April 18, 1961 K. C. SCHNEIDER 2,980,032

FUEL PUMP

Filed Feb. 27, 1959

FIG. 1

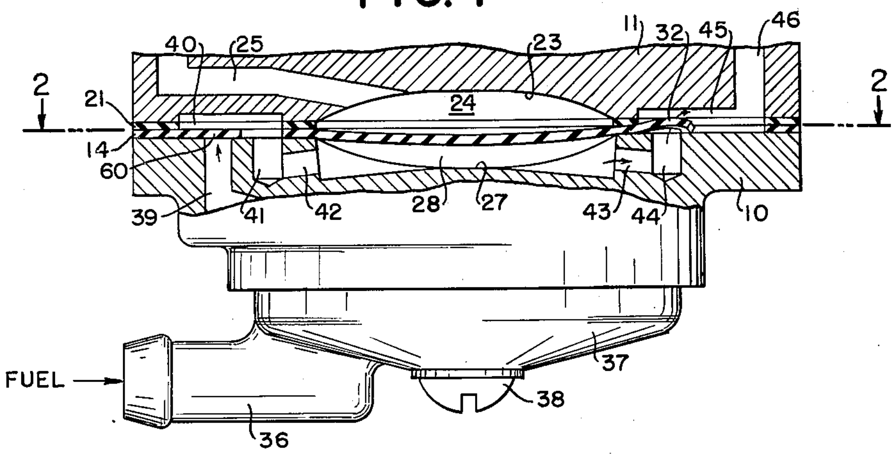


FIG. 3

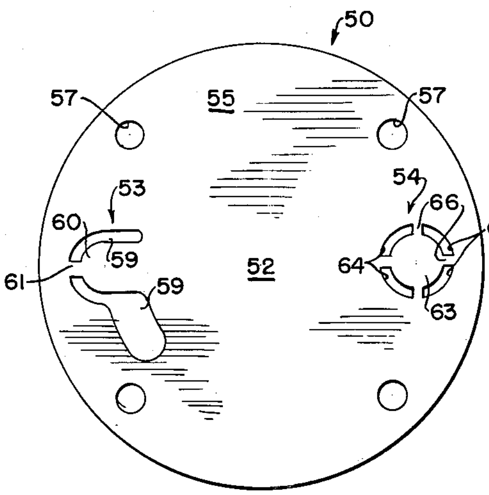
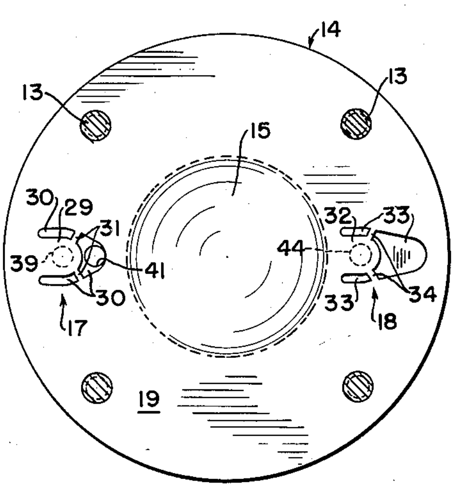


FIG. 2



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FUEL PUMP

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6 Claims. (Cl. 103—150)

This invention relates to diaphragm-type fuel pumps in which unidirectional flow of fuel is maintained by check valve means integral with the pump diaphragm. The invention provides a diaphragm for use in such a pump, wherein the check valve means includes flaps which are restrained in such a manner that they are permitted only limited displacement out of the plane of the diaphragm.

In some diaphragm-type fuel pumps, unidirectional flow of fuel is maintained by flap type check valves integral with the diaphragm and operatively associated with the fuel inlet and outlet passages. Such check valve flaps are generally separate from the pumping portion of the diaphragm and are each enclosed in valve chambers formed in the body of the pump. When the pressure in the valve chamber is greater than the pressure in the fuel passage, the flap is urged tightly against its seat around the opening thereby preventing back-flow of fuel from the chamber into the passage. Conversely, when the pressure within the passage exceeds that within the chamber, the flap is unseated and displaced out of the plane of the diaphragm into the chamber thereby permitting the fuel in the passage to flow into the chamber.

Flap valves of this type are usually formed of very thin sheet material which is highly flexible so that the flaps respond readily to small pressure differentials, and they are uniformly flat so that they can effect a continuous seal around the opening of the fuel passage. It has been found, however, that in diaphragms which have been in operation for long periods of time, the flaps often lose their original flatness and no longer seat readily to seal the fuel passages. Needless to say, this greatly reduces the efficiency of the pump since at each stroke a certain amount of fuel leaks under the distorted portions of the flap and correspondingly less fuel is delivered from the outlet of the pump.

There are many reasons why conventional flap elements lose their flat shape in this manner. The fact that they must be formed of such thin and flexible sheet material gives rise to some of the difficulty because if they are overstressed during the repeated bending of the flap into and out of the plane of the diaphragm a permanent warped shape is imparted to the thin sheet material. It also appears that the flap elements are sometimes distorted by being unevenly stressed when the pump is assembled, due to excessive tightening together of the pump body members holding the diaphragm in place. Also, the flaps are generally formed from synthetic elastomers which, if unevenely or excessively heated, are unable to resist curling during use.

One of the primary purposes of this invention, therefore, is to provide a fuel pump of the type described having flap elements integral with the pump diaphragm which remain uniformly flat even after long use. This is accomplished without departing from the use of thin flexible sheet materials from which conventional pump diaphragms are presently formed, and also without radically altering the design of ordinary pump body members.

Moreover, these advantages are achieved without adversely affecting the efficiency or fuel-delivery capacity of the pump.

The invention provides a unitary flexible substantially flat sheet diaphragm for use in a diaphragm-type pump comprising a displaceable pumping portion adapted to partly define a pumping chamber, and at least one check valve portion adapted to control flow of fluid through the pump. The check valve portion comprises a flat valve flap having a base joined integrally with the diaphragm and a free end essentially separated by cut-out sections from the main body of the diaphragm. The free end of the valve flap is displaceable out of the plane of a cut-out section of the diaphragm; but at least one flexible web finger bridges the cut-out section and joins the free end of the valve flap to the diaphragm. By this construction, displacement of the flap element out of the plane of the cut-out section is limited without being prevented, and the flap is restrained from permanently bending, curling, or otherwise becoming distorted out of its original uniformly flat shape.

Preferred embodiments of the invention are described hereinbelow with reference to the accompanying drawing, wherein—

Fig. 1 is an elevation partly in section of a pump according to the invention;

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

Fig. 3 is a plan view of a modified form of a pump diaphragm according to the invention.

Referring first to Figs. 1 and 2, the pump includes a pair of body members **10** and **11** which are fastened together in substantially face-to-face relationship by means of a plurality of screws **13** disposed about their corresponding peripheries. As seen in Fig. 1, the upper portion of the body member **11** is broken away to indicate that the pump may be incorporated in a larger assembly such as a carburetor. In this embodiment, the pump is of the type actuated by a source of fluctuating fluid pressure, though it can also be mechanically actuated by a cam shaft or similar means.

Separating the facing surfaces of the body members **10** and **11** is a flat uniformly thin flexible diaphragm **14** of circular shape. The diaphragm **14** includes a central pumping portion **15**, separate inlet and outlet check valve portions **17** and **18** respectively, and a peripheral gasket portion indicated generally at **19** which makes up the remainder of its area. The gasket portion **19** of the diaphragm is that area which in the assembled pump underlies a gasket **21** positioned against the upper body member **11**. It will be noted that the screws **13** extend through corresponding holes in both the gasket portion **19** of the diaphragm and the gasket **21**. By this arrangement, the gasket portion **19** of the diaphragm, in conjunction with the gasket **21**, provides a fluid tight seal which isolates each of the inlet and outlet check valve portions **17** and **18** and the pumping portion **15** from one another when the pump is assembled.

An actuating cavity **23** is formed in the upper body member **11**. This cavity together with the upper side of the pumping portion **15** of the diaphragm defines an actuating chamber **24**. The actuating chamber **24** communicates with a source of fluctuating fluid pressure (such as the crank-case of a two-cycle engine) through an air passage **25**.

A pumping cavity **27** is formed in the other pump body member **10**. This latter cavity, together with the lower side of the pumping portion **15** of the diaphragm, defines a pumping chamber **28**. As seen most clearly in Fig. 2, the check valve portion **17** includes a valve flap **29** integrally joined at its base to the adjacent gasket portion **19** of the diaphragm. Its free end is separated by cut-out sections **30** from the main body of the diaphragm. This free outer end of the flap **29**, however, is integrally connected to the remainder of the main body of the diaphragm sheet by a pair of web fingers **31** which bridge the cut-out sections **30**. The valve flaps **29** and the web fingers **31** are of the same uniform thickness as the surrounding portions of the diaphragm, so they can be formed by stamping or punching out the cut-out sections **30**.

Similarly, the outlet check valve portion **18** includes a valve flap **32** integrally joined at its base to the diaphragm, with its free end separated from the surrounding portion of the diaphragm by cut-out sections **33**. A pair of integral webs **34** connect the free end of the valve flap **32** to the main body of the diaphragm across the cut-out sections **33**.

The element of the fuel system of this novel pump can best be described in the order in which they are encountered by fuel passing through the pump. Fuel is drawn into the pump through an inlet nozzle **36** into a suitable filter **37** which is held in place by a screw **38**. The fuel then passes into an inlet passage **39** formed in the body member **10**, proceeds through the inlet check valve portion **17** of the diaphragm **19** (as is described in detail below), and enters an inlet valve chamber **40** defined substantially by the body member **11**. It is then directed from the valve chamber **40** through the cut-out section **30** of the diaphragm **14** into intersecting bores **41** and **42** in the body member **10** and then into the pumping chamber **28**. From the pumping chamber **28**, the fuel exits under pressure into the intersecting bores **43** and **44** and through the outlet check valve portion **18** of the diaphragm (as is also described in detail below). It then enters an outlet valve chamber **45** from which it proceeds under pressure to the outlet fuel passage **46**.

The operation of this novel pump is as follows: The cyclically fluctuating air pressure in the actuating chamber **24** causes the pumping portion **15** of the diaphragm **14** to flex alternately in and out of the pumping chamber **28**. At each stroke of the pumping portion **15** out of the pumping chamber **28**, the internal pressure in the pumping chamber **28** is decreased. This reduction in pressure is transmitted to the inlet valve chamber **40** and when the pressure therein drops below the pressure in the inlet fuel passage **39**, the flap element **29** is lifted and fuel is sucked through into the pumping chamber. The webs **31**, however, restrain the free end of the flap element **29** and prevent it from being displaced very far out of the plane of the surrounding portions of the diaphragm **14**. At the same time, the webs **31** permit the flap **29** to be raised a sufficient distance off its seat to allow the fuel to pass easily from the fuel inlet passages **39** into the pumping chamber **40**.

As this takes place at the inlet check valve portion **17**, the reduction in pressure in the pumping chamber **28** is also transmitted to the bore **44** adjacent the outlet check valve portion **18** of the diaphragm. This causes the pressure in the outlet valve chamber **45** to exceed that in the bore **44** and, as a result, the flap element **32** is forced tightly against its seat to seal off the opening. This prevents back-flow of fuel from the outlet passage **46** into the pumping chamber **28** at each intake stroke of the pumping portion **15** of the diaphragm.

Upon the completion of the intake stroke, the pumping portion **15** of the diaphragm moves downwardly into the pumping chamber **28** thereby increasing the pressure of the fuel therein. The effect of this at the inlet check valve portion **17** is to force the flap element **29** against its seat to seal off the inlet passage. This prevents back-flow of fuel from the pumping chamber **28** into the inlet passage **39** during the pumping stroke of the diaphragm. At the outlet check valve portion **18** there is a simultaneous increase in pressure in the bore **44** which causes it to exceed the pressure within the outlet valve chamber **45**. This causes the flap element **32** to be lifted from its seat (as shown in Fig. 1) and permits some of the fuel in the pumping chamber **28** to be forced out under pressure into the outlet passage **46**. As the flap element **32** is lifted in this manner, however, the webs **34** prevent it from being displaced very far out of the plane of the surrounding diaphragm, yet do not substantially hinder the flow of fuel into the valve chamber **45**.

Because of the restraining action of the webs **31** and **34**, the flap elements **29** and **32** respectively are not excessively displaced. As a result they do not become so stressed as to warp even after prolonged use. Also, if thermal stresses due to overheating tend to cause curling of the diaphragm material, the webs minimize the deformation of the valve flaps and insure that they sufficiently retain their original flat shape to continue to seat effectively. The webs **31** and **34** likewise compensate for uneven stress which might be imparted to the flap elements **29** and **32** by excessive tightening together of the body members **10** and **11** during assembly of the pump.

Turning now to Fig. 3, a modified form of the pump diaphragm **50** is shown. The diaphragm **50** includes a central pumping portion **52**, inlet and outlet check valve portions **53** and **54** respectively, and a peripheral gasket portion **55** which makes up the remainder of the diaphragm's area. Since the diaphragm **50** is to be assembled with a pair of pump body members in the manner described previously, a plurality of apertures **57** are located in its gasket portion **55** to accommodate the screws for holding the pump body members together.

The inlet check valve portion **53** includes a cut-out section **59** into which extends a flat valve flap **60**, which is joined integrally at its base to the main body of the diaphragm. Bridging the cut-out section **59** and integrally joining the outermost end of the valve flap **60** to the main body of the diaphragm is a single web finger **61**. This finger limits the displacement of the flap **60** out of the plane of the diaphragm sheet and aids in preventing it from being distorted out of its original flat shape. The cut-out section **59** shown in Fig. 3 extends to one side of the flap element **60**. Hence, this check valve portion is adapted for use in a valve chamber wherein the inlet passage is not in radial alignment with the bores leading from the valve chamber to the pumping chamber.

The outlet check valve portion **54** is of still different construction. It includes a circular valve flap **63** disposed in a concentric cut-out section **64**. The valve flap **63** is integrally joined to the main body of the diaphragm by a plurality of web fingers **66** which bridge the cut-out section **64**. Any one of these web fingers can be regarded as defining the base of the circular valve flap, and the others as joined to the free end of the valve flap. This type of valve flap is particularly adapted for use in the outlet valve chamber of a pump wherein the fuel enters through the cut-out section and exits from the chamber without passing back through the diaphragm. An example of such arrangement is shown in Figs. 1 and 2 where the pressurized fuel enters from the bore **44** into the outlet valve chamber **45** and then exits therefrom through the outlet passage **46** without passing back through the diaphragm. One of the primary advantages of this outlet check valve portion **54** is that the flap element **63** is lifted substantially evenly from its seat when fuel passes therethrough, thereby tending to insure that the valve flap element seats flat when it returns to sealing engagement with its associated fuel passage.

I claim:

1. For use in a diaphragm-type pump, a unitary flexible substantially flat sheet diaphragm comprising a displaceable pumping portion adapted to partly define a pumping chamber, at least one check valve portion adapted to control flow of fluid through said pump, said check valve portion comprising a flat valve flap having a base integral with said diaphragm and an end portion essentially separated by cut-out sections from the main body of said diaphragm, the end portion of said valve flap being dis-

placeable out of the plane of said diaphragm, and at least one flexible web finger bridging said cut-out sections and joining the end portion of said valve flap to said diaphragm, said web finger limiting without preventing displacement of said end portion of the valve flap out of the plane of the diaphragm.

2. A diaphragm-type fuel pump comprising two body members joined together in substantially face-to-face relationship, a flexible diaphragm separating the substantially cojoined faces of said body members, said diaphragm including a pumping portion which partly defines a pumping chamber in one of said body members, both of said body members having fuel inlet and outlet passages formed therein communicating with said pumping chamber, said diaphragm also including check valve portions located in said fuel passages for controlling flow of fluid through said pump, at least one of said check valve portions comprising a flat valve flap having a base integral with said diaphragm and an end portion essentially separated by cut-out sections from the main body of said diaphragm, the end portion of said valve flap normally being in sealing relation with the fuel passage with which it is associated and being displaceable out of the plane of said diaphragm to permit flow of fuel through its associated fuel passage, and at least one flexible web finger bridging said cut-out sections and joining the end portion of said valve flap to said diaphragm, said web finger limiting without preventing displacement of said end portion of the valve flap out of the plane of the diaphragm.

3. For use in a diaphragm-type fuel pump, a diaphragm of substantially flat flexible material comprising a displaceable pumping portion adapted to partly define a pumping chamber, and two separate check valve portions adapted to maintain unidirectional flow of fuel through said pump, each of said check valve portions comprising a valve flap having a base joined integrally to said diaphragm and an end portion essentially separated by cut-out sections from the main body of the diaphragm, the end portion of said valve flap being displaceable out of the plane of said diaphragm, and restraining means comprising at least one web finger integrally joined both to the end portion of said valve flap and to the main body of the diaphragm bridging said cut-out sections and limiting without preventing displacement of said end portion of the valve flap out of the plane of the diaphragm.

4. For use in a diaphragm-type fuel pump, a diaphragm according to claim 3 wherein the restraining means in at least one of said check valve portions comprises two integral separate web fingers bridging the cut-out sections from opposite sides of the end portion of the valve flap to the main body of the diaphragm.

5. For use in a diaphragm-type fuel pump a diaphragm according to claim 3 wherein the restraining means in at least one of said check valve portions comprises a single integral web finger bridging the cut-out sections from the outermost end of the valve flap to the main body of the diaphragm.

6. A diaphragm-type fuel pump comprising two body members joined together in substantially face-to-face relationship, a substantially flat flexible diaphragm separating the substantially cojoined faces of said body members, said diaphragm including a pumping portion which partly defines an actuating chamber in one of said body members and a pumping chamber in the other of said body members, said actuating chamber being adapted to communicate with a source of fluctuating fluid pressure, both of said body members having fuel inlet and outlet passages formed therein communicating with said pumping chamber, said diaphragm also including two separate check valve portions located in the respective fuel passages for maintaining unidirectional flow of fuel through said pump, each of said check valve portions comprising a flat valve flap having a base integral with said diaphragm and an end portion essentially separated by cut-out sections from the main body of said diaphragm, the end portion of said valve flap normally being in sealing relation with the fuel passage with which it is associated and being displaceable out of the plane of said diaphragm to permit flow of fuel through its associated fuel passage, and at least one flexible web finger bridging said cut-out sections and joining the end portion of said valve flap to said diaphragm, said web finger limiting without preventing displacement of said end portion of the valve flap out of the plane of the diaphragm.

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