

Aug. 20, 1940.

O. E. ZODER

2,212,486

SAFETY APPARATUS

Filed Feb. 21, 1940

2 Sheets-Sheet 1

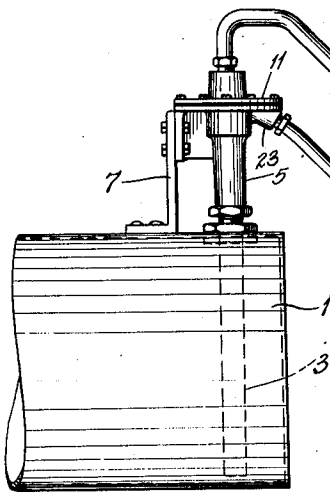


FIG. 1.

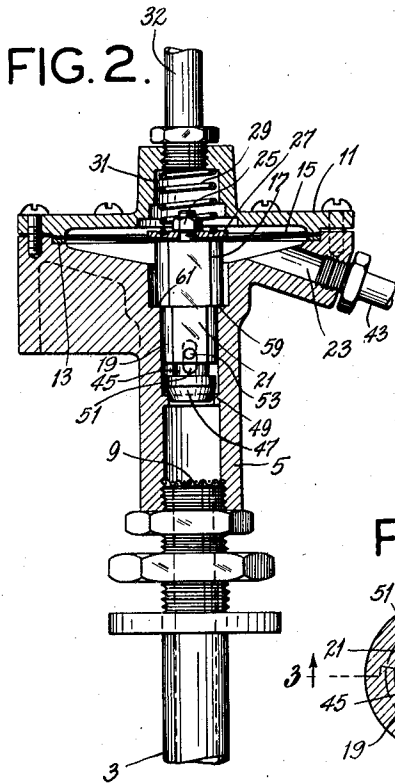


FIG. 2.

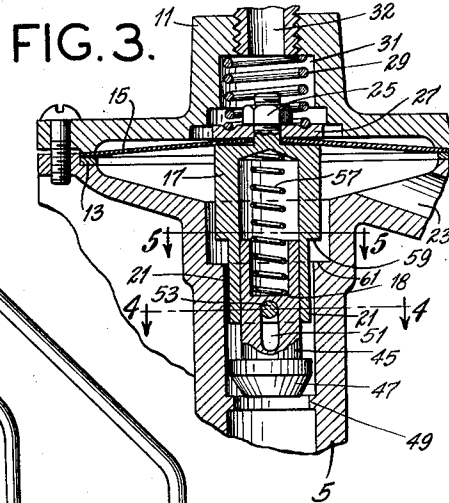


FIG. 3.

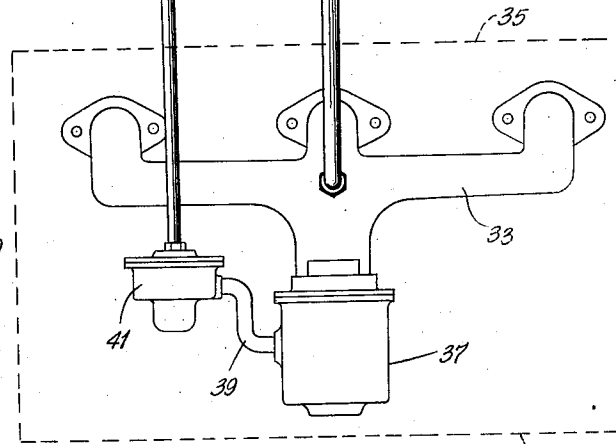
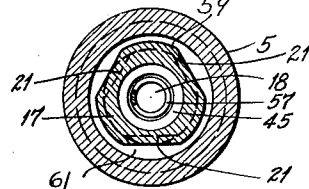
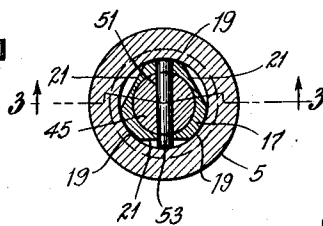


FIG. 4.

FIG. 5.



Orrin E. Zoder,
Inventor.
Haynes, Koenig and Wolf,
Attorneys.

Aug. 20, 1940:

O. E. ZODER

2,212,486

SAFETY APPARATUS

Filed Feb. 21, 1940

2 Sheets-Sheet 2

FIG. 6.

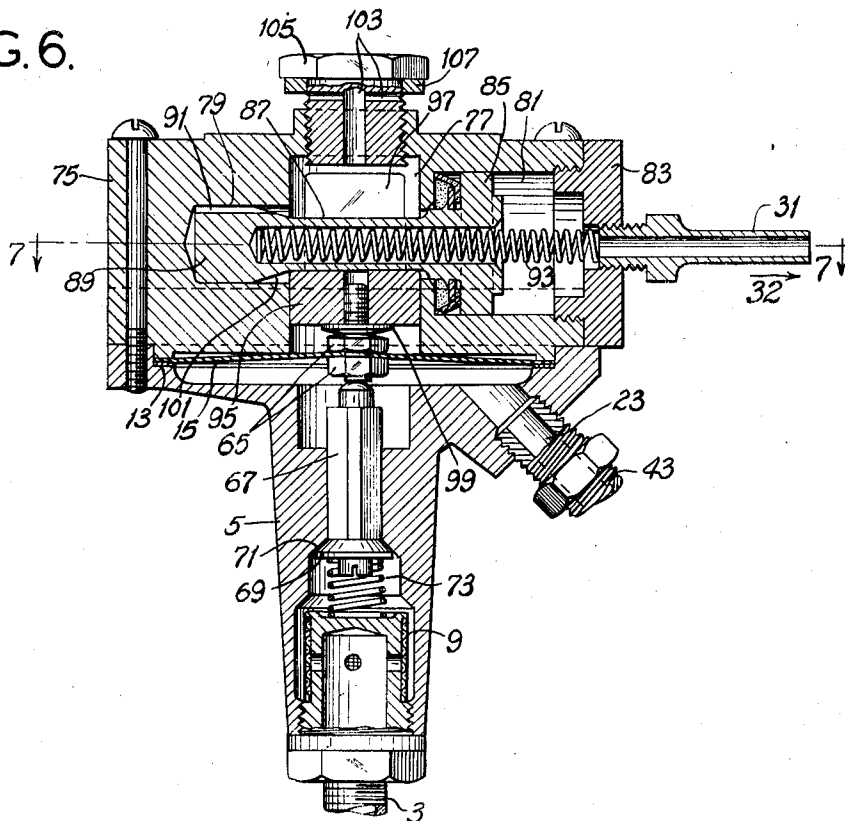
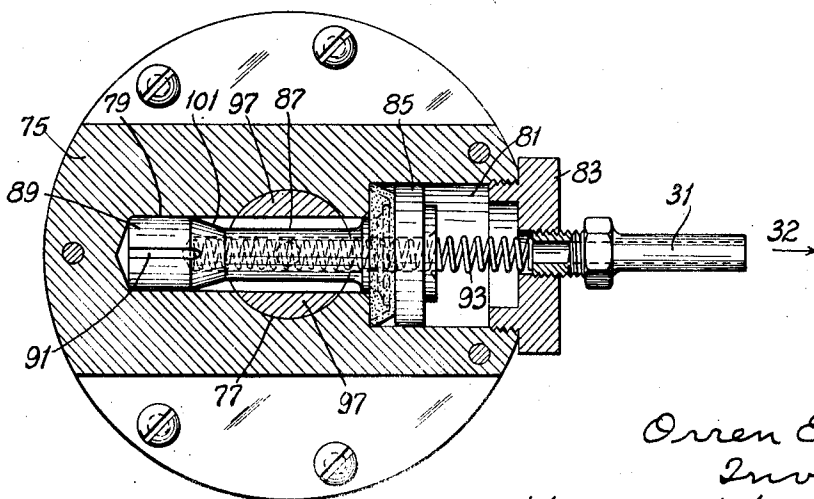


FIG. 7.



Orren E. Zoder,
Inventor.
Haynes, Boerig and Wolf,
Attorneys.

UNITED STATES PATENT OFFICE

2,212,486

SAFETY APPARATUS

Orren E. Zoder, St. Louis, Mo., assignor, by mesne assignments, to Zoder, Incorporated, St. Louis, Mo., a corporation of Missouri

Application February 21, 1940, Serial No. 320,015

23 Claims. (Cl. 123—136)

This invention relates to safety apparatus, and with regard to certain more specific features, to safety apparatus for tanks which carry dangerous fluids, such as inflammables.

5 The invention is an improvement upon the invention disclosed in my United States patent application Serial No. 305,159, filed November 18, 1939, for Safety apparatus, and its divisional application Serial No. 337,183, filed May 25, 1940, for Safety apparatus, and upon the construction disclosed in United States Patent 1,461,662, dated July 10, 1923.

Among the several objects of the invention may be noted the provision of improved means to avoid under certain abnormal conditions an emptying action from a tank through a pump and carbureter; the provision of such means wherein under most normal operating conditions the pump is relieved of safety valve operating duty; and the provision of means of the class described which, when the pump does operate said valve, the pump operates only against a light load. Other objects will be in part obvious and in part pointed out hereinafter.

25 The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which are illustrated several of various possible embodiments of the invention,

Fig. 1 is a diagrammatic side elevation of the invention shown applied;

Fig. 2 is an enlarged vertical section of the invention showing it in protective position;

Fig. 3 is a view similar to Fig. 2 but further enlarged showing the device in a normal operating condition and approximately on line 3—3 of Fig. 4;

Fig. 4 is a horizontal section taken on line 4—4 of Fig. 3;

Fig. 5 is a horizontal section taken on line 5—5 of Fig. 3;

Fig. 6 is a vertical section showing another form of the invention; and,

Fig. 7 is a horizontal section taken on line 7—7 of Fig. 6.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now more particularly to Fig. 1, there is shown at numeral 1 a tank which is a class example of tanks for inflammable fluids

and to which the present invention applies. Inserted into the tank is a suction line 3, which reaches to a point near the bottom of the tank, so that by drawing off fluid through the line 3, the tank may be substantially emptied.

The invention consists in a hollow body 5 which may be supported on the tank 1 by means of a bracket 7. The body 5 is fastened to and in communication with the suction line 3. A strainer 9 serves the usual protective purposes against withdrawal of foreign material.

Fastened to the body 5 is an enclosing cap 11, which, with the aid of a gasket 13, clamps in place a flexible, impermeable diaphragm 15. Thin sheet metal is a suitable material for the diaphragm.

The diaphragm has fastened at its center on its lower side a valve holder 17 which at 19 slides and is guided in the body member 5. The holder 17 is provided with a shoulder 59. The shoulder 59 by contacting with a shoulder 61 in the body 5 limits downward movement of the holder 17. The holder is also provided with polygonal faces 21 for the passage of fluid toward an outlet 23. Fastening means 25, by means of which the holder 17 is hermetically sealed to the diaphragm 15, also holds in place an upper washer 27. A predeterminedly compressed spring 29 presses against the washer 27 to bias the diaphragm 15. The other end of the spring 29 reacts against 30 the cap 11 in a recess 31. The boss which carries the recess has threaded thereto a suction line 32 which reaches to the intake manifold 33 of the internal combustion engine 35 which is served by this apparatus. A carbureter serves the manifold 33 as shown at 37 and has a fluid connection 39 with a fluid (gasoline) pump 41 operated by the internal combustion engine. The pump 41 draws fluid over a line 43 from the outlet 23.

The holder 17 slidably carries a valve 45. The head 47 of this valve is engageable with a valve seat 49 in the body 5. The valve 45 is provided with a slot 51 which permits a limited movement of the valve in the holder 17. Limitation of movement is imposed by a pin 53 which is held by the holder 17 and passes through the slot 51. A relatively low pressure spring 57 reacts between the top of the holder 17 and a hollow seat 18 in the valve 45. Thus, the valve is normally pushed by spring 57 down as far as possible toward the lower end of the holder 17.

One application of the invention is to motor-boats in which the engines, such as 35, are at a low elevation, while the gasoline tanks such as 55

1, may be higher. This incurs a suction head upon the contents of a tank such as 1, due to a syphon action over the line 43; that is, when an engine such as 35 is shut off and there is a leaky float valve in the carbureter 37 and leaky or weak valves in the pump 41. This causes syphoning of inflammable fluid from the tank 1, which may run out of the bowl of the carbureter 37 and into the boat to cause a fire hazard. The present invention avoids this hazard.

Operation of the device is as follows:

First let it be assumed that the engine 35 is shut off. This means that atmospheric pressure is then carried in the manifold 33 and that the diaphragm 15 is depressed by the spring 29, as shown in Fig. 2. This causes the shoulder 59 of the body member 17 to be seated on the shoulder 61 of the body 4 and places the pin 53 at some distance down in the slot 51. This compresses the valve spring 57 to seat the valve head 47 on the valve seat 49. The strength of the spring 57 is made such that, should the valves in the pump 41 and in the carbureter 37 leak, the spring 57 will hold shut the valve 45 and prevent a syphoning action under the gravity head in the line 43. Thus, danger of syphoning action is avoided during non-operating periods of the engine 35, regardless of the condition of the valves of the carbureter 37 and pump 41. On the other hand the spring 57 is made no stronger than necessary to accomplish the above.

When the engine 35 starts two things occur:

1. A vacuum is drawn in the manifold 33. This vacuum extends to the line 32 and is applied to the top of the diaphragm 15, thus drawing the latter up against the action of spring 29 and promptly relieving spring 57.

2. At the same time the pump 41 draws fluid over the line 43 from the line 3. This causes a tendency to open the valve 47 if it is not already open, but ultimately the suction in the line 32 becomes great enough to lift the diaphragm 15 to a position where the pin 53 moves to the upper end of the slot 51 and positively opens the valve 47 without aid from the action of pump 41. This action entirely unloads the pump 41 of the duty of lifting the valve 47 against the valve spring 57 (see Fig. 3). Thus, the wear on pump 41 is decreased and its life is increased.

Should a condition occur in which the vacuum in the line 32 is substantially reduced, as by quickly accelerating the engine 35, then the diaphragm 15 will accordingly proportionally descend and carry down with it the member 17 and the valve 45. This causes the valve 45 to seat more or less, depending upon the degree of loss of vacuum. The greater the vacuum loss after the valve 45 seats, the more spring 29 expands and the greater the valve spring 57 is deflected as valve 45 seats. The pump 41 by its suction action over line 43 causes an opening of the valve 45 against spring 57 each time that the pump makes a suction stroke. But, the pump is called upon to operate against the valve spring 57 only during the short periods under which the motor 35 is accelerating. Over the other longer periods that the vacuum in the manifold 33 is good, the valve 45 is held open by the manifold vacuum (or at least the spring 57 is partially relieved), thus freeing the pump 41 completely (or partially) of the valve opening load. This materially extends the life of the pump, as stated above.

And even when the pump 41 is called upon to open the valve 45, it is not opening it against

the action of the spring 29, but only against the relatively weak spring 57. Thus, even under maximum valve opening duty, the pump 41 is called upon only to act against the small load of the spring 57.

Furthermore, it is seldom that the vacuum is entirely lost in the manifold 33 while the engine is operating, so that when the pump 41 is working the spring 29 is seldom deflected its maximum. That is, the partial lifting effect of the diaphragm 15, even during acceleration, at least partially reduces deflection (and loading) of spring 57 so that the work of the pump 41 is reduced.

On the other hand, it is certain that, when the motor has stopped, the vacuum is entirely lost in the manifold 33, which ensures that the spring 29 will press the diaphragm 15 down its maximum extent, thus seating the valve 45 and deflecting the lower spring 57 to its maximum. Under this condition the spring 57, being deflected a maximum amount, consequently exerts its greatest force against opening the valve 45, and therefore greatest resistance against syphoning action over the line 43. This extra resistance is particularly useful (reliable) on boats where the rolling and pitching changes the syphon head.

And, at all other times, when the engine 35 is operated the diaphragm 15 is at least somewhat higher than in its lowermost position, thus drawing back the upper end of the spring 57 so that its required deflection is less.

It will be understood that mechanical equivalents of the diaphragm 15 would be a Sylphon bellows, or a piston, or the like.

It will be perceived that if desired the diaphragm 15 may be made self-returning, instead of employing the spring 29. This may be done by making it a Sylphon bellows or the like.

It will be seen that if desired the expansion of the spring 57 under the conditions of Fig. 3 may be complete so that there is no compression in the spring. This means that under partial vacuum conditions above the diaphragm 15 there will be required the lowest possible deflecting force for that spring in opening the valve 45 by action of the pump 41. At the same time the spring 57 is designed for producing a force, when deflected the necessary amount for the position of parts as shown in Fig. 2 (dead engine), that the suction head in line 43 will not open the valve.

Acceleration of engines such as 35 may occur at any speed. Therefore it is possible that the diaphragm 15 may sink at any speed of the engine 35, thus closing the valve 45. Under such conditions it is not desirable that the pump 41 reopen the valve against the action of the diaphragm 15 and its spring 29. It is for this reason that I use the spring 57 between the diaphragm and the valve so that under accelerating conditions at any speed the pump 41 needs only to open the valve 45 against the relatively light spring 57.

This invention makes the spring 57 easy and not so critical to design, because the valve 47 can more definitely be closed with a stronger spring 57 against the hydraulic syphon head, while depending upon the intake manifold suction to definitely open it when the engine starts, without overloading the pump 41 for the latter purpose. Thus, more hydraulic syphon head can be resisted.

From the above, it will appear that the mem-

ber 5 is essentially a hollow housing wherein is a movable member or diaphragm dividing it into two compartments. One compartment (the lower one) on one side of the diaphragm has an inlet for connection with the supply container and an outlet for connection with a fluid pump of the engine; whereas the compartment on the other side (upper side) of the diaphragm has a suction outlet for connection with the suction manifold of that same engine. The valve in the lower compartment closes against the inlet of that compartment and is biased away from the diaphragm toward closing position. The compartment below the diaphragm may be designated as a flow compartment, and the compartment above the diaphragm may be designated as a suction compartment.

In Figs. 6 and 7 is shown another form of the invention wherein like numerals designate like parts. In this case, the diaphragm 15 carries a head 65 which on its lower side contacts the upper end of a valve stem 67. The valve stem 67 being of triangular form and guided on its rounded corners through a circular opening may pass fluid. The lower end of the stem 67 is provided with a valve head 69 which is normally pressed by means of a spring 73 into closed position at a seat 71. A suitable vacuum in the line 43 caused by the action of the pump 41, in addition to any syphon head, will result in depression of the diaphragm 15 so that the anvil 65 presses down the stem 67 to open the valve 69 against the action of the spring 73. It is intended that a mere syphon head will not accomplish this end, the spring 73 being adapted to the purpose.

Attached to the body 5 is a head block 75, which among other things clamps down the edge of the diaphragm 15 in connection with the gasket 13. This block has a hollow portion formed as a vertical cylinder 77 intersected by concentric horizontal cylinders 79 and 81. Cylinder 81 is capped as shown at 83 and is provided internally with a sliding piston 85. Cap 83 carries a connection 31 for line 32. The piston 85 has a reduced extension 87 which passes through the vertical cylinder 77 and at its other end is provided with a slide 89 which operates in the guide cylinder 79. A slot 91 permits air to work freely behind the slide 89.

A compression spring 93 normally presses the piston 85 to the left as shown, but any vacuum drawn in the line 32 which is attached to the engine intake manifold 33 tends (through 31) to draw piston 85 against the pressure of the spring 93.

In the vertical cylinder 77 is a piston 95, bifurcated at 97, freely to accommodate the reduced waist 87 as shown in Fig. 7. The bottom of the slot 97 of the piston 95 is normally pressed upward by the expansive action of the spring 73 acting through the valve stem 67, head 65 and a plug 99 attached to the piston 95. A cam portion 101 between the waist 87 and the slide 89 is adapted, upon motion of the piston 85 to the right, to contact the lower end of the notch 97 and force down the parts 95, 99, 65, 15, 67, thus opening the valve 69 against the action of the spring 73. This occurs under a vacuum in the line 32, so that whenever the engine is operating, the valve 69 is opened, or partially opened, depending upon the degree of vacuum.

Air is introduced behind the pistons 85 and 95 by the ports 103 in an adjustable cap 105.

Piston 95 may fit loosely because of the diaphragm 15.

From the above it will be seen that this alternative form of the invention results in a mechanical opening of the valve 69 when a vacuum exists in the intake manifold of the engine, as when the engine is operating. When this vacuum is destroyed, or reduced, the valve 69 closes or tends to close. Thus, the vacuum engendered by the pump in the line 43 is called upon to open the valve only when it is not being opened by the intake manifold vacuum. This, as already explained, serves to relieve the pump of its load under all conditions in which the intake manifold vacuum is effective.

If the diaphragm 15 should break, the member 105 may be screwed down until a gasket 107 beneath it seats, thus cutting off the air inlet ports 103. This eliminates outward leakage of gasoline that may pass the broken diaphragm 15. At the same time, the lower end of the member 105 contacts the upper end of the bifurcated piston 95 and forces down the valve 69 to hold it open without suction aid either from the line 32 or 43. Then the pump simply draws through the open valve 69 without the features described being operative. This is an emergency feature to permit temporary operation after a diaphragm has been broken.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. Safety apparatus comprising a hollow housing, a movable member dividing said housing into two compartments, a compartment on one side of the movable member having an inlet and an outlet for connection with a fluid pump of an engine, the compartment on the other side of the member having a suction outlet for connection to a suction manifold of said engine, a valve in the first-named compartment closing outwardly toward the inlet of that compartment, and means biasing said valve away from said movable member and toward closing position.

2. Safety apparatus comprising a hollow housing, a movable member dividing said housing into two compartments, a compartment on one side of the movable member having an inlet from a fluid tank and an outlet connecting with a fluid pump of an engine, the compartment on the other side of the movable member having a suction outlet for connection to a suction manifold of said engine, a valve in the first-named compartment closing against the inlet of that compartment, means biasing said valve away from said movable member, and a lost-motion connection between the valve and movable member whereby motion of the latter away from the valve finally unseats the valve.

3. Safety apparatus comprising a hollow housing, a movable member dividing said housing into two compartments, a compartment on one side of the member having an inlet and an outlet for connection with a fluid pump of an engine, the compartment on the other side of the member having a suction outlet for connection to a suction manifold of said engine, a valve in the first-named compartment closing outwardly toward

the inlet of that compartment, means biasing said valve away from said member and toward closing position, and means on the other side of the movable member biasing it toward the valve.

4. Safety apparatus comprising a hollow body, a movable member dividing the hollow of said body into two compartments, the compartment on one side of said member having an inlet from a fluid tank and an outlet connected to a pump of an engine, the compartment on the other side of the member having an outlet connected to an intake manifold of said engine, a valve in said first-named compartment seating against flow from the inlet, a spring between the valve and the support normally biasing the valve to its seat, a spring on the other side of the movable member normally biasing the movable member to bias the valve toward its seat, the last-named spring being stronger than the first-named spring.

5. Safety apparatus comprising a hollow body, a movable member dividing the hollow of said body into two compartments, the compartment on one side of said member having an inlet from a fluid tank and an outlet connected to a pump of an engine, the compartment on the other side of the member having an outlet connected to an intake manifold of said engine, a valve in said first-named compartment seating against flow from the inlet, a valve support connected to the movable member and having a lost-motion connection with said valve, said connection being adapted to move the valve to open position upon predetermined movement of said movable member away from the valve, a spring between the valve and its support normally biasing the valve to its seat, and a spring on the other side of the member normally biasing the member toward the valve to cause the valve to seat.

6. Safety apparatus comprising a hollow body, a movable member dividing the hollow of said body into two compartments, the compartment on one side of said member having an inlet from a fluid tank and an outlet connected to a pump of an engine, the compartment on the other side of the member having an outlet connected to an intake manifold of said engine, a valve in said first-named compartment seating against flow from the inlet, a valve support connected to the movable member and having a lost-motion connection with said valve, said connection being adapted to move the valve to open position upon predetermined movement of said movable member away from the valve, a spring between the valve and its support normally biasing the valve to its seat, and a spring on the other side of the member normally biasing the member toward the valve to cause the valve to seat, the last-named spring being stronger than the first-named spring.

7. Safety apparatus comprising a hollow housing, a flexible diaphragm dividing said housing into a suction compartment and a flow compartment, the flow compartment having an inlet from a tank and an outlet connected to a fuel pump of an engine, the suction compartment having a suction outlet connected to the intake manifold of said engine, a valve seating against flow from said inlet, a valve holder attached to said diaphragm, spring means on the other side of the diaphragm normally biasing the diaphragm toward the valve, spring means between the valve and said holder normally biasing said valve to its seat, and a lost-motion connection between the valve and the holder whereby the holder in a

lifted position may withhold the valve from its seat, said valve spring means under such conditions having a maximum expansion and the spring means above the diaphragm under such conditions being compressed under vacuum conditions.

8. Safety apparatus comprising a hollow housing, a flexible diaphragm in the housing dividing it into two compartments, a liquid outlet in one compartment subject to syphon head and an inlet therein, a suction outlet in the other compartment, a valve in the first-named compartment closing toward the inlet, a valve spring biasing said valve away from the diaphragm toward its closing position, a spring on the other side of the diaphragm normally biasing the diaphragm toward the valve to compress the valve spring when the valve seats, said valve spring being designed to effect a force under the last-named conditions wherein the syphon suction head to which the outlet is subjected will not open the valve.

9. Safety apparatus comprising a hollow housing, a flexible diaphragm in the housing dividing it into two compartments, a liquid outlet in one compartment subject to syphon head and an inlet therein, a suction outlet in the other compartment, a valve in the first-named compartment closing toward the inlet, a valve spring biasing said valve away from the diaphragm toward its closing position, a spring on the other side of the diaphragm normally biasing the diaphragm toward the valve to compress the valve spring when the valve seats, said valve spring being designed to effect a force under the last-named conditions wherein the syphon suction head to which the outlet is subjected will not open the valve, and a lost-motion connection between the valve and the diaphragm adapted to unload the valve spring when suction occurs at the suction outlet.

10. Safety apparatus comprising a hollow housing, a flexible diaphragm in the housing dividing it into two compartments, a liquid outlet in one compartment subject to syphon head and an inlet therein, a suction outlet in the other compartment, a valve in the first-named compartment closing toward the inlet, a valve spring biasing said valve away from the diaphragm toward its closing position, a spring on the other side of the diaphragm normally biasing the diaphragm toward the valve to compress the valve spring when the valve seats, said valve spring being designed to effect a force under the last-named conditions wherein the syphon suction head to which the outlet is subjected will not open the valve, and a lost-motion connection between the valve and the diaphragm adapted to unload the valve spring when suction occurs at the suction outlet and upon greater suction entirely to lift the valve from its seat.

11. Safety apparatus comprising a hollow housing, a flexible diaphragm in the housing dividing it into two compartments, a liquid outlet in one compartment and an inlet, a suction outlet in the other compartment subject to a syphon head, a valve in the first-named compartment, a valve spring biasing said valve toward its seat, a spring on the other side of the diaphragm normally biasing the diaphragm toward the valve to compress the valve spring when the valve seats, said valve spring being designed to effect a force under the last-named conditions wherein the syphon head will not open the valve, suction in said suction outlet being adapted to draw the diaphragm into position to unload the valve spring according to said suction.

12. Safety apparatus comprising a hollow housing, a flexible diaphragm in the housing dividing it into two compartments, a liquid outlet in one compartment and an inlet, a suction outlet in the other compartment subject to a syphon head, a valve in the first-named compartment, a valve spring biasing said valve toward its seat, a spring on the other side of the diaphragm normally biasing the diaphragm toward the valve to compress the valve spring when the valve seats, said valve spring being designed to effect a force under the last-named conditions wherein the syphon head will not open the valve, suction in said suction outlet being adapted to draw the diaphragm into position to unload the valve spring according to said suction, and a lost-motion connection between the diaphragm and the valve whereby the latter is lifted under diaphragm movement.

13. Safety apparatus comprising a housing, a flexible diaphragm dividing said housing into two compartments, one compartment having a liquid inlet and a liquid outlet, the other compartment having a suction outlet, a valve in the first-named compartment seating toward said inlet, means connecting the valve and the diaphragm and including a biasing element tending to load the valve after the diaphragm seats it, and a lost-motion connection between the valve and the diaphragm tending to effect lifting of the valve after a predetermined movement of the diaphragm away from said seat, said diaphragm being normally biased toward the seat, but adapted under suction conditions in said suction outlet to move away from the seat.

14. Safety apparatus comprising a housing, a flexible diaphragm dividing said housing into two compartments, one compartment having a liquid inlet and a liquid outlet, the other compartment having a suction outlet, a valve in the first-named compartment seating toward said inlet, means connecting the valve and the diaphragm and including a biasing element tending to load the valve after the diaphragm seats it, and a lost-motion connection between the valve and the diaphragm tending to effect lifting of the valve after a predetermined movement of the diaphragm away from said seat, said diaphragm being normally biased toward the seat, but adapted under suction conditions in said suction outlet to move away from the seat, the motion of the diaphragm toward the seat, after the valve is seated, being enough to deflect the valve-biasing element to load the valve to remain closed against a predetermined suction in said liquid outlet.

15. Safety apparatus for an internal combustion engine having a suction manifold and a fluid pump and served by a fluid tank, comprising a hollow body, a movable member in said body dividing it into two compartments, one of which compartments has a suction inlet communicating with the tank and an outlet communicating with the pump, the other compartment having a suction connection with said suction manifold, a valve closing toward said inlet, and means between the movable member and the valve normally biasing the valve toward its seat.

16. Safety apparatus for an internal combustion engine having a suction manifold and a fluid pump and served by a fluid tank, comprising a hollow body, a movable member in said body dividing it into two compartments, one of which compartments has a suction inlet communicating with the tank and an outlet communicating with the pump, the other compartment having a suc-

tion connection with said suction manifold, a valve closing toward said inlet, and means between the movable member and the valve normally biasing the valve toward its seat, said movable member being also biased toward said seat.

17. Safety apparatus for an internal combustion engine having a suction manifold and a fluid pump and served by a fluid tank, comprising a hollow body, a movable member in said body dividing it into two compartments, one of which has a suction inlet communicating with the tank and an outlet communicating with the pump, the other compartment having a suction connection with said suction manifold, a valve closing toward said inlet, means between the movable member and the valve normally biasing the valve toward its seat, said movable member being also biased toward the valve seat, means normally limiting the motion of the diaphragm toward said seat, and a lost-motion connection between the valve and said movable member whereby said member upon motion away from the seat may positively lift the valve away from its seat.

18. In safety apparatus for engines with intake manifolds and fuel pumps, a hollow body, a movable means in said body dividing it into two compartments, one of which compartments has a fluid inlet and a fluid suction outlet to a fuel pump, the other compartment having a suction outlet to a manifold, a valve biased to a seat in said fluid inlet, means to open the valve in response to suction in said outlet, a connection between the movable means and the valve, and means on the other side of said movable means adapted to actuate the movable means to open said valve in response to vacuum from an intake manifold.

19. In safety apparatus, a hollow body, a movable member in said body dividing it into two compartments one of which has a fluid inlet and a fluid suction outlet, a valve biased to a seat inwardly in said inlet, and adapted to be opened by the pressure of the movable member upon suction in said outlet, means in the compartment on the other side of the diaphragm adapted to move toward the movable member to open said valve, a cam for operating said last-named means, and suction means associated with the cam, exposed to intake manifold suction pressure.

20. In safety apparatus, a hollow body, a flexible diaphragm in said body dividing it into two compartments, one of which has a fluid inlet and a suction outlet for liquid, a valve biased to a seat inwardly in said inlet, and adapted to be opened by the pressure of the diaphragm upon suction in said outlet means, a member in the compartment on the other side of the diaphragm adapted to move toward the diaphragm to open said valve, a cam for operating said member, and a piston associated with the cam, said piston being exposed to intake manifold suction pressure to move the cam to force said member to open said valve.

21. In safety apparatus, a hollow body, a flexible diaphragm in said body dividing it into two compartments, one of which has a fluid inlet and a suction outlet for liquid, a valve biased to a seat inwardly in said inlet, and adapted to be opened by the pressure of the diaphragm upon suction in said outlet, a member in the compartment on the other side of the diaphragm adapted to move toward the diaphragm to open said valve, a cam for operating said member, and a piston associated with the member, said piston being exposed to intake manifold suction to move the

cam so as to open said valve, and air inlet means behind said piston and above the diaphragm.

22. In safety apparatus, a hollow body, a flexible diaphragm in said body dividing it into
5 two compartments, one of which has a fluid inlet and a suction outlet for liquid, a valve biased to a seat inwardly in said inlet, and adapted to be opened by the pressure of the diaphragm upon
10 suction in said outlet, a member in the compartment on the other side of the diaphragm adapted to move toward the diaphragm to open said valve,
a cam for operating said member, and a piston associated with the cam, said piston being exposed to intake manifold suction to move the
15 cam so as to open said valve, air inlet means behind said piston and above the diaphragm, and means for cutting off said air inlet means at will and for depressing through said member to force

the diaphragm to open said valve against its bias.

23. In safety apparatus, a hollow body, a flexible diaphragm dividing said hollow body into two compartments, one compartment having a liquid inlet and a liquid suction outlet, a valve
5 normally biased to a seat downstream in said outlet, means associated with said diaphragm contacting said valve to open it upon depression of the diaphragm caused by suction in said outlet, a bifurcated piston in the compartment above
10 the diaphragm which is concentric with the valve, a laterally operable piston. a cam associated therewith movable into the bifurcated piston to depress the same, said laterally operable piston being exposed to suction pressure in an
15 intake manifold.

ORREN E. ZODER.