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3,309,068

FUEL PUMPING AND CHARGE FORMING APPARATUS

Original Filed Sept. 4, 1962

2 Sheets-Sheet 1

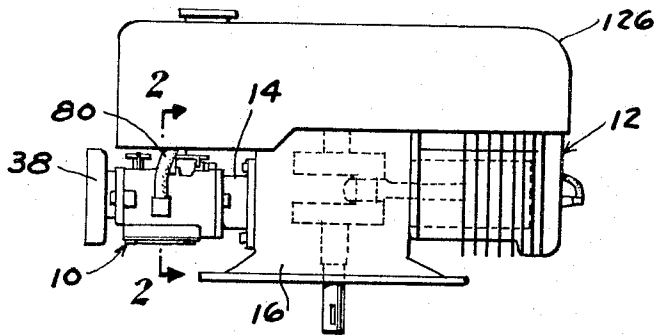


FIG. 1

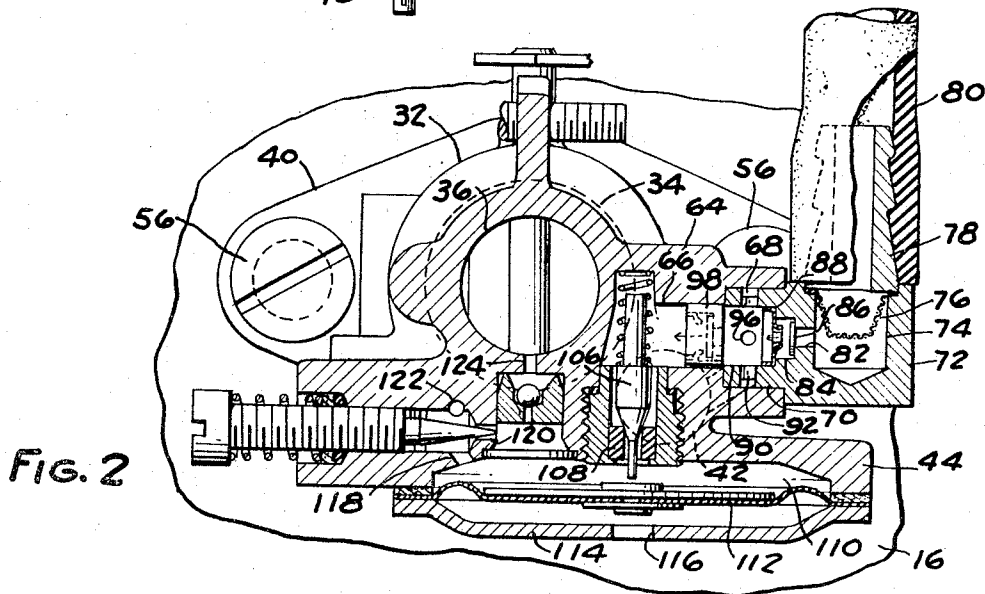


FIG. 2

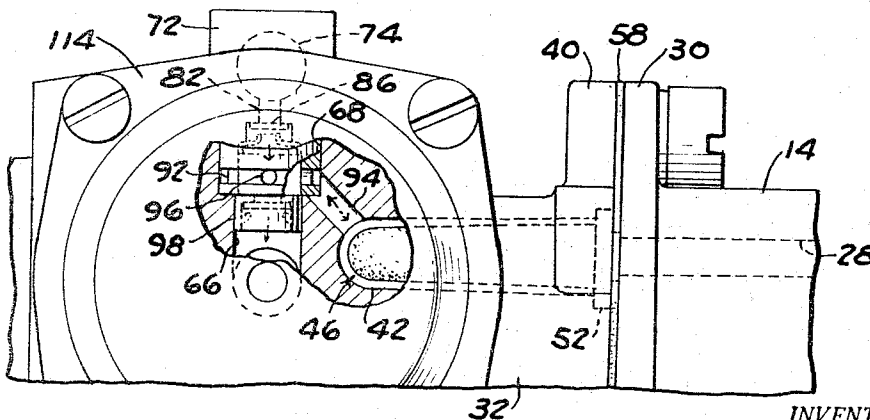


FIG. 3

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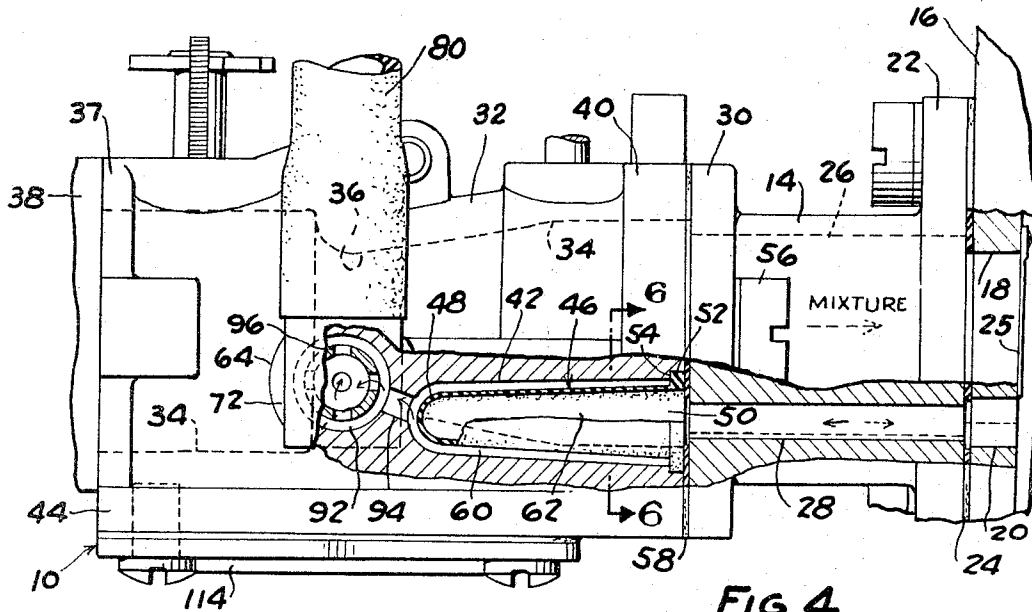


FIG. 4

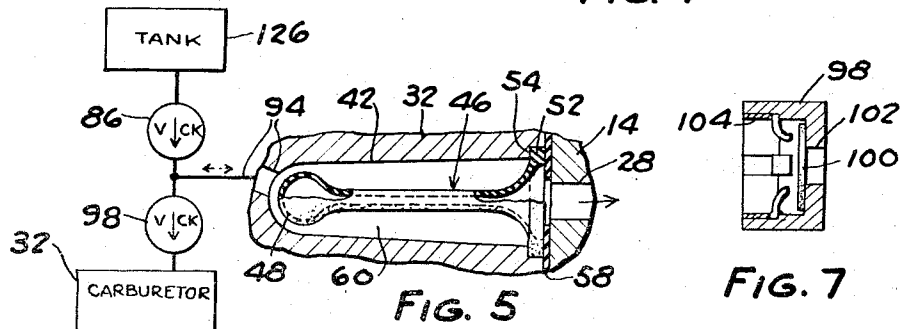


FIG. 5

FIG. 7

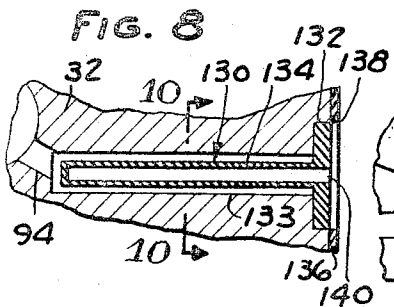


FIG. 8

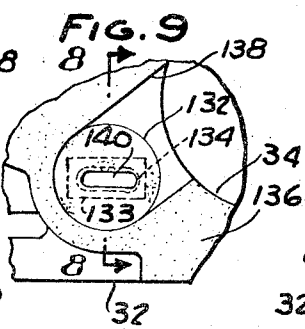


FIG. 9

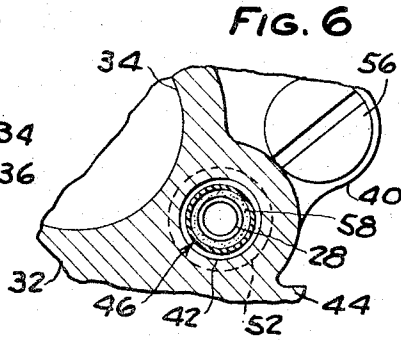


FIG. 6

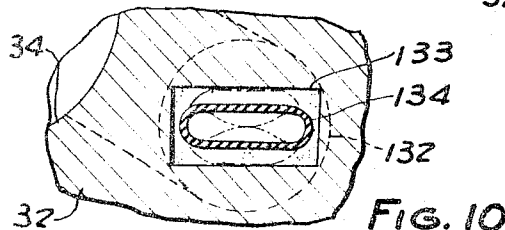


FIG. 10

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FUEL PUMPING AND CHARGE FORMING
APPARATUS

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Continuation of application Ser. No. 221,147, Sept. 4,
1962. This application Aug. 21, 1964, Ser. No. 391,081
12 Claims. (Cl. 261—35)

This application is a continuation of our copending application, Ser. No. 221,147, filed Sept. 4, 1962, now abandoned and entitled Fuel Pumping and Charge Forming Apparatus.

This invention relates to apparatus for delivering fuel to internal combustion engines and more particularly to a combination fuel pump and carburetor which may be used with either a two-cycle or four-cycle internal combustion engine.

It is an object of the present invention to provide an improved all-position carburetor having an improved fuel pump incorporated therein in an arrangement which is compact, lightweight, simplified in construction and easy to service.

Another object is to provide an improved combination carburetor and fuel pump assembly wherein the fuel pump is disposed in heat exchange relation with the mixture conduit of the carburetor so that fuel circulating through the pump circuit is cooled by carburetor evaporation to thereby minimize or prevent vapor lock.

A further object is to provide a carburetor and fuel pump assembly of the above character wherein the fuel pump is actuated by means of pressure changes occurring in the crankcase of the engine to which the carburetor is attached, the pressure pulsations being conducted to the pump solely via internal passageways so as to obviate the problems of external pressure lines.

Still another object is to provide a carburetor having an integral fuel pump utilizing an improved single-ended tubular diaphragm disposed in a pump bore co-operatively formed therewith in the casing of the carburetor to thereby provide a well protected, high capacity fuel pump capable of delivering a relatively uniform output even when subjected to excessive diaphragm actuating pressure.

Other objects, features and advantages of the present invention will become apparent from the following description and drawings, in which:

FIG. 1 is an elevational view of a single cylinder two-cycle internal combustion engine having an improved carburetor and fuel pump assembly attached thereto in accordance with the present invention.

FIG. 2 is an enlarged sectional view on the line 2—2 of FIG. 1.

FIG. 3 is a fragmentary bottom view of the carburetor and fuel pump assembly of FIG. 2, with a portion broken away to illustrate detail.

FIG. 4 is an enlarged elevational view of the carburetor and fuel pump assembly as viewed in FIG. 1 with portions broken away to illustrate detail.

FIG. 5 is a fragmentary elevational and partially schematic view of the fuel pump portion of the carburetor illustrating the pump diaphragm in the collapsed condition thereof.

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 4.

FIG. 7 is an enlarged sectional view of the outlet check valve of the fuel pump.

FIG. 8 is a fragmentary sectional view on the line 8—8 of FIG. 9 illustrating a modified form of the fuel pump of the present invention.

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FIG. 9 is a fragmentary end elevational view of the modified fuel pump of FIG. 8.

FIG. 10 is an enlarged sectional view taken on the line 10—10 of FIG. 8 illustrating the expanded, normal and contracted shape of the diaphragm of the modified fuel pump.

Referring to FIG. 1, an improved all-position carburetor and fuel pump assembly 10 of the present invention is shown mounted on a conventional single cylinder two-cycle internal combustion engine 12. Assembly 10 is bolted to an intake pipe 14 which in turn is bolted to the intake structure of a crankcase 16 of engine 12 to thereby provide the sole support for assembly 10.

As more clearly shown in FIG. 4, crankcase 16 is provided with the usual admission port 18 for carbureted air, but is modified from conventional construction by having a pressure communicating port 20 which is offset from port 18 but within the area covered by the mounting flange 22 of pipe 14. A gasket 24 is clamped between pipe 14 and crankcase 16 and has suitable openings which register with ports 18 and 20. A conventional reed-type inlet check valve 25 is mounted on the inside surface of the wall of crankcase 16 so as to cover admission port 18 but not pressure port 20. Pipe 14 has a pair of large and small bores 26 and 28 respectively which register with ports 18 and 20 respectively and extend axially through pipe 14 so as to open adjacent one another to the face of a carburetor mounting flange 30 of pipe 14. It is to be understood that pipe 14 serves as an adaptor for supporting the carburetor-pump assembly 10 spaced outwardly from crankcase 16 and may be dispensed with in certain applications where it is desired to mount assembly 10 directly on crankcase 16.

The improved carburetor and fuel pump assembly 10 of the present invention comprises a unitary casing 32 (FIGS. 2 and 4) preferably made of cast aluminum. A mixture conduit 34 (broken lines, FIG. 4) having a venturi throat 36 therein extends completely through casing 32. The inlet end of conduit 34 is surrounded by a mounting flange 37 for receiving a conventional air filter 38, and the outlet end is surrounded by a mounting flange 40 for securing the carburetor casing to pipe 14. Pipe bore 26 registers with conduit 34 so as to conduct the fuel and air mixture formed in venturi throat 36 to the crankcase.

In accordance with the present invention a fuel pump bore 42 is provided completely within carburetor casing 32 (FIGS. 3 and 4). Bore 42 extends inwardly from an opening in the face of flange 40 and parallel to the axis of mixture conduit 34 to a point substantially adjacent throat 36. As shown in FIG. 6, bore 42 is nested closely adjacent conduit 34 so that only a thin wall of metal separates bore 42 and conduit 34, thus promoting heat transfer therebetween. Bore 42 is also nested between conduit 34 and a generally flat fuel chamber flange 44 of casing 32 (FIG. 2). By so incorporating the fuel pump in otherwise unused space located within the exterior dimensions of the carburetor, the inclusion of the pump structure does not increase the effective overall dimensions of the carburetor.

Another feature of the present invention is the provision of a flexible tubular fuel pumping membrane, one form of which comprises a generally cylindrical diaphragm 46 (FIGS. 3—6) which has a closed end 48 and an open end 50 disposed respectively adjacent the inner and outer ends of bore 42. Diaphragm 46 increases gradually in diameter from the closed to the open ends thereof, but is of uniform thickness except for a substantially thicker gasket portion 52 which is integrally joined to the periphery of diaphragm 46 at the open end thereof. The entire diaphragm is preferably made of flexible and resilient ma-

terial, such as synthetic rubber, which is impervious to and unharmed by gasoline or other fuel supplied to the engine.

Bore 42 is counterbored at the open end thereof to provide a seat 54 adapted to receive gasket 52, the counterbore being slightly less in depth than the thickness of gasket 52 so that it protrudes slightly beyond the outer face of flange 40. Hence when the carburetor is bolted to pipe flange 30 and mounting bolts 56 are tightened, gasket 52 is compressed between bore seat 54 and an apertured gasket 58 provided between flanges 30 and 40 (FIGS. 4 and 5). Diaphragm 46 is thus clamped in sealed relation with the wall of pump bore 42 and serves to divide the bore into a fuel pumping chamber 60 and a gaseous pressure chamber 62, the latter chamber being in communication with the pulse pressure passages 28 and 20.

Referring to FIGS. 2 and 4, inlet and outlet valves of the fuel pump are located in an annular boss 64 extending from the pump side of casing 32. Boss 64 has a bore 66 therein opening into a larger bore 68. A boss 70 of a fuel inlet fitting 72 is received with a press fit in bore 68. Fitting 72 has a bore 74 which is enlarged at its upper end to receive the marginal portion of a frusto-conical filter screen 76. A nipple 78 secures filter 76 in bore 74 and in turn receives a fuel line hose 80. An inlet passage 82 in fitting 72 connects bore 74 with a larger valve bore 84 in boss 70, and a valve disc 86 is loosely received in bore 84 for axial movement between inlet 82 and a perforated spider 88 secured in a still larger bore 90 of boss 70. Boss 70 has a peripheral groove 92 (FIGS. 2 and 3) which registers with a pump passage 94 opening at one end into bore 68 and at the other end into the inner end of pump bore 42. A series of four radial passages 96 connect groove 92 with bore 90. A outlet check valve 98 (FIGS. 2 and 7) is fitted in bore 66 and comprises a hollow plug having a valve disc 100 loosely received between an inlet aperture 102 thereof and a perforated spider 104 mounted in a larger bore of the plug.

Certain of the remaining details of the carburetor structure shown herein are known in the art and therefore only the principal parts are identified hereinafter, the operation thereof being readily apparent to one skilled in the art. The flow of fuel from bore 66 is controlled by a spring biased inlet needle valve 106 (FIG. 2) which extends through an inlet seat 108 and into a fuel chamber 110 formed by flange 44 and a carburetor diaphragm 112. A diaphragm cover 114 with an atmospheric vent 116 is secured to flange 44. Fuel is drawn from fuel chamber 110 by the aspiration effect occurring in venturi throat 36 during the engine intake stroke. The fuel is drawn from chamber 110 via a passage 118, and then branches to a main adjustment orifice 120 and an idle fuel control passage 122 leading respectively to a main nozzle orifice 124 and to primary and secondary idle fuel discharge ports (not shown) which open into the side of mixture conduit 34 downstream of orifice 124.

The operation of the improved fuel pump of the invention is as follows. As the piston of the two-cycle engine 12 moves toward the cylinder head thereof during the compression stroke, the air pressure in crankcase 16 drops below atmospheric pressure, thereby causing diaphragm 46 to contract until it assumes the collapsed shape shown in FIG. 5. This lowers the pressure in pumping chamber 60, causing outlet check valve 98 to close, inlet check valve 86 to open and fuel to be drawn into chamber 60 from a fuel tank 126 via hose 80, through fitting 72, filter 76, bores 82, 84 and passages 96 and 94.

As the piston moves away from the cylinder head during the power stroke of the engine, the crankcase pressure rises above atmospheric pressure, thereby inflating diaphragm 46 so that it expands radially outwardly towards the surrounding wall of pump bore 42, normally stretching the diaphragm to the shape shown in FIG. 4. This expansion of the diaphragm forces the fuel which has

been drawn into pumping chamber 60 back out passage 94, causing inlet valve 86 to seat and outlet valve 98 to open, thereby forcing the fuel into bore 66 from which it is released by the operation of inlet needle valve 106. The stretched diaphragm aids in suction or fuel lift as it starts to contract again towards its normal shape as the pressure drops.

Referring to FIGS. 8, 9 and 10, there is shown a modified form of the combined pump and carburetor of the invention. A flattened tubular diaphragm 130, preferably made of the same material as diaphragm 46, is provided having an integral mounting gasket portion 132 similar to gasket portion 52 so that it may be mounted in a modified pump cavity or bore 133 in the same manner as the previous embodiment. The flattened diaphragm 130 is preferred since it has been found to have a higher volumetric pumping capacity and ability to pump against a higher pressure head than that of the cylindrical diaphragm 46. This results from the provision of a hollow flexing portion 134 which in cross section is generally elliptical, e.g., two wide parallel sides joined by outwardly bowed narrow sides (FIG. 10), throughout its length when in its normal, relaxed condition with pressure equalized inside and out. The expanded oval shape and contracted hour glass shape of portion 134 resulting respectively from inflation and deflation thereof in response to variations in engine crankcase pressure are shown in broken lines in FIG. 10. Due to the elliptical cross sectional shape of portion 134 there is less internal resistance offered by the material of the diaphragm as it is flexed between the expanded and contracted configurations, and consequently higher efficiency is obtained.

Another feature of the modified carburetor and fuel pump combination of FIGS. 8-10 is the provision of an apertured mounting gasket 136 (FIGS. 8 and 9) which fits against the end face of carburetor flange 40 in the manner of gasket 58 (FIG. 4). However, in addition to having apertures which register with the outlets of the carburetor conduit 34 and pump bore 133, gasket 136 has a slot 138 (FIG. 9) extending between these outlet apertures which connects the opening 140 of diaphragm 130 to conduit 34. When the carburetor is mounted on the intake manifold of a four-cycle engine, the modified gasket 136 may be used in place of gasket 58 and intake pipe 14 and in such case the pump diaphragm (46, FIG. 5; 130, FIG. 8) is then operated by pressure pulsations occurring in the intake passageway rather than by the pressure pulsations occurring in the crankcase. Thus, when gasket 136 is utilized as described, the pump diaphragm (46, 130) is operated by fluid pressure pulsations in the fuel-air intake passageway which are communicated to the pump diaphragm through the slot 138. As is well known, fluid pulsations are present in the intake passageways as well as the crankcases of both two-cycle and four-cycle internal combustion engines. Any source of pulsations in the engine may be used to operate the fuel pump.

In accordance with still another feature of the invention, the pump cavity may be formed generally complementary in shape to the normal, pressure equalized configuration of the diaphragm, e.g., bore 133 being rectangular in the case of diaphragm 130, and dimensioned to provide a predetermined expansion space for the diaphragm. As illustrated in FIG. 10, diaphragm flexing portion 134 expands with increasing crankcase or intake pressure until it is pressed against the top and bottom walls of the complementary bore 133, and thereafter any further increase in pressure applied to the interior of the diaphragm does not substantially alter its shape. Thus by suitably dimensioning the pump cavity, it is possible to restrict the maximum volume of fuel pumped regardless of the diaphragm inflation pressure, a desirable feature on engines where high crankcase pressures occur. It is to be understood that this concept of controlling maximum fuel flow by the relationship between the pump

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cavity and pump diaphragm shape and size is applicable to both the cylindrical and flattened forms of diaphragm disclosed herein.

From the above description it will now be understood that a carburetor and fuel pump constructed in accordance with the present invention provides a highly compact structure which requires no external hoses or piping connections other than fuel line 80. The incorporation of the fuel pump directly in carburetor casing 32 protects the pump structure and yet diaphragm 46, 130 is easily accessible for replacement by merely detaching the carburetor from pipe 14. The inlet and outlet check valves 86 and 98 are also easily accessible by merely pulling out fitting 72 from carburetor boss 64. Manufacturing costs are reduced since pipe flange 30 (or the wall of crankcase 16 itself) serves as a cover plate for pump bore 42, 133. The problem of vapor lock is reduced or eliminated due to the proximity of pumping chamber 60 to mixture conduit 34, the evaporating fuel in the conduit serving to cool the fuel in the pump chamber. In applications where the gases utilized as a pressure medium for actuating the diaphragm may reach relatively high temperatures, this cooling effect also promotes longer life in diaphragm 46, 130.

It is to be understood that the above disclosed fuel pump is equally well adapted for use with a float type carburetor as well as with a diaphragm-type carburetor as illustrated herein. Also, the carburetor and integral fuel pump combination of the present invention may be used on a two-cycle engine of a rotary valve or third port design as well as with a reed valve design as shown herein, and on multiple or single-cylinder engines. The pump bores 42, 133 need not be disposed parallel to the throttle and venturi bores 34, 36 although the parallel relationship is preferred for ease in die casting the carburetor casing and in assembling the carburetor-pump in addition to the aforementioned heat transfer advantages.

We claim:

1. In combination a carburetor and a fuel pump adapted for use with an internal combustion engine serving as a source of pulsating fluid pressure for operating said pump, said carburetor comprising a casing adapted to be mounted on an intake structure or the like of said engine, said casing having a mounting face and a conduit with an opening in said face, said conduit being adapted to supply an air-gas charge to said engine, said pump comprising a cavity in the wall of said casing, a flexible diaphragm disposed in and cooperating with said cavity to form a pumping chamber at one side of said diaphragm and a pressure chamber at the other side of said diaphragm, an inlet opening for said cavity at said mounting face adjacent said conduit opening, a mounting gasket adapted to abut said mounting face and said intake structure to provide a seal between said casing and said intake structure when said casing is mounted thereon, said basket having a first aperture therethrough in line and registering with said conduit opening, said gasket also having a second aperture therethrough in line and registering with said cavity inlet opening, and said gasket further having a slot connecting said first and second apertures, one end of said slot communicating with said first aperture, the other end of said slot communicating with said second aperture whereby when said casing is mounted on said intake structure with said gasket disposed between said mounting face and said intake structure, pulsating fluid pressure from said engine intake structure is conducted from said first aperture through said slot and said second aperture to said pressure chamber.

2. A combination carburetor and fuel pump for an internal combustion engine serving as a source of fluid pulsations such as occur in the engine crankcase and engine intake passageway while the engine is running, said carburetor comprising a casing having a mounting face for mounting the carburetor in fuel-air mixture supplying relation with the engine, said casing also hav-

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ing a fuel-air mixture passageway therethrough terminating at an outlet opening in said mounting face and a cavity extending inwardly from a second opening in said mounting face said outlet opening of said mixture passageway and said second opening of said cavity being juxtaposed at said mounting face, said cavity being closely adjacent and generally parallel to said mixture passageway, inlet and outlet ports in said casing for connecting said cavity with a source of fuel and for supplying fuel to the fuel mixture passageway, a flexible diaphragm in the form of a closed end tube positioned in said cavity with the closed end remote from said second opening and the open end adjacent said second opening whereby when the carburetor is mounted in fuel mixture supplying relation with said engine fluid pulsations from said engine are communicated to the diaphragm through the open end thereof to cause said diaphragm to pulsate and pump fuel from the source of fuel and supply the same to the fuel mixture passageway.

3. A combination carburetor and fuel pump adapted for use with an internal combustion engine serving as a source of pulsating fluid pressure for operating said pump comprising a casing constructed to be mounted on an intake structure or the like of said engine wherein said intake structure has an admission port for carburetted air and a pulsating fluid pressure communicating port, said casing having a mounting face thereon which abuts said intake structure when said casing is mounted thereon, said casing having a conduit therethrough for providing an air-gas charge to said engine, one end of said conduit having an outlet opening at said face adapted for registration with the carburetted air port of said intake structure, a cavity in said casing, one end of said cavity having an opening at said mounting face in juxtaposition to the outlet opening of said conduit and adapted for registration with the pulsating fluid pressure communicating port of said intake structure, a flexible diaphragm disposed in and cooperating with said cavity to form a pumping chamber at one side of said diaphragm and a pressure chamber at the other side of said diaphragm, said diaphragm having a peripheral portion arranged adjacent said mounting face and dimensioned relative to said cavity opening so that said diaphragm is accessible for assembling and disassembling said diaphragm and said casing when said casing is dismounted from said intake structure to expose said mounting face, said diaphragm being generally tubular and closed at one end and open at the other end to form an open mouth with said peripheral portion of said diaphragm surrounding said mouth, said cavity being shaped generally complementary to said diaphragm to accommodate said diaphragm therein with said closed end remote from said mounting face, said pumping chamber having fuel inlet and outlet means for transferring fuel from said pumping chamber to said conduit, said cavity opening at said mounting face being placed in registration with said pulsating fluid pressure communicating port upon mounting of said casing on said intake structure with said conduit outlet opening in registration with said carburetted air intake port to thereby place said other side of said diaphragm in direct fluid communication with the source of pulsating fluid pressure from said engine to operate said diaphragm in response to said pulsating fluid pressure whereby when said casing is dismounted from said intake structure said mounting face is exposed and said diaphragm is thereby accessible for assembly and disassembly of said diaphragm and said casing.

4. The device set forth in claim 3 wherein said cavity has a generally straight axis that passes through said diaphragm and extends through said opening of said cavity at said face.

5. The device set forth in claim 4 wherein said conduit has a generally straight longitudinal axis extending in a direction generally parallel to the axis of said cavity and through said opening of said conduit, and said conduit axis and said cavity axis are closely adjacent each other.

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6. The device set forth in claim 3 wherein said diaphragm has its peripheral portion seated directly adjacent said opening of said cavity at said face and said peripheral portion of said diaphragm and abutting portions of said casing and said intake structure are dimensioned such that said peripheral portion is sealably seated when said casing is mounted on said intake structure.

7. The device set forth in claim 6 wherein said casing has an annular seat at said one end of said cavity extending inwardly of said casing from said face for assembling said peripheral portion of said diaphragm with said casing, said seat and said peripheral portion being dimensioned such that said peripheral portion projects outwardly of said mounting face so that said peripheral portion is clamped in sealed relation on said seat when the casing is mounted on said intake structure.

8. The device set forth in claim 3 wherein said casing has fuel admitting port means opening to said conduit in an area upstream of said conduit outlet opening, said cavity extends inwardly of said casing from said face with the inner end of said cavity disposed remote from said face and substantially adjacent said port area of said conduit, and said fuel inlet and outlet means communicate with said pumping chamber at said inner end of said cavity and with said conduit at said fuel admitting port means whereby fuel pumped by said diaphragm to said conduit flows through the casing remote from the mounting face.

9. The combination set forth in claim 3 wherein said mounting face has a flat substantially uninterrupted marginal portion generally encircling said openings and constructed to cooperate with a corresponding face on said intake structure when said casing is mounted on said intake structure.

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10. The combination set forth in claim 3 wherein said mounting face defines a substantially flat continuous plane and said outlet opening of said conduit and said opening of said cavity are disposed in said plane.

11. The combination set forth in claim 3 wherein said casing further comprises mounting means for cooperating with a plurality of fasteners to secure said casing on said intake structure with said mounting face abutting said intake structure so that when said casing is supported on said intake structure said fasteners may be removed to detach said casing from said intake structure to expose said face and render said diaphragm accessible for disassembly of said diaphragm and said casing without further disassembly of said casing.

12. The combination set forth in claim 3 wherein said diaphragm has a hollow flexing portion extending generally parallel to the axis of said cavity, said flexing portion being generally oval in cross section when equal pressures are acting interiorly and exteriorly thereon.

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