Nov. 24, 1964 G. R. ANDERSON 3,158,193

FUEL SUPPLY SYSTEM

Filed July 14, 1961

FIG. 1

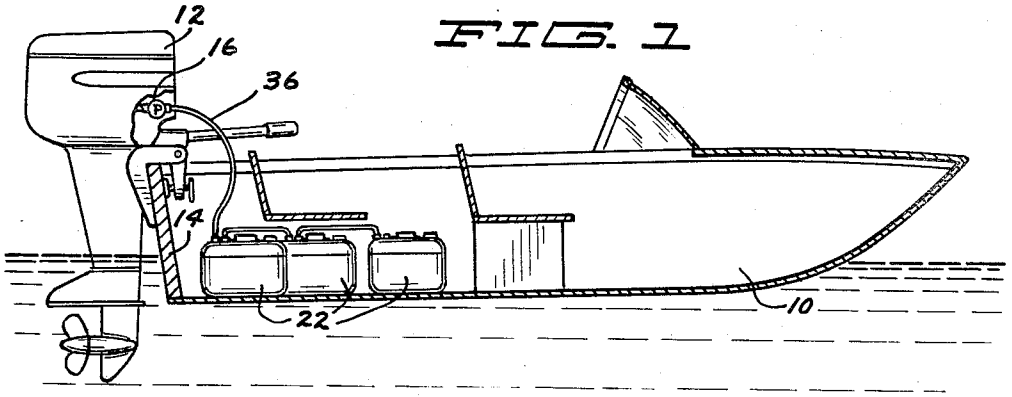


FIG. 2

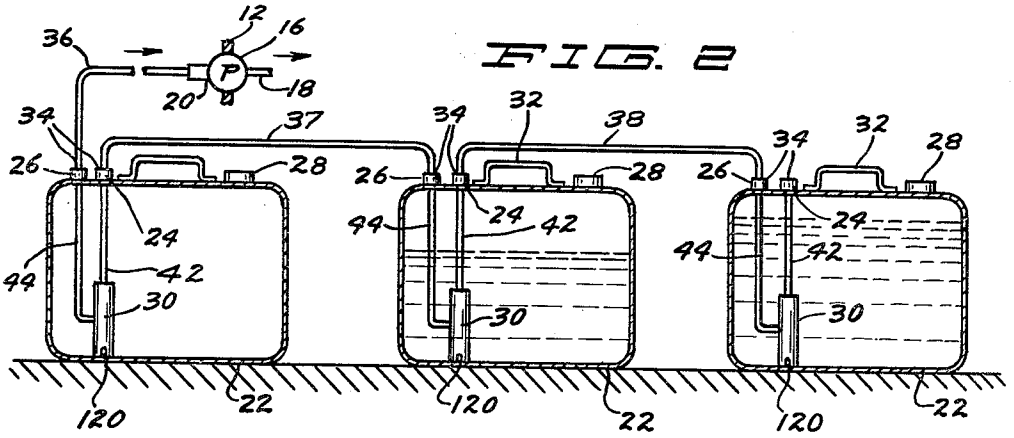


FIG. 3

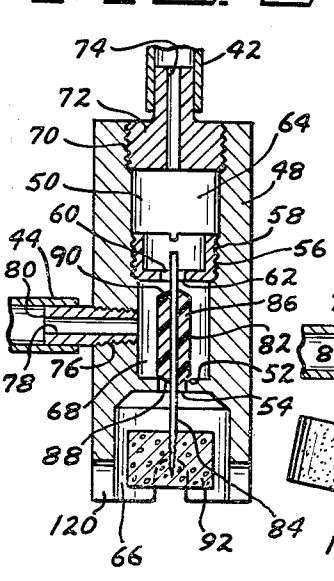
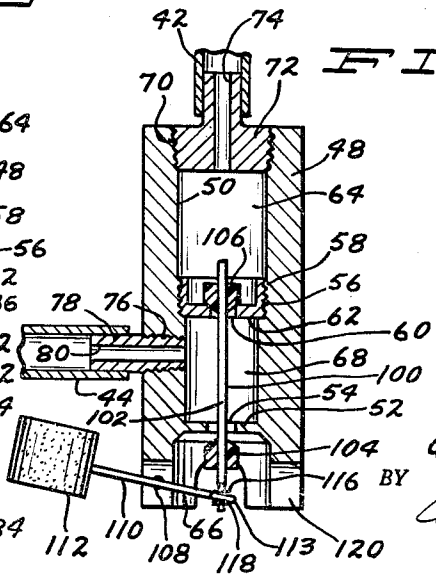


FIG. 4



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FUEL SUPPLY SYSTEM

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This invention relates to fuel supply systems and storage tanks and more particularly to apparatus enabling fuel to be withdrawn from a plurality of tanks one at a time.

While the invention is suitable for a variety of applications, it is particularly well suited for use in supplying fuel to the motor of a motor boat or the like. Many small boats, such as runabouts, and the other outboard motor boats do not have enough available space for a single large fuel tank. Thus, for the small boat operator, who cannot employ a single relatively large tank, or the boat operator who must carry gasoline to his boat, it is necessary to keep several small fuel tanks in the boat in order to run the motor for extended periods of time.

It is, of course, imperative that such tanks be easily carried when filled with fuel. In general, tanks of over about six gallons in capacity cannot be considered portable. When an engine of relatively large horsepower is employed, the motor will often consume more than one tank of fuel in a day's boating thus requiring the operator to stop, disconnect the fuel line running from the tank to the motor and transfer the line to a new fuel tank after the fuel in each tank is consumed. This operation is, of course, time consuming and even more important can be a potential hazard under many boating conditions, for example, in passing a large ship, traveling in heavy currents, or when towing water skiers. Thus, occasionally, when power is most needed, all of the fuel in the tank will be consumed and the motor will stop.

Automatic tank transfer systems have been previously proposed and have come into relatively common use in aircraft. However, as far as I am aware, none of such tank transfer systems are satisfactory for the purpose of my invention. Many such systems require pressurization of the fuel tank in order to withdraw fuel therefrom. In applications such as boating, it is impractical as well as hazardous to pressurize the tanks. Moreover, the tanks must be portable, independently movable, and easily detachable. The required valves must be relatively simple in construction and low in cost in order to be of practical value. Moreover, the redirecting or transfer of flow from one tank to the next must be entirely automatic, reliable in operation and must not cause interruption of fuel flow during the transition period. Furthermore, for several reasons it is desirable to empty each of the tanks entirely before any fuel is withdrawn from one of the other tanks. First, because evaporation of volatile fractions from the fuel in a half emptied tank will cause the remaining fuel to become stale, second, because fire hazards will be reduced and third, because it will then be unnecessary to partially fill all of the tanks each time the boat is used. Thus, according to the present invention, some of the tanks may still be completely full after an extended run and only the others need be filled.

It is thus an important object of the present invention to provide an improved tank transfer system wherein fuel is stored in a plurality of tanks and withdrawn from such tanks one after another in succession and wherein each such tank is completely emptied before fuel is withdrawn from one of the other tanks.

It is another object of this invention to provide an improved fuel transfer system wherein fuel can be withdrawn from successive tanks by a single pump connected between the tanks and the engine or other device requiring fuel and wherein no pressurization in the tanks is required to assist in withdrawing fuel from the tanks.

It is another object of this invention to provide an improved fuel and storage transfer system wherein fuel is withdrawn from a plurality of fuel storage tanks one at a time and wherein transition of withdrawal from one tank to one of the other tanks will take place without interrupting the flow of fuel.

It is still another object of this invention to provide an improved fuel transfer system employing a plurality of similar portable interchangeable fuel tanks each including a fuel transfer valve therein and wherein said valve is relatively simple in construction and low in cost.

Briefly stated, the present invention provides a fuel tank transfer system including a plurality of separate independently movable or permanently fixed storage tanks. Each of the tanks has an open fuel inlet connection and an open fuel outlet connection and each tank includes a float operated valve. This valve is preferably contained within the tank. Each of the float operated valves includes a second valve seat communicating between the inlet connection and outlet connection of the tank. A movable valve element provided in the valve includes a second valve head adapted to cooperate with the second valve seat. A first valve seat communicates with the outlet connection of the tank and the interior of the tank. A movable valve element including a first valve face is adapted to cooperate with the first valve seat.

For simplicity of construction, it is preferred that a single movable element be used.

A float is operatively connected to each movable valve element to move the second valve face into contact with the second valve seat when the float is urged upwardly by the fuel in said tank and out of contact with the second valve seat when the float is moved downwardly thereby allowing fluid to flow from the tank inlet connection to the tank outlet connection when the level in the fuel falls below the level of the float.

A float is operatively connected to the first said movable valve element to move said first valve face onto the said first valve seat when the second valve face is out of contact with the said second valve seat and away from said first valve seat when the second valve face is in contact with the second valve seat. For the convenience of construction, it is preferred that a single float be provided in each of the tanks. A plurality of such tanks are adapted to be connected together with the inlet connection of each tank secured to the outlet connection of a succeeding tank and the outlet connection of one of the tanks is adapted to be connected to an engine or to other device requiring fuel.

Specifically, each of the tanks includes a valve comprising a housing having two inlet openings therein and a single outlet opening. One of these inlet openings communicates with the interior of the tank and the other of said inlet openings is adapted to be connected to the outlet connection of one of the other of the tanks.

During operation, fuel is selectively withdrawn from each of the tanks in succession. As each tank is emptied, fuel is then withdrawn from the next adjacent or succeeding tank responsive to the lowering of the float as the last portion of the fuel is drawn from the tank and without an interruption of the flow of fuel during the time this transition is made.

According to a preferred form of the invention, the valve comprises a housing having an opening or bore therethrough with first and second spaced apart valve seats therein. Each of these valve seats is provided with a valve port or opening therein. The bore is divided into a pair of end chambers on either side of valve ports and a central chamber between the valve ports. The valve is preferably positioned within the tank with the

bore disposed vertically so that one of the end chambers comprises an upper end chamber and other of the end chambers comprises a lower end chamber, the lower end chamber communicating with the interior of the tank and the upper end chamber communicating with the inlet connection of the tank. The outlet connection of the tank communicates with the central chamber.

When a single movable valve element is used, it is preferably slidably mounted within the bore and is provided with a valve head at each end. The valve heads are preferably positioned within said central chamber, in which case, the float can be rigidly connected to the lower end of the movable valve element. If desired, the valve heads can be spaced apart and each positioned in one of the end chambers and in this instance the float is preferably connected to one end of a lever arm, the other end of which is operatively connected to the lower end of the movable valve element.

The invention will be best understood by reference to the specification which sets forth a preferred form of the invention and to the drawings wherein—

FIG. 1 is a vertical longitudinal sectional view of a boat and motor utilizing the present invention.

FIG. 2 is a semi-diagrammatic vertical sectional view of the fuel transfer system according to the present invention.

FIG. 3 is a vertical sectional view of a fuel flow transfer valve of the present invention.

FIG. 4 is a vertical sectional view of another form of flow transfer valve of the present invention.

Referring now to the drawings, there is shown in FIG. 1 a boat **10** and motor **12** secured to the transom **14** of the boat **10**. Means for transferring or pumping fuel comprises a fuel pump **16** secured to the motor **12**. A pump outlet duct **18** is connected between the outlet of pump **16** and the carburetor (not shown) of the motor **12**. The inlet of the pump **16** is provided with a quick disconnect coupling **20** of known construction.

A plurality of similar interchangeable portable fuel tanks **22** provide fuel for the engine **12**. While any number of such tanks can be used, three such tanks are shown by way of example. Each of the tanks **22** is provided with an open inlet connection **24** and an open outlet connection **26**, a removable fill cover **28**, a fuel transfer valve **30** within the tank and carrying handle **32** connected to the upper surface of the tank.

The inlet connection **24** and outlet connection **26** of each of tanks **22** are preferably provided with quick disconnect couplings **34**. A duct or line **36** is secured between the inlet connection **26** of the tank **22** at the left in FIGS. 1 and 2, and the pump **16**. Another fuel duct or line **37** is secured between the inlet connection of the same tank and the outlet connection **26** of the center tank of FIGS. 1 and 2. A similar fuel line or duct **38** is connected between the inlet connection of the latter tank and the outlet connection of the tank **22** at the right of FIGS. 1 and 2. The lines **36**, **37** and **38** may be easily and quickly disconnected at either end thereof when it is desired to fill the tanks or remove them from the boat. The tanks, of course, are filled through the opening cover by the fill cap **28**.

Connected between the inlet connection **24** and the valve **30** of each tank **22** is an inlet duct **42** and connected between the outlet connection **26** and each of valves **30** is an outlet duct **44**.

The tanks are thus connected together in series, the outlet of one tank being connected to the inlet of the next adjacent tank and as many tanks as required can be thus connected together in series. It is understood, however, that the inlet connection of the tank at the end of such a series of tanks will have no fuel line connected thereto and also the tank at the opposite end of such a series of tanks will have its outlet connection connected to the inlet of the engine **12**.

Ducts **42** and **44** are preferably metal conduits which in addition to serving as fuel lines are used to position the valve **30** securely within the tank. As shown in FIG. 2, the valve **30** is positioned at the bottom of the tank **22** with the lower end thereof against the lower surface of tank **22**.

Reference is now made to FIGS. 3 and 4 which show two valves **30** according to the present invention. These valves are similar in construction except as described hereinbelow. The valves **30** include a housing **48** which is cylindrical in cross-section and of somewhat greater height than width. The housing **48** is provided with a vertically extending opening or bore **50** therein which extends from one end to the other. The bore **50** is provided with a reduced diameter to form a first valve seat **52** and a first valve port **54**. The bore **50** is screw threaded at **56** to receive a removable valve seat member **58**. Valve seat member **58** includes a second valve port **60** and second valve seat **62**.

The first and second valve seats **52** and **62** respectively divide the bore **50** into a pair of end chambers **64** and **66** and a central chamber **68** between the valve seats **52** and **62**. The valve chamber **64** comprises an upper valve chamber and the valve chamber **66** comprises a lower valve chamber. The upper end of the bore **50** is screw threaded at **70** to receive an adapter **72** to which the inlet duct **42** is secured. The adapter **72** is provided with an opening **74** therein to allow communication between the duct **42** and the upper chamber **64**.

The housing **48** is bored and threaded at **76** to receive an adapter **78** to which the outlet duct **44** is secured. The adapter **78** is provided with an opening **80** to allow communication between the outlet duct **44** and the central chamber **68**.

Referring now particularly to FIG. 3, it will be seen that the valve **30** is provided with a movable valve element **82**. While the movable valve element may be constructed in various ways, according to one form of the invention, it comprises a shaft **84** concentrically and slidably mounted within the bore **50** and extending through the ports **60** and **54**. Shaft **84** is of a sufficiently small diameter so that it will not obstruct the flow of fuel through the ports **54** and **60**. Secured rigidly to shaft **84** and positioned within the central chamber **68** is a valve sealing element **86** preferably formed from resilient material such as rubber. The valve sealing element **86** includes a first valve head **88** at the lower end thereof and a second valve head **90** at the upper end thereof. Each valve head includes a frustoconical valve face and the valve face of the lower valve head **88** is adapted to cooperate with and seal the first valve seat **52** while the upper valve head **90**, and its valve face, are adapted to cooperate with and seal the second valve seat **62**.

Operatively connected to the movable valve element **82** is a float **92**. According to the form of the invention shown in FIG. 3, the float **92** is rigidly secured to the lower end of the shaft **84** and is entirely contained within the chamber **66**. Thus, as can be seen in the figures, when the level of the fuel within the tank **22** is above the float **92**, the float **92** will rise causing the upper valve head **90** and its valve face to seal the valve seat **62** and thus close the port **60**. When the level of fuel falls below the float **92**, the float will lower causing the movable valve element **82** to lower and thereby causing the lower head **88** and its valve face to seat against and seal the valve seat **52** thus closing port **54**.

The valve **30** of FIG. 4 is similar to the valve of FIG. 3 and the same parts are indicated by corresponding numbers except for the movable valve element which in FIG. 4 is designated **100** and the float and its connection to the valve element **100**. The movable valve element **100** of valve **30** of FIG. 4, comprises a shaft **102** mounted concentrically within the bore **50** and movable longitudinally of the bore. Shaft **102** has mounted concentrically there-

on at the upper and lower ends thereof a pair of spaced apart valve heads 104 and 106. The valve heads 104 and 106 are secured to the shaft 102 rigidly by any suitable means such as adhesive and they are preferably formed from a resilient material, such as rubber. Each of the valve heads 104 and 106 is spaced outwardly of the valve ports 54 and 60, the lower valve head 104 being adapted to cooperates with an seal the valve seat 52 of port 54 and the upper valve 106 being adapted to cooperate with and seal the port 60 of valve seat 62. Each of the valve heads 104 and 106 are provided with tapered or frustoconical valve faces adapted to seat against the respective valve seats.

Pivotally connected to the lower end of the housing 48 by means of a horizontal pivot pin 108 is a lever arm 110. Connected to the outward end of lever arm 110 is a float 112. The opposite end of lever arm 110 is operatively connected by any suitable means to the lower end of the movable valve element 100. For purposes of example, this connection is shown as a Y-shaped fork 113 including a pair of prongs which extend on either side of the shaft 102. A pair of spaced apart stops 116 and 118 are provided on shaft 102 to limit the upward and downward movement of the fork 113 thereon. Thus, when the float 112 moves downwardly, the movable valve element 100 will move upwardly thereby causing the lower valve head 104 to seat against the lower valve seat 52 thereby closing port 54. When the float 112 moves upwardly, movable valve element 100 will move downwardly causing the valve head 106 to seal port 60.

In the valves of both FIGS. 3 and 4, the lower end of chamber 66, as can be seen, communicates with the interior of the tank within which the valve 30 is mounted. To assure an unrestricted flow of fuel from the tank into the valve, chamber 66 is provided with a plurality of circumferentially spaced apart openings 120 in the side wall thereof.

For purposes of describing the operation of the invention, it will be assumed that all of the tanks are filled with fuel. With all of the tank filled, the float of each valve will be raised causing the upper valve face to seal the port 60 of each of the valves. The fuel will be drawn through line 36 from line 44 and from the chamber 66 of the valve 30 of the tank, at the left of FIGS. 1 and 2. Thus, tank 22 at the left in the figures, will be emptied first. When the float of the valve 30 in this tank is lowered, fuel will then be withdrawn from the next succeeding tank viz. the center tank of FIGS. 1 and 2. This operation is repeated until all of the tanks are emptied.

Under conditions of actual use, the invention proved to be rugged in construction, reliable in operation, and was economically manufactured. It was found that no interruption in fuel flow occurred when transition of flow from one tank to another took place. The tanks emptied one at a time as described hereinabove, substantially all of the fuel being withdrawn from one tank before any was withdrawn from the next succeeding tank.

It is understood that suitable modifications may be made in the structure as disclosed, provided such modifications come within the spirit and scope of the appended claims. Having now therefore fully illustrated and described my invention, what I claim to be new and desire to protect by Letters Patent is:

1. A fuel tank transfer system for an engine comprising in combination a plurality of connected fuel storage tanks, each such storage tank having a fuel port and fuel outlet therein, and each tank including a float operated valve, each such float operated valve comprising a first valve seat communicating between the outlet of its tank and the port of its tank, and a movable valve element including a first valve face adapted to cooperate with said first valve seat, a second valve seat communicating between the outlet of said its tank and the interior of said its tank, a movable valve element including a second valve face adapted to cooperate with said second valve seat, float means operatively connected to the first said movable valve element to move said first valve face into contact with said first valve seat when said float means is urged upwardly by the fuel in said tank and out of contact with said first valve seat when said float means is moved downwardly thereby allowing fuel to flow from said port to said outlet when the level in said tank falls below the level of said float means, said float means operatively connected to the second said movable valve element adapted to move said second valve face onto said second valve seat when said first valve face is out of contact with said first valve seat and out of contact with said second valve seat when said first valve face is in contact with said first valve seat and duct means connecting the outlet of one of said tanks to said engine and the port thereof to the outlet of another of said tanks.

2. A fuel tank transfer system for an engine comprising in combination at least first and second fuel storage tanks, each of said tanks having an outlet connection and an inlet connection, a first fuel line connecting the first tank fuel outlet connection to the engine, a pump connected to said first fuel line for moving fuel from said first tank through said first tank outlet connection and fuel line to the engine, and a second fuel line connecting the second tank outlet connection to the first tank inlet connection, said first and second tanks each including therein a valve housing having first and second inlet openings and an outlet opening, a first duct connecting the outlet opening to the tank outlet connection, a second duct connecting the first tank inlet connection to the second inlet opening, the first inlet opening being open to the tank interior, valve means within the valve housing movable between a first position opening the first inlet opening to and closing the second inlet opening to the outlet opening and a second position opening the second inlet opening to and closing the first inlet opening to the outlet opening, and a float exposed to fuel in the tank and operatively connected to the valve means therewith to hold the valve means in the first position while fuel remains in the tank but to move the valve means to the second position when fuel has been substantially drained from the tank.

3. The subject matter of claim 2 wherein each said valve housing is provided with a first annular valve seat between the first inlet opening and the outlet opening and a second annular valve seat between the second inlet opening and the outlet opening, said seats being coaxially aligned, and said valve means in each housing including an elongated valve element extending concentrically through said seats and having first and second axially spaced valve heads thereon for respective sealing engagement with the first valve seat in said second position and with the second valve seat in said first position.

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