

- [54] **FUEL FEED SYSTEM FOR RECYCLING FUEL**
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Related U.S. Application Data

- [60] Continuation of Ser. No. 402,322, Oct. 1, 1973, abandoned, which is a division of Ser. No. 228,775, Feb. 23, 1972, abandoned, which is a division of Ser. No. 17,729, March 9, 1970, abandoned.
- [52] U.S. Cl. **123/73 R; 123/73 A; 123/73 PP; 123/73 CB; 123/DIG. 2**
- [51] Int. Cl.² **F02B 33/04**
- [58] Field of Search **123/73 R, 73 A, 73 CB, 123/73 PP, DIG. 2**

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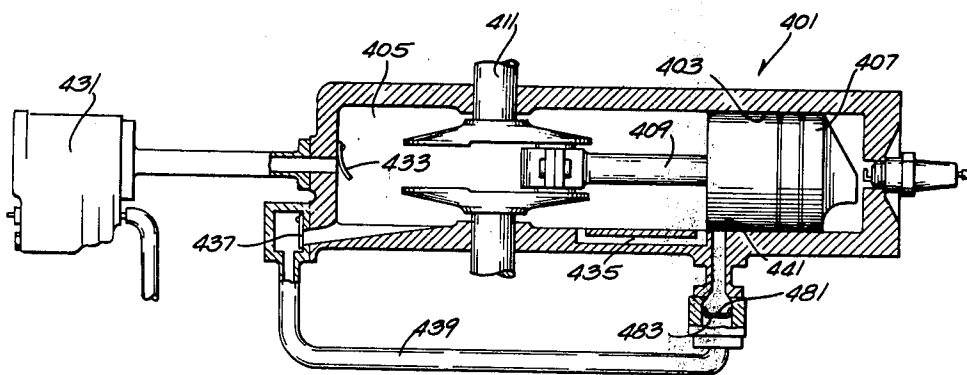
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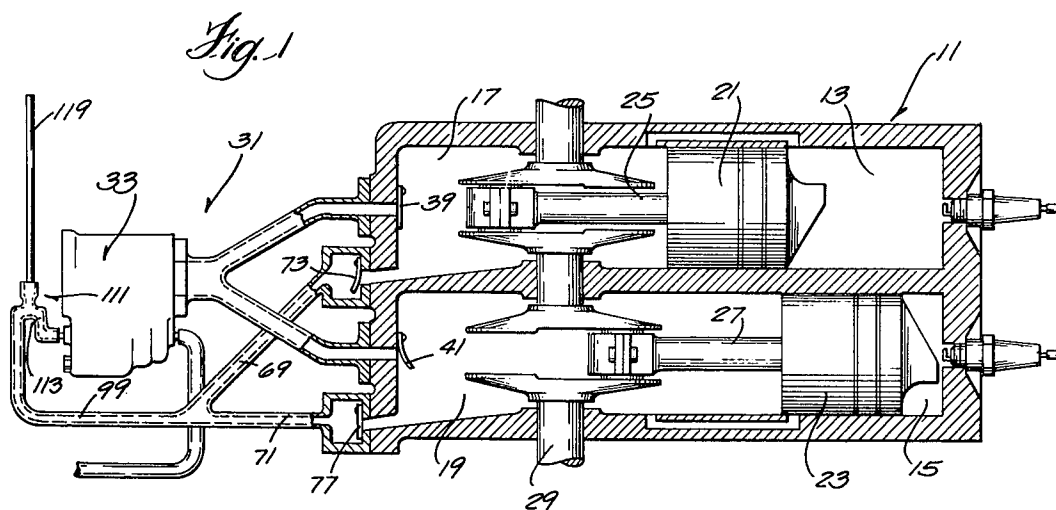
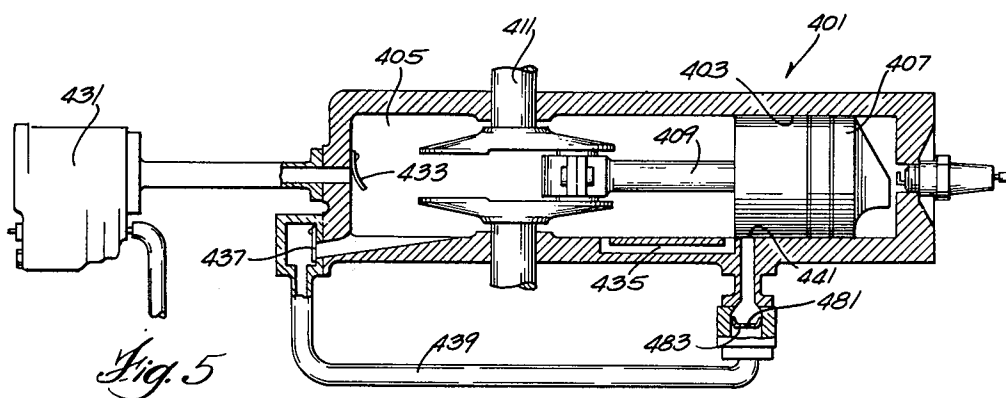
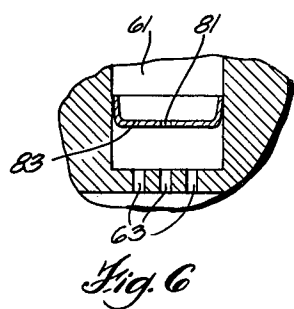
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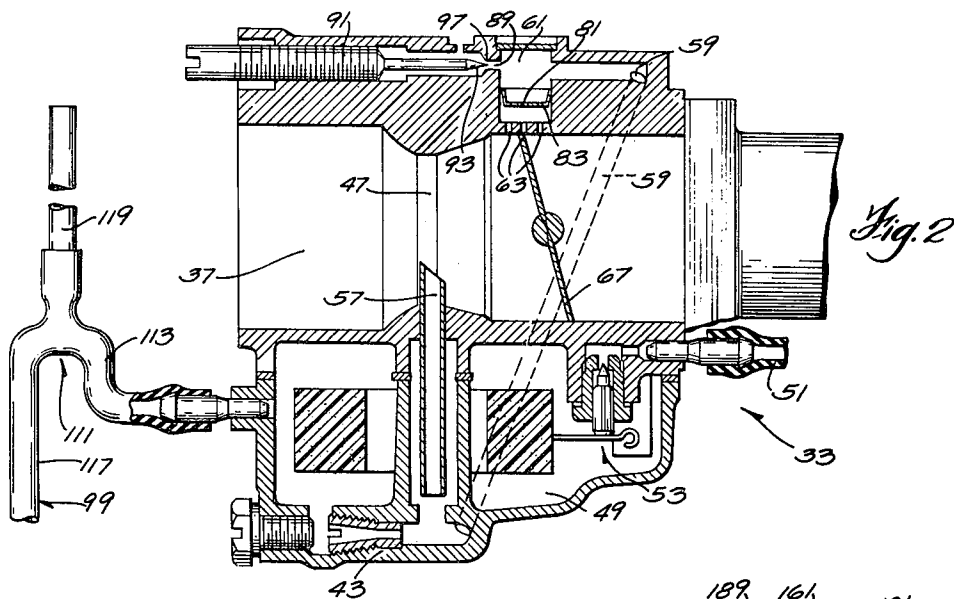
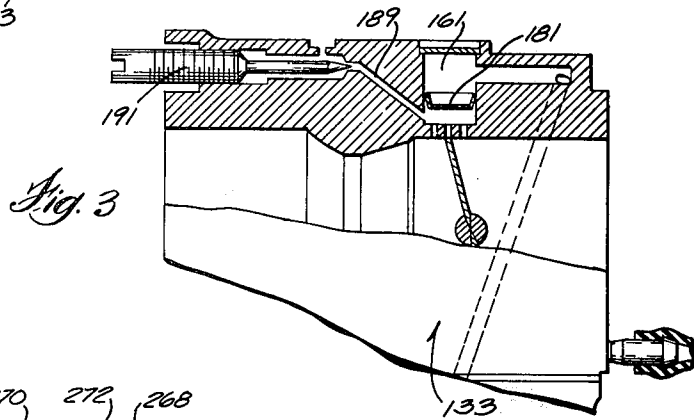
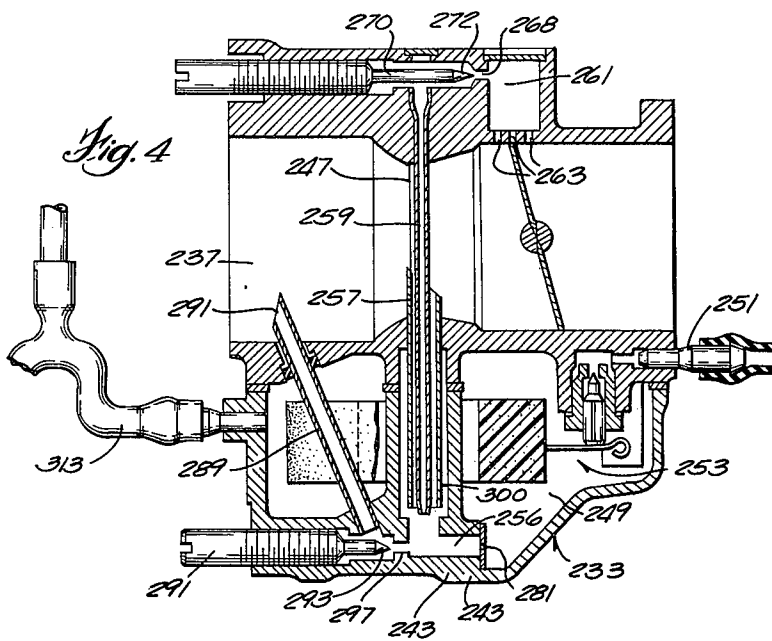
[57] **ABSTRACT**

Disclosed herein is a fuel feeding system comprising a carburetor having fuel passage means communicating between a fuel nozzle and a fuel bowl and including a sharp-edged orifice, together with means for controllably admitting air into the fuel passage means. Also disclosed herein is a fuel feeding system in which "ends" or "drains" are recycled from the crankcase through a sharp-edged orifice into an engine cylinder.

1 Claim, 6 Drawing Figures







FUEL FEED SYSTEM FOR RECYCLING FUEL

This application is a continuation of our application Ser. No. 402,322 filed Oct. 1, 1973 and now abandoned, which, in turn, is a division of application Ser. No. 228,775 filed Feb. 23, 1972, and now abandoned, which is a division of application Ser. No. 17,729 filed Mar. 9, 1970, and now abandoned.

BACKGROUND OF THE INVENTION

The invention relates generally to internal combustion engines, and particularly to two-stroke internal combustion engines wherein lubricant is commonly mixed with fuel. The invention also relates to fuel feeding arrangements for internal combustion engines generally.

Rough or uneven engine operation and even engine stalling can occur with present fuel feeding systems in response to changes in the viscosity of the fuel being supplied to the engine. Such changes and viscosity can occur when high viscosity "ends" or "drains" collect in the crankcase of a two cycle engine and are re-cycled into the fuel feeding system or directly into the cylinder or cylinders. Such viscosity change can also occur when switching from one source of fuel to another, and particularly in connection with two-stroke engines, when changing from one fuel-oil mixture to another, i.e., when there are differences in mixture ratio between the two mixture sources.

The Heidner U.S. Pat. No. 3,132,635 discloses a two cylinder, two-stroke engine including one arrangement for pumping "ends" or "drains," such as oil or the like, from the crankcases to the cylinders.

SUMMARY OF THE INVENTION

The invention provides for a fuel feeding system for an internal combustion engine, which system is largely independent of variation in viscosity of the fuel being fed to the engine. In accordance with the invention, the fuel feeding system includes a "sharp-edged" orifice which under given pressure conditions will supply a constant volume flow, notwithstanding changes in fuel viscosity. In arrangements where high viscosity "ends" or "drains" are re-cycled by being pumped into a carburetor bowl, employment of a sharp-edged orifice between the bowl and the air-fuel induction passage or venturi section thereof will provide for smooth engine operation independently of the amount of re-cycled high viscosity fuel.

In arrangements where high viscosity "ends" are re-cycled directly to a cylinder, a sharp-edged orifice can be used to meter a substantially constant volume flow to the cylinder independently of the viscosity of the "ends."

Other objects and advantages of the invention will become known by reference to the following description and the accompanying drawings in which:

Drawings

FIG. 1 is a schematic view, partially in section, of an engine and associated fuel feeding system in accordance with the invention.

FIG. 2 is an enlarged view, partially in section, of the carburetor included in the fuel feeding system of FIG. 1.

FIG. 3 is a fragmentary view, partially in section, of a modified carburetor which can be incorporated in the fuel feeding system of FIG. 1.

FIG. 4 is an enlarged sectional view of still another modified carburetor which can be employed in the fuel feeding system of FIG. 1.

FIG. 5 is a schematic sectional view of another engine and fuel feeding system in accordance with the invention.

FIG. 6 is an enlarged sectional view of the sharp-edged orifice which is included in the embodiment of FIG. 2 and which is similar to the sharp-edged orifices embodied in FIGS. 3 and 5.

GENERAL DESCRIPTION

Shown in FIG. 1 of the drawings is a more or less conventional, two cylinder, two-stroke engine 11 including separate cylinders 13 and 15 each having respective crankcase portions 17 and 19 and respective pistons 21 and 23 connected by respective rods 25 and 27 to a crankshaft 29 rotatably journaled in the crankcases 17 and 19. The engine 11 also includes a fuel supply system 31 including a carburetor 33 (See also FIG. 2) having an air-fuel induction passage 37 leading (See FIG. 1) through reed valves 39 and 41 to the respective crankcases 17 and 19.

The carburetor 33 can be generally of conventional construction, except as modified in accordance with the invention. As shown in FIG. 2, the carburetor includes a frame or housing 43 which defines the air-fuel induction passage 37 including a venturi section 47. The carburetor housing also includes a fuel reservoir or bowl 49 into which fuel is admitted in a conventional manner from a fuel line 51 leading from a remote fuel tank (not shown) in response to operation of a conventional float valve 53. In turn, the reservoir 49 communicates with a main or high speed nozzle or jet 57 terminating in the venturi section 47 and through a conduit 59 with a relatively large void or cavity 61 from which one or more secondary or idling nozzles or jets 63 communicate with the air-fuel induction passage 37 downstream of the venturi section 47. As has been the common practice, the secondary or idle nozzles 63 are located in straddling relation to a throttle valve 67 when the throttle valve is closed and extend from the enlarged recess or void 61 communicating with the receiver 49 through the conduit 59.

Shown schematically in FIG. 1 are re-cycling conduits 69 and 71 which are respectively connected to the crankcases 17 and 19 in the area where "ends" or "drains" of high viscosity will normally tend to collect. The conduits 69 and 71 are respectively provided with check valves 73 and 77 to afford fluid flow from the crankcases 17 and 19 while also preventing return flow. As thus far described, the construction is entirely conventional as disclosed, for instance, in part, in the before mentioned Heidner U.S. Pat. No. 3,132,635.

In accordance with the invention, means are provided for obtaining uniform fuel flow to the secondary nozzles 63, notwithstanding variation in fuel viscosity. In the disclosed construction, such means includes a sharp-edged orifice 81 which is located in the void or cavity 61 between the conduit 59 and the secondary nozzles 63.

The sharp-edged orifice 81 is provided by utilizing a relatively thin metal plate or partition 83 having therein the circular orifice 81 which is relatively small (See FIG. 6) as compared to the over-all circular size of the plate 83. One sharp-edged orifice in accordance with the invention has a wall thickness of 0.002 inches and an orifice diameter of 0.020 and an orifice wall area to

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orifice area ratio of approximately 15:1. Such a sharp-edged orifice is substantially viscosity independent at given pressure conditions at least within the range of fuel viscosity between 0.538 centistokes representing a gasoline to oil mixture of 50:1 and 3,850 centistokes representing a gasoline to oil mixture of 1:1.

In operation, the suction in the air-fuel induction passage 37 created by piston operation, causes sufficient fuel flow through the conduit 59 to fill the cross sectional area of the cavity 61 above the plate 83 and thereby provide a solid wall of fuel above the sharp-edged orifice 81.

As used herein, the term "sharp-edged" orifice is intended to refer to an orifice in a thin partition or wall. Preferably, the partition or wall is as thin as possible and the orifice is as large as possible consistent with maintaining a substantial ratio between the orifice area and the over-all size of the wall or partition in which the orifice is located. It is believed that substantial deviation from the 15:1 ratio between the overall area of the orifice wall and the orifice area is possible and that an orifice wall area to orifice area ratio as low as 3:1 is practical. Although the orifice diameter is preferably greater than the wall thickness, it is further believed that a sharp-edge orifice in accordance with the invention can have an orifice diameter to wall thickness ratio which can be as low as 1:1. Still further, it should be noted that for best results, the orifice should be clear of burrs or other irregularities.

Also in accordance with the invention, means are provided for regulating the quantity of fuel flow through the sharp-edged orifice 81 and particularly at idle conditions. In the construction disclosed in FIG. 2, such means is in the form of an air inlet passage or bleed 89 communicating with the atmosphere and with the cavity 61 upstream of the sharp-edged orifice 81. Air flow through the passage 89 can be controlled or metered by an adjustable needle valve 91 having a metering point 93 extending axially into a cylindrical portion 97 of the passage.

Air flow through the needle valve controlled passage 89 and into the cavity 61 upstream of the sharp-edged orifice 81 affects the pressure condition downstream of the orifice 81 as compared to the pressure condition upstream and therefor controls the quantity of fuel flowing through the orifice. Such fuel flow can be closely controlled by controlling the air flow through the passage and therefore the pressure differential between the upstream and downstream sides of the orifice can also be closely controlled. In this regard, increased flow of air through the passage 89 will reduce flow through the orifice 81, while reducing the air flow through the passage 89 into the cavity 61 will increase fuel flow through the orifice 81. Thus, adjustment of the needle valve 91 can be employed to control the pressure differential across the sharp-edged orifice 81 and therefor the flow rate through the orifice 81, notwithstanding variation in the fuel viscosity.

Also in accordance with the invention, the conduits 69 and 71 leading from the crankcases 17 and 19 are connected to the reservoir 49 for delivery of "ends" or "drains" from the crankcases 17 and 19 to the carburetor 33. The conduits 69 and 71 can either constitute branches from a single conduit 99 which, as shown in FIGS. 1 and 2, flows into the reservoir 49 or both conduits 17 and 19 can be independently connected to the reservoir 49. Because of the provision of the previously mentioned check valves 73 and 77 and the movement

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of the pistons 21 and 23 relative to the crankcases 17 and 19, the pulsating pressures produced in the crankcases 17 and 19 will serve to pump fuel "ends" or "drains" from the crankcases 17 and 19 to the reservoir 49, thus variably affecting the viscosity of the fuel in the reservoir 49.

Also in accordance with the invention, and in order to avoid adversely affecting carburetor operation, means are provided for relieving pressure which may accompany re-cycled fuel from the crankcases 17 and 19. While various arrangements can be employed, in the disclosed construction, and as shown schematically in FIGS. 1 and 2, the conduit 99 includes, adjacent to the carburetor 33, an inverted U-shaped portion 111 having one leg 113 directly and immediately supplying fuel to the carburetor reservoir 49 and having another leg 117 communicating with the crankcases 17 and 19. At its top, the U-shaped portion 111 communicates with a vent line 119 to the atmosphere, which line 119 relieves the fuel from any significant pressure condition prior to passage into the carburetor bowl or reservoir 49. While the pressure venting means has been disclosed in a schematic fashion and in a physical location exterior to the carburetor housing 43, the pressure venting means can readily be bodily incorporated into the frame or housing 43 of the carburetor 33.

Shown in FIG. 3 is a carburetor 133 which is also in accordance with the invention, and which is essentially identical to the carburetor 33 shown in FIG. 2, except that the carburetor 133 includes an air bleed passage 189 which communicates between the atmosphere and the downstream side of a sharp-edged orifice 181. Adjustment of a needle valve 191 serves to effect the pressure in the cavity 161 on the downstream side of the orifice 181 and permits control of the pressure differential between the upstream and downstream sides of the orifice 181 so as to afford control of fuel flow, notwithstanding viscosity variation. The arrangement shown in FIG. 3 is preferred over the arrangement shown in FIG. 2.

In the above two embodiments, the sharp-edged orifices 81 and 181 have been employed to meter fuel flow to the secondary nozzles and therefor to insure even engine operation at idling and at low speed operation, notwithstanding fuel viscosity variation. It is also in accordance with the invention to control fuel flow to the main nozzle by means of a sharp-edged orifice so as to contribute to smooth engine operation at speeds above idling, notwithstanding fuel viscosity variation. Accordingly, there is shown in FIG. 4 another carburetor 233 which is in accordance with the invention and which includes a frame or housing 243 defining an air-fuel induction passage 237 including a venturi section 247, and a fuel reservoir or bowl 249 having a fuel supply inlet 251 controlled by a conventional float valve structure 253. The carburetor 233 also includes an inlet 313 into the reservoir or bowl 249 for re-cycled fuel. An arrangement similar to that disclosed with respect to FIG. 2 can be employed to vent any pressure to which the re-cycled fuel may be subject. Communicating with the fuel reservoir 249 is a fuel conduit or passage 256 which supplies fuel to a tubular main nozzle 257 terminating in the venturi section 247 of the air fuel induction passage 237 and which communicates through a secondary fuel conduit or passage 259 with a series of secondary or idling nozzles or jets 263. Although other constructions could be employed, in the disclosed construction, the secondary fuel conduit 259

extends, in part, within the main nozzle 257. In addition, the secondary fuel conduit 259 extends through a metering aperture 268 and communicates with a plugged void or cavity 261 from which the secondary nozzles 263 extend. Control of the fuel flow rate to the secondary nozzles 263 from the conduit 259 is controlled by a needle valve 170 having a point 272 movable relative to the metering aperture 268 to control the flow of fuel through the passage 259.

In order to avoid flow rate variation because of viscosity variation, to both the main and secondary nozzles, a sharp-edged orifice 281 is provided at the entrance to the passage 256 from the fuel bowl 259, i.e., at a point upstream of the communication between the passage 256 and each of the lower end of the main nozzle 257 and the secondary fuel conduit 259 leading to the idle nozzles 263. While the orifice 281 is shown at the entrance to the passage 256, it should be understood that the orifice 281 could be located in the passage 256 upstream from the beginning of the main nozzle 257 and of the secondary conduit 259 leading to the idle nozzles 263.

Also provided is an air bleed arrangement permitting adjustment of the pressure differential between opposite sides of the orifice 281. While various arrangements can be employed, in the disclosed construction, there is shown in FIG. 4 an air tube 289 having one end 291 located in the air-fuel induction passage 237 upstream from the venturi section 247 and extending through a metering aperture 297 into the fuel passage 256 at a point located between the sharp-edge orifice 281 and the juncture of the passage 256 with the main nozzle 257 and the secondary fuel conduit 259. As in the other embodiments, there is provided an adjustable needle valve 291 having a pointed end 293 movable relative to the metering aperture 297 so as to control the amount of air which is drawn into the passage 256 and thereby to affect the pressure differential between the opposite sides of the sharp-edged orifice 281. As has been previously explained, such pressure differential controls the flow rate through the orifice 281 independently of fuel viscosity variation. It is to be noted that the air tube 289 leading to the passage 256 has its inlet in the air-fuel induction passage 237 so as to tend to provide increasing amounts of air with increasing suction in the air-fuel induction passage.

If desired, a sharp-edged orifice and an air venting or bleeding arrangement, such as already disclosed, can be located so as to control fluid flow to the main nozzle only without affecting flow to the secondary nozzle. Referring to FIG. 4, the secondary conduit 259 could be communicated with the reservoir 249 separately from the main nozzle 257 and independently of the sharp-edged orifice controlling flow to the main nozzle, the length of the main nozzle 257 could be shortened and a sharp-edged orifice could be located at the point 300 beneath the shortened lower end of the main nozzle. In addition, an air bleed could be introduced between the sharp-edged orifice and the shortened lower end of the main nozzle.

In general, in all of the above disclosed embodiments, there is a wall of fuel behind the sharp-edged orifice which, together with the orifice structure, will result in a given flow independently of the viscosity variation and in accordance with the pressure differential existing between opposite sides of the orifice. In each of the embodiments, there is also disclosed means for metering controlled amounts of air in relation to the orifice

so as to control the pressure variation between opposing sides, whereby to control fuel flow at an essentially constant value under given pressure conditions, notwithstanding viscosity variation.

Shown in FIG. 5 is still another embodiment of the invention. Specifically, disclosed in FIG. 5 is a two-stroke engine 401 including a cylinder 403 having a crankcase 405 and a piston 407 operable in the cylinder 403 and connected by a rod 409 to a crankshaft 411 journaled in the crankcase 405. An air-fuel mixture is supplied to the crankcase 405 from a carburetor 431 and through a check or reed valve 433. Fuel-air mixture flow from the crankcase 405 to the cylinder 403 is primarily through a transfer passage 435. In addition, "drains" or "ends" are drained through a check valve 437 to a conduit 439 leading from the crankcase 405.

In accordance with the invention, the "drains" are arranged to return to the cylinder 403 at a point 441 adjacently spaced from the transfer passage 435 toward the head end of the cylinder 403, which drains are returned through a sharp-edged orifice 481 in an enlarged well 483 so as to provide for substantially uniform flow from the conduit 439 to the cylinder 403 in response to the pressure condition created in the conduit 439 by the pumping action of the crankcase 405 and when the conduit 439 is open to the cylinder 403 as when the piston 407 is adjacent bottom dead center.

In some instances, where large quantities of drains are produced, it may be desirable to route some of the drains to a carburetor constructed in general accordance with FIGS. 2, 3 and 4, while routing another portion of the drains directly back to the cylinder as shown, for instance, in FIG. 5.

In addition to being applicable to two-stroke engines, the invention is applicable to four-stroke engines which may be subject to variation in fuel viscosity as, for instance, when changing between kerosene to gasoline upon variation in engine speed. Still further, it should be pointed out that the advantages of using a sharp-edged orifice with or without an air metering valve, are not limited to applications in connection with re-cycled fuels. Sharp-edged orifices in accordance with the invention are also applicable for use with "fresh" fuels and particularly where variation in the viscosity of the "fresh" fuel mixture can occur. In all of the above embodiments, the drains can be pumped by means other than the disclosed two-stroke crankcase pumping action.

It should also be pointed out that just as a carburetor is calibrated to a particular engine, the size of the sharp-edged orifice will also normally have to be calibrated to a particular engine. Still further, it is possible to use several small orifices in a single partition or wall in order to get the desired total amount of flow.

Various of the features of the invention are set forth in the following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A two-cycle internal engine including a crankcase having a portion in which "drains" accumulate, a cylinder extending from said crankcase, a piston movable in said cylinder and relative to said crankcase, a transfer passage communicating, subject to piston operation, between said crankcase and said cylinder, a conduit communicating with said crankcase portion, valve means in said conduit preventing flow to said crankcase

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and permitting flow from said crankcase, said conduit
communicating with said cylinder independently of

said transfer passage.

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Dedication

3,929,111.—*Robert K. Turner*, Waukegan; *Edgar Rose*, Glencoe, Ill. FUEL FEED SYSTEM FOR RECYCLING FUEL. Patent dated Dec. 30, 1975. Dedication filed Apr. 10, 1984, by the assignee, *Outboard Marine Corp.*

Hereby dedicates to the Public the remaining term of said patent.
[*Official Gazette July 3, 1984.*]