Nov. 10, 1970 T. C. COVILL 3,539,818

SYSTEM FOR CONTROLLING THE TRANSFER OF MATERIALS INTO OR OUT OF A RESERVOIR

Filed July 19, 1968 2 Sheets-Sheet 1

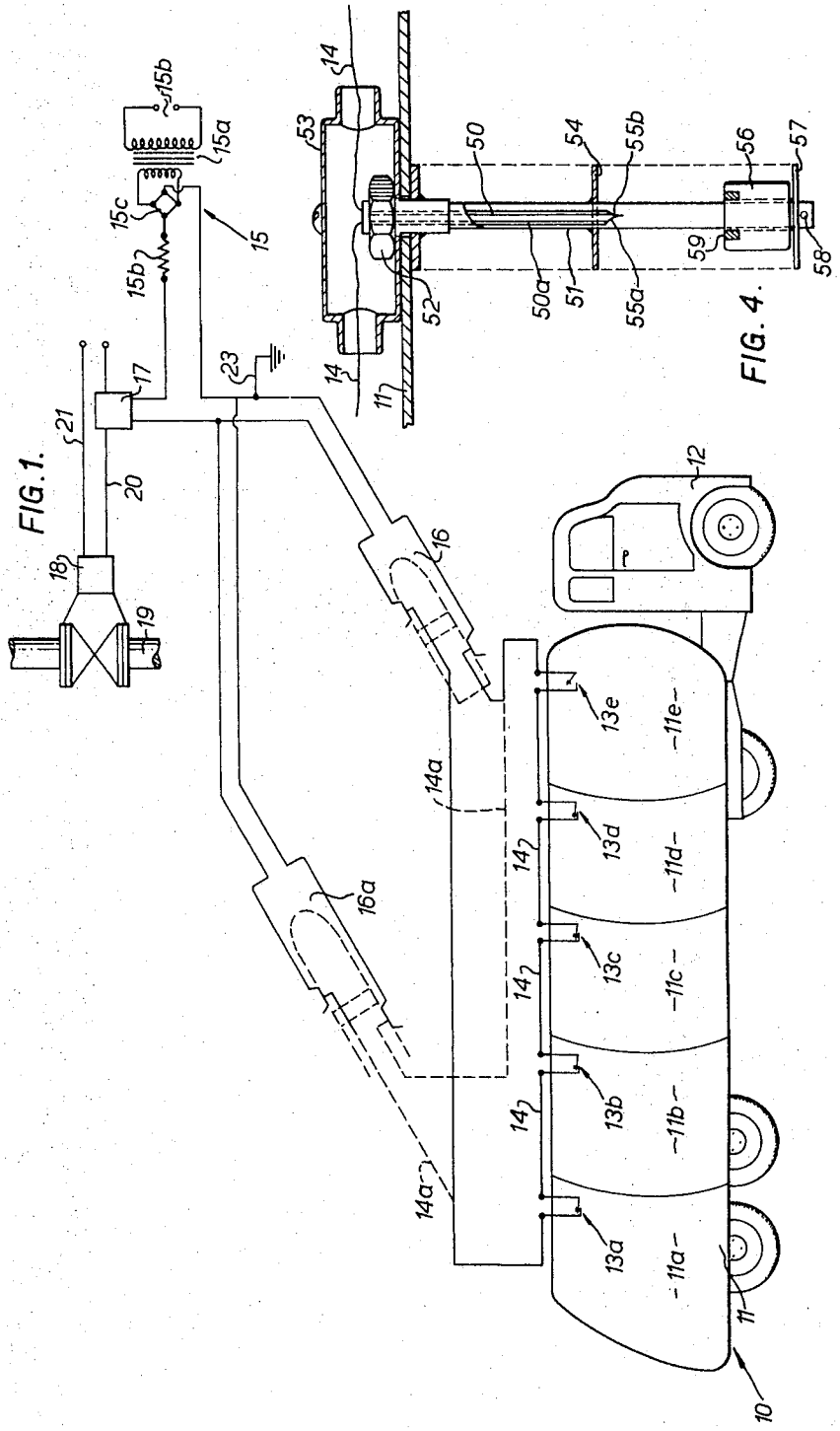

FIG. 1.

FIG. 4.

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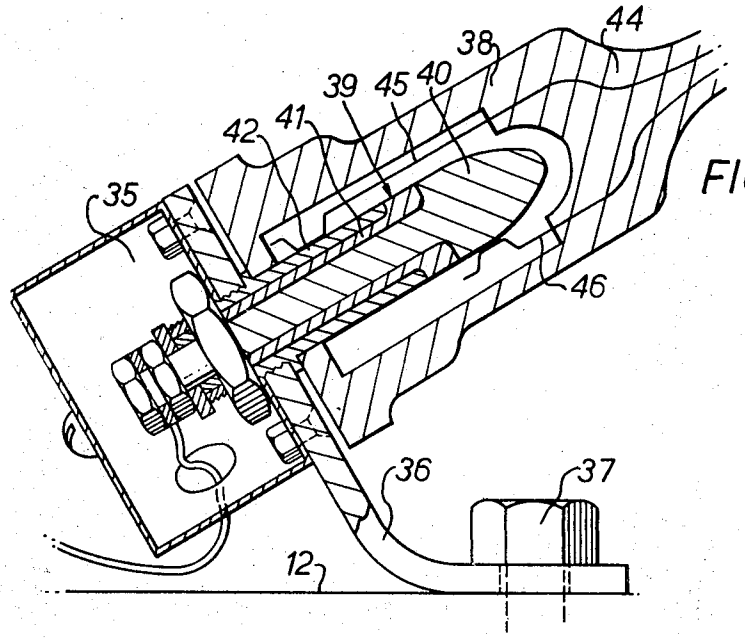

FIG. 3.

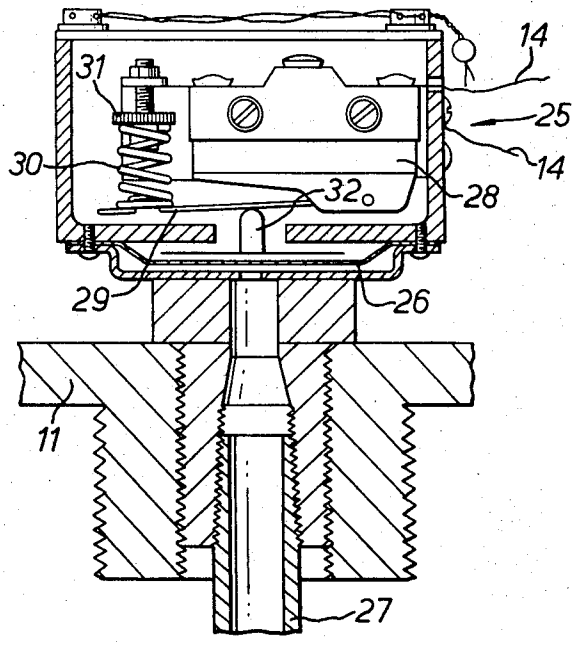

FIG. 2.

United States Patent Office 3,539,818
Patented Nov. 10, 1970

3,539,818

SYSTEM FOR CONTROLLING THE TRANSFER OF MATERIALS INTO OR OUT OF A RESERVOIR

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Filed July 19, 1968, Ser. No. 746,136
Claims priority, application Great Britain, July 24, 1967, 33,869/67
Int. Cl. B67d 5/30
U.S. Cl. 307—9 9 Claims

ABSTRACT OF THE DISCLOSURE

A system for controlling the transfer of material into or out of a mobile reservoir such as a fuel tank. A switch device associated with an electrical circuit interrupts said circuit when the amount of material in the reservoir falls outside a selected limit. The reservoir may be compartmentalized into a plurality of horizontally separated compartments which are separately controlled by the same electrical circuit.

The present invention relates to a system for controlling the transfer of material into or out of a reservoir for gases, liquids or particulate solids, and is particularly concerned with a means for filling and/or emptying the reservoir wherein the reservoir and the filling and/or emptying means are movable relative to each other.

It is often required during the filling and/or emptying of a reservoir that the amount of material stored in the reservoir should fall within one or more particular limits: i.e., the amount of material in the reservoir should not exceed a specified maximum quantity and/or should not fall below a specified minimum quantity. Common examples where one or more of these requirements are to be met in the filling and/or emptying of road tankers and marine tankers.

The present invention seeks to provide a system for ensuring that the maximum and/or minimum amount of material stored in the reservoir is automatically controlled.

The system in accordance with this invention comprises a switch device associated with the reservoir, fixedly located transfer means operable for transferring material into or out of the reservoir, and means for detachably interconnecting the switch device and the transfer means to form a circuit, the switch device being arranged to interrupt the circuit when the amount of material in the reservoir falls outside a selected limit, and the transfer means being operable only when the circuit is complete.

The circuit may be arranged for transmitting electrical, pneumatic or hydraulic signals.

Preferably, a part of the circuit when completed, provides a connection to earth from the reservoir. This is advantageous where the material to be transferred is inflammable since any accumulated static charge due to friction in the material can be discharged with substantially no risk of fire or explosion from this cause. Conveniently, the connection to earth may be through the fixedly-located part of the circuit so that the interconnection of the switch device and the transfer means concurrently earths the reservoir, and provides a definite indication that the reservoir is earthed. In the case where the circuit transmits electrical signals, the voltage and circuit would be, of course, quite small. The electrical energy may be supplied in the form of direct current or of alternating current, or rectified alternating current.

The transfer means may include a valve and/or a pump for the transfer of material, and a relay which

operates when the circuit is complete to provide power, in operation, for the valve and/or pump.

The switch device may operate in accordance with either the level or the weight of material in the reservoir.

The invention also includes an installation comprising at least one reservoir in combination with the system as described in the preceding paragraphs.

There may be a plurality of reservoirs in the installation, there being a switch device for each reservoir, and the devices being all connected.

Preferably, the or each device is mounted on the, or a respective, reservoir.

The invention will now be described by way of non-limitative example only and with reference to the accompanying drawings, in which:

FIG. 1 depicts diagrammatically one form of an installation incorporating a system in accordance with the invention.

FIG. 2 illustrates a part of the installation of FIG. 1 to a greater scale.

FIG. 3 illustrates another part of the installation of FIG. 1 to a greater scale, and

FIG. 4 depicts an alternative part which may be used in place of the part shown in FIG. 2.

Referring first to FIG. 1, the installation generally indicated by reference numeral **10**, comprises a reservoir or tank **11** forming the cargo-carrying part of a mobile road tanker **12** suitable for transporting a liquid such as petroleum spirit, or a dry, particulate solid such as sugar or flour. The tank **11** is divided into a number of horizontally separated compartments **11***a*–**11***e*, each of which is required to be filled with cargo to a specified level.

Each compartment **11***a*–**11***e* is provided with an electrical switch **13***a*–**13***e* respectively which is responsive to the level of cargo in the corresponding compartment. The switches **13***a*–**13***e* are electrically connected in series by conducting wires **14**. When the level of cargo in a compartment is below a specified maximum level, the switch **13** for that compartment is closed. If the specified maximum level in a compartment is exceeded, the corresponding switch is open.

It will be appreciated that when the maximum level of cargo for each compartment **11***a*–**11***e* is not exceeded, all the switches **13***a*–**13***e* will be closed and will form an uninterrupted electrical path. As depicted in FIG. 1, the specified maximum level of cargo in compartment **11***e* has been exceeded and switch **13***e* is open, thus interrupting the electrical path.

The switches **13***a*–**13***e* are connected to a fixedly located intrinsically safe source of electrical energy generally indicated by reference **15**, via a two pole detachable connecting plug **16** which is adapted to engage electrically with suitable contacts connected respectively to switch **13***a* and switch **13***e*. (An "intrinsically safe source" is a source which is certified by Her Majesty's Factory Inspectorate of the Ministry of Labour as being incapable of producing sparks of sufficient energy to ignite stored materials or vapours emanating therefrom.) In this case, the source **15** comprises a step-down transformer **15***a* which is connected to an alternating mains supply **15***b* of 240 volts, and has a low-voltage output of, say 15 volts alternating current. The transformer output is connected to two contacts of a full-wave rectifier **15***c* and the two other contacts of the rectifier **15***c* are connected respectively to a high ohmic-valve resistor **15***d*, and the connecting plug **16**. The source **15** thus provides full-wave rectified alternating current at 15 volts and a low current. The current may be of the order of 20 milliamps when the circuit is complete and functioning correctly.

A relay **17** is provided in series with the resistor **15***d* of source **15**. The relay **17** serves to control the supply of

electrical power to a fixedly located solenoid valve **18** for regulating the flow of cargo through a filling pipe **19** and a flexible filling hose (not shown) for transferring cargo into a desired compartment **11***a*–**11***e*.

The arrangement is such that when current flows through the relay **17**, the relay **17** provides a path for electrical power to pass via lines **20** and **21** to the valve **18**. The valve **18** opens enabling cargo to pass through pipe **19** and the flexible hose (not shown) to the required compartment **11***a*–**11***e*. This situation will result only when all of the switches **13***a*–**13***e* are closed, i.e. the specified maximum level of cargo for every compartment **11***a*–**11***e* has not been exceeded and when the detachable connecting plug **16** is in the position shown.

When the current through the relay **17** is interrupted, e.g. due to exceeding the specified cargo level in one of the compartments **11***a*–**11***e*, or because the connecting plug **16** is not attached in its electrically-connecting location—the relay **17** interrupts the electrical conduction path in line **20** causing the solenoid valve **18** to become inactivated and to close the passage for cargo in pipe **19**. Thus, two conditions must be fulfilled in order that cargo can flow through pipe **19**; these conditions are that the connecting plug **16** must be connected and that the maximum specified level of cargo in every one of the compartments **11***a*–**11***e* must not have been exceeded.

In many instances, the movement of the cargo either in the tank **11** or through the pipe **19** generates static electrical charges which can be hazardous if allowed to accumulate. This is particularly the case when the cargo is inflammable, e.g. petroleum spirit, sugar or flour. In the embodiment of the invention depicted in FIG. 1, any static charges associated with the road tanker **12** are discharged to earth through an earthing strap **23** attached to one of the leads from the source **15**. For convenience, it is preferred to arrange the earthing strap **23** as part of the fixedly-located part of the installation comprising, inter alia, the source **15**, the relay **17** and the solenoid valve **18**.

In the arrangement of FIG. 1, there is depicted a connecting plug **16***a* substantially identical with the connecting plug **16** but at a different location on the road tanker **12**. The connecting plug **16***a* is connected into the aforedescribed electrical circuit in parallel with plug **16**, but so that it functions in the same manner as plug **16** and may be used as an alternative thereto to suit the convenience of the operating personnel. Preferably, only one at a time of the plugs **16**, **16***a* is employed, the choice being determined to suit the convenience of the personnel involved. The connecting electrical conductors are indicated by the dotted lines **14***a*.

It is to be noted that the system in accordance with the invention is "fail safe." That is to say that any break in the electrical connections will cause the solenoid valve **18** to become inoperative so that the loading operation is interrupted until the break is remedied.

The regulation of the quantity of material transferred into or out of each compartment of the tank **11** may be effected by suitable measuring devices (not shown) upstream of the solenoid valve **18**. If these measuring devices, or their control systems, break down, the system of the invention inactivates the material transfer system, thus avoiding troublesome, expensive or dangerous spillages of cargo. For example, during the filling of a road tanker with a measured quantity of petroleum, the tank of the tanker may initially contain some residual petroleum from its previous duty, and there will not be sufficient room in the tank to accomodate the measured quantity; in such circumstances, the system of the invention will prevent any overfilling of the tank and the consequential spillages. Alternatively, the system of the invention may be employed to regulate the transfer of material in the absence of other measuring devices.

FIG. 2 shows in greater detail a preferred form of switch which may be used as one of the switches **13***a*–**13***e*, particularly for liquid cargoes.

The switch, generally designated by reference **25** comprises a flexible diaphragm **26** of polytetrafluoroethylene exposed to the cargo space of the tank **11** via an electrically-insulating tube **27** of nylon or unplasticised polyvinyl chloride extending downwardly to just below the desired maximum height of cargo, and a micro-switch **28** having contacts (not shown) which are in electrical contact when the level of cargo in the tank is less than the desired maximum level (corresponding with the switches **13***a*–**13***d* of FIG. 1) and which become separated in a manner hereinafter explained when the desired maximum level in the tank is exceeded (corresponding with switch **13***e* of FIG. 1). The microswitch **28** has an operating arm **29** which is biassed to an inoperative position by a spring **30**, the compression in the spring **30** being adjustable by an adjusting nut **31**.

When the cargo in a compartment **11***a*–**11***e* approaches the desired maximum level, it closes off the lower end of the tube, trapping air and/or vapour therein. If the level of the cargo continues to rise, the trapped air and/or vapour is compressed and the rise in pressure moves the diaphragm upwardly so that it pushes upwardly against an actuating member **32**. The actuating member **32** is displayed upwardly into contact with the operating arm **29** which then is moved upwards to cause the contacts in the microswitch **25** to separate, so that the electrical circuit is interrupted. The effect of this interruption has already been explained by reference to the switches **13***a*–**13***e* of FIG. 1. When the level of the cargo falls, the pressure in the tube **27** falls and eventually the corresponding movement of the diaphragm permits the microswitch to complete the electrical circuit.

Pressure switches are advantageous in that no electrical conductors need enter the cargo compartments **11***a*–**11***e*.

Since the parts of the pressure switch which are exposed to the interior of the tank **11** (the tube and the diaphragm) are electrically non-conductive, the risk that static changes accumulating in the tank **11** will be discharged outside the tank **11** is almost negligible.

FIG. 4 shows in detail another form of switch which may be used in place of the switch shown in FIG. 2. This switch comprises two rigid electrical conductors **50***a*, **50** which are retained in a tube **51** extending downwardly from a retaining nut **52**. The nut **52** retains the tube **51** and a connection housing **53** against the top of the tank **11**. About half-way down the outside of the tube **51** is a fixed annular washer **54**, and within the tube, just below the level of the washer **54**, is a springy metal contact **55***a* which is supported by the conductor **50***a*, and extends downwardly therefrom and somewhat inwardly towards a similar springy metal contact **55***b* supported by the conductor **50**. Both of the contacts **55***a*, **55***b* are of magnetisable metal, such as steel.

An annular float **56** of spongy polyvinyl chloride is arranged to travel up and down around the tube **51** when the surface of the cargo has risen above the float's lowest position as determined by an adjustable annular washer **57** resting on a cotter pin **58** extending through the tube **51**.

Recessed into the top of the float **56** is an annular magnet **59**.

When the level of the cargo is so high that the float **56** is disposed adjacent the washer **54**, and with the magnet **59** substantially surrounding the contacts **55***a*, **55***b*, the contacts are outwardly attracted away from each other by the annular magnet **59**.

While the contacts **55***a*, **55***b* are touching, under the action of their inherent springiness, they provide an electrical path through the switch from the lead **14** on one side of the switch to the lead **14** on the other side thereof, in correspondence with the switches **13***a*–**13***d* of FIG. 1. When the contacts **55***a*, **55***b* are separated by the attraction of the annular magnet **59**, the electrical path through the switch is interrupted, as in the case with the switch

13*e* of FIG. 1. If the level of the cargo should fall so that the float moves downwardly away from the washer **54**, the contacts **55***a*, **55***b* will spring back into their mutually contacting position thus providing an uninterrupted electrical path through the switch.

The invention may take forms other than that described for example, where the cargo is a particulate solid, it may be preferred to replace the above-described forms of switch by other means, such as a proximity probe. This latter comprises, in effect, a condenser including a downwardly protruding conductive electrode concentrically surrounded by an annular electrode. The cargo is able to rise into the space between the two electrodes thus increasing the capacitance of the condenser. When the capacitance attains a selected value, the circuit including the proximity probe is interrupted by a switch.

In another form, the switches **13***a*–**13***e* may be replaced by means responsive to the weight of the cargo, e.g. strain gauges. When a selected weight of cargo is exceeded, the circuit is interrupted.

The invention may be modified for operations involving the discharge of cargo from tank **11**. In this case, the switches **13***a*–**13***e*, pressure switches float-operated switches, proximity probes or strain gauges are adapted to interrupt the electrical circuit when a specified minimum quantity of cargo remains in the tank **11** or a compartment thereof.

Various combinations of the features disclosed above may be employed without departing from the invention as defined by the appended claims.

What is claimed is:

1. A system for controlling the transfer of material into or out of a mobile reservoir comprising:

(a) a reservoir;

(b) a spring biased diaphragm switch disposed in said reservoir, responsive to the level in said reservoir;

(c) a fixedly-located transfer means operable for transferring material into said reservoir; and

(d) means for detachably interconnecting said diaphragm switch and said transfer means to form a circuit which is interrupted by said diaphragm valve when the amount of material in said reservoir falls outside a selected limit thereby cutting off operation of said transfer means.

2. The system of claim **1** including a means for grounding said electrical circuit connected to said transfer means.

3. The system of claim **1** wherein said diaphragm switch comprises:

(a) an electrically insulated tube extending into said reservoir;

(b) an actuating member disposed inside said insulating tube, responsive to the level of material in said reservoir;

(c) an operating arm, responsive to said actuating member, disposed above and in communication with said actuating member;

(d) a microswitch disposed above said actuating member, and in communication with said operating arm;

(e) a spring means connected to said actuating member and said operating arm, which biases said arm so that said switch is normally closed.

4. A system for controlling the transfer of material into or out of a mobile reservoir comprising:

(a) a reservoir;

(b) a switch comprising a magnetic activating means responsive to the level in said reservoir;

(c) a fixedly located transfer means operable for transferring material into said reservoir; and

(d) means for detachably interconnecting said switch and said transfer means to form a circuit, which is interrupted by said switch when the amount of material in the reservoir falls outside a selected limit, thereby cutting off operation of said transfer means.

5. The system of claim **4** including a means for grounding said circuit.

6. The system of claim **4** wherein said switch comprises:

(a) a tube, provided with a pair of annular constraints around said tube at two vertical levels, disposed in said reservoir;

(b) a pair of electrical conductors connected to said circuit and disposed in said tube, each of the ends of said conductors tipped with a magnetizable metal contact, said contact biased to touch each other below said upper annular constraint;

(c) a magnetized float disposed around said tube between said constraints providing the means for opening said circuit when said float reaches the level of said touching contacts.

7. A system for controlling the transfer of material into or out of a reservoir comprising:

(a) a reservoir comprising a plurality of horizontally separated compartments;

(b) a plurality of series connected switch devices, one said device disposed in each of said compartments;

(c) a fixedly-located transfer means operable for transferring material into any of said compartments;

(d) means for detachably interconnecting said plurality of switch devices and said transfer means to form a circuit which is interrupted when the amount of material in any of said compartments falls outside a selected limit, thereby cutting off operation of said transfer means.

8. The system of claim **7** wherein each of said switch devices comprises an actuating member responsive to the level of material in said compartment, disposed inside a tube, said actuating member activating an operating arm to disengage a microswitch, whereby said circuit is interrupted.

9. The system of claim **7** wherein said switch device comprises a magnetized float responsive to the level of material in said compartment, disposed around the tube in which a pair of electrical conductors, electrically connected to said circuit, are disposed with their ends in electrical communication by means of a pair of magnetizable metal contacts, whereby said float acts to break the circuit when the level in said compartment moves said float up to the point where said conductors are in electrical communication.

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U.S. Cl. X.R.

141—139, 219; 220—88; 222—56, 67, 68, 75; 307—118