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Filed June 5, 1940

Serial No. 339,025
2 Sheets-Sheet 1

FIG. 5

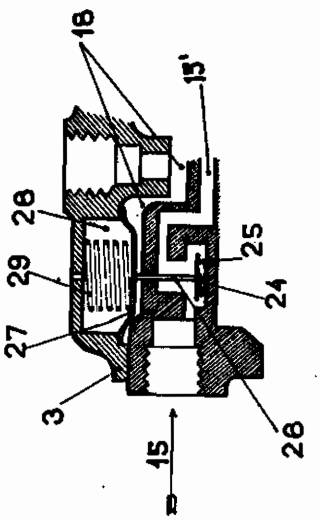

FIG. 4

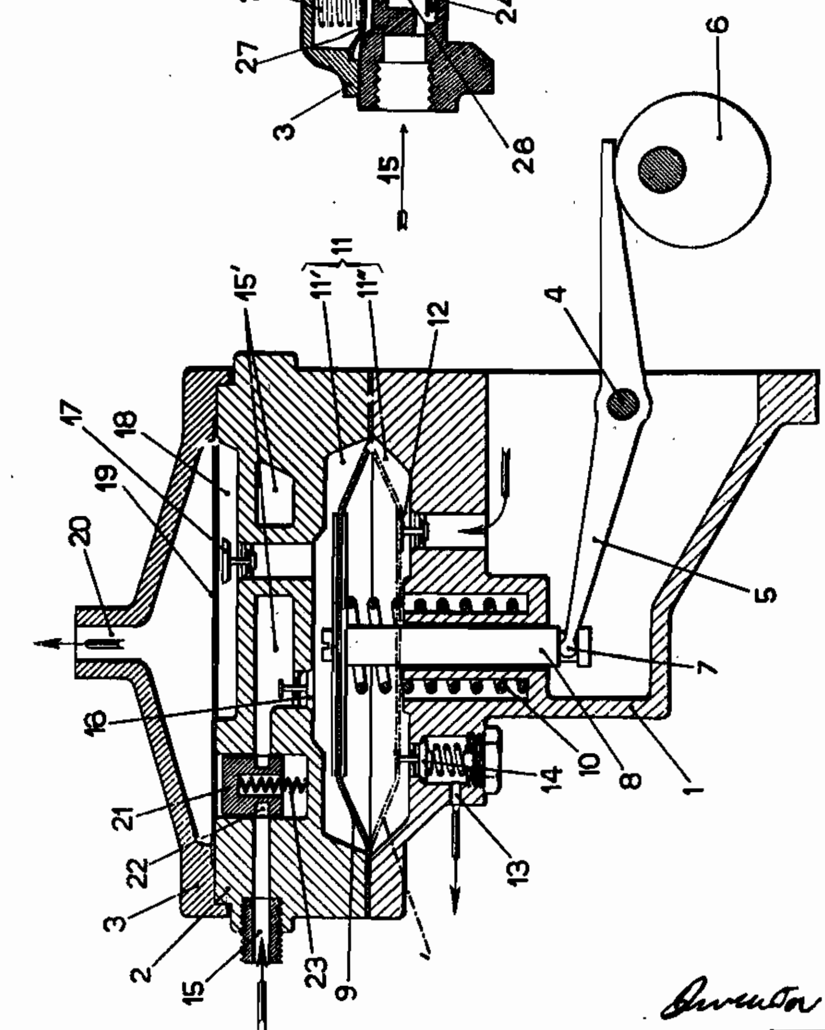

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FIG.2

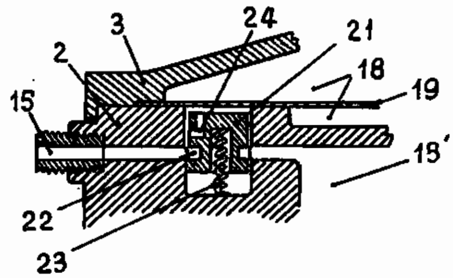


FIG.3

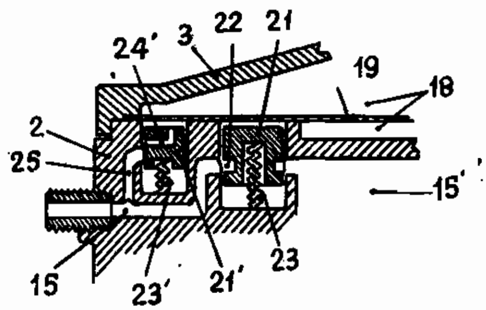
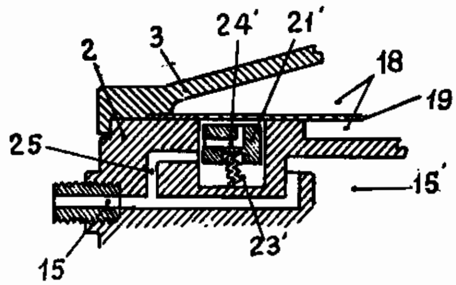


FIG.4



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ALIEN PROPERTY CUSTODIAN

DIAPHRAGM PUMPS FOR FEEDING FUEL TO EXPLOSION ENGINES

Louis Guichard, Paris, France; vested in the Alien Property Custodian

Application filed June 5, 1940

In the diaphragm pumps used at the present time for feeding fuel to explosion engines, the displacements of the diaphragm are of variable amplitude which is dependent on the consumption of the engine. In order to obtain this result only the suction movement of the diaphragm in question is positively controlled, the delivery movement being produced by a spring which is necessarily of small power owing to the low value the delivery pressure is required to have (of the order of about 150 gm. per sq. cm.)

Now, at high speeds of operation, the power of said spring is too small to overcome the resistances, in particular those due to the inertia offered by the lever-spindle-diaphragm assembly etc. of the pump. Consequently, the pump lever which is controlled by the eccentric becomes "loose", that is to say it is no longer permanently in contact with said eccentric, thereby producing shocks, noises and disturbances in the output of the pump whereof the diaphragm cannot beat regularly.

Although endeavours have been made to remedy this drawback by means of a second spring which tends constantly to keep the pump lever in contact with the controlling eccentric, this contrivance does not produce the desired result.

When the phenomenon known by the name of "vapor lock" starts, the output should be at its maximum in order to eliminate said phenomenon; now, unless the use of apparatus of undesirable bulk and high cost is considered, this is not the case with present day pumps, the diaphragms of which have a movement of very small amplitude, so that a certain amount of fuel remains for a comparatively long time in contact with the hot metal walls which are insufficiently cooled owing to the very small output; it is these conditions which necessarily produce the "vapor lock" referred to above and this tendency is enhanced by the fact that the fuel which is introduced into the pump is already at a fairly high temperature which it has acquired in the supply pipe.

The diaphragm pump which is the object of the present invention and which is based on quite a different conception from that on which the present day pumps are based, radically overcomes the drawbacks specified above, this being effected without any complication, without greater bulk and, consequently, without higher cost of manufacture than that of the usual apparatus kwown hitherto.

The novel diaphragm pump according to the invention has the following features and advantages:

The regulation of the output and of the delivery pressure of the fuel is no longer effected by means of a weak delivery spring, but by means of a special regulating piston-valve which controls the passage cross-section of the suction pipe of the pump.

Since the delivery spring no longer has a direct influence on the output and on the pressure, it can be given the necessary power to prevent the control lever from becoming loose (looseness due to the inertia effects), whereby silent operation is obtained; furthermore, it is possible to eliminate the spring which is provided in the present day pumps and which is solely intended to keep the pump lever in contact with the controlling eccentric.

The diaphragm effects its total displacement at each cycle and consequently sucks up the maximum volume at all speeds of operation.

The vapor lock phenomenon is automatically eliminated by means of the novel application of a means based on the well known physical phenomenon of the evaporation of a liquid in a vacuum with a considerable fall of temperature, said evaporation phenomenon taking place automatically during the suction stroke of the diaphragm (which always takes up the same maximum volume) whether a small quantity of fuel remains in the pump chamber (and in a storing chamber located before said pump chamber), or whether a very small portion of fuel is introduced at the outset, said fuel evaporating with a considerable fall of its temperature during the increase in the volume sucked in by the diaphragm during its suction stroke. Owing to the fact that this operation takes place at each stroke of the pump, it will be seen that, by the cooling of the liquid (by evaporation in a vacuum) and, consequently, by the cooling of the walls of the chamber, the vapor lock phenomenon is eliminated without its being necessary to use special devices which considerably increase the cost of the pump.

In order to realize the extent of the phenomenon on which the means used in the present invention is based, it is sufficient to observe that a vehicle of average power consumes about 4 c. c. of fuel per second and that the novel pump (of usual size) delivers in the same time a volume of about 1000 c. c. The differences between the two above mentioned volumes readily explains the evaporation phenomenon of the fuel in a vacuum, which is the result aimed at in order to obtain the fall of temperature.

The feature of the novel pump, according to which the diaphragm effects its maximum displacement at each cycle, enables the same diaphragm to be used for two purposes. The upper face of the diaphragm cooperates with the upper compartment of the pump body chamber to form a fuel pump, whereas the lower face of the aforesaid diaphragm cooperates with the lower compartment of the same chamber to form a pneumatic (compression or vacuum) pump.

Thus, there is obtained in the same apparatus, on the one hand a fuel pump having the advantages specified above, and on the other hand a pneumatic pump forming either a source of compressed air, or a sourse of vacuum. Said source of vacuum may advantageously ensure the operation of usual depression operated apparatus, for example a wind-shield wiper. The compressed air may likewise ensure the operation of a pressure operated wind-shield wiper, which may be more powerful than a depression operated apparatus. The same pressure operated wind-shield wiper may moreover be connected on the one hand to the pneumatic pump, and on the other hand to the induction pipe of the engine. A wind-shield wiper which is operated in this manner has a power which it is impossible to obtain otherwise for the same size.

Of course, the pneumatic pump may be used for any other purpose.

In the pumps known at present, the suction and delivery nozzles are generally formed in the same part and cannot be directed in any desired direction with respect to each other. The novel pump which is the object of the present invention enables this drawback to be obviated inasmuch as the suction nozzle, for example, is carried by a part which may occupy horizontally (about its vertical axis) any required direction, whereas the delivery nozzle is provided in the central part of a cover which is independent of the part referred to above, where it is in the most favorable position for the pipe and for the flow of the fuel towards the carburettor.

It may however happen that, in spite of the control of the passage cross-section of the supply pipe by means of the piston-valve which was mentioned above, an undesirable over-pressure occurs in the delivery chamber (that might possibly flood the carburettor), which over-pressure is due to the delivery of a considerable excess of fuel.

In order to remedy this drawback, the invention provides a modification which enables the excess of fuel in the delivery chamber to return, either to the fuel supply pipe, or to a separate pipe.

In other words, the regulation, instead of being based solely on the quantity of liquid introduced into the pump, is also based on the return, before the pump inlet, of the excess of liquid which is liable to produce an undesirable over-pressure in the delivery chamber.

Finally, the invention further provides another method of distribution for obtaining the regulation of the output and of the delivery pressure of the liquid. In this latter embodiment, a simple valve controlled by a diaphragm is substituted for the piston-valve or valves placed in the passage of the liquid fuel in the induction pipe.

In the accompanying drawing, a number of embodiments of the invention have been shown diagrammatically and by way of non-limitative examples.

Fig. 1 is a vertical section of a diaphragm pump according to one embodiment of the invention;

Fig. 2 is a section of a portion of the pump illustrated in Fig. 1 and showing an embodiment of another system of regulation;

Fig. 3 is a similar section to the previous one, of a modification of said system of regulation;

Fig. 4 is a similar section to the previous ones, of another modification of the system of regulation in question;

Finally, Fig. 5 is a similar section of another embodiment.

As can be seen in Fig. 1 of the accompanying drawing, the apparatus comprises diagrammatically a frame 1 (containing the actuating mechanism of the pump), a block 2 (containing the regulation system with the evaporating chamber) and a cap 3.

In the frame 1 is pivoted at 4 the control lever 5 which is actuated from the outside by the eccentric 6 driven by the engine to be supplied. The lever 5 is engaged, with its fork-shaped end 7, with the lower part (provided with a circular groove) of a rod 8, the upper end of which is secured to a diaphragm 9 of which the edge is clamped between the frame 1 and the block 2.

A comparatively strong spring 10 constantly tends to push the diaphragm towards the upper part/its stroke, said diaphragm moving in a chamber 11 which is limited by the frame 1 and the block 2 and is separated into two compartments 11′ and 11″ by the aforesaid diaphragm. Owing to the powerful spring 10, the diaphragm 9 always effects its total displacement and the lever 5 is always in contact with the eccentric 6.

The compartment 11″ communicates with the outside through an intake valve 12 and with the delivery pipe 13 through a delivery valve 14. By reversing the mounting of the valves 12 and 14, the pipe 13 becomes the suction pipe and enables a depression operated apparatus to be actuated.

In the block 2 (in which is provided the compartment 11′ of the chamber 11) is located the supply pipe 15 for the fuel and an evaporation chamber or space 15′, the aforesaid pipe being controlled by the intake valve 16. A delivery valve 17 places the compartment 11′ of the pump in communication with a chamber 18 which is closed by the cap or cover 3, the edge of which cooperates with the upper edge of the body 2 to hold the filter 19 in position, the cover 3 carrying the delivery nozzle 20.

According to one of the essential features of the invention, the passage cross-section of the intake pipe 15 is controlled by a piston-valve 21 which is provided with an annular groove 22 for the passage of the fuel and which is subjected to the action of a suitably calibrated spring 23 which tends to keep the piston-valve 21 in the position shown in the drawing.

The upper part of the cavity in which the piston-valve 21 moves, communicates with the delivery cavity 18.

The operation of the pump which has just been described is as follows:

The various members being in the position shown in the drawing, the eccentric 6 will, during its rotation, rock the lever 5 which, as it rocks, moves the rod 8 and consequently the diaphragm 9 downwards and brings the latter into the position 9′ shown in dotted lines, said diaphragm, during its suction displacement, compressing the spring 10.

The fuel which is sucked through the pipe 15 and passes through the annular groove 22 of the piston-valve 21, the chamber 15' and the intake valve 16, fills the upper compartment 11' which thus absorbs a certain quantity of fuel.

As regards the pneumatic part of the pump, the valve 14 is opened by the action of the compressed air in the lower compartment 11'' during the downward movement of the diaphragm.

As the eccentric 6 continues to rotate, the diaphragm 9, under the action of the spring 10, effects its upward stroke (delivery stroke) during which it carries with it the rod 8 which holds the lever 5 pressed against the aforesaid eccentric.

The liquid which was sucked up during the previous period is then forced into the chamber 18 through the valve 17, the fuel being evacuated at 20 in the direction of the carburettor, for example.

During the same upward stroke of the diaphragm 9, the inlet valve 12 of the pneumatic part of the device is lifted and allows a certain amount of air to enter the compartment 11'', said air being then forced out at 13 through the valve 14 during the following compression stroke.

The fuel delivered must not however exceed a predetermined pressure (in order to prevent the carburettor from flooding). This regulation of the pressure is effected by the piston-valve 21 cooperating with the calibrated spring 23. When the pressure in the compartment 18 reaches a certain value, the piston-valve 21 is forced into its housing and the upper part of said piston-valve closes more or less the passage cross-section of the pipe 15. Consequently the diaphragm is only able to suck up a portion of the fuel or even none at all if the piston-valve 21 is forced right into its housing by the pressure in the chamber 18.

In this manner the regulation of the output and of the pressure is obtained.

Owing to the fact that the diaphragm 19 always effects its complete stroke (at whatever speed the engine is operating), the volume sucked up during suction stroke of the diaphragm is always much greater than that required for the fuel consumption. When the suction pipe 15 is closed by the action of the piston-valve 21, the gasoline which is still in the chamber 15' and in the compartment 11' is vaporized by the effect of the vacuum created by the suction stroke of the diaphragm. This vaporization considerably lowers the temperature of the liquid, thereby contributing to cool the whole apparatus and eliminate the failures due to the vapor lock phenomenon.

It is true that during the up-stroke of the diaphragm 9, the vapors in the compartment 11' are again condensed, but this does not occur in the chamber 15' where the aforesaid vapors subsist and wherein the temperature remains low.

In the embodiment shown in Fig. 2, the piston-valve 21 is provided with a communication duct 24 which starts from the upper face of the valve in question and opens laterally, slightly above the annular groove 22.

It will immediately be seen that when the pressure in the delivery chamber 18 reaches a certain value, the piston-valve 21 is forced in and closes more or less the passage cross-section of the pipe 15. If the aforesaid pressure becomes too great, the piston-valve is forced further in so that not only is the chamber 15' completely shut off from the supply pipe 15, but also the delivery chamber 18 is placed in communication, through the duct 24, with the aforesaid supply pipe 15 (or with another appropriate pipe).

The means formed by the regulation of the pressure in the delivery chamber 18 may moreover be applied independently of the method of regulation shown in Fig. 1.

In other words, and as shown in Fig. 3, it is possible to provide, in addition to the piston-valve 21 of Fig. 1, an auxiliary piston-valve 21' which is subjected to the action of a spring 23' and is provided with a communication duct 24'. When the pressure in the chamber 18 reaches a certain value, the piston-valve 21 moves downwards and isolates the chamber 15' from the pipe 15. If the pressure in the chamber 18 reaches an excessive value, the auxiliary piston-valve 21' (which is subjected to the pressure in said chamber) is in turn forced down in spite of the action of the springs 23'; it thus places the delivery chamber 18 in communication with the pipe 15 (or with another pipe) through the duct 24' and a branch duct 25.

As shown in Fig. 4, it is also possible to design the pump with a single regulating member which does not act on the inlet, viz, a single piston-valve 21' which is subjected to the action of a spring 23' and is provided with a communication duct 24', which piston-valve does not control the passage cross-section of the fuel supply pipe 15 (which cross-section thus remains constant), but solely the pressure in the delivery chamber 18.

In this case, the intake of fuel remains constant, the excess of fuel which is constantly supplied to the compartment 18 simply returning, through the duct 24' which opens into a branch duct 25, either to the supply pipe 15, or to a separate pipe.

Finally, in the last embodiment shown in Fig. 5, regulation of the output by means of a piston-valve has been completely eliminated and regulation by means of a valve 24 provided with a weak spring 25 substituted therefor. Said valve 24 is in touch with a rod 26, the other end of which is in contact with a circular diaphragm 27 lodged in a cavity 28 of corresponding shape in the cover 3, with a spring 29 interposed between the diaphragm and said cover.

This device operates in the following manner:

When the pressure below the cover at 18 reaches a predetermined value, it acts on the diaphragm which pushes back the spring 29. At the same time, the small spring 25 lifts the valve 24 which closes more or less or even completely the passage for the liquid in the pipe 15.

When the pressure below the cover 3 falls, the spring 29 pushes back the diaphragm 27 which acts through the rod 26 on the valve 24 which compresses the spring 25 and the passage 15 is thus opened more or less.

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