Nov. 5, 1968 R. L. WESTON ET AL 3,409,040

FUEL SUPPLY SYSTEM FOR INTERNAL COMBUSTION ENGINE

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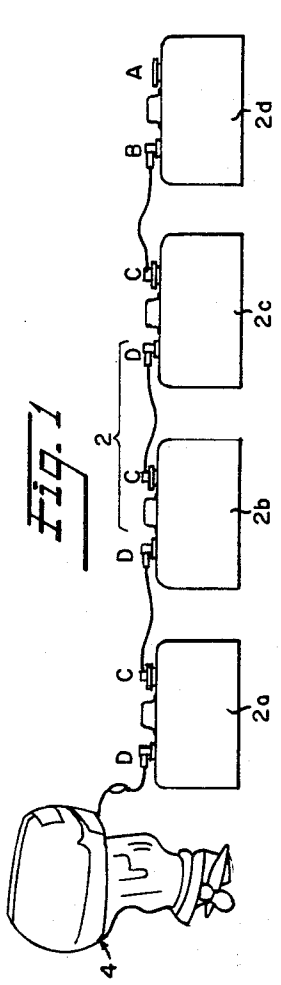


Fig. 1

Fig. 2

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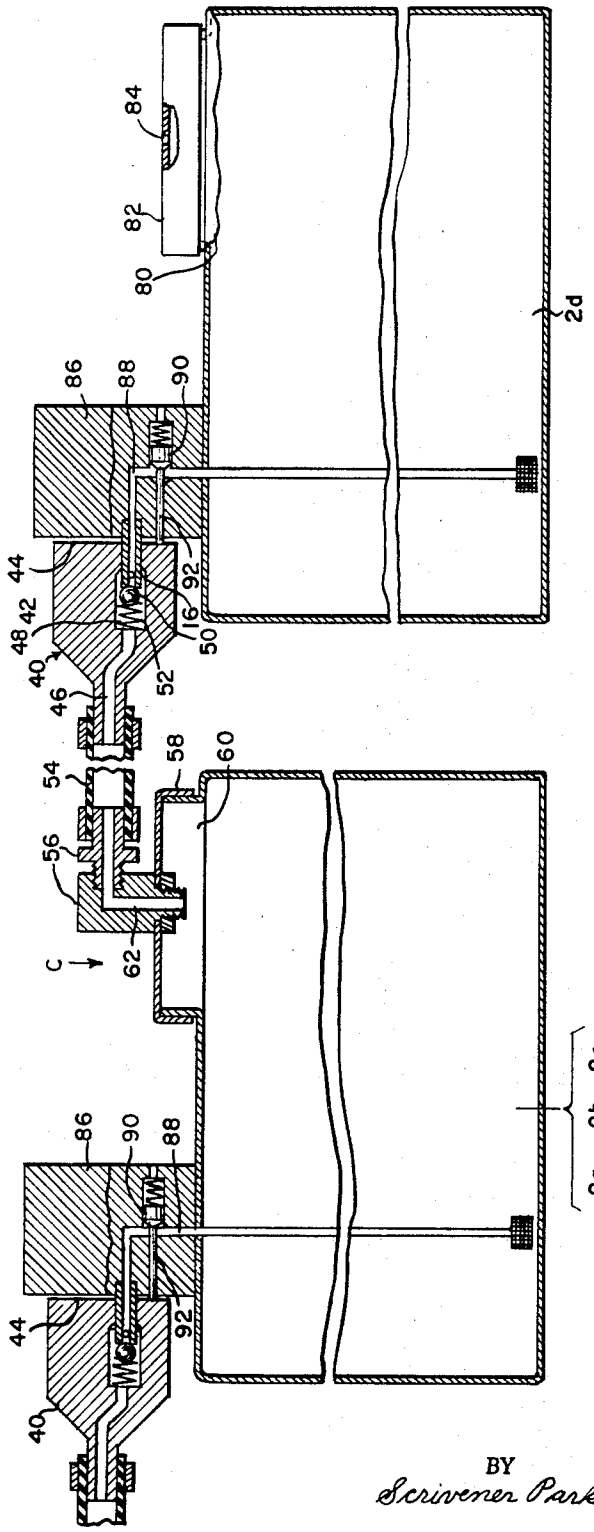


Fig. 3

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FUEL SUPPLY SYSTEM FOR INTERNAL COMBUSTION ENGINE

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ABSTRACT OF THE DISCLOSURE

A portable and expandible fuel supply system for an internal combustion engine comprising a plurality of portable fuel tanks arranged in series, each tank being connected to the next in the direction toward the engine and the last tank being connected to the fuel inlet of the engine. The connection between adjacent tanks permits fuel to be drawn from the tanks in succession, emptying first the tank most remote from the engine and then each successive tank in the direction of the engine.

This invention relates broadly to systems and apparatus for supplying liquid fuel to an internal combustion engine and, more particularly, provides a new and improved system and apparatus for supplying liquid fuel to an engine which draws in liquid fuel by means of a fuel pump. While the invention is useful to supply liquid fuel to any type of internal combustion engine, and is applicable to any type of fuel tank, it will be described herein in connection with an engine of the outboard marine type.

In the usual outboard marine engine installation a single fuel tank is connected to the fuel intake of the outboard engine and fuel is drawn from the tank by operation of the fuel pump. In the use of such a fuel supply system it has found on numerous occasions that the single fuel tank will be drained to dryness without knowledge of the operator of the boat. When this occurs it is necessary to disconnect the dry tank from the engine and replace it with a tank containing fuel, which, of course, is time consuming and causes a possibly dangerous situation under conditions of heavy traffic or rough seas. In fact, even if the depletion of fuel to dryness is anticipated by the pilot the necessity to change tanks can be potentially dangerous, and it has been recognized that some means of enlarging the fuel supply without enlargement of the tanks, which would be undesirable because of the necessity that they be easily portable, would be of considerable advantage and very desirable.

It has therefore been an object of this invention to provide a fuel supply system for an internal combustion engine such as an outboard marine engine the capacity of which system may be enlarged to any desired extent and which will include any number of conventional fuel tanks connected in series and to the engine so that any desired amount of fuel will be available for operation of the engine. In accordance with the invention a number of filled fuel tanks may be connected in series and the end tank of the series connected to the fuel intake port of the engine, the operation of the system being such that fuel is drawn successively from the tanks beginning with the tank most remote from that connected to the engine.

The invention is described in the following specification and is illustrated in the accompanying drawings, in which:

FIG. 1 is a schematic view showing a number of fuel tanks connected together in series with the end tank connected to the fuel intake of an outboard motor, all in accordance with the invention;

FIG. 2 is an enlarged view of two tanks of one conventional type connected in series and modified in accordance with the invention, these being representative of any number of tanks, and showing particularly the fittings and other parts which are provided by the invention for connecting successive tanks, and

FIG. 3 is a view which is similar to FIG. 2 but shows the connection, in accordance with the invention, of a number of fuel tanks of a second conventional type.

In accordance with the invention any number of fuel tanks **2** many be connected in series, four such tanks being shown in FIG. 1 at **2***a*, **2***b*, **2***c* and **2***d*. The tank **2***a*, which is the closest in the series to the outboard engine **4**, is connected to the fuel intake of the engine.

Means are provided by the invention for causing operation of the fuel pump of the engine **4** to draw fuel from the series-connected tanks in such a way that the tank most remote from the motor, which is the tank **2***d* in FIG 1, is emptied first, followed by the tanks in succession as the engine is approached. Thus, in the system shown in FIG. 1 the tanks would be emptied in the order of **2***d*, **2***c*, **2***b* and **2***a*. This operation of the system is produced by means of the connections between adjacent tanks which are provided by the invention.

These connecting means between successive tanks are disclosed in FIG. 2 of the drawings and it will be understood that while only two tanks are shown in this figure the connections disclosed are applicable to any number of tanks between the last tank **2***d* and the engine **4**. Therefore, in FIG. 2 the last tank **2***d* in the series is shown and the other tank, which is indicated collectively by the numerals **2***a*, **2***b*, **2***c*, is representative of all tanks between the last tank **2***d* and the engine.

In order fully to understand the invention it is believed to be necessary to describe first the conventional single-tank system and its operation, and reference is therefore made to the tank **2***d* and its associated parts, as shown in FIG. 2, as this disclosure is of a conventional tank of one usual type. This tank is provided in its top wall with a filler opening **6** having an imperforate filler cap **8**, both of which are conventional and are indicated generally by the letter A in the drawings. To the top wall there is also permanently connected an external valve body fitting **10** having a fuel passage **12** therethrough which terminates interiorly of the tank in a depending tube **14** which extends to the bottom of the tank, and terminating at its other end in the side wall of the fitting **10** with an exterior nipple **16**. Within the body of the fitting there is a valve **18** which is normally urged by spring **20** to close the fuel passage **12** and which has a stem **22**, the end of which extends outwardly from the valve body adjacent and parallel to the fuel nipple **16**. An air passage **30** extends through the body **10** and communicates with atmosphere at its upper end and with the interior of the tank above the fuel therein at its lower end. This air passage is normally closed by a valve **32** which is constantly urged to closed position by a spring **34** and this valve also has a stem **36**, the end of which extends outwardly of the valve body parallel to the fuel nipple **16** and the stem **22** of valve **18**. This fuel and air valve fitting **10** is conventional and its structure per se forms no part of the invention. It is designated by the letter B in the drawings.

The fuel and air valves of this conventional fuel and air valve fitting B and the corresponding, but modified, valve fittings of the other tanks **2***a*, **2***b*, **2***c* of the fuel supply system provided by the invention are adapted and intended to be operated by a hose fitting which is indicated generally at **40** in FIG. 2 and which is of conventional construction in the specific fuel tank construction being described. This fitting comprises a body **42** having a flat end surface **44** and also having a passage **46** therethrough having an enlarged chamber **48** within which is a ball **50** which is constantly urged by a spring **52** toward end wall **44** to a seated position closing passage **46**. The end of the hose fitting **40** opposite to end wall **44** is reduced

in diameter to receive the end of a hose **54**, the other end of which is connected, or may be releasably connected, to a nipple **56** on the filler cap **58** which closes the filler opening **60** of the next adjacent fuel tank in the direction of the engine **4** and which is designated C on tanks **2***a*, **2***b*, **2***c* in all figures of the drawings. The nipple **56** and filler cap **58** have a passage **62** therethrough which communicates with the hose **54** and also with fuel nipple **16** when the hose fitting **40** is in the operative position shown in FIG. 2. All of these described parts are conventional with the exception of the modified filler cap **58**, its nipple **56** and the passage **62** through the nipple, it being understood that in the conventional single-tank fuel supply systems of the prior art type being described the hose **54** leads directly to the fuel intake of the engine and the filler cap is imperforate.

The foregoing description applies, in part, only to the last tank **2d** of the series of tanks, and certain of the parts described above are modified in accordance with the invention in order to achieve its objectives. In FIG. 2 there is shown a fuel tank, indicated by the collective numerals **2***a*, **2***b*, **2***c*, which represents and discloses the construction of the parts of all fuel tanks of the system except the tank **2d** which is most remote from the engine. In FIG. 2 tank **2***a*, **2***b*, **2***c* is shown connected to the engine **4** but could be connected to another tank closer to the engine, which in turn could be connected to the engine. This tank has the filler opening **60**, filler cap **58**, nipple **56** with fuel passage **62**, fuel tube **14** within the tank, valve body fitting **10**, fuel passage **12** communicating with fuel tank tube **14** and nipple **16**, valve **18** which is normally urged by spring **20** to a position closing the fuel passage **12** and which has stem **22** protruding from the valve body fitting adjacent the nipple **16**, hose fitting **40** having passage **46** therethrough, ball valve **50** which is normally seated by spring **52** to close passage **46**, and end wall **44**.

All of these parts of the valve body fitting **10** and hose fitting **40** of tanks **2***a*, **2***b*, **2***c* have exactly the same construction as the corresponding and correspondingly numbered parts of tank **2d**, but the valve body fitting **10** of each of tanks **2***a*, **2***b*, **2***c* is modified in an important way in accordance with the invention. In this modification, the air passage **30** of the valve body fitting is permanently closed so that no air may be admitted to the interior of the tanks **2***a*, **2***b*, **2***c*. This closing of the air passage may be done in any desired or suitable way but is most easily done by cutting the stem **36** of the air passage valve **32** flush with the wall of the valve body fitting through which it extends, as shown in FIG. 2, so that this valve will not be opened when the end wall **44** of the hose fitting is brought into operative position adjacent the valve body fitting **10** as shown in FIG. 2.

In the use and operation of the described system and parts any number of fuel tanks may be used and arranged in series with respect to the engine and may be filled to any desired depth, leaving air space above the fuel in each tank. The imperforate filler cap **8** is put in place to close the filler opening **6** of the last tank **2d** of the series, which is the tank most remote from the engine. This tank already has a place, as a permanent fixture, the valve body fitting **10** and its associated parts, including the two protruding valve stems **22**, **36**, all as shown in FIG. 2. The fitting **40** of hose **54** is now brought adjacent the valve body fitting **10** and the nipple **16** is inserted in the opening in end wall **44** of the fitting which communicates with the passage **46** in the hose fitting, causing the end of the nipple to unseat the ball valve **50** thereby communicating the fuel passage **46** in the hose fitting **40** and the hose itself to the fuel passage **12** in the valve body fitting. At the same time, the end wall **44** of the hose fitting **40** engages the ends of the valve stems **22**, **36** and depresses these, opening the valves **18**, **32** against the forces of springs **20**, **34** and thereby opening the fuel passage **12** and the air passage **30**. With the opening of these valves and the unseating of ball valve **50** air is introduced to the upper part of tank **2d** above the level of fuel therein and fuel can flow from tank **2***d* to the next tank **2***c* in the direction of the engine through tube **14**, fuel passage **12**, nipple **16**, chamber **48**, fuel passage **46**, hose **54**, nipple **56** and passage **62** in the filler cap **58** which closes the filler opening **60** of tank **2***a*, **2***b*, **2***c*.

The connections of each of the succeeding tanks **2***c*, **2***b*, **2***a* in the direction of the engine to the next succeeding tank in the same direction are identical. These are the connections between the valve body fitting D of each tank and the modified filler cap fitting C of the next tank in the direction of the engine. These fittings D and C are shown in connection with tank **2***a*, **2***b*, **2***c* in FIG. 2 of the drawings and, as described above, it will be seen that in each fitting D the valve controlling the air passage in valve body fitting **10** has been made inoperative, preferably by cutting off the valve stem, so that it will not be engaged by end wall **44** of the hose fitting **40** when that fitting is connected to the valve body fitting **10**. When that connection occurs the nipple **16** will enter the fuel passage **46** in the hose fitting and will engage and unseat the ball valve **50** while, at the same time, the end wall **44** of the hose fitting will depress the valve stem **22** to open the fuel passage valve **18**. When these things occur fuel may pass from any of the tanks **2***a*, **2***b*, **2***c* to the next succeeding tank in the direction of the engine or to the engine itself in the case of the tank **2***a* which is adjacent the engine.

When the engine is operating, suction from the fuel pump will be exerted through the open fuel passages and hoses of the connected tanks. As none of the tanks **2***a*, **2***b*, **2***c* are open to air above the level of fuel therein, while the end tank **2***d* is open to air above the level of fuel therein through the open fuel passage **30**, atmospheric pressure on the fuel in the last tank **2***d* will cause fuel to flow from that tank to the next tank **2***c*, to the next tank **2***b*, to the next tank **2***a*, and thence to the engine. The end tank **2***d* will therefore be the first to be depleted of fuel, followed in succession by depletion of the succeeding tanks **2***c*, **2***b*, **2***a* in that order.

The invention has been described above in connection with one of the principal conventional types of gas tank, in which the filler cap of the tank most removed from the engine is imperforate and air is admitted into that tank above the fuel through the air passage **30** in the valve fitting, which passage is controlled by the valve **32**. In other conventional gas tank structures which are also commercially available, air is admitted above the fuel in the tank most removed from the engine through an opening in the filler cap and there is no air passage through the valve fitting.

The application of the invention to a series of gas tanks of this second conventional type is disclosed in FIG. 3, of the drawings. In this figure there are shown the gas tanks **2***d* and **2***a*, **2***b*, **2***c*, these numerals being used to indicate the same relative positions of the tanks as is shown in FIG. 1 of the drawings. Tank **2***d* has filler opening **80** in its top wall which is closed by filler cap **82** having an opening **84** therethrough by which air is constantly admitted to the tank above the level of fuel therein when the engine is in operation. To the top wall of the tank there is also permanently connected an external valve body **86** which has a fuel passage **88** therethrough which is controlled by valve **90** which is normally spring pressed to closed position but which may be engaged and opened by parts carried by the fitting **40**. In the embodiment disclosed in FIG. 3 the valve has a stem **92** which protrudes beyond the wall of the fitting in the closed position of the valve and which is adapted to be engaged by the end wall of the member **44** to open the valve.

Each of the tanks **2***a*, **2***b*, **2***c*, which are connected in series between the tank **2***d* and the engine **4**, has a filler opening **60**, a filler cap **58** and other parts having the same construction as those carried by the filler cap **58** and con-

nected to the fitting **40** and therefore being designated in FIG. 3 by the same numerals as those used in FIG. 2.

The upper wall of each of tanks **2***a*, **2***b*, **2***c* is also provided with a fitting **86** which has the same construction as fitting **86** on tank **2***d* and which therefore need not be described in detail here. None of the fittings **86** on tanks **2***a*, **2***b*, **2***c* or **2***d* has an air passage therethrough.

It will be seen that in the use of the embodiment of the invention shown in FIG. 3 the tanks will be connected in series, as shown in FIG. 1, in the same way as the embodiment of the invention shown in FIG. 2, the only difference being that in the embodiment of FIG. 3 air is admitted to the end tank **2***d* through an opening in the filler cap and is not admitted through an air passage in the fitting **86**, there being no such valved air passage in the type of fuel tank now being described. Therefore, in the use of the embodiment shown in FIG. 3 there is no need to block off or otherwise render inoperative the air passage in the fitting, as is done with tanks **2***a*, **2***b*, and **2***c* of FIG. 2.

It will be understood that the illustrations of valves and other parts in the drawings are schematic and are simplified for purposes of illustrating the invention and do not necessarily show the exact structures or relations of parts of commercially available tank structures.

It will be apparent that by this invention we have provided a system giving any desired amount of added fuel capacity without the necessity of installing larger tanks, whereby the fuel capacity of any boat may be made as large as desired. In addition, the individual fuel tanks, being of normal portable size, may be easily removed for filling or for movement from boat to boat. All of this is accomplished with conventional equipment which must be only slightly modified in order to produce the advantages of the invention.

While we have described and illustrated certain embodiments of the invention it will be apparent to those skilled in the arts to which the invention relates that other embodiments, as well as modifications of those disclosed, may be made and practiced without departing in any way from the spirit or scope of the invention, for the limits of which reference must be made to the appended claims.

What is claimed is:

1. A suction-type fuel supply system for an internal combustion engine, comprising a plurality of fuel tanks each having two openings in the top wall thereof, one of said tanks being adjacent the fuel intake of the engine and one being most remote from the engine in the series of tanks, each of the tanks except that most remote from the engine having in one of its top wall openings a fitting having a fuel passage therethrough terminating at its one end in a nipple external to the fitting and at its other end in a tube extending to the bottom of the interior of the tank, a spring pressed valve in each of said fittings normally closing the fuel passage therethrough and having a valve stem extending externally of the fitting adjacent said nipple, each of the tanks except that most remote from the engine having its other top wall opening closed by a filler cap having a passage therethrough terminating in a hose fitting which is exterior of the cover, the tank most remote from the engine having in one of its top wall openings a fitting having a fuel passage therethrough terminating at its one end in a nipple external to the fitting and at its other end in a tube extending to the bottom of the interior of the tank and also having an air passage therethrough open at its one end to atmosphere and at its other end to the interior of the tank above the level of fuel therein, two spring pressed valves within said last named fitting which respectively normally close said fuel and air passages therethrough and each of which has a valve stem extending exteriorly of the fitting in a direction parallel to the fuel passage nipple and which may be depressed to open said valves, the tank most remote from the engine having an imperforate filler cap for its second top wall opening, and hose connections between the fuel passage of the fitting of each tank and the filler cap passage of the next adjacent tank in the direction of the engine, each of said hose connections having at its one end a member for connection to the fitting of the next adjacent tank in the direction away from the engine, said hose member when connected to the fitting of the tank most remote from the engine being operable to depress the two valve stems thereon to open both the fuel and air passages through the fitting and when connected to the other fittings to depress the single valve stem thereon to open the fuel passage therethrough, each of said hose connections having at its other end a member for connection to the filler cap passage of the next adjacent tank in the direction of the engine, and a hose connection between the fuel intake of the engine and the member which is connected to the top wall opening fitting on the tank which is adjacent the fuel intake of the engine, whereby operation of the engine to produce suction at its fuel intake will empty the tanks in the order of first the tank most remote from the engine and then the succeeding tanks in the direction of the engine.

2. A suction-type fuel supply system for an internal combustion engine, comprising a series of fuel tanks each having two openings in the top wall thereof, one of said tanks being adjacent the fuel intake of the engine and one being most remote from the engine in the series of tanks, each of the tanks having in one of its top wall openings a fitting having a fuel passage therethrough terminating at its one end in a nipple external to the fitting and at its other end in a tube extending to the bottom of the interior of the tank, a spring pressed valve in each of said fittings normally closing the fuel passage therethrough, each of the tanks except that most remote from the engine having its other top wall opening closed by a filler cap having a passage therethrough terminating in a hose fitting which is exterior of the cap, the tank most remote from the engine having for its second top wall opening a filler cap having an air passage therethrough, and hose connections between the nipple of the top wall opening fitting of each tank and the filler cap passage of the next adjacent tank in the direction of the engine, each of said hose connections having at its one end a member for connection to a top wall opening fitting which when connected to the fitting of the tank adjacent the engine or one more remote from the engine operates the valve therein to open the fuel passage through the fitting, each of said hose connections having at its other end a member for connection to the filler cap passage of the next adjacent tank in the direction of the engine, and a hose connection between the fuel intake of the engine and the member which is connected to the top wall opening fitting on the tank which is adjacent to the fuel intake of the engine, whereby operation of the engine to produce suction at its fuel intake will empty the tanks in the order of first the tank most remote from the engine and then the succeeding tanks in the direction of the engine.

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