April 30, 1929.

J. F. HOWARTH

1,710,983

DIAPHRAGM CONTROL VALVE

Filed Sept. 27, 1927

Fig. 3.

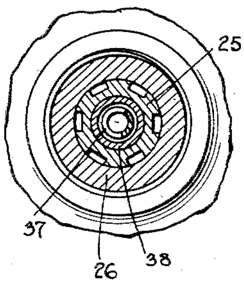


Fig. 1.

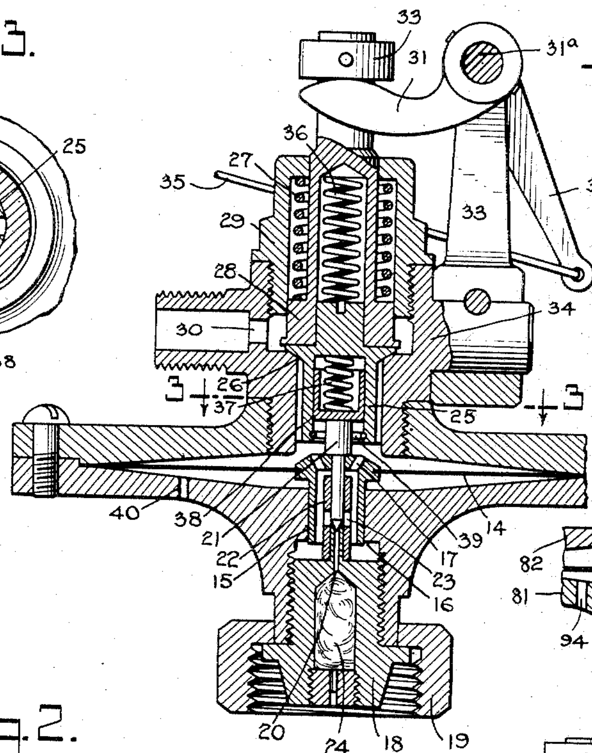


Fig. 5.

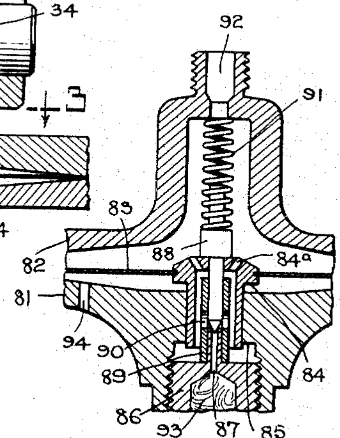


Fig. 2.

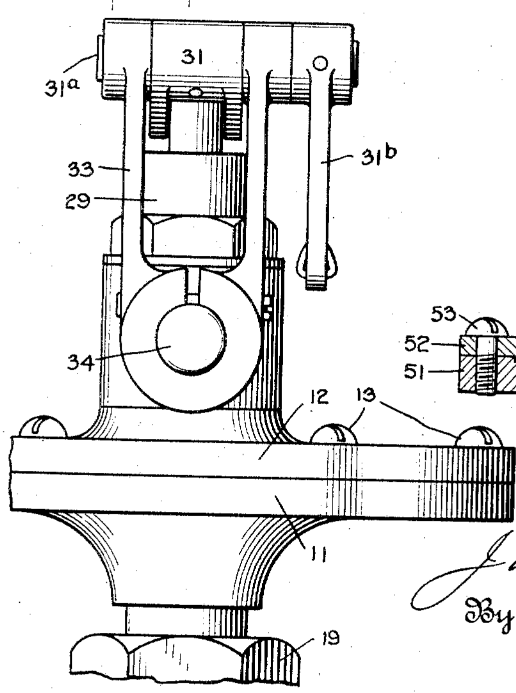
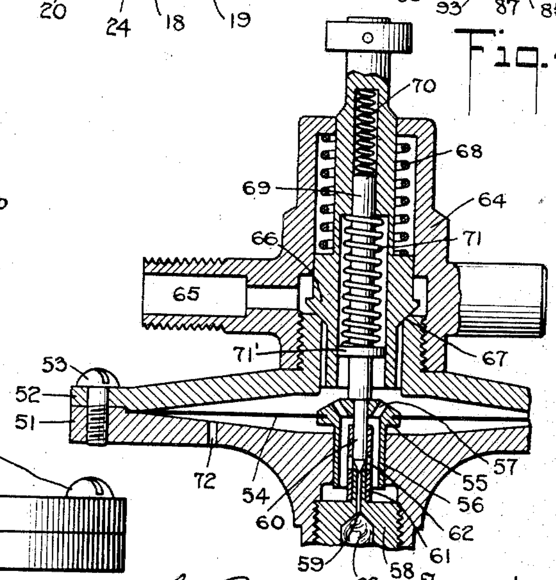


Fig. 4.



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By his Attorneys.

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UNITED STATES PATENT OFFICE.

JOHN FREDERICK HOWARTH, OF NEW YORK, N. Y.

DIAPHRAGM CONTROL VALVE.

Application filed September 27, 1927. Serial No. 222,379.

This invention relates to certain novel and useful improvements in diaphragm operated valves, and while I have in the present instance described the same as used as a priming device for internal combustion engines, I wish it to be understood that the invention is not limited in its useful application to this particular purpose, as it may be employed in any connection wherein the adoption of a valve for controlling fluid pressure or vacuum is deemed advantageous or desirable.

In carrying out my invention it is my purpose to provide a valve of the aforementioned type which would embody the desired features of simplicity, efficiency and durability, and which may be manufactured, marketed and installed at a relatively low cost.

It is also my purpose to provide a valve of this character, through the medium of which pressure or vacuum may be readily, accurately and instantly controlled.

With the above recited objects and others of a similar nature in view, my invention consists in the construction, combination and arrangement of parts set forth in and falling within the scope of the appended claims.

In the accompanying drawings

Fig. 1 is a vertical cross sectional view of one form of valve embodying my invention;

Fig. 2 is a view in end elevation of the valve and showing the manual control device thereof which I prefer to use when the valve is employed as a priming device for an internal combustion engine, such as an automobile;

Fig. 3 is a cross sectional view taken on line 3—3 of Fig. 1 looking in the direction of the arrow;

Fig. 4 is a vertical cross sectional view of a modified form of valve;

Fig. 5 is a similar view of a second modified or automatic form of valve.

In order that the construction and operation of my improved valve may be readily understood, I will now proceed to describe the same as used as a priming device for internal combustion engines as, when used for this purpose, the starting of the engine is greatly facilitated by the admission, into the inlet manifold, of combustible gases readily miscible with the air admitted through the carbureter throttle valve.

As is well known, in cold weather, it is very difficult to obtain from a carbureter (assumed to be properly adjusted for continuous running) a sufficient quantity of vaporized gasoline to enable the engine to be readily started. However, this difficulty may be overcome by the initial admission of a proper proportion of a combustible gas to provide the necessary difference in volatile matter so that upon the ignition of the charge the crank shaft will be at once operated with sufficient speed to cause high air velocity past the fuel nozzle of the carbureter, thereby vaporizing the gasoline to provide the necessary mixture for the continuous running of the engine.

By installing my valve between the source of fuel supply and the manifold of the engine, I am enabled to supply the engine cylinders with a highly volatile vapor on the initial operation of the pistons, and maintain such supply until the engine begins to operate normally with respect to its predetermined carbureter supply. Furthermore, when my valve is so installed, the highly volatile gas is supplied to the engine cylinders only while the crank shaft is being rotated and the carbureter throttle choked or practically closed, for, under such conditions, there will be created in the manifold and in the valve a sufficient vacuum to open the valve and allow the supply of priming gas to flow to the engine. When, however, the engine has picked up sufficiently to run upon its normal carbureter supply, and the carbureter throttle is opened, the vacuum in the manifold line will be so reduced that the diaphragm of valve will close thereby preventing the further flow of the highly volatile priming gas to the engine. Of course, as the diaphragm valve can only open in the presence of a sufficient vacuum or suction, should the engine stop, through accident or otherwise, the diaphragm valve will remain closed and therefore there can be no escape of dangerous volatile priming gases to confined spaces, such as the engine hood of an automobile, or the engine room of a boat, where an explosion of such gases might be exceedingly dangerous.

In the form of the invention shown in Figs. 1 to 3 inclusive, I provide a valve wherein both manual and engine operation is necessary to release the priming fuel from the source of supply, whether such fuel supply be under high pressure, (such as absorbed acetylene vended in containers) or whether the fuel is a liquid (such as ether) without head or pressure. Inasmuch as manual manipulation alone will not release the volatile gas, the possibility of accidents by unintentional manipulation of the manual control is obvious.

The diaphragm valve is so constructed as to check backfire from reaching the diaphragm of the device and destroying the same, and means are provided for preventing the diaphragm being acted upon by a partial vacuum when the manual control, shown particularly in Figs. 1 and 2, is released.

Referring now to the accompanying drawings in detail, and particularly to the form of valve shown in Figs. 1 to 3 thereof, the said valve comprises a casing formed of sections 11 and 12 connected by the screw bolts 13. Clamped between the contiguous walls of the casing is a flexible diaphragm 14, formed of any suitable material, such as metal, and having centrally disposed therein, a tubular ported stem 15, which is free to slide in bore 16 in the lower casing section 11. The ports of the stem 15 are shown at 17, and provide communication between the interior of the stem and the valve chamber above the diaphragm. Into the lower valve section 11 is threaded a nipple 18, while a union 19 is provided for connecting the valve with a suitable source of fluid supply, such as a gas chamber for containing the priming gas in the present instance. The nipple 18 is provided with a nozzle 20 forming a seat for the needle valve 21 which slides in the sleeve 22, ports 23 being provided in the sleeve for the exit of the gas from the nipple to the tubular stem, and thence through the port 17 of the latter, to the valve chamber above the diaphragm. A body of suitable filter material shown at 24 is placed in the nipple to prevent foreign particles, such as carbon, from obstructing or blocking the nozzle 20.

The mechanism for manually controlling the valve shown in Figs. 1 and 2 comprises a check valve 25 normally retained closed on its seat 26 by means of a spring 27 and plunger 28, the spring 27 being housed in the cap 29 and bears at its upper end against the top of the cap and at its lower end against the shoulder of the plunger 28. Thus, the normal action of the spring 27 is to force the plunger down against the check valve 25 and hold the latter closed against its seat thereby preventing the action of vacuum of the inlet manifold of the engine upon the diaphragm. The outlet of the valve is indicated by the numeral 30 and, in the present instance, is threaded to receive a suitable pipe connection, such as a connection with the inlet manifold of an internal combustion engine.

For the purpose of manually operating the valve, I provide a mechanism comprising a lever arm 31 adapted to bear against collar 32 on the outer end or stem of the plunger 28, this lever 31 being fastened upon a shaft 31ª journalled in the yoke 33. A lever 31ᵇ is also connected with the shaft 31ª and has attached to its free end an operating rod 35 which is adapted to be manipulated by the operator. The yoke 33 is mounted upon a suitable stud 34 forming a part of the upper portion of the valve body or casing. The stem of the plunger 28 is hollow, and has located therein a coil expansion spring 36, the lower end of which bears against the top of the check valve 25, while the upper end bears against the top or interior wall of the plunger stem. This spring 36 exerts a light pressure on the valve 25 in opposition to the pressure of a second coil spring 37 which is seated in a cup 38 at the upper end of the needle valve 21, this spring-holding cup sliding in a socket formed in the check valve. The sliding movement of the spring-holding cup 38 in the check valve is limited by the stop ring 39 at the mouth of the socket of the check valve 25. Inasmuch as the spring 37 is stronger than the spring 36 and acts in opposition thereto, the spring 36 cannot hold the check valve 25 closed against its seat 26 when the pressure or force of the spring pressed plunger 28 is removed from the check valve, but when such removal takes place the check valve will open slightly to provide a passageway from the diaphragm chamber through the outlet 30. The diaphragm chamber is provided with an airport 40 for the purposes hereinafter mentioned.

From the above description taken in connection with the accompanying drawings, the construction and operation of the valve mechanism shown in Figs. 1 to 3 inclusive, will be readily understood. Assuming, for example, that the outlet 30 of the valve is connected with the inlet manifold of the gas engine, and that the union 19 connects the valve with a suitable source of priming gas supply, such for example, as a tank for acetylene gas, and that it is desirable to start the engine by priming the latter from such gas supply, the operation is as follows:

The operator pulling upon the rod or wire 35 rocks the lever 31ᵇ on the rock shaft 31ª thereby throwing the arm 31 upward against the collar 32 on the stem of the plunger 28, and lifts the plunger from the check valve and against the tension of the spring 27. The result is that the holding pressure of the plunger against the check valve being released, and the spring 37 being stronger than the spring 36, such spring 37 will force the check valve slightly upward from its seat thereby opening slightly communication between the diaphragm chamber and the outlet 30, this upward movement of the check valve 25 bringing the stop ring 39 of the latter into contact with the spring-holding cup 38, but at this time the needle valve will of course be maintained closed by the relatively strong spring 37. However, the slight opening of the check valve 25 permits the vacuum or suction to operate on the diaphragm 14, causing the latter to move or buckle upward, air of course passing through the airport 40 into the diaphragm chamber beneath the diaphragm. This upward movement of the diaphragm will cause the ported stem 15 to slide upward and the end of this stem bearing against the adjacent shoulder of the needle valve 21 will force the needle valve, and also the check valve, completely open as against the action of the relatively weak spring 36. Under such open conditions of the check valve and the needle valve the priming gas will pass through the nipple 18, the nozzle 20, the ports 17 in the stem 15, and thence pass the check valve and out through the valve casing outlet 30 to the inlet manifold of the engine, where it will perform its function of priming. When the engine has been sufficiently primed the operator simply releases the pull on the rod 35 and the spring 27 will immediately force the plunger 28 down against the check valve forcing the check valve to its seat and, of course, likewise returning the needle valve to closed position, through the intermediate parts, thereby cutting off the supply of the priming gas. Of course, in starting the engine, when the latter has been primed sufficiently to draw in the normal supply from the carbureter, the throttle valve of the carbureter is opened to furnish such supply and the operator releases the pull on the rod 35 to close the diaphragm valve. This operation will only take a few seconds. However, irrespective of the actuation of the manual operating mechanism, when the engine has picked up its normal speed and with the carbureter throttle open and drawing its normal supply from the carbureter the vacuum on the outlet 30 of the valve will be so reduced as to be unable to elevate or buckle the diaphragm, and consequently the needle valve will be automatically seated or closed by the action of the spring 36, although at this time the check valve might remain open slightly, due to the action of the spring 37. Therefore, irrespective of the manual operating mechanism, when the engine is normally operating, the priming gas supply will be automatically cut off. This will be appreciated when it is realized that when an engine is being cranked for starting the partial vacuum is approximately 10″ of mercury, when the engine starts and idles the partial vacuum reaches 18″, while when the throttle valve is opened, and the engine is running normally, the partial vacuum is lowered to 6″. As the diaphragm will not operate under the action of the vacuum at less than 10″, naturally, the needle valve will automatically close.

It will be noted that employing the former check valve shown in Fig. 1, when the valve is slightly open, should there be any backfire the pressure on top of the valve will be such as to overcome the action of the spring 37 and will force the valve to closed position against its seat thereby preventing any damage to the diaphragm by reason of such backfire.

In Fig. 4 I have shown a modified form of the device, in this construction the form of check valve shown in Fig. 1 being omitted. In the modification the valve body includes the casing sections 51 and 52 fastened together by the screw bolts 53 and holding the diaphragm 54. The latter is provided with a ported stem 55 free to slide in the bore 56 of the casing, the ports of the stem being shown at 57, and are for the purpose of allowing passage of fuel from a source of supply which is connected with the nipple 58, through the nozzle 59 and thence when the valve is open through the ports 57 and out through the outlet 65. The nozzle 59 forms a seat for the needle valve 60 which is guided in a sleeve 61, the latter having ports 62 for the passage of the gas, a suitable packing of filtering material 63 being provided to prevent foreign particles from blocking nozzle 59. To the section 52 of the casing is secured a valve bonnet 64 having an outlet 65, and within the bonnet is located a plug valve 66, normally maintained against its seat 67 by means of the coil spring 68. As will be seen, the plug valve is hollow or tubular in form, and has located therein the shank 69 of the needle valve. A coil spring 70 operates against the top end of the needle valve shank 69, while a second spring 71 bears at its lower end against a collar 71′ on the shank, and at its upper end against the shoulder at the interior of the plug valve shank. The casing is also provided with a suitable airport 72.

When the parts of the valve are positioned as shown in Fig. 4, the needle valve 60 is held tightly against a seat by the co-action of the springs 70 and 71. To operate the valve, for example in priming an engine, the plug valve 66 is manually lifted, as in Fig. 1, against the pressure of the spring 68, thus placing the diaphragm in communication with the inlet manifold of the engine, while at this time the needle valve is held in its seat by the action of the spring 71, as spring 70, with the plug valve lifted, is no longer under tension and therefore does not operate.

The engine may now be cranked, either by hand or power, with the carbureter valve nearly closed (the idling position) and the pumping action of the piston will create a partial vacuum in the inlet manifold, and at the same time air will pass into the diaphragm chamber, beneath the diaphragm, through the port 72. Thus the diaphragm will be raised, the needle valve opened, and the gas or fuel may pass from the source of supply through the valve and out through the outlet 65, as will be readily understood. When the engine is running at normal speed with the carbureter throttle open, the valve will close as described in the construction shown in Fig. 1.

Referring to Fig. 5 this modification which may be used as an automatic valve for refrigerating systems consists of a valve casing comprising sections 81 and 82 which are bolted together at their outer edges and hold the diaphragm 83, which has a ported central stem 84, free to slide in its guide 85 in casing 81, ports 84[a] being provided to allow the passage of fluids, gases or vapours, entering through union 86, and nozzle 87, which forms a seat for needle valve 88 guided in sleeve 89 having ports 90 to pass vapours. A spring 91 keeps needle valve 88 normally closed on its seat in nozzle 87. An outlet port 92 is provided with means for conduit connection, and a filter 93 prevents nozzle 87 being fouled by foreign particles.

The operation of this modification will be readily understood. The port 92 being connected to negative pressure, and the union 86 being connected to the positive pressure side, as in a refrigerating system, the pumping action of the compressor creating a negative pressure or partial vacuum on the suction side, operates the device, the said partial vacuum acting on the diaphragm 83 within the casing 82. Atmospheric pressure enters through vent 94 lifting diaphragm 83, ported stem 84, and needle valve 88, allowing the refrigerant to flow through nozzle 87, thus maintaining a definite partial vacuum on the expansion or cooling side of the system.

It will of course be understood that the examples of use of my valve which I have herein recited are merely by way of illustration, as there are many other uses to which the valve may be put, other than in connection with internal combustion engines and refrigerating systems. For example, it may be employed to provide means for preventing conduits and tanks from collapsing under atmospheric pressure should the air or contents of the conduits or tanks be exhausted, indeed, to automatically break and maintain a partial vacuum at any predetermined pressure. It may be employed as a means to automatically admit air in the return water pipes of a heating system to prevent the suspension of water in such pipes; and may also be used as an automatic regulator to cut in or out auxiliary pumps on a vacuum pipe line in power plants. It may be used to cut off the steam supply to turbines should the vacuum in the condenser be reduced below a safe pressure, thus preventing end thrust on the turbine rotors or consequent stripping of the blades. The invention will also be found particularly useful as a controlling valve for all kinds of gas plants, systems and engines.

Therefore, while I have herein shown and described certain preferred embodiments of my invention, I wish it to be understood that it is not limited to all the precise details of construction herein set forth by way of illustration, nor to the precise uses herein set forth, as modification and variation may be made and the valve applied to other uses than those mentioned, without departing from the spirit of the invention or exceeding the scope of the appended claims.

What I claim is:

1. A valve of the class described, having a fluid inlet and a fluid outlet and a diaphragm chamber, a diaphragm located in said chamber having a passage communicating with the inlet and the outlet, and a valve member extending through the passage of the diaphragm and normally closing the inlet against the pressure of an incoming fluid and adapted to be opened by movement of the diaphragm when vacuum is applied to said diaphragm to permit the flow of fluid from the inlet to the outlet and through the passage of the diaphragm.

2. A valve of the class described, having an inlet and an outlet and a diaphragm chamber, a diaphragm located in said chamber, a valve controlling the passage of fluid from the inlet to the diaphragm chamber, and manually operable means normally holding said valve in closed position against the pressure of an incoming fluid, said valve being adapted to be opened by the movement of the diaphragm when vacuum is applied to the latter to permit the flow of fluid from the inlet to the outlet.

3. A valve of the class described, comprising a casing having an inlet and an outlet and a diaphragm chamber, a diaphragm located in said chamber, a valve member controlling the passage of the fluid from the inlet to the diphragm chamber, a check valve controlling the passage of fluid from the diaphragm chamber to the outlet, means normally holding the first mentioned valve member in closed position against the pressure of an incoming fluid, and means for normally holding the check valve in closed position, said valve member being operable by the movement of the diaphragm to open communication between the inlet and the valve chamber under the application of a vacuum on the outlet, when the check valve is opened.

4. A valve of the class described, comprising a casing having an inlet and an outlet, a valve controlling the passage of fluid through the inlet to the valve casing, a second valve controlling the passage of fluid from the valve casing to the outlet and operating when in closed position to close the first named valve, said first mentioned valve being adapted to be opened for the passage of an incoming fluid, upon the application of a vacuum when the second valve is opened.

5. A valve of the class described, comprising a valve casing having an inlet and an outlet and a diaphragm chamber, a diaphragm located within the chamber, a valve operable by the movement of the diaphragm, a valve controlling the flow of fluid from the inlet

to the diaphragm chamber, means for normally holding said valve in closed position, a check valve operating with the first mentioned valve and controlling a passageway between the diaphragm chamber and the outlet, and means for normally holding said second valve in closed position, the construction being such that when the second valve is open, vacuum would be exercised upon the diaphragm to open the first mentioned valve and permit the passage of fluid, under pressure, through the inlet, the diaphragm chamber, and thence through the outlet.

6. A valve of the class described, comprising a valve casing having an inlet and an outlet and a diaphragm chamber, a flexible diaphragm located in said chamber, a needle valve controlling the passage of fluid from the inlet to the diaphragm chamber, spring devices normally holding said needle valve in closed position, a check valve associated with the needle valve and controlling a passage from the diaphragm chamber to the outlet, and spring devices normally holding the check valve in closed position, the said needle valve being opened by the action of the diaphragm when the check valve is opened and vacuum is exerted upon the diaphragm.

7. A valve of the class described comprising a casing having an inlet and an outlet and a diaphragm chamber, a diaphragm located in the chamber, a nozzle leading from the inlet to the diaphragm chamber, a valve controlling said nozzle and normally closing the same, a check valve controlling a passage between the diaphragm chamber and the outlet, means normally holding such check valve in closed position, and means operable to open the check valve and permit suction to be exerted upon the diaphragm to open the valve controlling the nozzle to admit the passage of the fluid, under pressure, from the inlet through the diaphragm chamber and thence through the outlet.

8. A valve of the class described, comprising a casing having an inlet and an outlet and a diaphragm chamber, a ported stem projecting from the inlet into the diaphragm chamber, a diaphragm located within the chamber and connected with said stem, a nozzle communicating with the valve inlet and projecting into the stem, a needle valve controlling said nozzle, a spring device normally holding said needle valve in closed position, a check valve controlling a passage from the diaphragm to the valve casing outlet, a spring device normally holding such check valve in closed position, and means for opening the check valve against the action of its spring device to cause the operation of the diaphragm under the exercise of a vacuum to open the needle valve and permit the passage of fluid from the inlet through the valve casing to the outlet.

9. A valve of the class described, comprising a casing having an inlet and an outlet and a diaphragm chamber, a diaphragm located within the said chamber, a hollow stem connected with the diaphragm and communicasing with the inlet, a valve controlling the passage of the fluid from the inlet through the hollow stem to the diaphragm chamber, a check valve controlling the passage of fluid from the diaphragm chamber to the outlet, spring devices normally holding such controlling valves in closed position against the pressure of an incoming fluid, and means for operating the valves to open the same and permit the passage of the fluid from the inlet through the valve casing to the outlet.

10. A valve of the class described, comprising a casing having an inlet and an outlet and a diaphragm chamber, a diaphragm located within the chamber, a nozzle located between the inlet and the diaphragm chamber, a needle valve controlling said nozzle, a check valve controlling a passage between the diaphragm chamber and the outlet, spring devices normally holding the needle valve in closed position on the nozzle, a spring tensioned plunger normally holding the check valve in closed position, and means for operating the plunger to permit the opening of the check valve, thereby causing the needle valve to be opened upon the exercise of a vacuum upon the diaphragm.

11. A valve of the class described, comprising a casing having a valve inlet and an outlet and a diaphragm chamber, a diaphragm located within the chamber, a hollow stem connected with said diaphragm and communicating with the valve inlet and having ports therein, a nozzle communicating with the inlet and projecting into the stem, said nozzle having ports therein, a needle valve controlling the flow of the fluid through the nozzle, spring devices normally holding the needle valve in closed position, a check valve controlling a passage between the diaphragm chamber and the outlet, spring devices normally holding the check valve in closed position, and means for operating the check valve to permit the action of the diaphragm, under vacuum, to open the needle valve.

12. A valve of the class described having a fluid inlet and a fluid outlet, a valve mechanism controlling a passage between the inlet and the outlet and including a fluid pressure actuated valve adapted to be opened upon the application of vacuum to permit the flow of fluid from the inlet to the outlet, and further including pressure responsive means operating to close the passage between the outlet and the valve upon a reduction in the initially applied operative vacuum.

Signed at New York city in the county of New York and State of New York this 21st day of September, A. D. 1927.

JOHN FREDERICK HOWARTH.