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CONSTANT PRESSURE DIAPHRAGM PUMP

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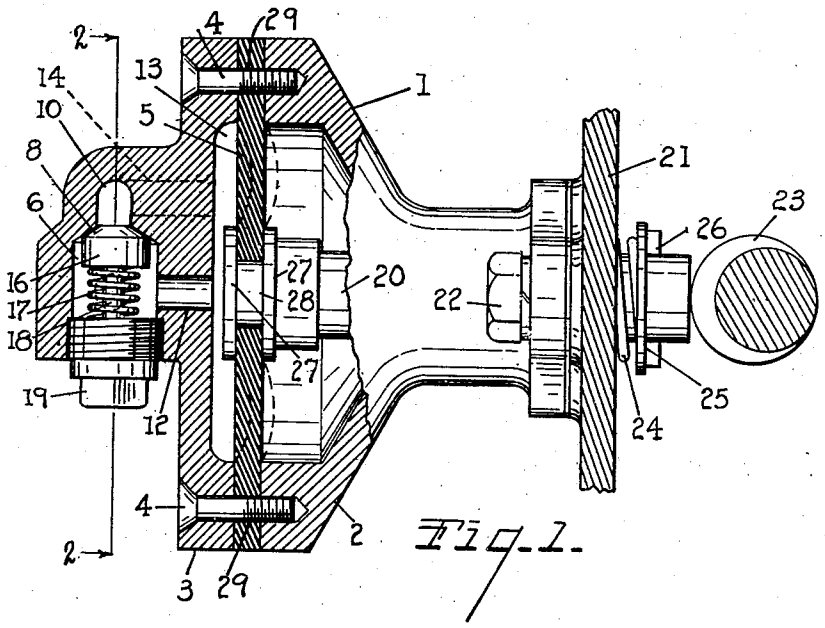

Fig. 1.

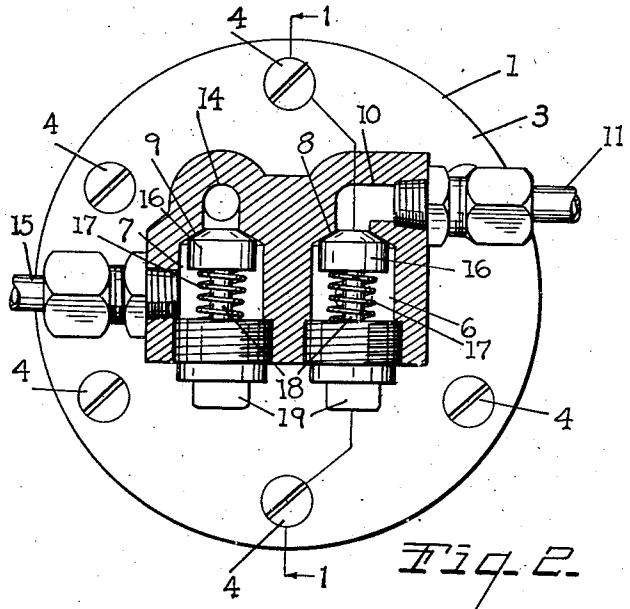

Fig. 2.

INVENTOR.
John H. Herder
BY Earl T. Chappell
ATTORNEYS

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CONSTANT PRESSURE DIAPHRAGM PUMP

John H. Herder, Kalamazoo, Mich.

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16 Claims. (Cl. 103—150)

This invention relates to improvements in constant pressure diaphragm pumps.

The main objects of my invention are:

First, to provide a diaphragm pump of novel and improved construction.

Second, to provide a pump of the type described having positively acting provisions for supplying fluid and operative when a predetermined pressure is built up to discontinue supply of fluid without interruption of the positively acting means.

Third, to provide a diaphragm pump having a novel and improved diaphragm construction.

Fourth, to provide a pump of the type described which is positively acting on the fluid discharge stroke.

Fifth, to provide a diaphragm pump particularly suitable for use in an automobile gasoline feed line having improved provisions whereby the possibility of building up an excessive pressure on the fuel is eliminated.

Further objects relating to details and economies of my invention will definitely appear from the description to follow. The invention is defined in the claims.

A structure embodying the features of my invention is illustrated in the accompanying drawing, wherein:

Fig. 1 is an elevational view partially broken away and in section on line 1—1 of Fig. 2, illustrating details of my pump.

Fig. 2 is a fragmentary view in section on line 2—2 of Fig. 1.

This invention relates to diaphragm pumps of the type designed for the positive delivery under a pressure not to exceed a predetermined maximum of fluid such as fuel for internal combustion engines and has been devised to eliminate certain defects characterizing hitherto known diaphragm pumps. However, it is to be understood that my pump is widely adaptable and applicable in any field where the use of a constant pressure diaphragm pump is indicated.

In previously known devices, considerable objection has existed because of the fact that there is no adequate method for controlling the operation of the diaphragm pump in a fuel feed line whereby excessive pressures in the fuel feed line will be avoided. It is usually the practice to maintain the fuel in the feed line at a pressure not in excess of three pounds per square inch and when pressures above this point are built up, there is danger of flooding the motor. In order to eliminate this possibility, it has hitherto been proposed to operate the diaphragm by springs or flexible linkage of one type or another and so far as I am aware positively acting reciprocating means for the diaphragm have been completely avoided.

My invention contemplates a novel construction having a positive and uniform stroke reciprocating means for the diaphragm on the pumping stroke and further provisions in the form of a flexible and elastic diaphragm whereby the building up of excessive pressures on the feed side of the pump is avoided and the use of a positive actuation made possible.

Referring to the drawing, the reference numeral 1 in general indicates a two-part housing formed of a pair of body members 2, 3 secured together by screws 4 with a diaphragm element 5 interposed therebetween, which element will be hereinafter more particularly described.

In the embodiment illustrated, the body members are formed as castings.

The member 3 is cored out to provide a pair of valve chambers 6, 7 having conical valve seats 8, 9 respectively. Intake valve chamber 6 communicates through a passage 10 with a feed line 11 which is tapped in the body member. A passage 12 in member 3 communicates with a pump chamber 13 on the left side of diaphragm 5 as viewed in Fig. 1, the diaphragm being clamped between the body members to close chamber 13. Discharge valve chamber 7 communicates with the pump chamber 13 through a passage 14 and likewise communicates with a discharge conduit 15 tapped into member 3. The valves 16 coacting with the valve seats 8 and 9 respectively are normally urged to closed position by coil springs 17 surrounding the stems 18 thereof. Plugs 19 threaded in member 3 at the bottom of chambers 6, 7 abut against springs 17 whereby the tension of the same may be conveniently regulated.

The other part of the pump housing, namely, body member 2, is formed to slidably receive a plunger 20 extending through the same and, if desired, through a bracket or other support 21 on which the pump is secured by bolts 22. The plunger is reciprocated positively on the pumping stroke by means of an eccentric 23 engaging the end of the plunger, return movement of the latter being accomplished through the agency of a coil spring 24 encircling the plunger and abutting the bracket 21 or member 2 on one side and on the other a washer 25 which is restrained by a pin 26 passing through the plunger.

From the foregoing, it will be apparent that diaphragm element 5 is positively reciprocated

to the left or on the delivery stroke by cam 23 and is returned to the right or on the suction stroke by spring 24. The plunger is supported for sliding movement in body member 2 by a suitable bearing surface (not shown) and spring 24 is chosen of suitable strength to perform its required function.

On the left hand end of plunger 20 as viewed in Fig. 1, I secure diaphragm element 5 between a pair of washers 27 of relatively large diameter. The diaphragm element is apertured to receive the reduced end 28 of the plunger with a very snug fit so that shifting movement of the diaphragm element relative to the plunger is impossible. Similarly, the holes 29 in the diaphragm element receiving screws 4 are drilled therein at points slightly radially inwardly of the positions which the screws occupy in mounted condition, whereby the diaphragm element will be maintained taut in all positions with no possibility of lateral shifting in operation. Diaphragm element 5 is formed of suitable material which is both flexible and stretchable, the latter characteristic being a very important one from the standpoint of the present invention. Rubber possesses these characteristics, as do certain compounds of rubber or synthetic materials which in addition are resistant to deterioration by gasoline, kerosene, etc.

In operation, on the suction or intake stroke, plunger 20 is retracted or moved to the right as viewed in Fig. 1 from the neutral position of the diaphragm illustrated in that figure and in which the diaphragm is substantially in the form of a flat disk, carrying with it the center of diaphragm element 5 in a manner which will be apparent. Accordingly, fluid enters intake chamber 6 and flows through passage 12 to the pump chamber 13. On the delivery stroke of plunger 20 under actuation by eccentric 23, the fluid is forced out of the pump chamber through passage 14 into outlet valve chamber 7 and into discharge conduit 15. The fluid passes yieldable intake and discharge valves 16 in opposition to the springs 17 in a manner which is well known.

The aforenoted action is the usual action of my device under normal operating pressures, namely, positive forward actuation of the plunger by eccentric 23 and retraction by spring 24. In the event, however, that the discharge pressure approaches and passes a predetermined amount, normally three pounds in fuel feed pumps, the flexible and elastic diaphragm element 5 will stretch and balloon backwardly from the position illustrated in solid lines in Fig. 1 to the position illustrated in dotted lines. The extent of this bulging or ballooning is sufficient to offset the normal displacement of the pump. In other words, excessive back pressure is prevented by offsetting the normal diaphragm displacement with a proportional volume automatically added to the pump chamber each time a predetermined pressure is reached. There is at this time a partial or no discharge depending on the pressure in discharge conduit 15; that is to say, the volumetric efficiency is automatically reduced so as to maintain a substantially constant pressure in the pump chamber. However, at all times, plunger 20 and the central portion of the diaphragm element continue to reciprocate backwards and forwards. The action of the working parts of the pump is uninterrupted, but fuel discharge or pumping is simply halted whenever maximum pressure is approached and exceeded through the ballooning of the elastic diaphragm element which essentially characterizes my invention.

By the provision of such an element, I am enabled to employ a positive actuation for the diaphragm on the pumping stroke as contrasted to hitherto known and widely employed yielding drives relied on to accommodate and nullify the effect of excessive discharge pressures. Such expedients have required further flexible linkages in order to make their operation possible and my construction requires none of these. It should be noted that the diaphragm is in neutral position, i. e., substantially in the form of a flat disk, when the plunger is at the extreme or left end of its stroke as viewed in Fig. 1. I thereby take full advantage of the stretchability of the diaphragm, since at that time and in that position it is under minimum tension and is less taut. It will be perfectly apparent, however, that my device will be operative, though not quite as satisfactorily, in case the end of the pumping stroke should find the plunger in a position slightly to either side of the plane occupied by the diaphragm in flat condition. Such considerations relate to the degree of success of the pump's operation and I desire to emphasize that in its fundamental aspect my invention resides in the concept of positively and uniformly actuating a flexible and elastic diaphragm.

The advantages of my pump construction will be immediately apparent. The same is simple in its parts and readily and cheaply manufactured and assembled. It is only necessary to select a diaphragm element 5 of proper flexibility and resiliency to yield under the maximum pressure which it is contemplated to impose on the pump. The factors of resilience and flexibility are of course influenced by the size of washers 27 and the diameter of the diaphragm as well as by its thickness. Therefore, by varying the size of the washers or the diameter of the diaphragm, the flexibility of the same may be readily controlled without altering the plunger stroke.

The only diaphragm actuating instrumentalities required are the eccentric and return spring or equivalent simple provisions. There is no possibility of sticking or jamming of parts such as is present in structures embodying a complicated system of parts. Moreover, my pump may be readily dismantled, parts replaced, and reassembled by inexperienced persons.

I have illustrated and described my improvements in an embodiment which is very practical. I have not attempted to illustrate or describe other embodiments or adaptations as it is believed this disclosure will enable those skilled in the art to embody or adapt my improvements as may be desired.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a diaphragm pump, a pair of body members providing a pump chamber and intake and discharge valve chambers each communicating with said pump chamber, said intake and discharge valve chambers further communicating with feed and discharge conduits respectively, a diaphragm element fixedly secured between said body members to close a side of said pump chamber, said diaphragm element comprising a flexible, elastic and stretchable disk rigidly clamped peripherally between said body members, a plunger secured to said diaphragm element to engage the same throughout a relatively limited area and slidably mounted in one of said body

members, said diaphragm element being subject to substantial radial stretching under tension therein arising from abnormal pressure in the pump chamber, and an eccentric operatively engaged with the free end of said plunger to positively actuate the same on the pumping stroke, there being a substantial area of the diaphragm between the point of securement of the plunger and the periphery of the diaphragm adapted to bulge oppositely of the direction of movement of the plunger when the diaphragm is subjected to a pressure in the pump chamber exceeding a predetermined allowable maximum value to thereby prevent an increase of the pressure in the chamber above said allowable maximum.

2. In a diaphragm pump, a housing providing a pump chamber, a diaphragm element fixedly secured to said housing to close a side of said pump chamber, said diaphragm element comprising a flexible, elastic and stretchable disk rigidly clamped peripherally to said housing, means to axially and positively reciprocate the center of the disk and a limited area surrounding the center, comprising a plunger secured to said diaphragm element centrally thereof and slidably mounted in said housing, said diaphragm element being subject to substantial radial stretching under tension therein arising from abnormal pressure in the pump chamber, and means to positively and uniformly actuate the plunger on the pumping stroke, said diaphragm element bulging oppositely of the movement of the plunger on the pumping stroke in the area between said limited area and the housing when the diaphragm is subjected to a pressure exceeding a predetermined maximum value, whereby to reduce the volumetric efficiency of the pump under such condition and prevent an increase in pump chamber pressure above said predetermined value.

3. In a diaphragm pump, a housing providing a pump chamber, a diaphragm element closing one side of said pump chamber, said diaphragm element comprising a flexible, elastic and stretchable member rigidly clamped to said housing peripherally, a plunger secured to said diaphragm element centrally thereof and slidably mounted in said housing, means to positively and uniformly actuate the plunger and diaphragm on the pumping stroke, said diaphragm element being subject to substantial radial stretching under tension therein arising from abnormal pressure in the pump chamber, and resilient means to return the plunger and diaphragm element on the suction stroke, said diaphragm element bulging oppositely of the movement of the plunger on the pumping stroke when subjected to a pump chamber pressure exceeding a predetermined maximum allowable value and thereby preventing an increase in pump chamber pressure above said allowable value, said plunger engaging the diaphragm element only adjacent the center thereof whereby said bulging is unimpeded.

4. In a diaphragm pump including a housing having a pump chamber in communication with fluid feed and discharge lines, a diaphragm secured to said housing and operative to draw fluid into said chamber from said feed line and expel it through said discharge line, said diaphragm consisting of a stretchable, flexible and elastic member subject to substantial radial stretching under tension therein arising from abnormal pressure in the pump chamber, means centrally connected to said diaphragm to reciprocate the same, comprising a plunger extending through said diaphragm and washers on either side of the diaphragm engaging the same throughout a predetermined restricted area only to rigidly clamp the diaphragm in that area, and means for positively and uniformly actuating said reciprocating means on the forward or pumping stroke, said diaphragm bulging rearwardly when subjected to a pressure in said pump chamber exceeding a predetermined maximum value, to thereby maintain the pump chamber pressure at or below said maximum value.

5. In a diaphragm pump including a housing having a pump chamber in communication with fluid feed and discharge lines, a diaphragm, means fixedly securing said diaphragm peripherally to said housing to close said chamber, said diaphragm extending across the housing in a taut condition in neutral position thereof, said diaphragm consisting of a flexible and elastic disk apertured centrally, a plunger extending through said diaphragm aperture, washers on said plunger on either side of the diaphragm to rigidly clamp the latter to the plunger, said washers being removable and replaceable to vary the area of the diaphragm exposed, and means for positively actuating said plunger to move the diaphragm on the forward or pumping stroke from an extreme retracted position to an extreme forward position substantially coincident with said neutral position, said diaphragm bulging rearwardly when subjected to a pressure in said pump chamber exceeding a predetermined maximum value, to thereby prevent increase of the pump chamber pressure above said value.

6. In a diaphragm pump having a pump chamber, a pair of body members secured together and a diaphragm interposed tautly between said body members in neutral position of the diaphragm and rigidly clamped therebetween to form one side of said pump chamber, said diaphragm comprising a flexible elastic member, and means to positively actuate said diaphragm along a path rearwardly only of said neutral position and in a direction to increase the pressure on fluid in said pump chamber, said diaphragm yielding in a direction opposite to the movement of the actuating means when subjected to a pressure in said chamber exceeding a predetermined maximum, to thereby prevent an increase in the pump chamber pressure above said predetermined value without affecting the movement of said actuating means.

7. In a constant pressure diaphragm pump, a hollow housing, a flexible, stretchable and elastic diaphragm having the periphery thereof fixedly secured to said housing, and with said housing constituting a pump chamber, said diaphragm being subject to substantial radial stretching under tension therein arising from abnormal pressure in the pump chamber, means connected with said diaphragm and covering a relatively small area thereof to reciprocate said area of the diaphragm in said housing from an extreme intake position to an extreme discharge position and vice versa, said diaphragm being mounted in the housing so as to extend thereacross in a taut condition in all positions of the plunger, and stretching radially when reciprocated by the reciprocating means as described, the elasticity of said diaphragm permitting the same to bulge rearwardly between said area and periphery in a direction opposite to the direction of movement of the area when subjected to a fluid pressure in excess of a predetermined value to thereby pre-

vent increase in the pump chamber pressure above said value, and means for imparting a uniform and positive pumping stroke to said reciprocating means.

8. In a constant pressure diaphragm pump, a housing, an elastic diaphragm extending across said housing and fixedly secured peripherally thereto, said diaphragm being adapted to be reciprocated axially of the housing between opposite extreme positions to pump fluid in the housing on one side thereof, means for peripherally securing the diaphragm to the housing under initial radial tension, and means for reciprocating the diaphragm axially of the housing, the elasticity of the diaphragm permitting the same to bulge oppositely of the direction of movement of the reciprocating means when the diaphragm is subjected to a fluid pressure exceeding a predetermined maximum whereby to prevent an increase in pressure above said predetermined maximum and maintain a constant pressure discharge, one of the extreme positions of movement of the center of the diaphragm being coincident with its position under said initial radial tension.

9. In a constant pressure diaphragm pump, a hollow chamber comprising a pair of members secured together by peripherally spaced securing means, a flexible and elastic diaphragm member adapted to be secured between said members and having a peripheral series of holes therein adapted to be engaged by said means, said holes being spaced inwardly slightly relative to said securing means whereby in mounted neutral position the diaphragm is maintained in a taut condition, and means positively connected to the center of the diaphragm for reciprocating the center.

10. In a constant pressure diaphragm pump, a housing, a flexible, stretchable and elastic diaphragm inside said housing and secured peripherally thereto, and means connected to the center of the diaphragm to reciprocate the same and ineffective to restrain movement of the diaphragm between the center and periphery thereof, said diaphragm being subject to substantial radial stretching under tension therein arising from abnormal pressure on the pumping side thereof, said means comprising a plunger, a pair of washers on said plunger for positively gripping either side of the diaphragm, and means for positively and uniformly actuating said plunger on the pumping stroke, said washers being removable and replaceable by washers of different diameter whereby to vary the area of the diaphragm between the center and periphery, said diaphragm bulging oppositely of the direction of movement of the plunger when subjected to a fluid pressure on one side thereof exceeding a predetermined value, to thereby prevent an increase in the pressure above said value, the ratio of the area of the washers to the area of the diaphragm serving to determine the extent of such bulging.

11. In a constant pressure diaphragm pump, a pump chamber including a flexible, stretchable and elastic diaphragm having the periphery thereof fixedly secured to said chamber and constituting one wall thereof, means connected centrally with said diaphragm to reciprocate the center of the diaphragm, said diaphragm being mounted so as to be in a taut condition when in a neutral position, and stretching radially to a substantial extent under tension arising from abnormal pressure on the pumping side thereof when the center thereof is reciprocated as described, the elasticity of said diaphragm permitting the same to bulge rearwardly between the center and periphery in a direction opposite to the direction of movement of the center when the diaphragm is subjected to a pump chamber pressure exceeding a predetermined value, to thereby render uniform the pressure in the pump chamber, and means for uniformly actuating said reciprocating means on the pumping stroke.

12. In a constant pressure diaphragm pump, an elastic diaphragm extending across said housing and secured peripherally thereto, said diaphragm being adapted to be reciprocated axially of the housing between opposite extreme positions, means for peripherally securing the diaphragm to the housing, and means for reciprocating the diaphragm axially of the housing, the elasticity of the diaphragm permitting the same to bulge oppositely of the direction of movement of the plunger when the diaphragm is subjected to a fluid pressure on one side thereof exceeding a predetermined value, whereby to prevent an increase in pressure on said side exceeding said value and maintain a constant pressure discharge, the periphery and center of said diaphragm lying substantially in a plane at one of the extreme positions of the reciprocating means.

13. A diaphragm pump comprising a housing providing a pump chamber having fluid intake and discharge ports communicating therewith, a diaphragm peripherally secured to said housing internally thereof to close one side of said pump chamber, said diaphragm comprising a flexible, stretchable and elastic disk clamped peripherally to said housing, said diaphragm being subject to substantial radial stretching under tension therein arising from abnormal pressure in the pump chamber, and means for uniformly and positively displacing said diaphragm in the direction of the pump chamber on the pumping stroke to expel fluid therefrom through the discharge port, said flexible and elastic disk bulging oppositely of the movement of the diaphragm on the pumping stroke to prevent an excessive pressure condition in the pump chamber and discharge line for the pump, the bulging of the diaphragm being proportional to and accommodating a volume of fluid in the chamber such as would otherwise result in a pressure in excess of a predetermined pressure in the chamber and discharge line.

14. A non-bypassing diaphragm pump comprising a housing having a diaphragm of elastic material stretchable substantially by internal radial tension arising therein from abnormal pressure on the pumping side thereof, said diaphragm being peripherally secured to the housing to divide the same into a pumping chamber on the pumping side of the diaphragm and an operating space, said diaphragm being in taut condition at all times, and means including a plunger traveling through said space and secured to the diaphragm for positively displacing the diaphragm at its point of connection to the plunger a uniform distance on each pumping stroke, said pumping chamber having inlet and discharge valves controlling the flow of fluid therethrough during pumping, said diaphragm stretching and bulging oppositely of the direction of positive displacement thereof in the event the pressure in said pumping chamber reaches a predetermined maximum whereby to prevent an increase in the pressure in the pumping chamber above said predetermined maximum.

15. A non-bypassing diaphragm pump comprising a housing having a diaphragm of elastic material stretchable substantially by internal radial tension therein arising from abnormal pressure on the pumping side thereof, said diaphragm being peripherally secured to the housing to divide the same into a pumping chamber on the pumping side of the diaphragm and an operating space, and means including a plunger traveling through said space and secured to the diaphragm for positively displacing the diaphragm at its point of connection to the plunger a uniform distance on each pumping stroke, said pumping chamber having means controlling the flow of fluid therethrough during pumping, said diaphragm stretching and bulging oppositely of the direction of positive displacement thereof in the event the pressure in said pumping chamber reaches a predetermined maximum whereby to prevent an increase in the pressure in the pumping chamber above said predetermined maximum.

16. A non-bypassing diaphragm pump comprising a housing having a diaphragm of elastic material stretchable substantially by internal radial tension therein arising from abnormal pressure on the pumping side thereof, said diaphragm being peripherally secured to the housing to divide the same into a pumping chamber on the pumping side of the diaphragm and an operating space, and means for positively displacing the diaphragm a uniform distance on each pumping stroke, said pumping chamber having means controlling the flow of fluid therethrough during pumping, said diaphragm stretching and bulging oppositely of the direction of positive displacement thereof in the event the pressure in said pumping chamber reaches a predetermined maximum whereby to prevent an increase in the pressure in the pumping chamber above said predetermined maximum.

JOHN H. HERDER.