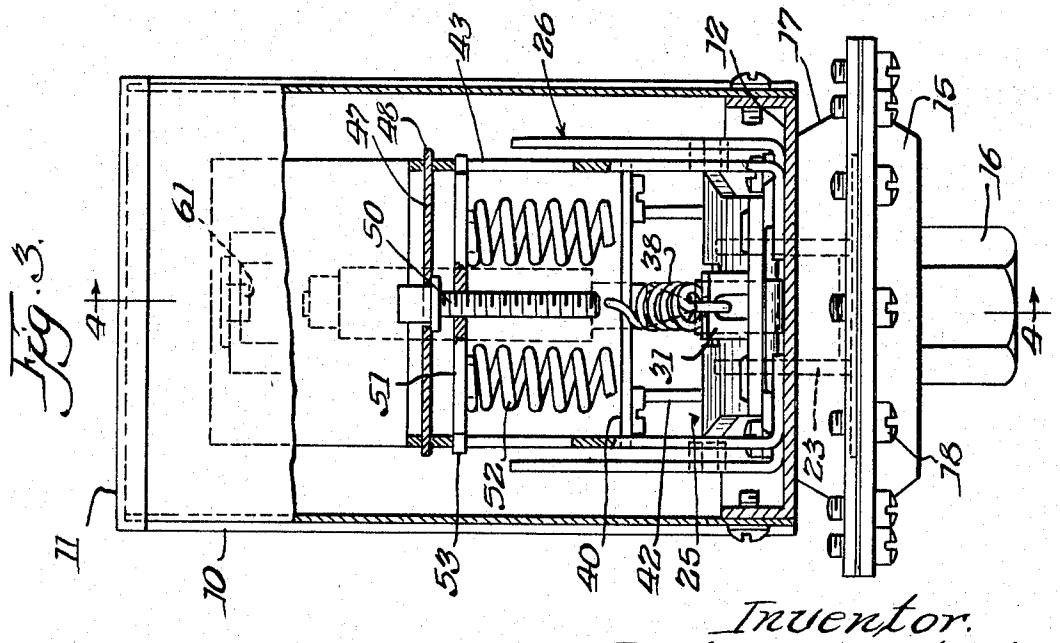


Fig. 3.



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LEVER OPERATED PRESSURE TRANSDUCER

Filed Sept. 21, 1966 3 Sheets-Sheet 3

Fig. 5.

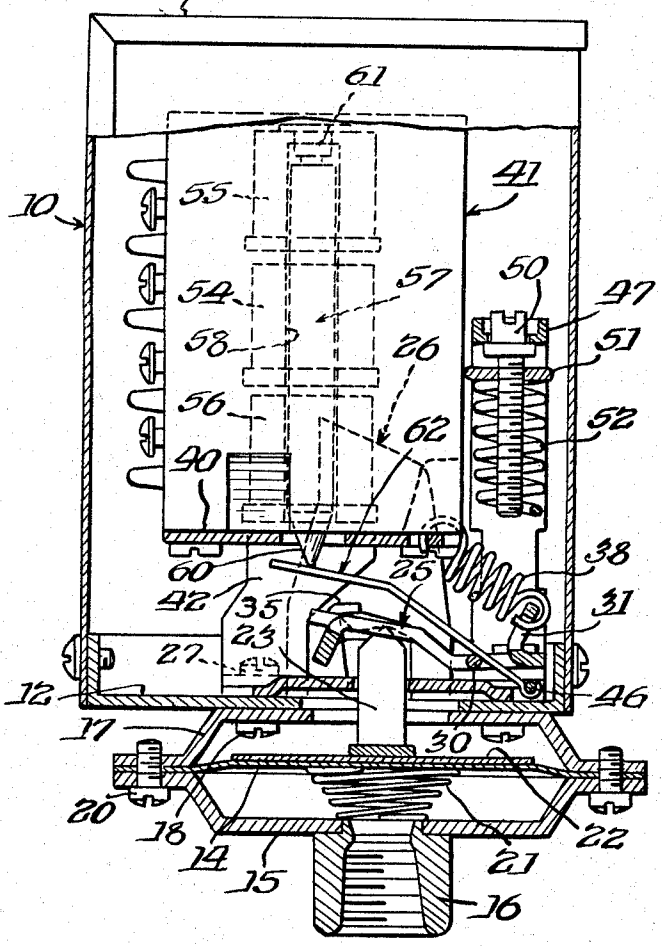


Fig. 7.

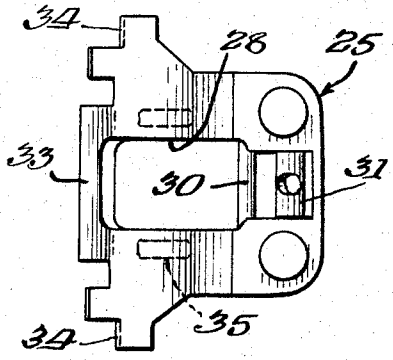


Fig. 8.

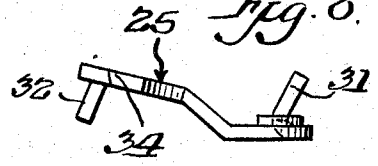
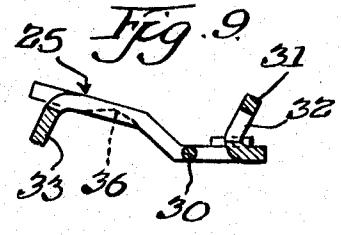


Fig. 9.



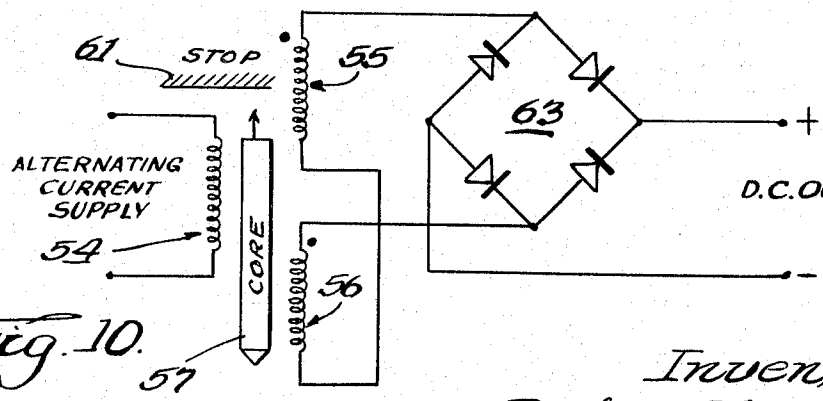


Fig. 10.

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3,382,470

LEVER OPERATED PRESSURE TRANSDUCER

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Filed Sept. 21, 1966, Ser. No. 581,109
8 Claims. (Cl. 336—30)

The invention relates to a pressure transducer and has reference more particularly to a pressure regulating device having a pressure movable metal core in associated relation with a linear variable differential transformer and wherein the direct current output of the transformer varies as a function of the core position.

When fluid pressure is applied to the diaphragm of the present device, a vertical force acts directly upon a diaphragm plate assembly having stirrups for actuating a pivoted lever and which lever is accordingly made pressure responsive. A movable metal core of a linear variable differential transformer is operatively associated with the pressure responsive lever by means of a core actuating lever and which multiplies the displacement of the pressure responsive lever due to the particular fulcruming of the two levers. Relatively minor movements of the diaphragm will thus cause considerable displacement in the position of the metal core. This is desirable since the output of the transformer is caused to vary as the position of the metal core varies with respect to two vertically spaced secondary windings.

Another object of the invention is to provide a pressure transducer of the character described wherein the fluid pressure on the pressure responsive lever is opposed by coil spring pressure and which can be adjusted for adjusting the device for operation within a particular range of pressures such as may be desired.

Another object of the invention resides in the provision of a pressure regulating device having a pressure responsive lever which is yieldingly held for pivotal movement against knife bearings and wherein the movement of the said lever is transmitted to a core actuating lever. The two levers have opposed pivotal mountings with the core actuating lever overlying the pressure responsive lever whereby to increase the displacement of the core actuating lever for any particular movement of the pressure responsive lever.

With these and various other objects in view the invention may consist of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended thereto.

In the drawings which illustrate an embodiment of the device and wherein like reference characters are used to designate like parts—

FIGURE 1 is a front elevational view of a pressure transducer constructed in accordance with and embodying the improved features of the present invention;

FIGURE 2 is a side elevational view of the pressure transducer illustrated in FIGURE 1 with the parts being shown in section;

FIGURE 3 is a rear elevational view of the pressure transducer of the invention;

FIGURE 4 is a vertical sectional view taken substantially on line 4—4 of FIGURE 3 and showing the parts with the metal core of the transformer in a down position;

FIGURE 5 is a vertical sectional view similar to FIGURE 4 but showing the position of the parts with the metal core of the transformer in an up position;

FIGURE 6 is a side elevational view of the metal frame on which the pressure responsive lever and the core actuating lever are journalled;

FIGURE 7 is a top plan view of the pressure responsive lever;

FIGURE 8 is a side elevational view of said lever;

FIGURE 9 is a horizontal sectional view taken transversely of the pressure responsive lever; and

FIGURE 10 is a schematic wiring diagram illustrating the action of the movable metal core with respect to the windings of the linear variable differential transformer.

Referring more particularly to the drawing wherein one embodiment of a pressure regulating device has been selected for illustrating the invention, the numeral **10** indicates a housing of metal or other suitable material having a top member **11**, and a bottom wall **12** formed with an upstanding rim **13** to which the housing **10** is secured. The housing for the diaphragm **14** consists of two parts, a circular base part **15** having a threaded inlet connection **16** and a circular top part **17** which is secured by the screws **18** to the bottom wall **12** of the housing. The base and top parts of the diaphragm housing are secured together around their periphery by the screws **20** with the diaphragm **14** being clamped therebetween.

The diaphragm is resiliently urged in an upward direction by the undersurface coil spring **21** and on the top side the diaphragm supports a plate assembly consisting of the plate **22** and the upstanding spaced stirrups **23**. The stirrups project upwardly through openings in the top part **17** and bottom wall **12**, and the pointed top end of the stirrups engage the pressure responsive lever **25**, the said lever being shown in detail in FIGURES 7, 8 and 9. The lever is held in knife bearings so as to be freely responsive to pressure variations of the diaphragm. The frame **26**, FIGURE 6, provides the pivot axis for the pressure responsive lever **25** and by means of the screws **27** the frame is fixedly secured to the bottom wall **12** of the housing. It will be observed that the lever **25** has a central opening **28**, a transversely extending fulcruming bar **30** and a rear tab **31** which is open at **32**. The front edge of the lever has a downturned apron portion **33** and on respective sides of the apron the lever is provided with knife pivots **34**.

In assembled relation, the lever **25** has its knife pivots **34** in contact with the bearings **35**, respectively, provided by the frame **26**. The lever rests on the stirrups **23** with the stirrups engaging in the concave recesses **36**. In accordance with the invention the pivots **34** are resiliently held in the bearings **35** by means of the toggle spring **38**. The pressure responsive lever is accordingly mounted in frame **26** for free pivotal movement on an axis extending transversely and horizontally parallel to the diaphragm. As best illustrated in FIGURES 4 and 5 the toggle spring is secured at its rear end in the opening **32** of the tab **31**. At its forward end the toggle spring is anchored in the base plate **40** of the supporting frame for the transformer **41**. The base plate is part of the frame which provides spaced legs **42** for supporting the transformer, the said legs being secured by the screws **27** to the bottom wall **12**.

The frame member **26** in addition to providing the knife bearings **35**, also provides a pair of spaced standards **43**, FIGURE 6, each standard being slotted longitudinally at **44**. A square opening **45** is also located in each standard and the frame assembly additionally includes a pivot bar **46**. A top member **47** is held between the standards by means of the square projections **48** at the ends of the top member and which enter the square openings **45**. By means of the rotatable threaded screws **50** a pressure plate **51** is located between the standards and a pair of coil springs **52** are confined between the pressure plate **51** and the rear end of the pressure responsive lever **25**. As best shown in FIGURE 3 a coil spring is located on each side of the toggle spring **38**. The coil springs **52** apply pressure to the rear end of the pressure responsive lever **25** and this pressure counters the upward pressure of the stirrups caused by the action of the fluid on the diaphragm **14**. However, by means of

the rotatable screws **50** the pressure plate **51** can be adjusted vertically and thus the pressure exerted by the coil springs **52** can be adjusted for varying the operative pressure ranges of the present device. To permit vertical adjusting movement of the plate **51**, the side projections **53** formed on the plate ride within the slots **44** in the standards.

Referring again to the transformer **41**, it is understood that the same is a linear variable differential transformer, a special type having a primary winding **54** and two secondary windings **55** and **56** spaced vertically top and bottom of the primary. A metal core **57** operates within a vertical passage **58** in the transformer in a manner to have inductive relation with the windings. The core may preferably have a V-shaped plastic tip **60** and the transformer is provided with a stop **61** located at the top end of the passage **58** so as to limit upward movement of the metal core.

The invention provides the pivoted lever **62** for actuating the metal core to cause the core to move up and down within the transformer. Lever **62** is pivotally associated with the pivot bar **46** and as best shown in FIGURE 5 the lever has a curved portion which engages the underside of the pivot bar. This in effect serves to maintain the rear end of the lever **62** in rotatable association with its pivot bar since the lever extends forwardly to overlie the fulcruming bar **30**. At its forward end the lever extends under the tip **60** of the metal core **57** so as to support the metal core. Accordingly any pivotal movement of the pressure responsive lever **25** is transmitted to the lever **62** to cause up and down movement of the core. Said movement of the core has an inductive effect on the secondary windings **55** and **56** of the transformer and the same thus functions in a manner to vary the direct current output of the transformer.

The lever **62** can thus be termed the core actuating lever and it will be seen that the same has its pivot axis disposed horizontally and in spaced parallel relation to the pivot axis of lever **25**. The bar **30** provides the fulcruming action for producing pivotal movement of the lever **62** on its axis **46**. As the lever **25** may oscillate on its knife bearings due to variations in the fluid pressure acting on the diaphragm, so also will the lever **62** oscillate and produce up and down movement of the core **57**. The fulcruming bar **30** has a point of contact with lever **62** which is much closer to the pivot axis **46** than the point of contact between the lever and the core tip **60**. This structural feature has been incorporated in the present device so that any movement of the pressure responsive lever **25** is materially increased as regards the outer free end of the lever **62**. The displacement of the core is thus increased for any particular variation in pressure transmitted by the diaphragm to the lever arrangement.

Core movement is translated into current output by the particular association of the secondary windings **55** and **56** with the primary windings **54** and by the connections of the secondary with each other and with the rectifying circuit **63**. The secondary windings **55** and **56** are reversely connected so that currents induced in the secondary **55** will flow in a direction to oppose and cancel the currents induced in the secondary **56**. Assuming that the pressure on the diaphragm **14** has increased to a value to elevate the core into contact with the stop **61**, then it will be observed that the iron core will have equal inductive relation with the lower half of the secondary **55** and with the upper half of the secondary **56**. The currents induced in the secondaries will thus oppose each other and cancel out so that the direct current output of the transformer will be zero. The fluid pump such as may be energized from the direct current output will terminate its operations to discontinue the pumping of the pressure fluid.

In time the pressure fluid will decrease and as the metal core moves down, more of the core will come into inductive relation with the secondary **56**, and less of the core will have inductive relation with secondary **55**. Some current will accordingly flow in the output circuit. Should the core move entirely out of inductive relation with secondary **55**, maximum current will be induced in the secondary **56** and this will flow through the rectifier and constitute the maximum direct current output of the transformer. During operation, core movement will fluctuate as the fluid pressure acting on the diaphragm may fluctuate so that the pressure acting on the diaphragm will be maintained approximately uniform.

In the event it is desired to change the pressure range within which the present device may operate, it is only necessary to adjust the compression of the coil springs **52**. As the pressure of the coil springs is increased the pressure range for the present device is likewise increased and in a similar manner the pressure range for the present device is decreased as the compressive force of the coil springs may be decreased.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings, as various other forms of the device will, of course, be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. In a pressure transducer, the combination with a linear variable differential transformer having a vertically movable metal core and wherein the rectified output of the transformer will vary as a function of the core position, of a pressure responsive lever and a core actuating lever, means respectively mounting said levers for limited oscillating movement on parallel horizontally spaced axes, the core actuating lever overlying the pressure responsive lever and having contact with the latter in a manner whereby core displacement is increased over that for any particular movement of the pressure responsive lever, and resilient means in compression relation with the free end of the pressure responsive lever for opposing the pressure movements of said lever.

2. In a pressure transducer as defined by claim **1**, wherein the resilient means in compression relation with the free end of the pressure responsive lever is capable of manual adjustment for varying the compression force exerted by said resilient means.

3. In a pressure transducer as defined by claim **1**, wherein the core actuating lever overlies and has contact with a fulcruming bar provided by pressure responsive lever, said fulcruming bar being located relatively adjacent the free end of the pressure responsive lever and having a position closer to the pivot axis of the core actuating lever than the point of contact between the metal core and the core actuating lever.

4. In a pressure transducer as defined by claim **1**, additionally including a fulcruming bar as part of said pressure responsive lever, said core actuating lever overlying and having contact with said fulcruming bar so that movement of the pressure responsive lever is imparted to the core actuating lever, and wherein the parts are so constructed and arranged that core displacement caused by movement of the core actuating lever is greater than the motivating movement of the pressure responsive lever.

5. In a pressure regulator, the combination with a transformer having a primary winding and a pair of spaced secondary windings, an iron core movable vertically within the transformer for varying the inductive relation of the core with respect to the secondary windings, a frame member, a pressure responsive lever pivotally mounted by said frame member for limited oscillating movement on a substantially horizontal axis, a core actuating lever also pivotally mounted by said frame member on a horizontal axis parallel to but spaced rearwardly of the pressure responsive lever, a fulcruming bar provide by said pres-

sure responsive lever, said core actuating lever overlying the fulcruming bar and extending forwardly of the pivot axis of the pressure responsive lever to contact and support the iron core, whereby movement of the pressure responsive lever is transmitted to the core actuating lever to cause movement of the iron core, and resilient means in compression relation with the rear end of the pressure responsive lever for opposing the pressure movements of said lever.

6. A pressure regulator as defined by claim 5, wherein the resilient means in compression relation with the rear end of the pressure responsive lever is manually adjustable to vary the compression force exerted by the resilient means.

7. A pressure regulator as defined by claim 5, additionally including knife bearings provided by the frame member for pivotally mounting the pressure responsive lever, and a toggle spring for resiliently holding the pivot formations of the lever in contact with the knife bearings.

8. A pressure regulator as defined by claim 5, additionally including a housing having a secured relation below said frame member, a diaphragm within said housing and adapted to have movement in response to pressure variations, a plate assembly supported by the diaphragm, and stirrup means extending upwardly from the plate assembly and contacting the pressure responsive lever, said point of contact of the stirrup means with the pressure responsive lever being between the pivot axis of the lever and the fulcruming bar.

References Cited

UNITED STATES PATENTS

2,040,181	5/1936	Mekelburg	200—83
2,790,869	4/1957	Hansen	200—83
3,015,006	12/1961	Elsner	200—83

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