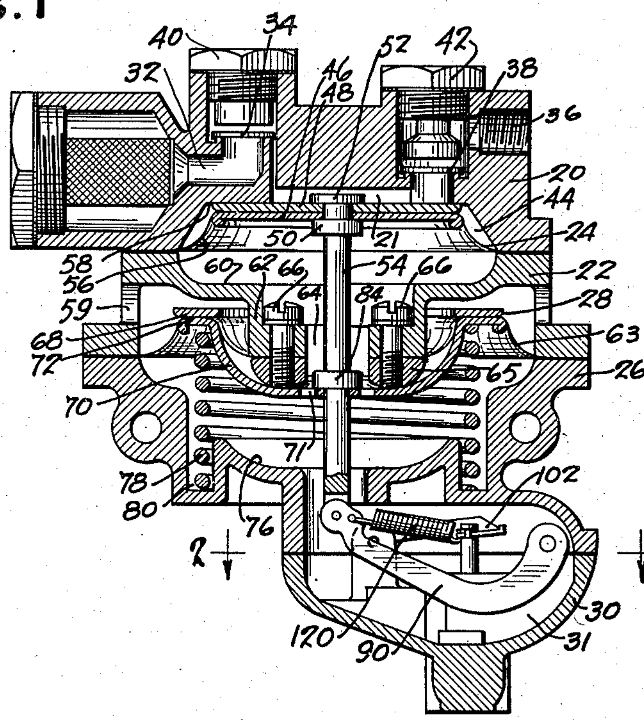
Nov. 12, 1940. F. BARFOD 2,221,071

PUMP

Filed May 29, 1937 4 Sheets-Sheet 1

Fig. 1



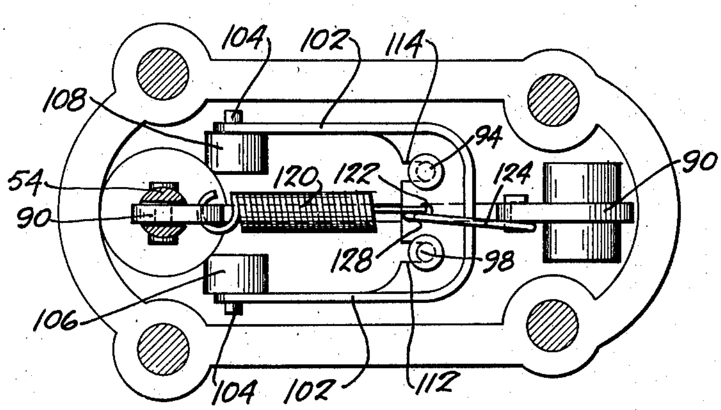


Fig. 2

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FIG. 3

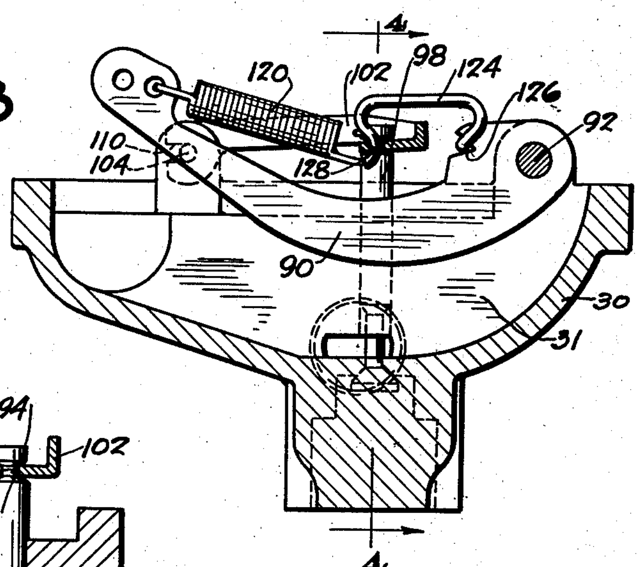

FIG. 4

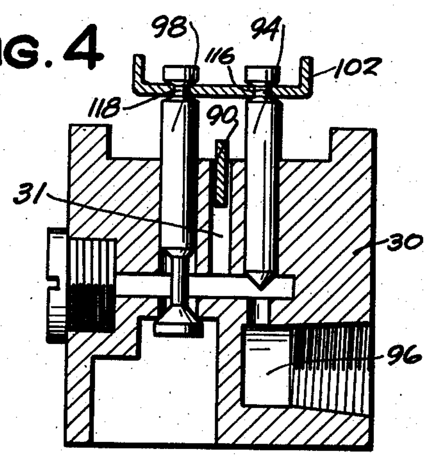

FIG. 5

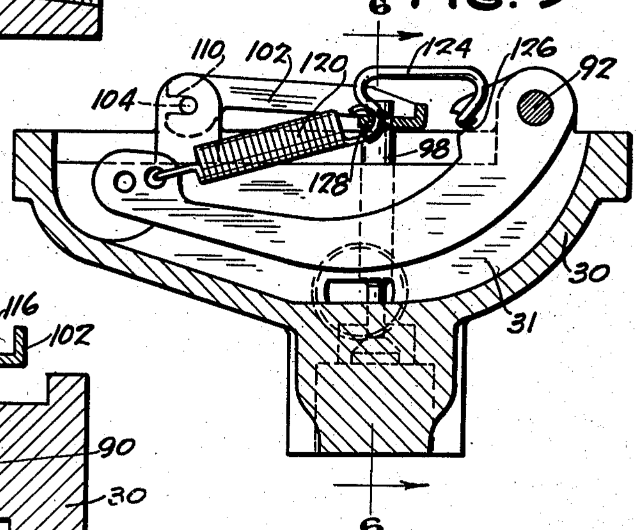

FIG. 6

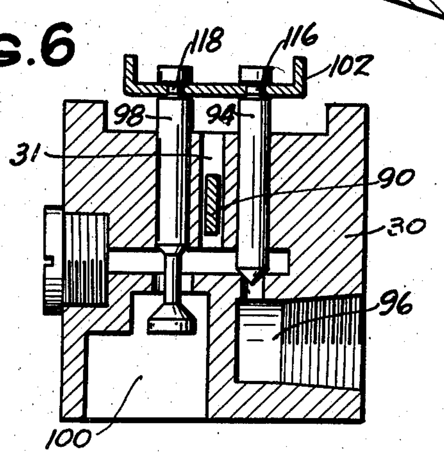

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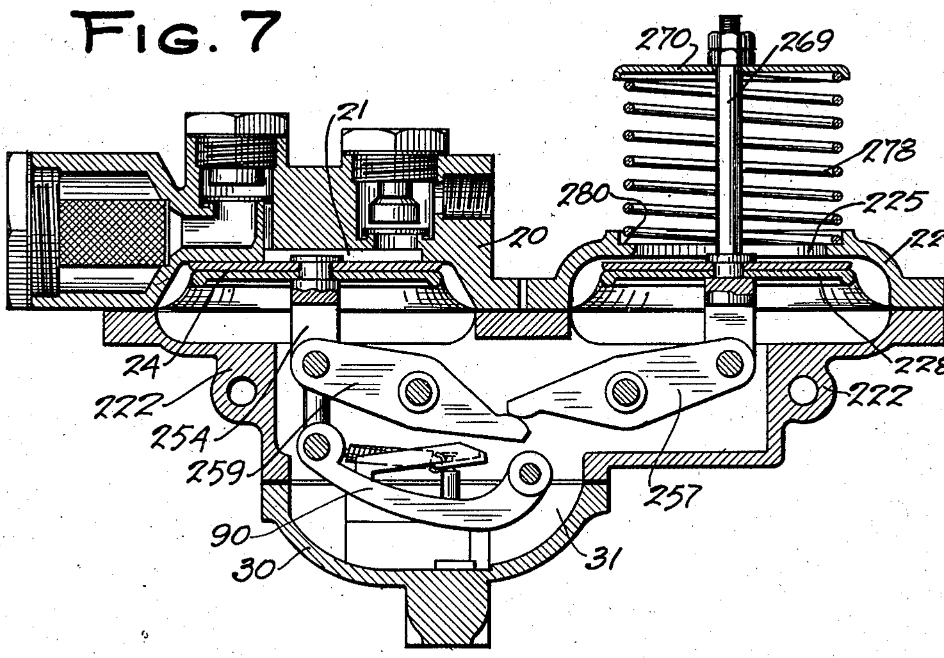
FIG. 7



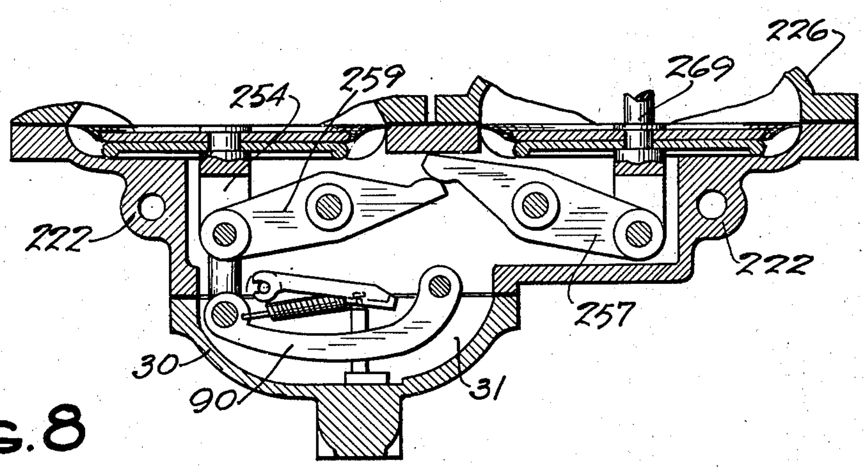


FIG. 8

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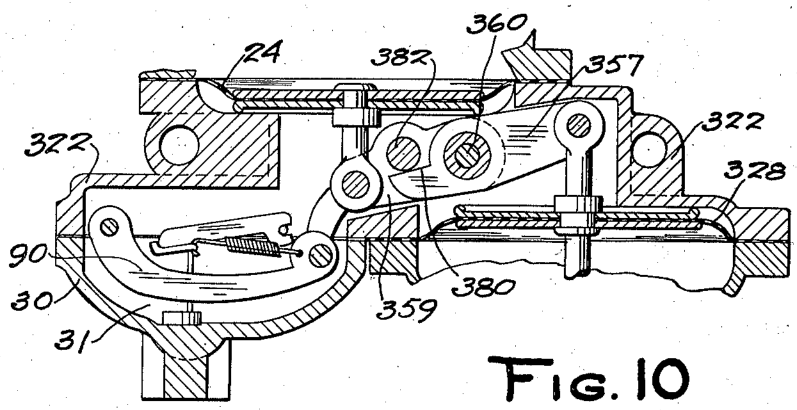

FIG. 10

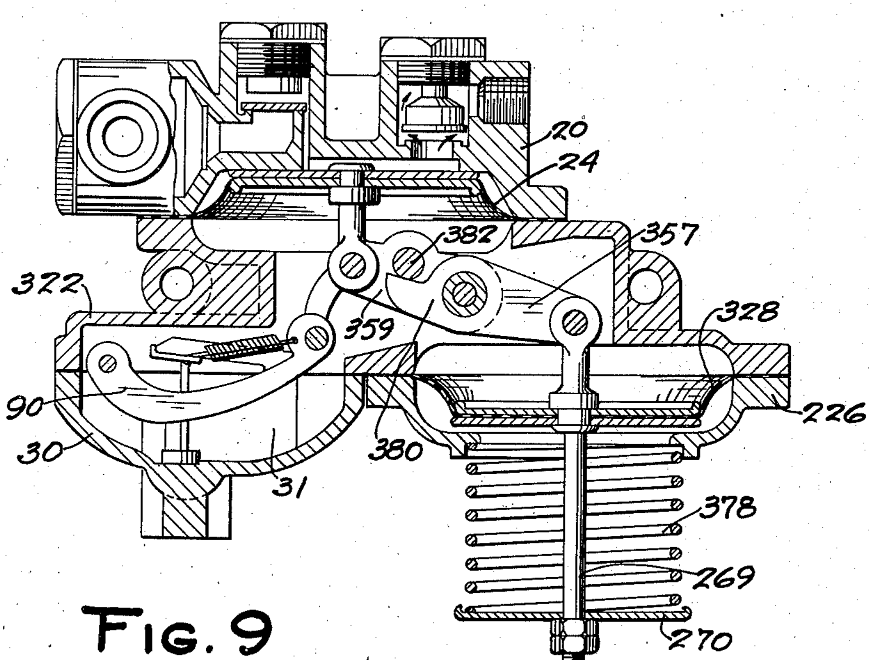

FIG. 9

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UNITED STATES PATENT OFFICE

2,221,071

PUMP

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Application May 29, 1937, Serial No. 145,487

18 Claims. (Cl. 103—152)

This invention relates to pumps and more particularly to pumps of the flexible diaphragm type adapted for operation by suction acting on one side of the diaphragm.

In pumps of such character where applied to automotive vehicles for the purpose of pumping fuel by the use of manifold vacuum, it has been found that the manifold vacuum, during certain operating conditions is too low to raise fuel from the supply tank to the carburetor bowl, particularly where the operating area of the vacuum side of the diaphragm is substantially equal to the pumping area of the diaphragm, or in other words where the displacement in the vacuum side of the pump is substantially equal to that in the fuel side of the pump during each stroke. This was substantially the situation in the old vacuum systems employed in motor vehicles, wherein no diaphragm was employed but wherein suction acted directly on the fuel drawn from the tank, for in effect the surface of the fuel in the vacuum tank formed the equivalent of a diaphragm, gravity in that case maintaining the fuel separate from the subatmospheric air.

With the increased use of down draft carburetion requiring less and less suction to draw fuel into the engine from the jets, and with the location of the float chamber bowl at a higher level due to the down draft arrangement, manifold vacuums have become lower and lower and it has in most cases been considered necessary to provide a mechanically driven pump to raise fuel from the tank to the float chamber bowl. Because of the variable demand from such a pump which bears no direct relation to the speed of engine rotation from which the pump is driven, mechanical difficulties arise. Also, the necessity for locating such a pump close to the hot engine for simplicity of drive causes the phenomenon of vapor lock to arise during hot weather. Further, the pump, for the sake of drive simplicity, must often be placed at a point well above the fuel tank level, thus inviting vapor locks due to the suction head.

The present invention embraces a pump admirably adapt d to take care of the fuel needs of an internal combustion engine by employing a vacuum pump of simple construction which may act to draw fuel into it and discharge fuel therefrom under pressure, and in addition employ a vacuum displacement on the side of the pump of double or more the displacement on the fuel side of the pump. The motive power being vacuum, the pump can easily be placed anywhere.

It is accordingly an object of the present invention to provide a vacuum pump of the diaphragm type adapted to draw fuel thereinto and to discharge fuel therefrom under pressure.

Another object of the invention is to provide a vacuum pump of the diaphragm type wherein the the diaphragm area subjected to vacuum is substantially greater than the effective pump diaphragm area.

A further object of the invention is to provide a vacuum pump of the diaphragm type wherein vacuum displacement for a given stroke exceeds pumping displacement.

Yet another object of the invention is to provide a vacuum pump in which pump inlet suction is produced, as well as pump outlet pressure, and in which the total pressure head produced by the pump may be substantially greater than the degree of vacuum being utilized.

Still another object of the invention is to provide a vacuum pump of the double diaphragm type, one diaphragm being adapted to store energy during the stroke in one direction to deliver energy to the stroke when moving in the return direction.

A further object is the provision of a vacuum pump of simple rugged design adapted to operate on pressures but slightly sub-atmospheric.

The above and other novel features of the invention will appear more fully hereinafter from the following detailed description when taken in connection with the accompanying drawings. It is expressly understood, however, that the drawings are employed for purposes of illustration only and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings, wherein similar reference characters refer to similar parts throughout the several views.

Fig. 1 is a longitudinal section through a preferred form of the pump;

Fig. 2 is a section taken on the line 2—2 of Fig. 1 showing vacuum valve actuating mechanism from above;

Fig. 3 is an enlarged sectional view of a portion of Fig. 1 showing vacuum valve actuating mechanism from the side;

Fig. 4 is a further section taken on the line 4—4 of Fig. 3 showing one of the valve positions;

Fig. 5 is a section corresponding to Fig. 3 showing the valve mechanism in vented position;

Fig. 6 is a section taken on line 6—6 of Fig. 5

showing the corresponding valve positions when vented;

Fig. 7 is a longitudinal section through a modified form of the invention;

Fig. 8 is a fragmentary showing of Fig. 7 with the vacuum valve mechanism in shifted position;

Fig. 9 is a further modified form of the invention, and

Fig. 10 is a fragmentary showing of Fig. 9 with the vacuum valve mechanism in shifted position.

Referring to Figs. 1–6, there is shown a composite pump casing having a pump chamber section **20**, an intermediate vacuum chamber section **22** with a diaphragm **24** therebetween, and a lower vacuum chamber section **26** with a second diaphragm **28** between the intermediate and lower sections, and a vacuum valve control section **30** therebelow.

The pump chamber is provided with an inlet passage **32** having a check valve **34**, and an outlet passage **36**, having a corresponding check valve **38**. Screw plugs **40** and **42** provide access to the valve parts and permit easy inspection thereof, as well as access thereto for reseating purposes if necessary.

The pump diaphragm **24** comprises a thin flexible member **44** clamped between the pump chamber section **20** and the intermediate section **22**, the central portion of which member is clamped between two rigid circular discs **46** and **48** held together between shoulders **50** and **52** on the piston rod or valve stem **54**. The annular portion **56** between the central discs and the casing is left slack so as to present at all times to the pump chamber a concave annular portion. The pump diaphragm is limited in its movement between the face **58** of the pump chamber section **20** and an annular shouldered portion **60** of the intermediate section **22**, which latter portion is further extended inwardly to form a partition **62** with an enlarged central opening **64** through which the stem **54** freely passes.

The second diaphragm **28** which is annular in shape is also formed from flexible material **63** clamped at its outer periphery between the casing sections **22** and **26**. Its upper surface is exposed to atmosphere through ports **59** in the intermediate section and its inner periphery is clamped between an annular seat on the underside of partition **62**, and an annular clamping ring **65** drawn tightly against the diaphragm by a plurality of fastening screws **66**. A narrow annular portion of the diaphragm centrally located with respect to the annular area thereof is clamped between an upper annular plate **68** and an annular flange **72** of a cup shaped member **70**, the flange **72** substantially corresponding in size with plate **68**. Any suitable fastening means such as rivets (not shown) but passing through the flange **72** and plate **68** may be employed to secure the parts together. As in the case of the diaphragm **24**, it will be observed that a certain amount of slack exists in the exposed portion of the diaphragm **63** so that the same presents a concave annular surface. Upward movement of the diaphragm is limited by the engagement of the cup shaped member **70** with the clamping ring **65**, and its lower movement is limited by the suitably shaped end wall **76** of the lower chamber casing section **26**. A spring **78** centered around the cup shaped member **70** and seated on its flange **72** at one end, rests at its other end in an annular groove **80** in the end wall of the casing section **26**. The stem **54** passes loosely through the cup shaped member **70** and is provided with a shoulder **84** adapted to engage the member **70**, whereby the cup shaped member may by reason of the spring, urge the stem upward, as will be hereinafter explained more in detail. Also the cup shaped member **70** is provided with apertures **71** providing free communication therethrough.

The lower end of the valve stem **54** is pivotally connected to a lever **90** pivoted at **92** to the casing section **30** and forming a part of a snap-action valve actuating mechanism for controlling the vacuum and atmospheric pressures within the chamber **31**. As shown in Fig. 4, the valve mechanism comprises a valve **94** adapted when down (see Fig. 6) to close off communication between the vacuum chamber **31** and the port **96** and source of vacuum, and a valve **98** adapted to close off the atmospheric connection **100** when up. Both of these valve elements **94** and **98** are loosely carried up and down simultaneously by a U-shaped lever **102** trunnioned at **104** on upstanding trunnions **106** and **108**. For easy assembly the lever is provided with slots **110** where trunnioned at **104**, and slots **112** and **114** for engaging annular necked portions **116** and **118** on the valve elements **94** and **98**, it being understood that the lever is retained in place by the snap-action tension spring **120** extending from a hole **122** in the transverse portion of the free end of the lever **102** and the lever **90**. In order to assure maximum and full stroke operation of the pump, a second spring **124** of the compression type is provided in the valve mechanism, and extends from a notch **126** in lever **90** close to the fulcrum thereof and a point **128** adjacent the hole **122** in the U shaped lever **102**. This spring tends to maintain the valves either up or down until the lever **90** has moved sufficiently far in either direction as the case may be to tension spring **120** to overcome spring **124**.

Operation of the pump is readily explained as follows: With the spring **78** expanded both diaphragms **24** and **28** are forced to the top position shown in Fig. 1 and the snap-action valve is tripped to the position shown in Fig. 4 just as this upper position is approached. Entrance of vacuum into chamber **31** draws diaphragm **28** down immediately compressing spring **78** and draws diaphragm **24** down slowly, or as fast as fuel will flow into the pump chamber **21** past check valve **34**. When the chamber **21** becomes full, the stem **54** has taken its lower position, moving the snap-action valve mechanism lever **90** to the position shown in Fig. 5, suddenly tripping and causing the valves **94** and **98** to take the position shown in Fig. 6, whereupon the chamber **31** and the diaphragms **24** and **26** are subjected to atmospheric pressure. The energy stored in spring **78** is thus released and drives the valve stem **54** with diaphragm **24** upward slowly forcing fuel out of the pump chamber as fast as it can flow into the carburetor float chamber, which flow is of course regulated by the usual float valve and carburetor demand. Thus on the down stroke, vacuum acting on the lower side of diaphragm **28** operates to compress spring **78** and that on the lower side of diaphragm **24** to draw fuel into pump chamber **21**. It is pointed out that if the suction head required to draw fuel into chamber **21** is very small, as where the fuel supply level is at or above the level of the chamber **21**, the force applied to diaphragm **24** by vacuum can be transmitted through rod **54**, shoulder **84** and cup **70** to aid in compressing the spring **78**. However, the maximum fuel inlet suction, against which the device as illustrated will operate, is restricted to the actual vacuum under diaphragm 24.

On the up-stroke, the entire force of spring 78, derived from the energy stored in the spring during the down stroke, is expended on diaphragm 24 in pumping fuel from the chamber 21. It is apparent that the actual fuel discharge pressure will depend upon the spring force and the area of diaphragm 24 over which said force is distributed. By making diaphragm 28 large, a relatively stiff spring can be utilized which in turn will result in the availability of a rather large force for pumping; also by making diaphragm 24 relatively small the spring force will be distributed over a small area and will result in a relatively high discharge pressure. It is therefore apparent that by properly proportioning the sizes of diaphragms 24 and 28 and properly designing the spring 78, the pump characteristics as to maximum fuel inlet suction, fuel delivery pressure, and fuel pumping capacity can be varied through wide ranges. The energy for the pumping or return stroke is stored during the intake or initial stroke, but due to the second diaphragm, the force of the pump intake or suction stroke is not lessened. Further, since the lower diaphragm is free from the upper diaphragm, the concavity of the upper diaphragm is not disturbed, there always being a pressure on the under side of the diaphragm equal to or less than the pressure on the top, and therefore, the flexible portion of the diaphragm remains flexed downward reducing to a minimum any likely fatigue, and consequent rupture. This would not be so were diaphragm 28 rigidly fixed to stem 54.

In practice, to increase the power of the pump, it will of course be understood that a Venturi booster may be used in conjunction with the vacuum connection at 96. The Venturi booster being placed in the manifold posterior to the throttle assures constant suction for the operation of the fuel pump. With the use of such a venturi, as the throttle is opened upon acceleration of the car, the mixture rushing into the manifold through the Venturi booster causes a depression at the restricted area which is transferred to the connected fuel pump causing its operation. On the other hand during idling of the engine the suction in the manifold is great and the same being transmitted to the fuel pump aids its operation. Thus it may be seen that at all speeds sufficient vacuum is created to assure operation of the fuel pump. For a further description reference is made to the Chandler Patent 2,051,820 where boosters of suitable type are shown at 80 and 178.

In the modification of Figs. 7 and 8, the diaphragms are arranged side by side rather than concentric and the two are connected by a lever mechanism. The casing comprises a pump section 20, and intermediate section 222, between which is clamped the rim of the pump diaphragm 24. The pump diaphragm as before is connected by a stem 254 with a snap-action valve mechanism enclosed in the vacuum valve lower section 30, and the structure thereof, in so far as the snap-action valve mechanism and section 30 is concerned, is identical to that of Fig. 1, and need not be considered again in detail.

The second diaphragm 228 is located alongside of the first, and is clamped in place over large aperture 225 by an annular section 226, and the diaphragm is urged to an upward position by a spring 278 seated in an annular shoulder 280 in the section 226 and bearing against a cup 270 adjustably positioned on the diaphragm stem 269.

The stored energy of the spring 278 is transmitted to the pump diaphragm through a lever system 257 and 259, the lever 257 being free to overrun lever 259 when the spring 278 is being compressed. Similarly, as in the previous modification, the movements of both diaphragms are limited by the casing walls, it being understood that in general the pump diaphragm 24 will have a movement slightly less than the maximum since the valve mechanism must, in practice, trip before the limit is reached.

In operation, when the chamber 31 is subjected to vacuum, diaphragm 228 is promptly drawn downward to its full limit of movement, and pump diaphragm 24 is drawn down as fast as fuel enters the pump chamber 21 and as diaphragm 224 reaches the lower limit, the valve trips and chamber 31 is vented, thereby releasing the energy in spring 278 which through levers 257 and 259 drives the pump diaphragm upward.

In Figs. 9 and 10, the second diaphragm 328 has been located underneath the intermediate section 322, and a pair of levers 357 and 359 pivoted on the same fulcrum 360 transmit the energy stored in spring 378 to the pump diaphragm 24, through an over-running connection comprising the jaw 380 on lever 357 engaging the pin 382 on lever 359. The structure otherwise is substantially similar, but in operation less friction is encountered in the lever system of Figs. 9 and 10 than in that of Figs. 7 and 8.

While the pump has been described as exceptionally useful in motor vehicle fuel supply systems, it should be understood that it has application in the general field as well, and the principle might equally well be applied to pumps operating from fluid under pressure, in which case the second diaphragm spring would move the first diaphragm down to draw fuel into the pump chamber.

However, for automotive vehicle use, it is obvious that the pump can be placed at a low level so that no trouble can possibly be experienced in drawing fuel from the tank, and such positioning merely requires a vacuum connection, and positioning at a low level is further made possible due to the forced discharge. Minimum wear is also present since the pump and its parts move only in response to demand, and not in response to some continuously rotating drive member.

Though several embodiments of the invention have been illustrated and described, it is to be understood that the invention is not limited thereto, but may be embodied in various mechanical forms and combinations as may be desired. As various changes in construction and arrangement of parts may be made without departing from the spirit of the invention, as will be apparent to those skilled in the art, reference will be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A pump comprising a chamber, a flexible diaphragm dividing said chamber into a pump portion and a vacuum actuation portion, means for applying vacuum to said actuation portion to draw the diaphragm theretowards from an initial position, means for venting said actuation portion after a predetermined movement of said diaphragm, energy storing means associated with said actuation portion of the chamber and

functionally independent of said diaphragm during the application of the vacuum to said actuation portion, said energy storing means being adapted to store energy when subjected to vacuum, and means for delivering said stored energy to said diaphragm when said actuation portion is vented to return said diaphragm to said initial position.

2. A pump comprising a chamber, a flexible diaphragm dividing said chamber into a pump portion and an actuation portion, means for changing the pressure in said actuation portion to move said diaphragm from an initial position in one direction through a predetermined movement and for venting said actuation portion thereafter, energy storing means associated with said actuation portion and subjected to said changing pressure for storing energy during said movement of the diaphragm in one direction, said energy storing means being functionally independent of said diaphragm during said movement of the diaphragm and means for delivering said stored energy to said diaphragm to move it in the other direction back to said initial position when said actuation portion is vented.

3. A pump comprising a chamber, fluid pressure responsive means dividing said chamber into a pump portion, and an actuation portion, means for changing the pressure in said actuation portion to move said fluid pressure responsive means from an initial position in one direction through a predetermined movement and for venting said actuation portion thereafter, energy storing means associated with said actuation portion and subjected to said changing pressure for storing energy therefrom during said movement of said pressure responsive means in said one direction, said energy storing means being functionally independent of said fluid pressure responsive means during said movement of the fluid pressure responsive means and means for delivering said stored energy to said pressure responsive means to move it oppositely back to initial position when said actuation portion is vented.

4. A pump comprising a chamber, a flexible diaphragm dividing said chamber into a pump portion and an actuation portion, inlet and outlet valves connected to said pump portion, a vacuum inlet valve connected to said actuation portion and a vent valve, means for actuating said vacuum inlet valve and said vent valve simultaneously and alternately to open one or the other in response to diaphragm movement, a second flexible diaphragm in the wall of the actuation portion of said chamber, a spring adapted to be compressed by said second diaphragm when subjected to vacuum, and means for transferring the energy of the compressed spring to move said first named diaphragm when the vent valve is opened.

5. A vacuum pump having a casing with two flexible diaphragms in the wall thereof, valve means for admitting vacuum or atmospheric pressure to said casing, means operated by movement of one of the diaphragms to actuate the valve means to cut off suction and vent the casing, and energy storing means including the other diaphragm for storing energy when subjected to vacuum, and means actuated by said stored energy for moving said one diaphragm to actuate the valve means to admit suction and close the vent, and a pump chamber having said one diaphragm acting as a portion of the wall thereof.

6. A pump comprising a chamber, a flexible diaphragm dividing said chamber into a pumping chamber and an actuating chamber, means for admitting and discharging liquid from said pumping chamber in response to movements of said diaphragm, means for admitting vacuum and venting said actuating chamber in response to diaphragm movement, a flexible diaphragm means in the wall of said actuating chamber and adapted for actuation in response to vacuum within said actuating chamber, a resilient means for storing energy moved by said diaphragm means when actuated in response to vacuum, and means for transmitting said stored energy to said first named diaphragm, when said actuating chamber is vented.

7. A pump comprising a casing providing a chamber, a flexible circular diaphragm dividing said chamber into a pump chamber and actuating chamber, inlet and discharge ports for said pump chamber, valve means for admitting vacuum or venting said actuating chamber, a stem connecting said diaphragm to said valve means through a snap acting mechanism, an annular reduced portion in said casing and extending into said actuating chamber, an annular flexible diaphragm forming a wall of said reduced portion and concentric with said circular diaphragm and said stem, means resiliently biasing said annular diaphragm against vacuum pressure within the actuating chamber, and means on said stem and annular diaphragm adapted to cooperate with said biasing means to drive both diaphragms in a direction opposite to that produced by suction, when the actuating chamber is vented.

8. In a pump, a pump chamber, a casing, a pair of flexible diaphragms therein, one exposed to atmosphere, and the other to the pump chamber, and both to atmosphere or vacuum within said casing, valve means for controlling the vacuum and venting of said casing, a spring urging said exposed diaphragm against the force of vacuum, and inter-engaging levers for transmitting the energy of said spring to said pump chamber diaphragm.

9. In a control mechanism for a pump of the diaphragm type having a flexible diaphragm, a valve operating lever having a limited movement, vent and vacuum valves actuated thereby and controlling the application of vacuum and atmospheric pressure to said diaphragm, a second lever eccentrically pivoted with respect to the operating lever, and extending oppositely with respect thereto and adapted to oscillate about the line joining the fulcrums of said levers, resilient tension means connecting said levers, whereby movement of said second lever through a predetermined angle will cause said operating lever to snap from one end to the other of its limited movement, and a connection from said second named lever to said diaphragm.

10. In a control mechanism for a pump of the diaphragm type having a flexible diaphragm, a valve operating lever having a limited movement, vent and vacuum valves actuated thereby and controlling the application of vacuum and atmospheric pressure to said diaphragm, a second lever eccentrically pivoted with respect to the operating lever, and extending oppositely with respect thereto and adapted to oscillate about the line joining the fulcrums of said levers, resilient tension means connecting said levers, whereby movement of said second lever through a predetermined angle will cause said operating

lever to snap from one end to the other of its limited movement, a resilient compression element extending from said operating lever to a point adjacent the fulcrum of said second named lever for positively urging the valves and the operating lever toward the limits of its movement until overcome by said tension means, and a connection from said second named lever to said diaphragm.

11. A vacuum operated fuel pump comprising a pump chamber, a vacuum chamber, a circular diaphragm separating said chambers, and having a rigid circular center portion and loose flexible annular portion, a stem secured to said center portion, a valve operating lever connected to said stem, vent and vacuum valves actuated by said valve operating lever and controlling the application of vacuum and atmospheric pressure to said diaphragm, means associated with said lever for opening the vacuum valve to admit vacuum when the circular diaphragm reaches one limit of its movement and for opening said vent to atmosphere when the circular diaphragm reaches the other limit of its movement, an annular flexible diaphragm surrounding said stem and having one side exposed to atmosphere and the other to said vacuum chamber, resilient means within the chamber urging said annular diaphragm against vacuum, and means for transmitting energy stored in said resilient means to said circular diaphragm to move the same when the vacuum chamber is vented.

12. In a vacuum operated fuel pump, a casing formed in sections having adjacent plane surfaces, a flexible diaphragm clamped between said surfaces and forming a pump chamber and a vacuum actuating chamber, a stem centrally secused to said diaphragm, vacuum inlet and vent valve means actuated by said stem, a shoulder on said stem, a second flexible diaphragm annular in form surrounding said stem and exposed on one side to atmosphere and on the other to the vacuum chamber, and resilient means urging said second diaphragm into engagement with said shoulder.

13. In a displacement pump, a pumping member having one surface in contact with the fluid being pumped, means for intermittently subjecting another surface of the pumping member to motive fluid pressure to cause it to move through a stroke, resilient means having a one-way connection with said pumping member and operative to move it through its opposite stroke, and a pressure responsive member having one surface subjected to said motive fluid pressure and operative to compress the resilient means to render the same inoperative during movement of the pumping member through said first mentioned stroke.

14. The invention defined in claim 13, wherein the effective area of said surface of the pressure responsive member is substantially greater than the effective area of said other surface of the pumping member.

15. In a pump, a pumping chamber, a variable pressure chamber, a pumping member movable in said pumping chamber and having a surface exposed to pressures in said pressure chamber, means for periodically varying the pressure in said pressure chamber to cause the pumping member to move through a stroke, a spring having a one-way connection with said pumping member and operative to move it through its opposite stroke, and a pressure responsive device having one surface exposed to pressures in said pressure chamber and operative to compress the spring to render it inoperative during movement of the pumping member through said first mentioned stroke.

16. The invention defined in claim 15, wherein the effective area of said surface of the pressure responsive device is substantially greater than the effective area of said surface of the pumping member.

17. In a displacement pump having a pump chamber, a source of suction, a diaphragm for drawing fluid into the pump chamber when subjected to said suction, and means associated with said diaphragm including a movable wall exposed on one side to atmosphere and on the other to said suction for storing energy while said diaphragm is drawing in fluid, said energy storing means being structurally and functionally independent of the pumping means during the energy storing period, and thereafter said energy storing means becoming operatively connected with the diaphragm to move the latter for discharging fluid from said chamber.

18. In a vacuum operated fuel pump, a source of vacuum, a vacuum operated means for drawing fuel into the pump, and energy storing means including a diaphragm exposed on one side to atmosphere and on the other side to said vacuum for storing energy when said first named means is drawing in fuel, said energy storing means being both structurally and functionally independent of the pumping means during the energy storing period, and means thereafter connecting the vacuum operated means and the energy storing means for expelling the fuel from the pump.

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