July 24, 1962 W. D. NUTTEN ETAL 3,045,605

FUEL FEEDING MEANS

Filed Sept. 15, 1958 2 Sheets-Sheet 1

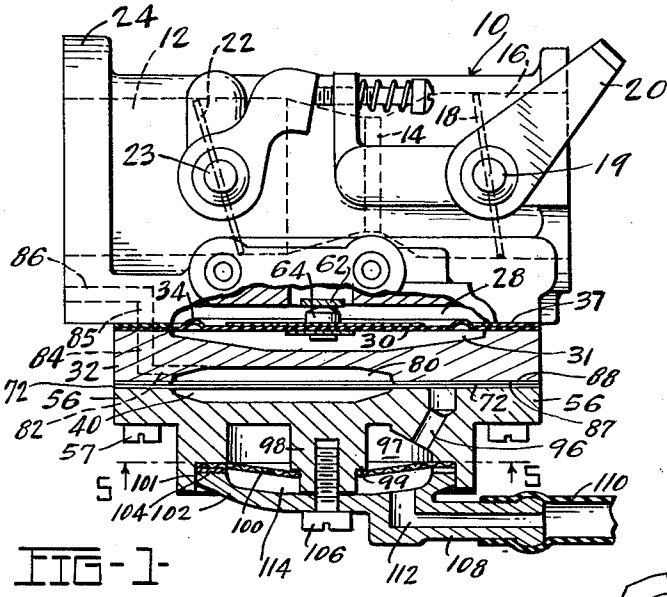


FIG-1-

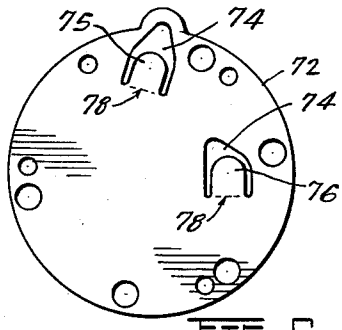


FIG-6-

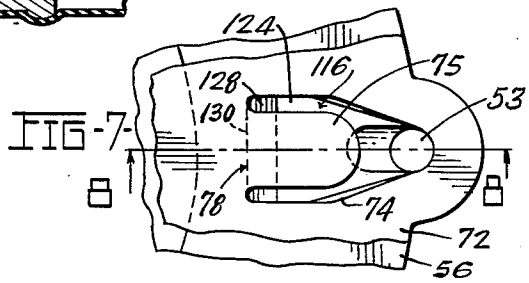


FIG-7-

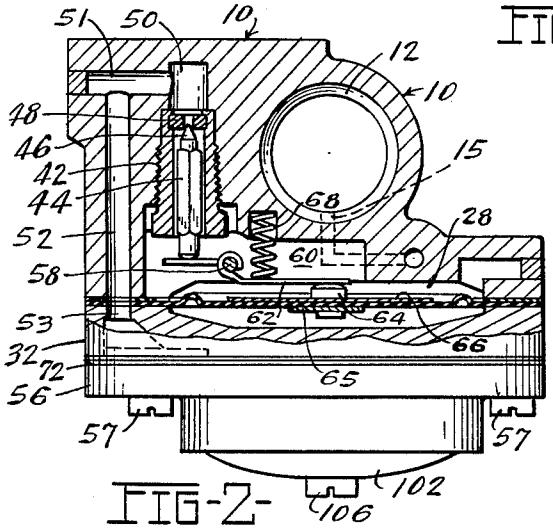


FIG-2-

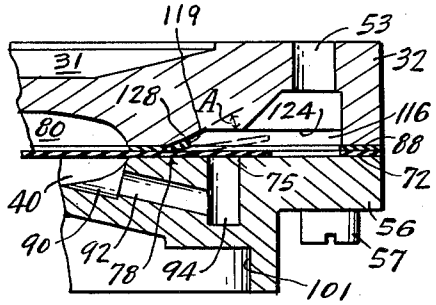


FIG-8-

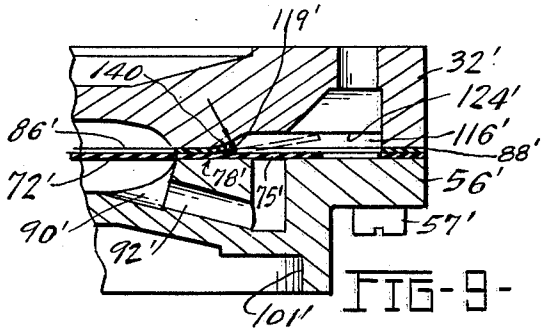


FIG-9-

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FUEL FEEDING MEANS

Filed Sept. 15, 1958 2 Sheets-Sheet 2

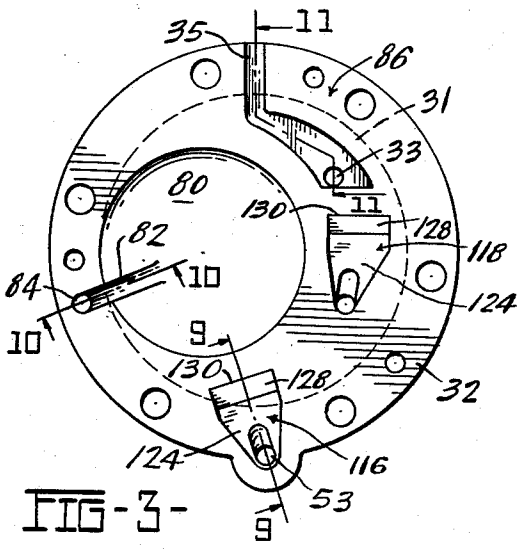


FIG-3-

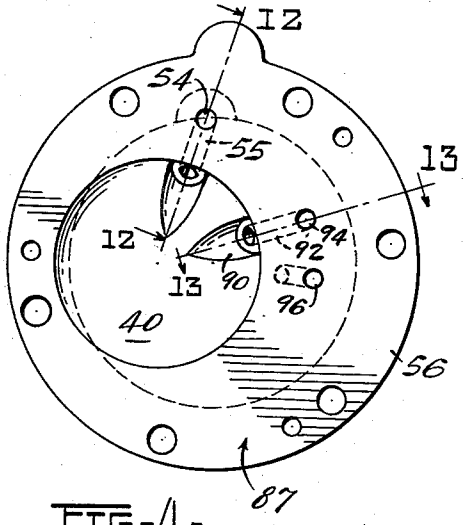


FIG-4-

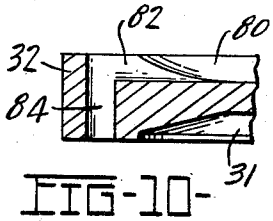


FIG-10-

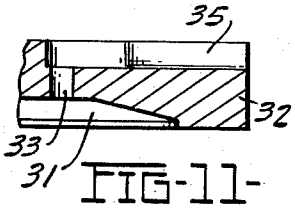


FIG-11-

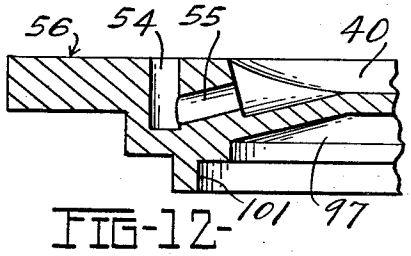


FIG-12-

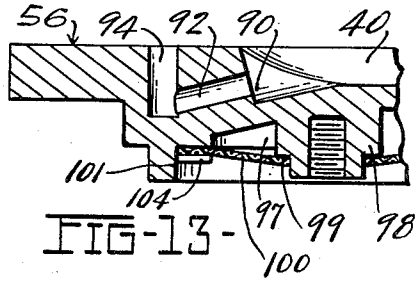


FIG-13-

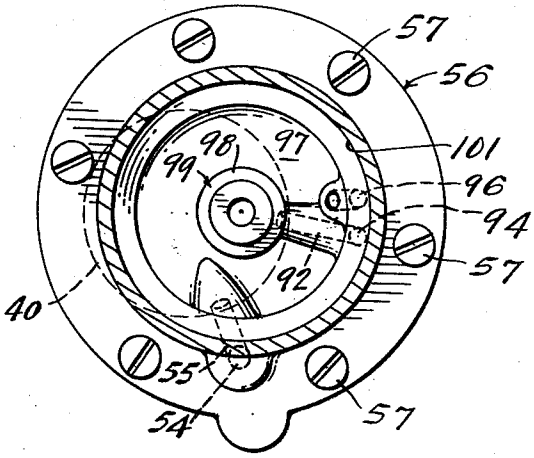


FIG-5-

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United States Patent Office 3,045,605 Patented July 24, 1962

3,045,605

FUEL FEEDING MEANS

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Filed Sept. 15, 1958, Ser. No. 760,939
9 Claims. (Cl. 103—150)

This invention relates to apparatus for delivering fuel to a charge forming device which is adapted to supply a combustible mixture of fuel and air to an internal combustion engine, the invention more especially relating to a diaphragm type pumping means.

Internal combustion engines of two-cycle type have come into extensive use in powering small boats, particularly of the outboard type, lawn mowers, chain saws, portable impacting devices, portable drill equipment and for industrial uses. A fuel feeding means or pump of the diaphragm type actuated by varying fluid pressure may be utilized either as an independent pump unit or as a component associated with a charge forming device for supplying fuel to the charge forming device or carburetor, the latter being utilized to deliver a combustible mixture of fuel and air to the engine.

Pumps or fuel feeding means for such purposes employ a flexible diaphragm pumping element arranged to form a wall of a pumping chamber and a wall of a fuel feeding chamber provided respectively at opposite sides of the diaphragm with the pumping chamber in communication with a source of varying fluid pressure as a motivating force for actuating the diaphragm.

When pumps of this character are utilized with a charge forming device associated with a two-cycle engine, the pumping chamber of the fuel feeding means is connected with the crankcase of the engine and the varying pressure in the crankcase utilized to actuate or vibrate the flexible diaphragm to obtain a pumping action. The pumping means may be actuated from any other source of variable pressure. A type of diaphragm pump of this character is illustrated in United States Patent No. 2,796,838 granted to Bernard C. Phillips on June 25, 1957.

The arrangement shown in this patent embodies a flexible diaphragm having valves cooperable with the inlet and outlet ports of the pump formed as integral tongues or flaps on the diaphragm. In valve closing position, the flaps or tongues forming the valves are arranged to lie against a flat or planar surface, a member adjacent the flap and opposite the valve ports being provided with recesses to accommodate opening movement of the valves. A gasket may or may not be used between the diaphragm and the adjacent member of the pump containing the recesses accommodating opening movements of the valves.

In the assembly of the components of the pump, the members at opposite sides of the pumping diaphragm are drawn into tight engagement with the diaphragm and the gasket, if one is employed, to provide a fluid tight construction. In such arrangement the valve tongues or flaps, when in closed position, are intended to lie coincident with a flat or planar portion of the adjacent member, but in many instances it has been found that the flap does not seat properly but is stressed or distorted away from the seat at a minute angle so that the port is not closed when the valve is intended to be in port-closing position.

It has been found that the pressure exerted upon the diaphragm or upon the gasket and diaphragm by the securing screws which hold these components in assembled relation causes a flexure or distortion of the valve flap or tongue preventing the valve from attaining a fully closed position, and in operation the valves do not

function properly, resulting in a partial or complete failure of the pumping means to feed fuel to a charge forming device.

In the utilization of the variable pressure in the crankcase of a two-cycle engine as a medium for actuating the pumping diaphragm, the speed of the engine may be 6000 r.p.m. or more resulting in movements of the diaphragm and valves of a corresponding number of pumping cycles and valve movements in the pumping means. The flap valves or tongues must seat properly at each pumping movement of the diaphragm or leakage results, a condition which is aggravated if the valves are stressed or biased away from seating positions.

The present invention embraces a pumping means of the diaphragm type embodying a configuration adjacent a flap valve of the pumping diaphragm whereby the assembly of the diaphragm and adjacent components of the pumping means do not affect the normal or valve closing position of a flap type valve whereby proper valve closing operation of the valve means is attained under all conditions of operation.

An object of the invention is the provision of a relief area or surface of the member adjacent the zone of hinge movement or flexure of a flap valve in a diaphragm pump of this character which eliminates any tendency of the valve to be flexed or distorted from its normal or closed position when the components of the pump are held in assembled relation.

Another object of the invention is the provision of a diaphragm pump having flap valves formed integrally with the diaphragm wherein a progressive or gradually receding relief or ramp surface is provided adjacent the hinge region of the flap valve functioning to avoid transmission of compressive stresses on the diaphragm to the flap valve portions thereof.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

FIGURE 1 is a side elevational view of a charge forming device or carburetor in combination with a diaphragm pumping means embodying the invention, the pumping means being shown in section;

FIGURE 2 is a transverse sectional view of the charge forming apparatus illustrated in FIGURE 1, the pumping means being shown in elevation;

FIGURE 3 is a plan view of one of the components of the pump provided with the cavity forming the pumping chamber and the recesses accommodating the opening movements of flap valves;

FIGURE 4 is a plan view of the component disposed at the opposite side of the diaphragm and provided with a cavity adapted to receive the liquid fuel;

FIGURE 5 is a sectional view taken substantially on the line 5—5 of FIGURE 1;

FIGURE 6 is a plan view of the pumping element or diaphragm;

FIGURE 7 is an enlarged fragmentary detail plan view of one of the pump components and a valve region of the diaphragm superposed thereon;

FIGURE 8 is a sectional view taken substantially on the line 8—8 of FIGURE 7 illustrating one form of valve relief surface;

FIGURE 9 is a view similar to FIGURE 8 showing a modified form of valve relief surface;

FIGURE 10 is a fragmentary sectional view taken substantially on the line 10—10 of FIGURE 3;

FIGURE 11 is a fragmentary detail view taken substantially on the line 11—11 of FIGURE 3;

FIGURE 12 is an enlarged detail sectional view taken substantially on the line 12—12 of FIGURE 4, and

FIGURE 13 is an enlarged detail sectional view taken substantially on the line 13—13 of FIGURE 4.

While the fuel feeding or pumping apparatus of the present invention is illustrated as particularly adapted for pumping liquid fuel to a charge forming device of an internal combustion engine of the so-called two-cycle type, it is to be understood that the pumping means of the invention may be used for pumping fuel to other types of charge forming apparatus or for any purpose wherein a diaphragm type pump may be employed.

It is to be understood that while a preferred form of pumping means of the invention is illustrated as forming a component of a charge forming device or carburetor, the pumping arrangement may be an independent unit connected between the source of fuel supply and the fuel inlet of a charge forming device or apparatus and is especially suited for supplying liquid fuel to a charge forming device which is adaptable for use in any angular position or in an inverted position.

Referring to the drawings in detail and initially to FIGURES 1 and 2, there is illustrated a charge forming device or carburetor combined with a fuel feed feeding means or fuel pump of the diaphragm type embodying the invention. The charge forming device or carburetor illustrated is of the diaphragm controlled type and is constructed with a minimum fuel lift distance whereby the fuel may be readily delivered into a mixing passage to be therein mixed with air and the resulting combustible mixture delivered into the crankcase of a two-cycle internal combustion engine by reason of the aspirating effect of varying pressures in the engine crankcase.

The pumping chamber of the pumping means is connected by a channel system formed in the carburetor body with the crankcase of the engine whereby separate connecting means between the pumping chamber and crankcase is avoided. A separate means or tube between the pumping chamber and crankcase may be used where the pumping means is independent of or spaced remotely from the charge forming apparatus.

The charge forming device or carburetor illustrated is inclusive of a body **10** formed with a mixing passage **12** which includes a venturi **14** into which fuel is delivered from an outlet or nozzle for admixing with air admitted through an air inlet **16** of the mixing passage. A disc-type valve **18** is mounted upon an operating shaft **19** and is disposed in the air inlet end **16** and functioning as a choke valve for controlling the admission of air into the mixing passage, the valve being manipulated by an arm **20** secured upon a portion of the shaft **19** extending exteriorly of the body **10**.

A disc-type valve **22** mounted upon a shaft **23** forms a throttle valve for regulating or controlling the flow of fuel and air mixture into the crankcase of a two-cycle engine (not shown). The body **10** is provided with a flange **24** adapted to be secured to the engine crankcase or other component to which the combustible mixture is to be delivered. The flange **24** may be secured to the crankcase by suitable bolts (not shown). The carburetor body **10** is formed with a fuel chamber or reservoir **28**, one wall of which is formed by a flexible diaphragm **30**, a gasket **37** being disposed between the carburetor body **10** and the diaphragm.

The diaphragm **30** may be fashioned of relatively thin, highly flexible material such as nylon cloth rendered impervious by impregnation with a resinous material which is resistant to the deleterious effects of hydrocarbon fuels. The diaphragm is preferably fashioned with one or more annular convolutions **34** to facilitate flexure or movement of the diaphragm. The fuel chamber **28** is unvented to the atmosphere so that the diaphragm **30** is responsive to the aspiration or reduced pressure in the mixing passage controlling fuel flow from the pumping means to the reservoir or chamber **28**.

The means associated with the diaphragm **30** for controlling fuel flow from the fluid receiving chamber **40** of the pumping means into the reservoir or chamber **28** in the carburetor is particularly illustrated in FIGURE 2. The body of the carburetor is provided with a threaded bore adapted to accommodate a fitting or valve guiding means **42** in which a valve member **44** is slidably disposed. The upper extremity **46** of the valve member **44** is tapered or cone-shaped and adapted to project into an opening or port formed in a valve seat **48**, the latter being fashioned of neoprene (chloroprene rubber) or other suitable material.

The port in the valve seat **48** is in communication by means of ducts **50**, **51** and **52**, formed in the carburetor body **10**, duct **53** formed in the pump component **32** and ducts **54** and **55** formed in the pump component **56**, with the fuel receiving chamber **40** of the pumping means.

The position of the fuel inlet valve member **44** is controlled by the relative position of the diaphragm **30** under the influence of the aspiration or reduced pressure in the mixing passage **12**. Pivotally supported upon a pin **58** in a recess **60** formed in the carburetor body is a lever **62**, one arm of the lever being in engagement with the lower end of the valve member **44**, the other arm of the lever being in contact with a headed member **64** which extends through the diaphragm and has a portion swaged into engagement with a reinforcing disc **65**.

A metal disc **66** is coincident with the upper surface of the diaphragm and forms an added reinforcement. An expansive coil spring **68** in engagement with the lever **62** normally exerts a slight pressure biasing the valve member **44** to seat the valve portion **46** in the seat member **48**. When no mixture is being delivered from the mixing passage, atmospheric pressure exists in the reservoir or fuel chamber **28** and the pressure of the spring **68** maintains the valve portion **46** in closed position so that no fuel is admitted into the chamber **28**.

However, when the engine with which the charge forming device is utilized is in operation, the aspiration or subatmospheric pressure in the mixing passage is effective through a fuel discharge orifice or outlet **15** between the chamber **28** and the mixing passage to influence the diaphragm **30** to be flexed upwardly against the pressure of the spring **68** swinging the lever **62** in a counterclockwise direction, as viewed in FIGURE 2, and lowering the valve **46** away from its seat so that fuel may flow from the chamber **40** in the pumping means into the carburetor chamber **28** thence into the mixing passage.

The rate of delivery of fuel past the fuel inlet valve **46** is thus determined by the amplitude of reduced pressure in the chamber **28** affecting the position of the diaphragm **30**. The space **31** formed as a circular recess in the upper portion of the pump member **32**, to provide for flexing movements of the diaphragm, is vented to the atmosphere by a duct **33** and a radial channel **35** shown in FIGURE 11.

The pumping means of the invention is inclusive of two generally disc-like members **32** and **56** with a pumping diaphragm **72** disposed between these members, as shown in FIGURES 1, 2 and 8, which are secured in assembled relation and to the carburetor body by screws **57** which are spaced circumferentially as shown in FIGURE 5. The diaphragm **72** and the members or components **32** and **56** of the pumping means are of generally circular configuration, as shown in FIGURES 4, 5 and 7. The diaphragm **72** of the pumping means is illustrated in FIGURE 6.

The diaphragm is formed with cutaway portions **74** of such configuration as to form flap valves or tongues **75** and **76** which are integral with the diaphragm material and are adapted for hinging or pivotal movement about the regions indicated at **78**. The member **32** is fashioned with a concave portion or cavity **80** which with the diaphragm **72** forms a pumping chamber. Formed ra-

dially from the central region of the chamber or cavity **80** is a channel **82** which is in communication with a duct or channel **84**. As shown in FIGURE 1, the channel **84** registers with a channel **85** formed in the carburetor body **10**.

The flange **24** of the carburetor body is formed with a channel **87** which is in communication with channel **85** and is adapted to establish communication with the crankcase of an engine with which the carburetor and pump may be used so that the varying pressure or pressure pulsations in the crankcase are communicated to the pumping chamber **80** and vibrate or flex the diaphragm to establish a pumping action in the fuel receiving chamber **40**. The surface **86** of the disc-like member **32** is flat to accommodate a gasket **88** of circular shape and having cutaway portions adjacent the pumping chamber, the ports or passages and the flap valves **75** and **76** to accommodate opening movements of the flap valves.

The substantially circular component **56** of the pump, shown in FIGURE 5, is provided with a concave recess or cavity **40** which with the diaphragm **72** provides a fuel receiving chamber. Formed in a wall of the cavity or chamber **40** is a recess or channel **90** which is in communication with a duct **92** which in turn is in communication with a port **94**. Also arranged in the disc-like member **56** is a duct or passage **96** for establishing a channel through which fuel is admitted from a chamber **97** formed in member **56** to a region under the inlet valve **76**, past the inlet valve **76** and through the duct **94** and passages **92** and **90** into the chamber **40**.

As shown in FIGURES 1 and 13, the member **56** is formed with a central boss portion **98** provided with a shoulder **99** which forms a stop means for positioning a filter medium or screen **100** through which the fuel is filtered before it is admitted into the region or chamber **97** above the strainer **100**.

The component **56** is formed with a circular recess **101** arranged to receive the peripheral edge zone of the fuel filter or strainer **100**. A closure member **102** of circular shape is fitted into the recess **101** for securing the filter **100** in position, a gasket **104** being provided adjacent the strainer **100** to form a fluid tight seal.

A securing bolt **106** is threaded into a bore formed in the boss portion **98** for securing the closure member **102** in fixed relation with the member **56**. The closure member **102** is integrally formed with a tubular projection **108** which is adapted to accommodate a flexible tube **110** adapted to be connected with a fuel tank or other supply of liquid fuel. The passage or duct **112** in the projection **108** opens into a chamber **114** provided by the curved shape of the closure member **102** beneath the strainer or filter **100**.

The member **32** is formed with recesses **116** and **118** shown in FIGURE 3 which, in assembly with the diaphragm **72**, are disposed respectively above the outlet flap valve **75** and the inlet flap valve **76**, the arrangement of the recess **116** and flap valve **75** being shown in detail in FIGURES 7 and 8. As shown in FIGURE 8, the passage **92** connected with a port **94** formed in member **56** conveys fuel from the fuel receiving chamber **40** to the port region adjacent the flap valve **75**. Each of the recesses **116** and **118**, which accommodate opening movement of the flap valves are formed with bottom surfaces **124** which are of flat or planar shape as shown in FIGURE 8.

With particular reference to FIGURES 3 and 8, it will be seen that the bottom surface **124** of each of the recesses **116** and **118** is joined with the flat or planar surface **86** of member **32** by an inclined or angularly arranged ramp or surface **128** and that the juncture of each inclined surface with the flat or planar surface **86** of member **32**, indicated at **130** in FIGURE 3 is adjacent the hinge region **78** of each of the flap valves **75** and **76**.

The region **119** of the gasket **88** adjacent each flap valve overhangs or extends over a portion of the ramp surface as shown in FIGURE 8. When the components of the pump are in assembled relation as shown in FIGURES 1, 2 and 8 and the screws **57** are drawn up, the regions of the gasket **88** and diaphragm adjacent the planar surfaces **86** and **87** of the members **32** and **56** are under compression stresses. The relief ramps facilitate the gradual or progressive expansion of the overhanging regions of the gasket adjacent the hinge zones **78** of the flap valves, the expansion of one region **119** of the gasket adjacent the flap valve **75** being shown in FIGURE 7. Thus the inclined or ramp surfaces serve to progressively diminish or relieve the compressive pressure on the hinge regions of the flap valves.

By providing the angular or inclined relief surfaces **128**, the compressive stresses of assembly on the gasket and diaphragm do not affect the position of the flap valves **75** and **76**, so that such valves normally remain in closed position.

It has been found that the relief surfaces **128** are essential to assure that the flap valves normally remain in closed position when the pump is not in operation and to assure proper closing of the valves during pumping operations to attain satisfactory operation of the pump.

It has also been found that an inclination of the surfaces **128** to the planar surface **86** of about fifteen degrees as indicated at A provides a satisfactory relief ramp. An open position of the valve **75** is indicated in broken lines in FIGURE 8.

The arrangement of flap valve **76** and recess **118** is substantially the same as that of valve **75** and recess **116** shown in FIGURE 8.

The operation of the pump construction of the invention for feeding fuel to the charge forming device shown in FIGURES 1 and 2 or to any other instrumentality is as follows: The pumping chamber **80** is in communication with a source of varying fluid pressure for causing flexure or reciprocation of the region of the diaphragm **72** registering with the cavities or chambers **40** and **80** to establish a pumping action. In the embodiment illustrated, the channels or passages **82**, **84** and **87** establish communication of the pumping chamber **80** through the carburetor flange **24** with an opening in the crankcase wall of a two-cycle engine whereby the varying pressure in the engine crankcase is utilized as the pumping force. It is to be understood that the chamber **80** may, however, be connected with any source of fluid pressure.

Assuming that the fuel is delivered through the orifice **15** from the fuel chamber **28** in the carburetor into the mixing passage **12**, the fuel control diaphragm **30** is elevated due to the aspiration or reduced pressure in the mixing passage effective in the fuel chamber **28** of the carburetor to swing the lever **62** in a counterclockwise direction, as viewed in FIGURE 2, permitting the valve member **44** to move away from the valve seat **48** to permit fuel to flow from the fuel receiving chamber **40** of the pump through the channels **53**, **52**, **51** and **50** into the carburetor fuel chamber **28**.

The vibration or flexure of the portion of the pump diaphragm **72** adjacent the chambers **40** and **80** causes fuel to be drawn from the chamber **114** through the strainer **100**, through the chamber or region **97** and passage **96**, past the valve **76** through the channels **94** and **92** into the fuel receiving chamber **40**. Fuel flows into the chamber **40** upon a suction stroke of the diaphragm **72** and upon a pressure stroke of the diaphragm, the fuel from chamber **40** flows through channel **55** and port **54** past the outlet flap valve **75** thence through the recess **116** and passages **53**, **52**, **51** and **50** into the carburetor fuel chamber **28** to replace the fuel delivered into the mixing passage **12**.

FIGURE 9 is illustrative of a modified configuration of ramp or relief surface for a flap valve of the diaphragm. In FIGURE 9, the pump members or components **32'** and **56'** are of the same character as the corresponding members shown in FIGURE 8. The member **32'** is formed with a recess **116'** having a flat bottom

surface 124', the recess 116' accommodating opening movement of the flap valve 75' formed on the diaphragm 72'. The bottom surface 124' of the recess 116' is joined to the planar surface 86' of member 32' by a curved transition or ramp surface 140. In this form of construction, the ramp surface 140 is of curved configuration, preferably generated as a radius about a point directly above the hinge region 78' of the flap valve 75'. Thus, the curved ramp or ramp surface 140 provides a gradually receding surface region from the flap valve providing for the gradual expansion of region 119' of the gasket 88' adjacent the flap valve 75' so as to prevent the compressive stresses exerted upon the gasket and diaphragm by the securing means 57' from distorting the flap valve 75'. It is to be understood that the curved ramp surface 140 may be utilized adjacent each of the flap valves.

The relief ramp construction of angular surface or curved surface adjacent each of the flap valves formed on the diaphragm providing gradual pressure relief for the adjacent regions of the gasket avoid any tendency for compressive pressures or stresses to distort the flaps. The relief surface construction assures that the valves will seat properly at all times during their operation.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than is herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

We claim:

1. In combination, pumping means for pumping liquid hydrocarbon fuels including a pair of members, a cavity formed in one of said members, a pumping diaphragm of flexible nonmetallic material extending across the cavity forming a fuel receiving chamber, said diaphragm being adapted to be flexed to establish pumping impulses in said fuel receiving chamber, a port for said fuel receiving chamber, valve means integrally formed on the diaphragm for said port, a flat valve seat formed on one of the members arranged for cooperation with the valve means for controlling the flow of fuel through the port, a recess formed in the other of said members adjacent the valve means to accommodate movement of said valve means to open position, means for securing the members and said diaphragm in fixed relation, a wall region of said recess adjacent the integral connection of the valve means with the diaphragm progressively receding from the plane of the diaphragm to relieve pressure of the member securing means on the valve means.

2. In combination, pumping means for pumping liquid hydrocarbon fuels including a pair of members, one of said members being formed with a cavity, a pumping diaphragm of flexible nonmetallic material extending across the cavity to form a fuel receiving chamber, said diaphragm adapted to be flexed to establish pumping impulses in said fuel receiving chamber, inlet and outlet ports for said fuel receiving chamber, flap valve means inegrally formed on the diaphragm for each of the ports, flat valve seats and recesses provided on the members respectively and arranged for cooperation with the valve means for controlling the flow of liquid fuel through the inlet and outlet ports, means for securing the members and said diaphragm in fixed relation, a wall region of each recess adjacent the integral connection of the flap valve means with the diaphragm progressively receding from the plane of the diaphragm to relieve pressure of the member securing means on the flap valve means.

3. In combination, pumping means for pumping liquid hydrocarbon fuels including a pair of members, each of said members being formed with a recess, a pumping diaphragm of flexible nonmetallic material extending across the recesses to form a pumping chamber and a fuel receiving chamber, said diaphragm adapted to be flexed by varying fluid pressure in the pumping chamber to establish pumping impulses in said fuel receiving chamber, inlet and outlet ports for said fuel receiving chamber, flap valve means integrally formed on the diaphragm for each of the ports, flat valve seats formed on one of the members arranged for cooperation with the valve means for controlling the flow of liquid fuel through the inlet and outlet ports, a recess adjacent each valve means formed in the other of said members to accommodate movement of said valve means to open positions, means for securing the chambers and said diaphragm in fixed relation, a wall region of each of said recesses adjacent the integral connection of the flap valve means with the diaphragm progressively receding from the plane of the diaphragm to relieve pressure of the member securing means on the valve means.

4. In combination, pumping means for pumping liquid hydrocarbon fuels including a pair of members, each of the members being formed with planar surfaces and a cavity, a pumping diaphragm of flexible nonmetallic material disposed between the planar surfaces of the members, one of said cavities forming with the diaphragm a pumping chamber and with the other a fuel receiving chamber, inlet and outlet ports for said fuel receiving chamber, valve means for said ports, at least one of said valve means comprising a flap portion hingedly joined with the diaphragm and adapted in closed position to engage a planar surface of one of said members, a recess having a bottom surface formed in the other of said members to accommodate flexing movements of the flap valve, means for securing the members and diaphragm in assembled relation whereby portions of the diaphragm are subjected to pressure of the securing means, and a curved ramp surface joining the bottom surface of the recess and a planar surface of the member containing the recess at the hinge region of the flap valve for relieving the flap valve from the pressure set up by the securing means.

5. In combination, pumping means for pumping liquid hydrocarbon fuels including a pair of members, each of the members being formed with planar surfaces and a cavity, a pumping diaphragm of flexible material disposed between the planar surfaces of the members, one of said cavities forming with the diaphragm a pumping chamber and with the other a fuel receiving chamber, inlet and outlet ports for said fuel receiving chamber, valve means for said ports, at least one of said valve means comprising a flap portion hingedly joined with the diaphragm and adapted in closed position to engage a planar surface of one of said members, a recess having a bottom surface formed in the other of said members to accommodate flexing movements of the flap valve, a gasket engaging one of said members having a portion extending into the recess, means for securing the members, gasket and diaphragm in assembled relation whereby portions of the gasket and diaphragm are subjected to pressure of the securing means, and an inclined ramp surface joining the bottom surface of the recess and a planar surface of the member containing the recess at the hinge region of the flap valve for relieving the portion of the gasket extending into the recess and the flap valve from the pressure set up by the securing means.

6. In combination, pumping means for delivering liquid fuel to a charge forming apparatus including a pair of disc-like members having planar surface areas, a pumping diaphragm formed of flexible nonmetallic material disposed between the planar surface areas of said members, means securing said members and diaphragm in fixed relation, concave recesses formed in said members and providing with said diaphragm a pumping chamber and a fuel receiving chamber, a duct in one of said members opening into the pumping chamber and adapted to be connected with a source of varying fluid pressure for vibrating said diaphragm to establish a pumping action, inlet and outlet ports formed in the other of said members for conveying liquid fuel into and away from the fuel receiving chamber, flap valves for each of said ports

formed integrally with the diaphragm, recesses formed in one of said members adjacent each flap valve to accommodate opening movements of the valves, and progressively receding transition surfaces forming portions of the walls of the recesses arranged adjacent the integral connection of each flap valve with the diaphragm to relieve pressure of the securing means upon the flap valves.

7. In combination, pumping means for delivering liquid fuel to a charge forming apparatus including a pair of disc-like members having planar surface areas, a pumping diaphragm formed of flexible nonmetallic material disposed between the planar surface areas of said members, means securing said members and diaphragm in fixed relation, concave recesses formed in said members and providing with said diaphragm a pumping chamber and a fuel receiving chamber, a duct in one of said members opening into the pumping chamber and adapted to be connected with a source of varying fluid pressure for vibrating said diaphragm to establish a pumping action, inlet and outlet ports formed in the other of said members for conveying liquid fuel into and away from the fuel receiving chamber, flap valves for each of said ports formed integrally with the diaphragm, recesses formed in one of said members adjacent each flap valve to accommodate opening movements of the valves, and inclined transition surfaces forming portions of the walls defining the recesses arranged adjacent the integral connection of each flap valve with the diaphragm to relieve pressure of the securing means upon the flap valves.

8. In combination, pumping means for pumping liquid hydrocarbon fuels including a pair of members being formed with a cavity, a pumping diaphragm disposed between the members and forming with the cavity a pumping chamber and a fuel receiving chamber, a gasket positioned between the diaphragm and one of the members, passage in one of the members opening into the pumping chamber adapted to be connected with a source of varying fluid pressure for actuating the diaphragm, inlet and outlet ports for said fuel receiving chamber, a flap valve for each port integrally formed on the diaphragm and adapted in port-closing position to engage a planar surface region on one of said members, the other of said members being formed with a recess having a planar bottom surface adjacent each of said flap valves to accommodate opening movements of said valves, means for securing said members, gasket and diaphragm in assembled relation whereby portions of the gasket and diaphragm are subjected to compressive pressure of the securing means, a ramp surface joining the planar bottom surface of each recess with a planar surface of the member, each ramp surface being inclined at an acute angle with respect to the planar surface, said gasket having portions extending into the recesses adjacent said ramp surfaces, said ramp surfaces being disposed adjacent the regions of the integral connections of the flap valves with the diaphragm for relieving the extending portions of the gasket and flap valves of the compression stresses set up by the securing means.

9. In combination, pumping means for pumping liquid hydrocarbon fuels including a pair of members being formed with a cavity, a pumping diaphragm disposed between the members and forming with the cavity a pumping chamber and a fuel receiving chamber, a gasket positioned between the diaphragm and one of said members, passage in one of the members opening into the pumping chamber adapted to be connected with a source of varying fluid pressure for actuating the diaphragm, inlet and outlet ports for said fuel receiving chamber, a flap valve for each port integrally formed on the diaphragm and adapted in port-closing position to engage planar surface regions on one of said members, the other of said members being formed with a recess having a planar bottom surface adjacent each of said flap valves to accommodate opening movements of said valves, means for securing said members, gasket and diaphragm in assembled relation whereby portions of the gasket and diaphragm are subjected to compressive pressure of the securing means, a curved ramp surface joining the planar bottom surface of each recess with a planar surface of the member, said gasket having portions extending into the recesses adjacent said curved ramp surfaces, said curved ramp surfaces being disposed adjacent the regions of the integral connections of the flap valves with the diaphragm for relieving the extending portions of the gasket and flap valves of the compression stresses set up by the securing means.

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