Sept. 29, 1953 M. KATCHER 2,653,544

FUEL AND VACUUM PUMP OPERATING LEVERS AND OPERATING SPRINGS THEREFOR

Filed Jan. 10, 1947 2 Sheets-Sheet 1

Fig. 1

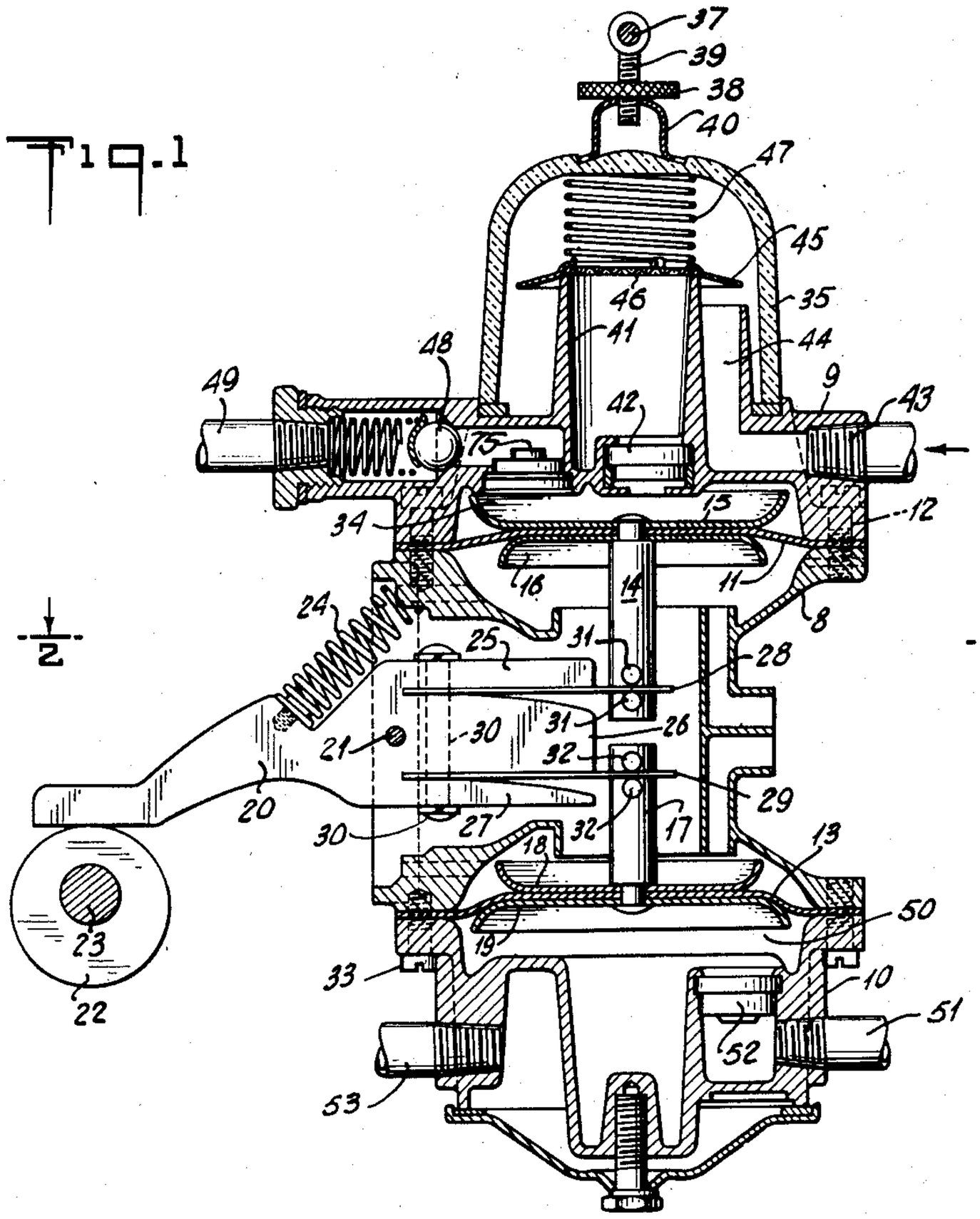
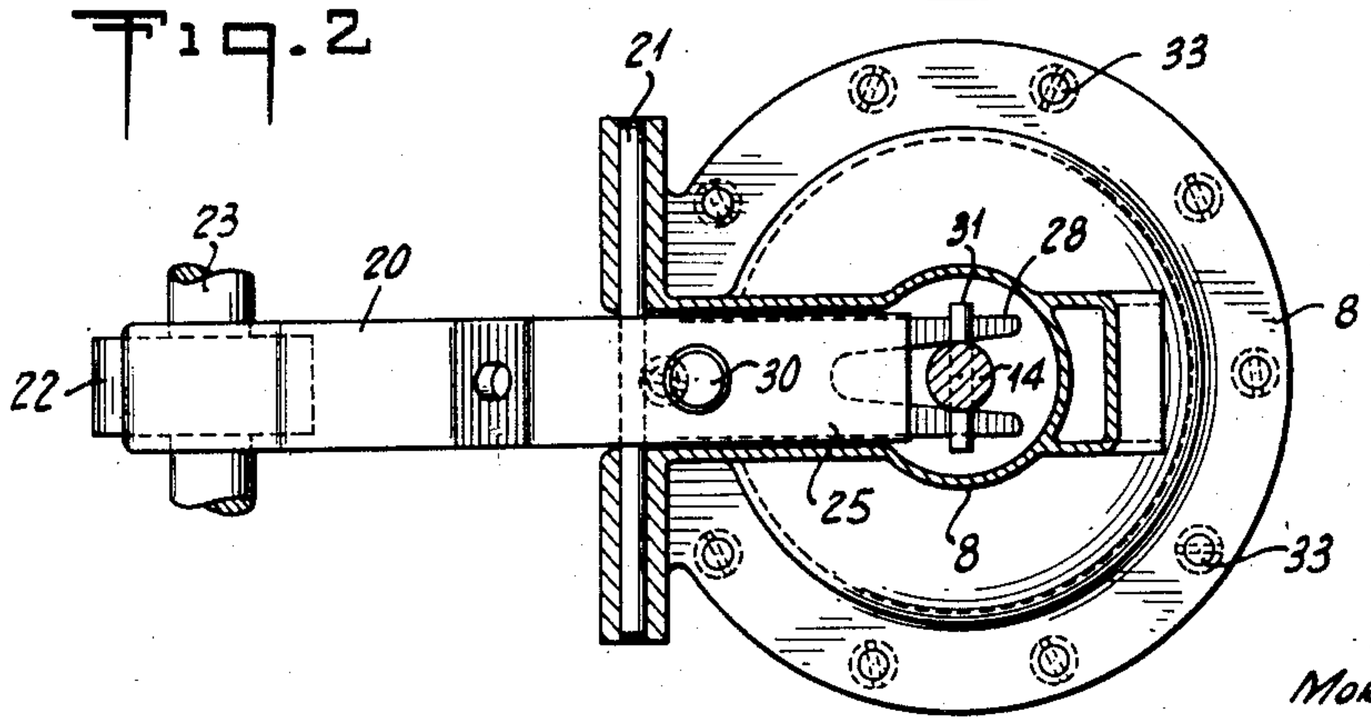


Fig. 2



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Filed Jan. 10, 1947 2 Sheets-Sheet 2

Fig. 3

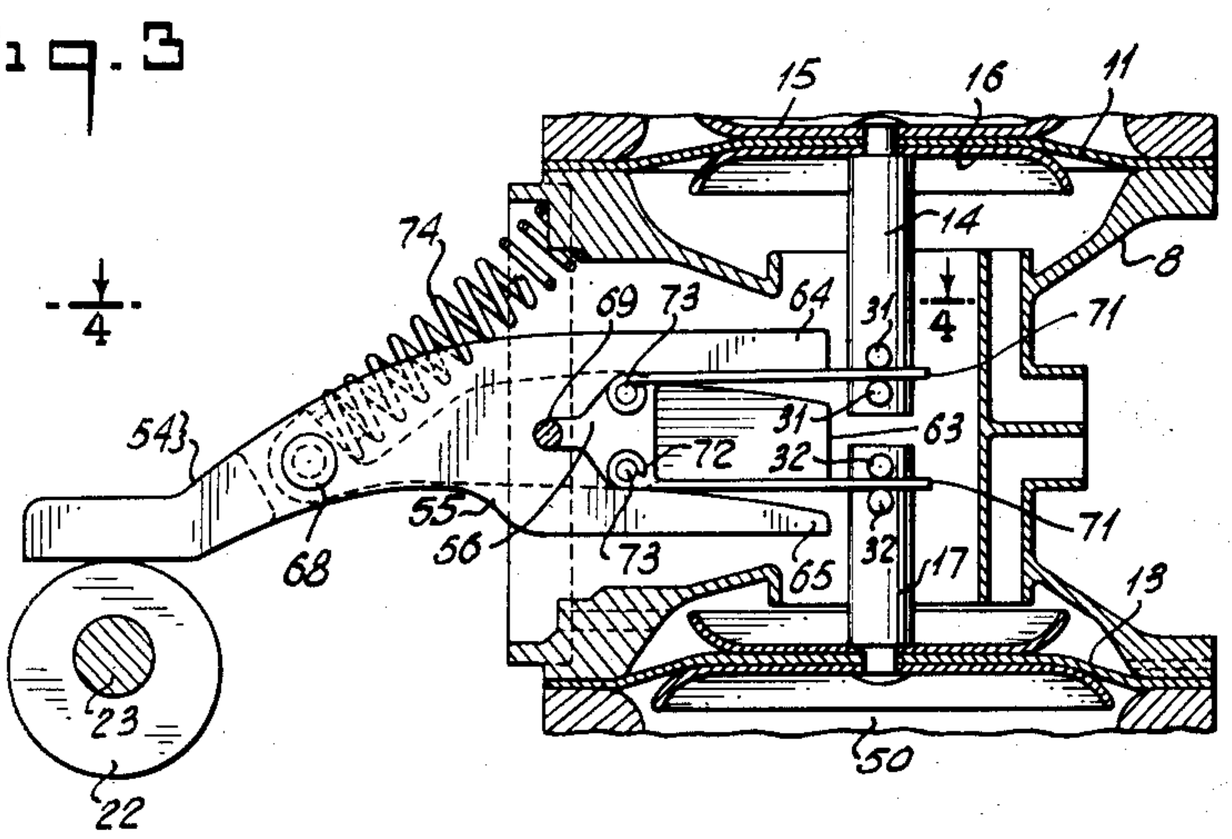

Fig. 4

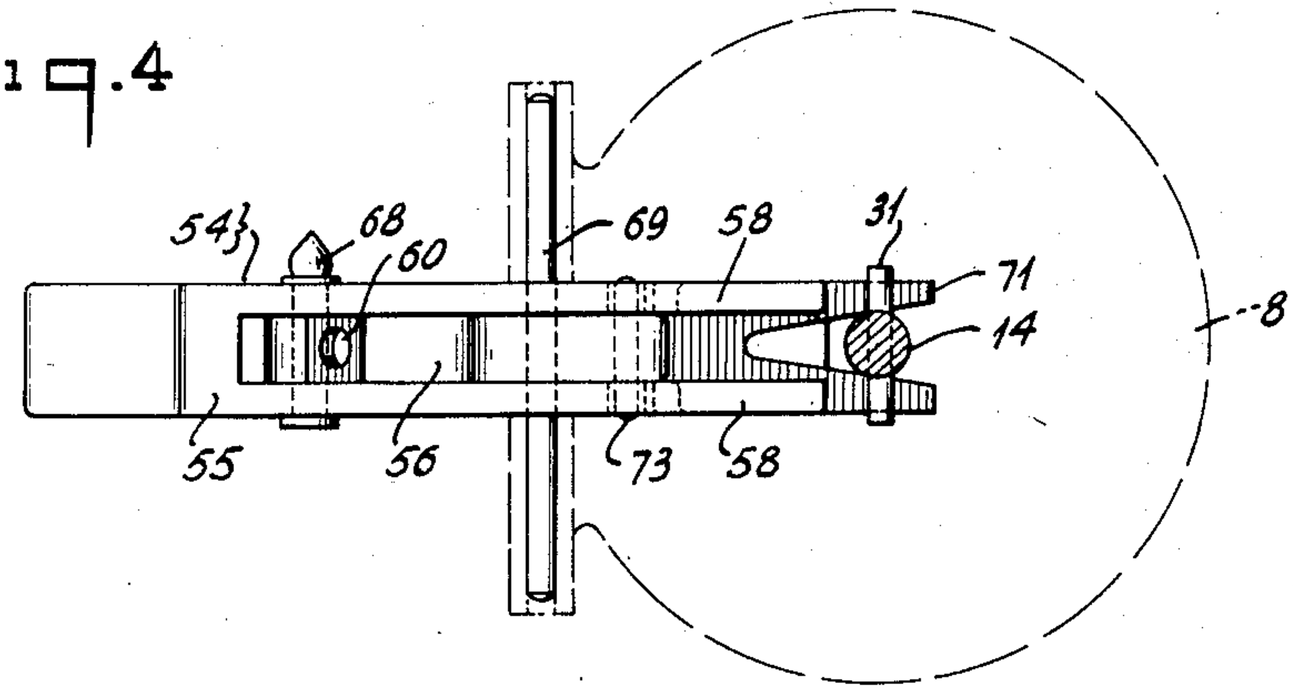

Fig. 5

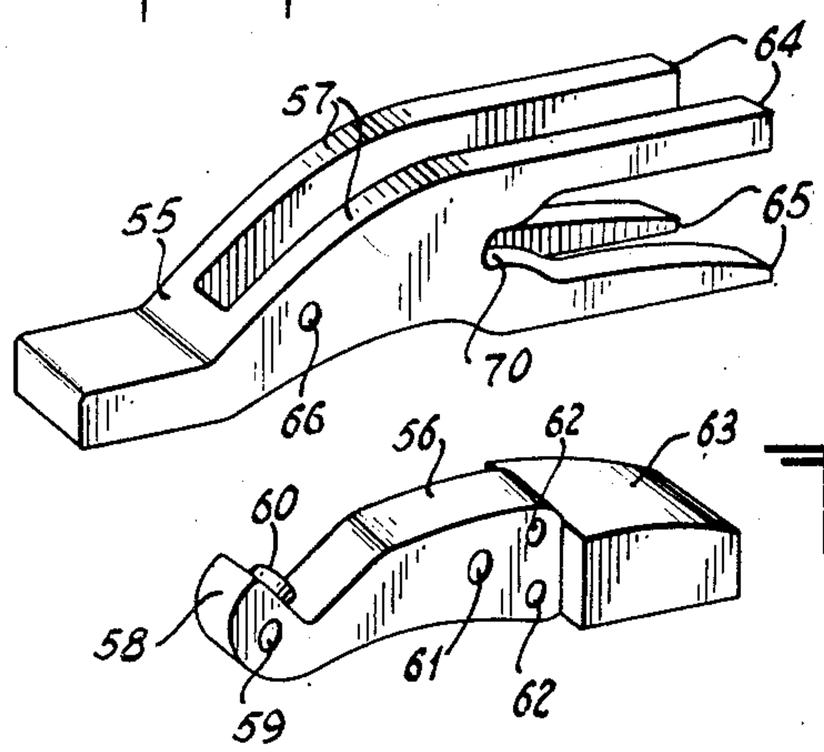

Fig. 7

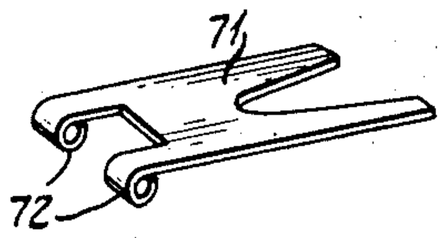

Fig. 6

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FUEL AND VACUUM PUMP OPERATING LEVERS AND OPERATING SPRINGS THEREFOR

Morris Katcher, New York, N. Y.

Application January 10, 1947, Serial No. 721,316

16 Claims. (Cl. 103—9)

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This invention relates to an operating lever and springs for combined diaphragm fuel and diaphragm vacuum pumps for use in internal combustion engines. The same principles governing the construction for the combined pump make it suitable for operating a fuel pump without its combination with the vacuum pump feature, and vice versa, for operating a vacuum pump without its combination with the fuel pump feature.

The lever is substantially a rigid member, in one form made of one piece, in another form made of pieces solidly fastened together. The lever has springs mounted on it, preferably plate springs, which are operatively connected to the diaphragms. When the lever is rocked, its motion is transmitted to the diaphragms via the springs. For motion of the diaphragms in one direction, the springs, which cantilever from the lever, are stiffened by such an engagement with the lever as to shorten the cantilever. This produces a substantially positive stroke of the diaphragms. For motion of the diaphragms in the opposite direction from that noted above, the springs are subjected to yielding or bending for the full length of their cantilever. The cantilever strength of the springs for their full length is such that they will yield materially only when the resistance of the diaphragms against being moved exceeds a predetermined amount. As is well known in the art, fuel pumps for internal combustion engines, send the fuel to a carburetor. When the feed exceeds the consumption, back pressure is developed on the pump. Accordingly, with a fuel pump, a positive stroke of the diaphragm is suitable for sucking the fuel into the pump, but the mechanism effecting the discharge stroke of the diaphragm must yield so as not to exceed a predetermined back pressure on the carburetor. A similar situation holds for vacuum pumps where it is desirable not to produce a vacuum less than a predetermined amount. Accordingly for a vacuum pump, a positive stroke of the diaphragm is suitable for the discharge or compression stroke, but the mechanism effecting the vacuum or suction stroke must yield to keep the vacuum above a predetermined minimum.

A further object of the invention resides in the novel construction making it possible to mount the combination fuel and vacuum pump on the engine with either the fuel diaphragm in the top position and the vacuum diaphragm in the bottom position or the vacuum pump diaphragm in the top position and the fuel pump diaphragm in the bottom position. To accomplish this, provision is made so that the inner end of the operating lever and springs are in such operative relation to the

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means connected to the diaphragms for effecting their strokes and in relation to the diaphragms themselves, that said lever rocks from a mean position which is suitable for either the fuel pump diaphragm or the vacuum pump diaphragm, no matter which is on top. The inner end of the operating lever must bear a constant relation to the diaphragms, even if it be necessary that its outer end be varied to suit the driving means of the particular engine with which the pump is to be used. Another form of this construction is to be found in my copending application serial No. 644,535 filed January 31, 1946, now U. S. Patent No. 2,570,560 issued October 9, 1951.

The strainer shown is suitable for filtering the fuel whether the fuel diaphragm is on top or whether it is on the bottom of the pump and upside down from its top position. Such a strainer is to be found in my application Serial No. 644,535 filed January 31, 1946, now U. S. Patent No. 2,570,560 issued October 9, 1951.

Other objects and advantages will become apparent upon further study of the specification and drawings in which:

Fig. 1 is a vertical section through the pump.

Fig. 2 is a section taken along the line 2—2 of Fig. 1.

Fig. 3 is a partial vertical section through the pump showing a modified form of operating lever.

Fig. 4 is a section taken along the line 4—4 of Fig. 3, only a portion of the pump housing being shown, said portion being shown in dotted lines.

Fig. 5 is a perspective view of the main part of the operating lever of Fig. 3 shown by itself.

Fig. 6 is a perspective view of the insert for the operating lever shown by itself, and

Fig. 7 is a perspective view of one of the lever springs of Fig. 3 shown by itself.

The housing of the pump, Figs. 1 and 2, comprises an intermediate member or portion 8, an upper portion or top member 9, and a bottom portion or member 10. Fuel diaphragm 11 is clamped between the intermediate portion 8 and the top portion 9 by means of screws 12. Vacuum diaphragm 13 is clamped between intermediate portion 8 and bottom portion 10 by means of screws 33. Stem 14 is connected to diaphragm 11 through the intermediacy of washers 15 and 16. Stem 17 is connected to diaphragm 13 through the intermediacy of washers 18 and 19. A solid operating lever 20 is pivotally mounted on intermediate portion 8 by means of pivot pin 21. The outer end of lever 20 is forced to ride on cam 22 by the pressure of spring 24. Cam 22 is fixedly mounted on shaft 23, usually the cam shaft of the engine motor. The inner end of lever

20 is divided into an upper finger 25, a relatively thick middle finger 26 and a lower finger 27. The upper surface of both fingers 26 and 27 is curved downwardly from their outer end to their inner end. In the space between upper finger 25 and middle finger 26 is set plate spring 28, while plate spring 29 is set in the space between middle finger 26 and lower finger 27. A rivet 30 extends through fingers 25, 26 and 27 and springs 28 and 29 holding the latter in place between the fingers. Upper stem 14 has a pair of spaced pins 31 extending through it. The forked inner end of spring 28 straddles stem 14 between pins 31. In a similar manner, the forked inner end of spring 29 straddles stem 17 between pins 32. As will be more fully explained hereafter, when lever 20 is rocked in a clockwise direction stems 14 and 17 are moved down with a substantially positive stroke and when said lever is rocked counterclockwise, said stems may be moved up with a yielding or resilient stroke. The outer end of spring 28, which end is nearer the pivotal axis of lever 20 than its projecting inner end, in the particular embodiment shown, is fixedly held between fingers 25 and 26, that is there is a fixing couple or holding moment present at the outer end of the spring when the latter has its projecting end subject to a downward force. The downward force is produced by the resistance of fuel diaphragm 11 against being pushed up by the inner or projecting end of spring 28 when lever 20 is rocked in a counterclockwise direction. In a similar manner, the outer end of spring 29 is fixedly held between fingers 26 and 27 so that there is a fixing moment induced at said outer end when its projecting end is subject to a downward force. The downward force is produced by the resistance of vacuum diaphragm 13 against being pulled up by the inner or projecting end of spring 29 when lever 20 is rocked in a counterclockwise direction.

Top member 9 forms the upper wall of fuel pump chamber 34, while its lower wall comprises diaphragm 11. Mounted on top of top member 9 is glass strainer bowl 35, held down on gasket 36 by means of bail 37, nut 38, screw 39 and washer 40. Bail construction of this type for holding strainer bowls to diaphragm fuel pumps is well known in the art. The top member 9 has a hollow cylindrical portion 41 extending up into bowl 35. At the bottom of cylindrical or tubular portion 41 is an inlet check valve 42 which allows the flow of fuel down from the inside of said portion into fuel pump chamber 34 but not in the reverse direction. Top member 9 is provided with fuel inlet 43, which can be connected to the fuel tank, not shown, and a passage 44 which receives the fuel from the inlet and delivers it near the top of tubular portion 41. An annular flange or baffle 45 is mounted on top of portion 41 so as to surround the latter and is provided with an opening over the open upper end of tubular member 41. Screen 46 is mounted in said opening. Baffle 45 acts to prevent any sludge which may have settled outside of portion 41 from reaching screen 46.

The screen 46 and flange 45 are held down on portion 41 by spring 47, the upper end of which reacts against the inside top of bowl 35. The fuel from the top of passage 44 flows through screen 46 into the inside of portion 41 and through check valve 42 into fuel pump chamber 34 when diaphragm 11 is moved downward for its suction stroke. Upon the upward or compression stroke of diaphragm 11, the fuel is forced through outlet check valves 75 and 48 into outlet 49 which

is usually connected to the carburetor, not shown, of an internal combustion engine. The double outlet check valve reduces the pulsations in the fuel being discharged from the pump. It forms the subject matter of application Serial No. 619,710 filed October 1, 1945, now abandoned, by William Hicks and myself.

As is well known in the art, when fuel is fed to the carburetor faster than it is consumed by the engine, back pressure is developed in the fuel line between the fuel pump and the carburetor, in the particular instance illustrated herein, in outlet pipe 49. In order to provide for this when diaphragm 11 is to be given its upward or compression stroke, spring 28 bends on its cooperating upward or compression stroke, because it has just sufficient stiffness to force stem 14 upward for a predetermined normal pressure in outlet pipe 49. The upper surface of middle finger 26 is suitably cut away or curved downward to permit the downward bending of spring 28. On the other hand, for the suction or downward stroke of diaphragm 11, the flat under surface of finger 25, especially its inner end, contacts spring 28, thereby stiffening the latter and making it substantially unbendable, producing a substantially positive suction stroke for diaphragm 11.

When operating lever 20 is swung clockwise, vacuum diaphragm 13 is given its compression stroke, discharging the air from vacuum chamber 50. This compression stroke is substantially positive because spring 29 bears against the flat bottom surface of finger 26 especially the inner end of the latter and is stiffened thereby, as only a small portion of it cantilevers beyond the inner edge of said finger to come between pins 32 on stem 17. On the other hand, the up or vacuum stroke of diaphragm 13 is a yielding one because spring 29 can bend down until it contacts the curved upper surface of finger 27. The spring 29 is provided of such strength that it will yield when the vacuum in vacuum chamber 50 falls below a predetermined minimum. As is well known in the art, it is desirable not to have less than a predetermined vacuum in the vacuum system for operating the various vacuum operated mechanisms usually provided in a motor vehicle, airplane or the like. On the vacuum stroke, air is sucked in through inlet 51 and check valve 52 into vacuum chamber 50. On the compression or discharge stroke, the air is forced out of vacuum chamber 50 through an outlet check valve, not seen, out through discharge outlet 53.

In the modified form shown in Figs. 3–7, the operating lever denoted in its entirety by the numeral 54, comprises a main portion 55, shown by itself in perspective in Fig. 5, and a central insert 56 shown by itself in perspective in Fig. 6. Main portion 55 is provided with two forked arms 57, each having an upper prong 64 and a lower prong 65. Central insert 56 is provided with a heel 58 having a hole 59 and a boss 60. The shank of insert 56 is provided with a hole 61 and two holes 62. Extending inwardly from said shank is a toe or finger 63 of a width equal to the total width of main portion 55. Central insert 56 is inserted between arms 57 so that its hole 59 is in alignment with holes 65 in main portion 55, only the near hole 66 being seen in Fig. 5. Pin 68 is inserted through aligned holes 59 and 66, while a pin 69 is inserted with a forced fit into hole 61, the outer portions of the latter pin extending into crotches 70 formed in forked arms 57, only the near crotch being seen in Fig. 5. Plate springs 71 are inserted between toe or finger 63 and prongs or fingers 64 and 65, the outer end

of said springs being provided with eyelets 72. Pins 73 are inserted through eyelets 72 and holes 62, after the eyelets and said holes are brought into alignment. The inner ends of springs 71 straddle stems 14 and 17 and come between the pairs of pins 31 and 32. Return spring 74 engages insert 56 at boss 60 for the return stroke of lever 54 after it has been rocked in a clockwise direction by eccentric 22 on shaft 23. The outer ends of springs 71 are fixedly held between fingers 63, 64 and 65 and by pins 73 as was explained above for springs 28 and 29.

For the upward or compression stroke of fuel diaphragm 11, upper spring 71 yieldingly urges stem 14 upward, the upper surface of toe 63 being curved to provide space to permit upper spring 71 to yield. As was explained for Fig. 1, this yielding action depends on the pressure in the feed line between the pump and the carburetor. When said pressure exceeds a predetermined value, upper spring 71 yields, otherwise it remains substantially unbent. On the other hand, upon the downward or compression stroke of diaphragm 11 and stem 14 there is substantially no yielding of upper spring 71 because it engages the lower flat surface of prongs 64 especially at their inner end.

When operating lever 54 is swung clockwise, vacuum diaphragm 13 is given its compression or discharge stroke. This compression stroke is substantially positive because lower spring 71 bears against the flat bottom surface of toe 63, only a small portion of it cantilevering beyond the edge of said toe to come between pins 32 on stem 17. On the other hand the up or vacuum stroke of diaphragm 13 is a yielding one when the vacuum chamber 50 is less than a predetermined value because lower spring 71 can bend down until it contacts the curved upper surface of toe 63. The purpose of this yielding has already been explained in connection with Figs. 1 and 2.

The terms upper and lower and those relating to direction and position as used in the claims are intended to be relative only as the pumps may be turned upside down or turned end to as explained hereinbefore.

If the pump is to be solely a fuel pump, vacuum diaphragm 13 and its appurtenances may be omitted and lever 20 need only have spring 28, Fig. 1, mounted on it. Finger 27 may be omitted. Even the inner portion of finger 26 may be omitted, as only its outer portion is needed fixedly to hold the outer end of spring 28. The same holds true for the lever of Fig. 3. Lower spring 71 and prongs 65 are not required and only the outer portion of toe 63 to fix the outer end of upper spring 71 is needed.

Conversely, if a vacuum pump be all that is desired, spring 28 and finger 25 of Fig. 1 may be omitted as well as that portion of finger 26 not required to fix the outer end of spring 29. Of course fuel pump diaphragm 11 and its appurtenances will also be omitted. Likewise for the construction of Fig. 3, upper spring 71 and prongs 64 may be omitted and only the outer portion of toe 63 to fix the outer end of lower spring 71 is required.

I claim:

1. A pivoted lever for use with rocking means for operating a combination fuel diaphragm and vacuum diaphragm pump, comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means, three fingers set in a row, one above the other on the lever on the opposite side of the axis from said portion and

pointing away from said axis, an upper plate spring mounted between the top and mid-finger, and a lower plate spring mounted between the mid-finger and the lower finger, said springs pointing away from the axis in the same direction as the fingers, the outer portion of each spring being fixedly held on the lever, the inner portion of each spring projecting inward beyond the ends of the fingers, the projecting portion of the upper spring being adapted for connection to the fuel diaphragm and the projecting portion of the lower spring being adapted for connection to the vacuum diaphragm, the bottom portion of the upper finger being shaped to engage the upper spring at least near the inner portion of the upper finger to stiffen the upper spring during the downward stroke of the fingers when the lever is rocked in a clockwise direction, the upper portion of the mid-finger being spaced from the lower portion of the upper finger to permit the upper spring to yield a substantial amount from its fixedly held outer portion during the upper stroke of the fingers when the lever is rocked in a counterclockwise direction, the bottom portion of the mid-finger being shaped to engage the lower spring at least near the inner portion of the mid-finger to stiffen the lower spring during the downward stroke of the fingers when the lever is rocked in a clockwise direction and the upper portion of the lower finger being spaced from the lower portion of the mid-finger to permit the lower spring to yield a substantial amount from its fixedly held outer portion during the upper stroke of the fingers when the lever is rocked in a counterclockwise direction, the strength of the springs being such as to yield a substantial amount only when their outer projecting portions encounter more than a predetermined resistance against being moved upward.

2. A pivoted lever for use with rocking means for operating a diaphragm pump having a portion adapted to be engaged by said rocking means and a spring having an end part fixedly held on a second portion of the lever and another end part projecting beyond and clear of the lever, said latter end part being fastened to the diaphragm for reciprocating the latter against its resistance to motion when pumping when the lever is rocked, said second portion of the lever being shaped to engage the spring nearer the latter's projecting end part during the stroke of the lever in one direction for stiffening the spring, than during the stroke of the lever in the opposite direction, the strength of the spring being such as to yield, during the stroke in said opposite direction, a substantial amount, only when its projecting end part encounters more than a predetermined resistance against being moved during the latter stroke of the lever, the position of said fixedly held end part of the spring on the lever, relative to the lever and the diaphragm, being such that during the stroke of the lever in said opposite direction, the resistance of the diaphragm against motion effects the bending of the spring away from the lever.

3. A pivoted lever for use with rocking means for operating a combination fuel diaphragm and vacuum diaphragm pump comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means, and a forked portion extending on the opposite side of said axis from said first portion, said forked portion having a pair of spaced arms, each of said arms being divided into an upper and a lower prong,

an insert having a heel coming between and fastened to said arms, said insert having a toe extending across the space between the arms and coming between the upper and lower prong of each arm, the bottom face of the upper prongs and of the toe being substantially flat, the upper face of the toe sloping downwardly away from the bottom face of the upper prongs, and the upper face of the lower prongs sloping away from the bottom face of the toe, providing space in both instances between the prongs and the toe, an upper plate spring set between the toe and the upper prongs having one end portion held with a fixing couple on the insert and its other end portion projecting beyond and clear of said toe and upper prongs, said projecting portion being adapted for operative connection to the fuel diaphragm for reciprocating the latter when the lever is rocked, said fixing couple normally holding the upper spring at its fixed end to resist bending of the spring away from the upper prongs, the bottom face of the upper prongs engaging the upper spring near the latter's projecting end portion during the downward stroke of the prongs for stiffening the upper spring, the space between the upper prongs and toe permitting the spring to yield a substantial amount during the upward stroke of the prongs, and a lower plate spring set between the toe and the lower prongs having one end portion held with a fixing couple on the insert, its other end portion projecting beyond and clear of said toe and lower prongs and adapted for operative connection to the vacuum diaphragm for reciprocating the latter when the lever is rocked, said latter fixing couple normally holding the lower spring at its fixed end to resist bending of the spring away from the bottom face of the toe, the bottom face of the toe engaging the lower spring near the latter's projecting end portion during the downward stroke of the toe for stiffening the lower spring, the space between the toe and the lower prongs permitting the spring to yield a substantial amount during the upward stroke of the toe, the strength of the springs being such as to yield a substantial amount only when their projecting end portions encounter more than a predetermined resistance against being moved during the upward stroke of the toe and prongs.

4. A pivoted lever for use with rocking means for operating a reciprocable pumping element comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means and a second portion extending on the opposite side of said axis from said first portion, a spring having one portion attached to the lever only at a place near said pivotal axis, and an end projecting beyond the second portion of the lever in a direction away from said axis, and a push and pull connection to said element for the spring at its projecting end pushing and pulling the element when the lever is rocked, the lever being formed to limit the cantilever length of said end of the spring by contact therewith near the end away from said axis of the second portion of the lever during the stroke of the lever in one direction, said lever being also formed to allow it to remain out of contact with the spring from the spring's place of attachment to the lever to the end of the spring away from the pivotal axis during the stroke of the lever in the opposite direction.

5. A pivoted lever for use with rocking means for operating a reciprocable pumping element comprising a portion to one side of its pivotal

axis adapted to be engaged by said rocking means and a second portion extending on the opposite side of said axis from said first portion, and a spring having one portion attached to the lever and an end projecting beyond the second portion of the lever in a direction away from said axis, the spring at its projecting end being fastened to the pumping element pushing and pulling the latter when the lever is rocked, the form of the lever being such to contact the spring near the end away from said axis of the second portion of the lever to stiffen the spring during the stroke of the lever in one direction, said form and place of attachment of the spring being such to permit the spring to bend away from the lever from a place on the lever nearer to said axis than said latter end during the stroke of the lever in the opposite direction, the force exertable by the spring during said latter stroke being less than during the former stroke and acting in the same direction as said latter stroke.

6. A pivoted lever for use with rocking means for operating a reciprocable pumping element comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means, and a second portion extending on the opposite side of said axis from said first portion, a spring having one portion mounted on the lever and a push and pull connection to said element for a second portion of the spring for reciprocating the element when the lever is rocked, the lever being forked-shaped with two prongs, the spring being set between the prongs, one prong being formed and located with respect to the spring to contact it on one face thereof at a predetermined distance from said axis on said opposite side of the axis to stiffen it during the stroke of the lever in one direction, the other prong of the lever being formed adjoining the other face of the spring to permit the spring to bend from a place on the lever nearer said axis on said opposite side than the predetermined distance during the stroke of the lever in the opposite direction, the spring exerting a force on said element in the direction of its stroke equal to its bending strength during said latter stroke.

7. A lever as claimed in claim 6 in which the spring is a plate spring with one end attached to the lever and the other end cantilevering therefrom and engaging the connection, one flat surface of the spring being toward the pumping element.

8. A pivoted lever for use with rocking means for operating the reciprocable pumping element of a vacuum pump comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means and a second portion extending on the opposite side of the axis from said first portion having a push and pull connection to the pumping element for reciprocating the latter when the lever is rocked, said second portion of the lever comprising a resilient part which increases in rigidity during the stroke of said part toward the pumping element said part exerting a push on said element during said stroke, and decreases in rigidity exerting a pull equal to its lessened bending strength on said element, during the stroke of said part away from the pumping element, of just sufficient amount to overcome a predetermined resistance of the pumping element.

9. A pivoted lever for use with rocking means for operating a pair of oppositely disposed pumping elements of a combined fuel and vacuum pump comprising a portion to one side of its

pivotal axis adapted to be engaged by said rocking means and a second portion extending on the other side of said axis from said first portion adapted for operative connection to the pumping elements for reciprocating them when the lever is rocked, said second portion of the lever comprising a pair of resilient parts each of which has a push and pull connection to one of the pumping elements exerting successively a push and pull on said elements when reciprocated, said parts increasing in rigidity during the stroke of the lever in one direction and decreasing in rigidity, each exerting a force equal to its lessened bending strength, during the stroke of the lever in the opposite direction, of just sufficient amount to overcome a predetermined resistance to motion of the pumping element to which it is connected.

10. A pivoted lever for use with rocking means for operating a diaphragm pump comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means, a finger on the lever on the opposite side of said axis, said finger pointing away from said axis, and a spring mounted on the lever having its end nearer the pivotal axis fixedly held on the lever, said spring having a portion at its other end project beyond the finger, pointing away from said axis in the same direction as does the finger, the spring at said latter portion having a push and pull connection to the diaphragm, pushing and pulling the diaphragm when the lever is rocked, said finger being suitably formed and located with respect to the spring to engage the spring on one side of it at a predetermined distance from the fixed end of the spring toward its projecting portion for stiffening the spring during the stroke of the lever in one direction, said lever on the opposite side of the spring being of such form to permit the spring to bend from a place on the lever nearer said fixed end than said predetermined distance during the stroke of the spring in the opposite direction, the force exertable by the spring during said latter stroke being of just sufficient strength to overcome a predetermined resistance of the diaphragm against being moved during said latter stroke.

11. A pivoted lever for use with rocking means for operating the reciprocable pumping element of a fuel pump comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means, a finger on the lever on the opposite side of said axis, said finger pointing away from said axis, and a spring mounted on the lever having its end nearer the pivotal axis fixedly held on the lever, said spring having a portion at its other end project beyond the finger, pointing away from said axis in the same direction as does the finger, the spring at said latter portion being adapted for operative connection to the pumping element for reciprocating said element when the lever is rocked, said finger being so located on the lever with respect to the spring, that when the spring is connected to said element, the finger comes between the spring and the element, said finger being suitably formed and located with respect to the spring to engage the spring on the side of the spring toward the pumping element at a predetermined distance from the fixed end of the spring toward its projecting portion for stiffening the spring during its stroke away from the pumping element when the lever is rocked, said lever on the side of the spring away from the pumping element being of such form to permit this spring to bend from a place on the lever nearer said fixed end than said predetermined distance during the stroke of the spring toward said element, the force exertable by the spring during said latter stroke being of just sufficient strength to overcome a predetermined resistance of the element against being moved during said latter stroke.

12. A pivoted lever for use with rocking means for operating the reciprocable pumping element of a vacuum pump comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means, a finger on the lever on the opposite side of said axis, said finger pointing away from said axis, and a spring mounted on the lever having its end nearer the pivotal axis fixedly held on the lever, said spring having a portion at its other end project beyond the finger, pointing away from said axis in the same direction as does the finger, the spring at said latter portion being adapted for operative connection to the pumping element for reciprocating said element when the lever is rocked, said finger being so located on the lever with respect to the spring, that when the spring is connected to said element, said spring comes between the finger and the element, the finger being suitably formed and located with respect to the spring to engage the spring on the side of the spring away from the element at a predetermined distance from the fixed end of the spring toward its projecting portion for stiffening the spring during its stroke toward the element when the lever is rocked, said lever on the side of the spring toward the pumping element being of such form to permit the spring to bend from a place on the lever nearer said fixed end than said predetermined distance during the stroke of the spring away from said element, the force exertable by the spring during said latter stroke being of just sufficient strength to overcome a predetermined resistance of the element against being moved during said latter stroke.

13. A pivoted lever for use with rocking means for operating a combination fuel diaphragm and vacuum diaphragm pump, the fuel diaphragm being oppositely disposed to the vacuum diaphragm, said lever comprising a portion to one side of its pivotal axis adapted to be engaged by rocking means, a pair of fingers on the lever on the opposite side of said axis from said portion, said fingers pointing away from the axis, and a pair of springs mounted on the lever, each spring adjacent a finger, each spring having its end nearer the pivotal axis fixedly held on the lever, each spring having a portion at its other end project beyond its adjacent finger in a direction away from said axis, the projecting portions of the springs being adapted to be connected to the diaphragms with the projecting portion of the first spring connected to the fuel diaphragm and the projecting portion of the second spring connected to the vacuum diaphragm, the first of said fingers coming between the first of said springs and the fuel diaphragm, the first spring being set between the fingers, the second of said springs coming between the second of said fingers and the vacuum diaphragm, the first finger being suitably formed and located with respect to the first spring to engage it on the side of it toward the fuel diaphragm at a predetermined distance from the fixed end of the first spring toward its projecting portion for stiffening the first spring during the stroke of the first spring away from

the fuel diaphragm, the second finger being of such form to permit the first spring to bend from a place on said second finger nearer the fixed end of the first spring than said predetermined distance during the stroke of the first spring in the opposite direction, the force exertable by the first spring during said latter stroke being of just sufficient strength to overcome a predetermined resistance of the diaphragm against being moved during said latter stroke, the second finger being suitably formed and located with respect to the second spring to engage it on the side of it away from the vacuum diaphragm at a predetermined distance from the fixed end of the second spring toward its projecting portion for stiffening the second spring during the stroke of the second spring toward the vacuum diaphragm, the form of the lever between the second spring and the vacuum diaphragm being such to permit the second spring to bend from a place on the lever nearer the fixed end of the second spring than said predetermined distance of the second spring during the stroke of the second spring away from the vacuum diaphragm, the force exertable by the second spring during said stroke away from the vacuum diaphragm being of just sufficient strength to overcome a predetermined resistance of the diaphragm against being moved.

14. A pivoted lever as claimed in claim 13 in which a third finger is provided on the lever in the portion of the latter between the second spring and the vacuum diaphragm, the second spring having its fixed end set between the second and third fingers, the form of the third finger being such to permit the second spring to bend from a place on the third finger nearer the fixed end of the second spring than said predetermined distance of the second spring during the stroke of the second spring away from the vacuum diaphragm.

15. A pivoted lever for use with rocking means for operating a pair of oppositely disposed pumping elements of a combined fuel and vacuum pump comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means, and a second portion extending on the other side of said axis from said first portion adapted for operative connection to the pumping elements for reciprocating them when the lever is rocked, said second portion of the lever comprising a pair of resilient parts each of which is

connected to one of the pumping elements and which increases in rigidity during the stroke of the lever in one direction and decreases in strength, each exerting a bending strength, during the stroke of the lever in the opposite direction, of just sufficient amount to overcome a predetermined resistance to motion of the pumping element to which it is connected, the lever and resilient parts bearing such operative relation to the pumping elements that said elements are substantially equally operative when one of the pumping elements is above the resilient parts and the other of the pumping elements is below as when said elements are inverted relatively to said parts.

16. A pivoted lever for use with rocking means for operating the reciprocable pumping element of a fuel pump comprising a portion to one side of its pivotal axis adapted to be engaged by said rocking means and a second portion extending on the opposite side of the axis from said first portion having a push and pull connection to the pumping element for reciprocating the latter when the lever is rocked, said second portion of the lever comprising a resilient part which increases in rigidity during the stroke of said part away from the pumping element, said part exerting a pull on the element during said stroke, and decreases in rigidity exerting a push on said element equal to its lessened bending strength during the stroke of said part toward the pumping element, of just sufficient amount to overcome a predetermined resistance of the pumping element.

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