

Nov. 28, 1944.

J. HULMAN ET AL

2,363,528

FLUID SYSTEM PRESSURE BOOSTER

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2 Sheets-Sheet 1

FIG. 1.

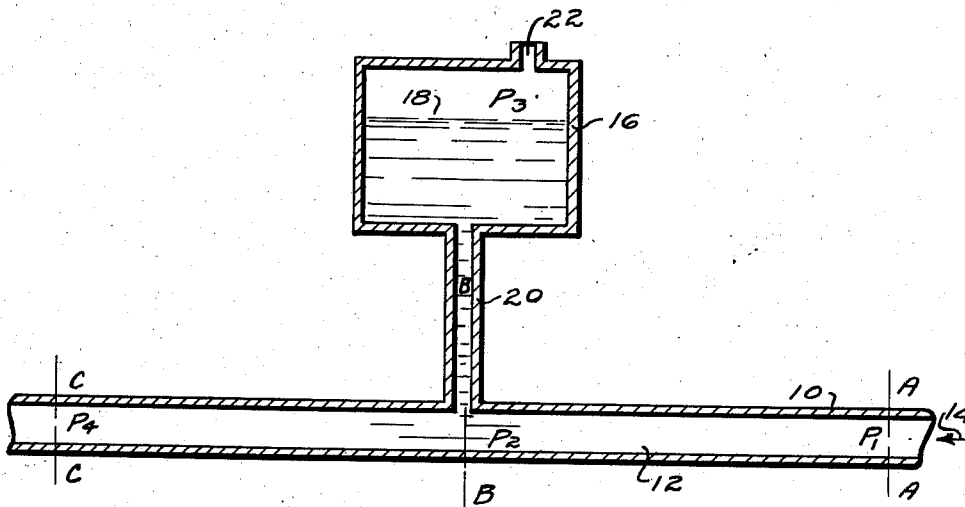
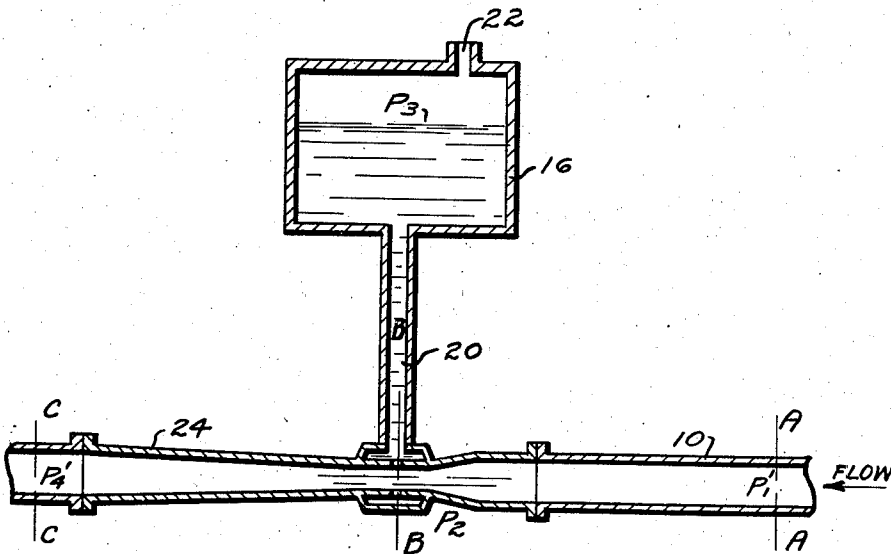


FIG. 2.



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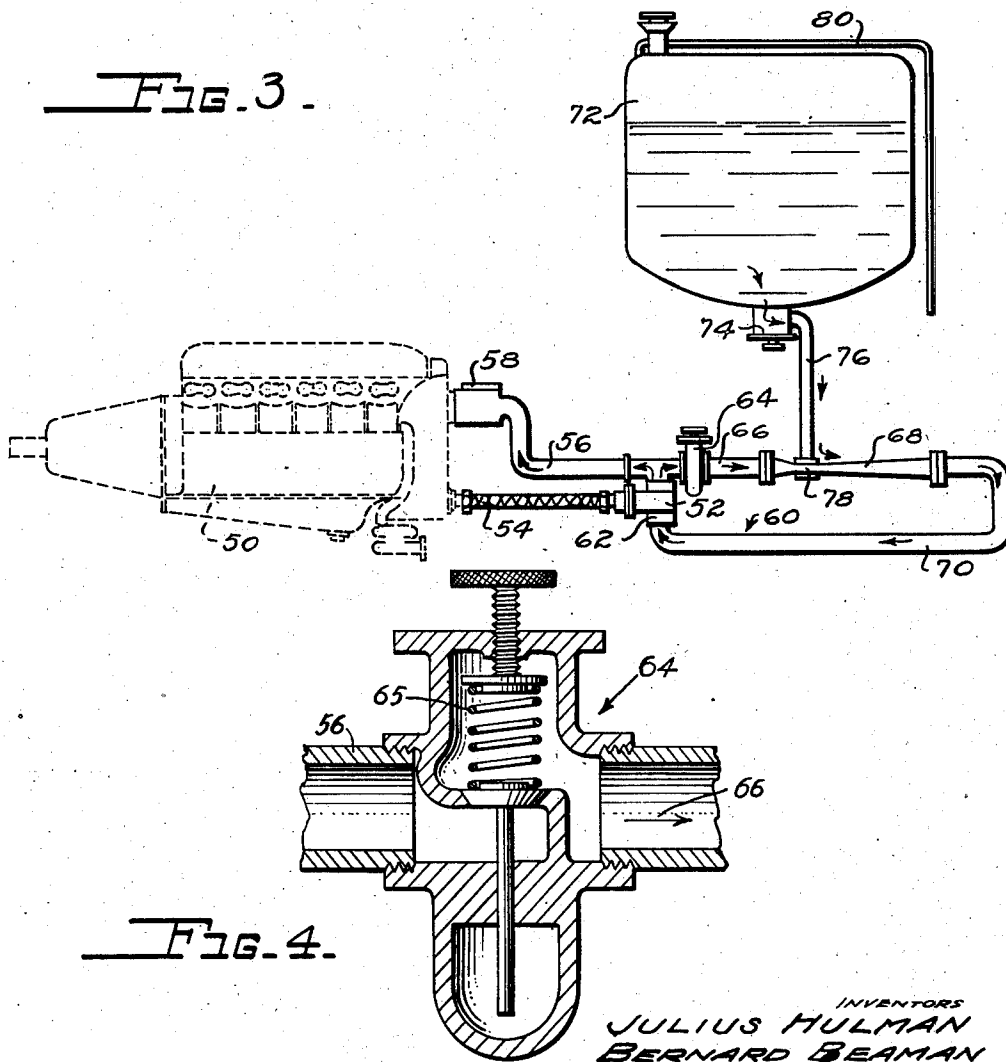
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FLUID SYSTEM PRESSURE BOOSTER

Julius Hulman and Bernard Beaman,
Dayton, OhioOriginal application August 6, 1941, Serial No.
405,673. Divided and this application Septem-
ber 4, 1942, Serial No. 457,300

3 Claims. (Cl. 103-5)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

This invention is a division of our co-pending application Ser. No. 405,673, filed Aug. 6, 1941, patented Dec. 8, 1942, No. 2,304,096, and relates to pressure boosters, and is applicable to any fluid system wherein a fluid is moved against a resistance.

The resistance may comprise no more than the friction encountered by the fluid in moving through the system, or it may include additional resistance, but in any event some pressure or head creating means is required at some part of the system to maintain flow.

Whatever the form that such pressure creating instrumentality may take, there will be a difference in pressure, as between the upstream and downstream side thereof, in the system, such difference usually being greater as the resistance to be overcome is higher.

Such pressure difference is, of course, a function of a fluid system of this character, but there are many instances where the pressure drop on the low side is so great as to be highly objectionable, such for example as when the suction head, due to lift or equivalent frictional resistance, approaches the stage where a liquid cavitates at the suction side of a pump.

It is therefore an object of this invention to provide means which may be incorporated in a fluid system of the general class above mentioned, and which will have the effect of raising the pressure at points where it may become undesirably low.

Another object is to provide a device of this kind which may be added to a conventional fluid system with little or no difficulty in installation.

Other objects and advantages and meritorious features will become evident as the following detailed description is read with reference to the drawings, wherein:

Figures 1 and 2 are diagrammatic illustrations included only to facilitate description of the principles of the invention.

Fig. 3 shows an application of the invention to the fuel system of an internal combustion engine.

Fig. 4 is an axial section through the relief valve drawn to an enlarged scale.

In Figure 1, which shows diagrammatically a portion of a conventional fluid system to which the improved features of this invention have not been applied, a pipe 10 contains a fluid 12 moving in the direction indicated by the arrow 14. A tank 16, filled with the fluid to the level 18 is connected to the pipe 10 by a conduit 20. The tank may preferably be vented at 22.

In Figure 1, P_1 is the pressure within the pipe 10 measured upstream of the tank connection as

at A—A; P_2 the pressure within the pipe 10 measured at the tank connection as at B—B; P_3 the pressure within the tank 16; and P_4 the pressure within the pipe 10 measured downstream of the tank connection as at C—C.

In Figure 2, which is a diagrammatic illustration of the apparatus Figure 1, but modified to illustrate the subject matter of the invention, the same pipe 10, tank 16, and conduit 20 are used, the pressures P'_1 , P_2 and P'_4 being taken at the same sections, namely, A—A, B—B and C—C.

The modification consists in removing a portion of the pipe 10 and replacing it with a venturi 24, the tank 16 being connected by the conduit 20 into the throat of the venturi. Since the throat pressure P_2 and the tank pressure P_3 are still the same as they are in the arrangement Figure 1, the pressures P'_1 and P'_4 will be higher, this being an inherent function of a venturi which is well understood.

In Figures 1 and 2 the tank 16 is shown as being vented to atmosphere through the opening 22 but it will be obvious that this vent may be connected to a source of pressure which may be above or below atmospheric pressure.

Referring again to Figure 1, and assuming that there is no flow from the tank 16 to the pipe 10, P_2 is equal to P_3 plus the head or equivalent head of the fluid above the pipe. A tank connection being necessary, it is made at the low pressure point in the system. If flow is in the direction of the arrow 14, P_1 is greater than P_2 and P_2 is greater than P_4 , the pressure loss being due to the flow of fluid in pipe 10. If the sections A—A and C—C are at considerable distances apart, the pressure P_4 may be considerably less than P_2 .

This gradual pressure drop is a function of a system of this character, and must be compensated for, if circulation is to continue, by some form of pressure raising means, usually a pump. Under some conditions of operation this presents no difficulty, being merely a matter of providing a pump of sufficient capacity to raise the pressure the desired amount.

Under other circumstances, however, the operating characteristics of the pump are considerably affected by a low pressure P_4 at the inlet side of the pump, as for instance when pumping a liquid and P_4 falls so low that the liquid boils at the pump inlet.

Referring now to Fig. 2, P_2 is equal to P_3 plus the head, just as it is in Figure 1. Fluid flow through a venturi, however, results in an increase in the velocity, and a consequent lowering of the pressure in the Venturi throat, the throat pressure being always less than the pressure at points just before entering and after passing through the venturi. It follows that, since the throat pressure P_2 is the same in Figure 2 as in Figure 1, the pressures P'_1 and P'_4 in Figure 2 are respec-

tively greater than the pressures P_1 and P_4 in Figure 1. Therefore by connecting a tank and feed pipe of a given pressure P_3 into the throat of a venturi 24, Figure 2, instead of directly into the pipe 10, Figure 1, all other points in the system, Figure 2, have their pressures raised an amount corresponding to the differences between the pressures P_1 and P_4 of Figure 1 and P'_1 and P'_4 of Figure 2.

The foregoing description is intended to cover the improved pressure booster generally. However, with a view of more clearly describing the principles involved, and without intent to place any limitation on its application, a specific embodiment of the invention had preferably be described.

A specific application of the invention to a fuel system for an engine is shown in Figure 3. In this particular system, the engine 50 drives a fuel pump 52 through a flexible shaft 54. Pump 52 delivers fuel at the proper pressure through the pipe 56 to the carburetor 58. The capacity of the pump may be several times the carburetor requirement, so the excess fuel will be circulated through the bypass circuit 60 back to the inlet side 62 of the pump.

The circuit 60 includes a relief valve 64 having a spring 65 which is adjusted to the pressure required at the carburetor, and which bypasses fuel only after this pressure is exceeded, circulation through the bypass circuit being in the direction of the arrow 66. A venturi 68 and a pipe 70 complete the bypass circuit to return the excess fuel back to the inlet 62 of the pump.

A fuel tank 72 has a sump 74 from which fuel is taken by the pipe 76 which has its lower end connected into the throat 78 of the venturi. A vent 80 connects the space above the fuel level in tank 72 to the atmosphere, although of course it may be connected to a source of super- or sub-atmospheric pressure, if desired. When connected to atmosphere as shown, the pressure at point 78 will of course be determined by the height of the fuel level in the tank 72, but due to the capacity of the venturi to raise the pressure at all points removed from the throat, the pressure in all other parts of the circuit 60, which includes the pressure at the inlet side 62 of the pump 52, will be higher, the amount of pressure increase being affected of course by the rate of flow, which is in turn affected by the amount of surplus capacity of the pump.

The desirability of raising the pressure at the inlet side of the fuel pump, particularly of fuel pumps for aircraft engines, is well known, for while no great difficulty is experienced at sea level in pumping against the normal suction head of a system of this kind, the difficulty is enormously increased at high altitudes due to the progressively lowered boiling point of the liquid fuel as altitude increases.

The normal suction lift is, of course, influenced to some extent by the height of the pump above the level of the fuel in the tank, which may vary considerably due to pitch or bank of the aircraft and may also be influenced by the size and length of the suction pipe, which is for that reason made of as large a diameter and as thin a wall as is consistent with good practice. But even with this attention to design, the normal suction lift is considerable, so that any device which will lessen that lift is considered of great importance.

In the fuel system shown in Figure 3, the venturi 68 raises the pressure at the inlet side 62

of the pump 52 and the suction lift is therefore correspondingly less, and while the pump may not require such assistance when operating at sea level, where it will ordinarily run full and without cavitation, yet for high altitude flying, the amount which a venturi arranged as shown in the drawing may raise the pressure at the pump inlet, where the fuel pressure in the system is ordinarily lowest, and where boiling begins, will materially add to the altitude which may be reached by aircraft equipped with this device.

While one specific embodiment of the invention has been shown and described, and its superiority noted, it will be apparent that the invention may be employed to good advantage in substantially any circulating fluid system where it is desirable to raise the pressure on the low pressure side of the circuit, which will be at the intake of the pressure producing means. This pressure rise is accomplished with little change in conventional practice and the necessary addition includes no moving parts, nor does it add to the power required to operate the system.

Throughout the specification and claims we have used the word "venturi", but it will be understood that this term is to be construed in its broader sense to include any device having its passageway restricted to one part to cause increased rate of flow and a consequent lowered pressure in the restricted part.

So, also, the term "throat" when applied to a venturi or its equivalent should be construed to include any connection near enough to the throat to get the benefit of the increased flow and lowered pressure.

We claim:

1. In a fluid system, a pump, means containing a continuous pressure tight passageway connecting the suction and discharge sides of said pump, a pressure responsive means in said passageway dividing it into a high pressure region between the pressure responsive means and the discharge side, and a low pressure region between the pressure responsive means and the suction side, a venturi included in the circuit in the low pressure region, a receptacle, and a single conduit extending from the receptacle and connecting it to the throat of the venturi.

2. In a fluid system, a pump, means containing a continuous pressure tight passageway connecting the suction and discharge sides of the pump, a spring loaded relief valve in said passageway, a venturi between said valve and the suction side of said pump, a vessel, and a single conduit extending from said vessel and connecting said vessel to the throat of the venturi.

3. For use in connection with a fuel system for an internal combustion engine, which system includes a carburetor, a fuel pump, a fuel tank and conduit means connecting the discharge side of the pump to the carburetor, the improvement in said system which comprises a conduit means connecting the discharge side of the pump pressure tight to the suction side, said second conduit means including a spring loaded relief valve and a venturi between said valve and the suction side of said pump, and a single fuel conduit means extending from said tank and connecting said tank to the throat of the venturi, whereby all fuel flowing to said carburetor passes through the throat of said venturi.

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