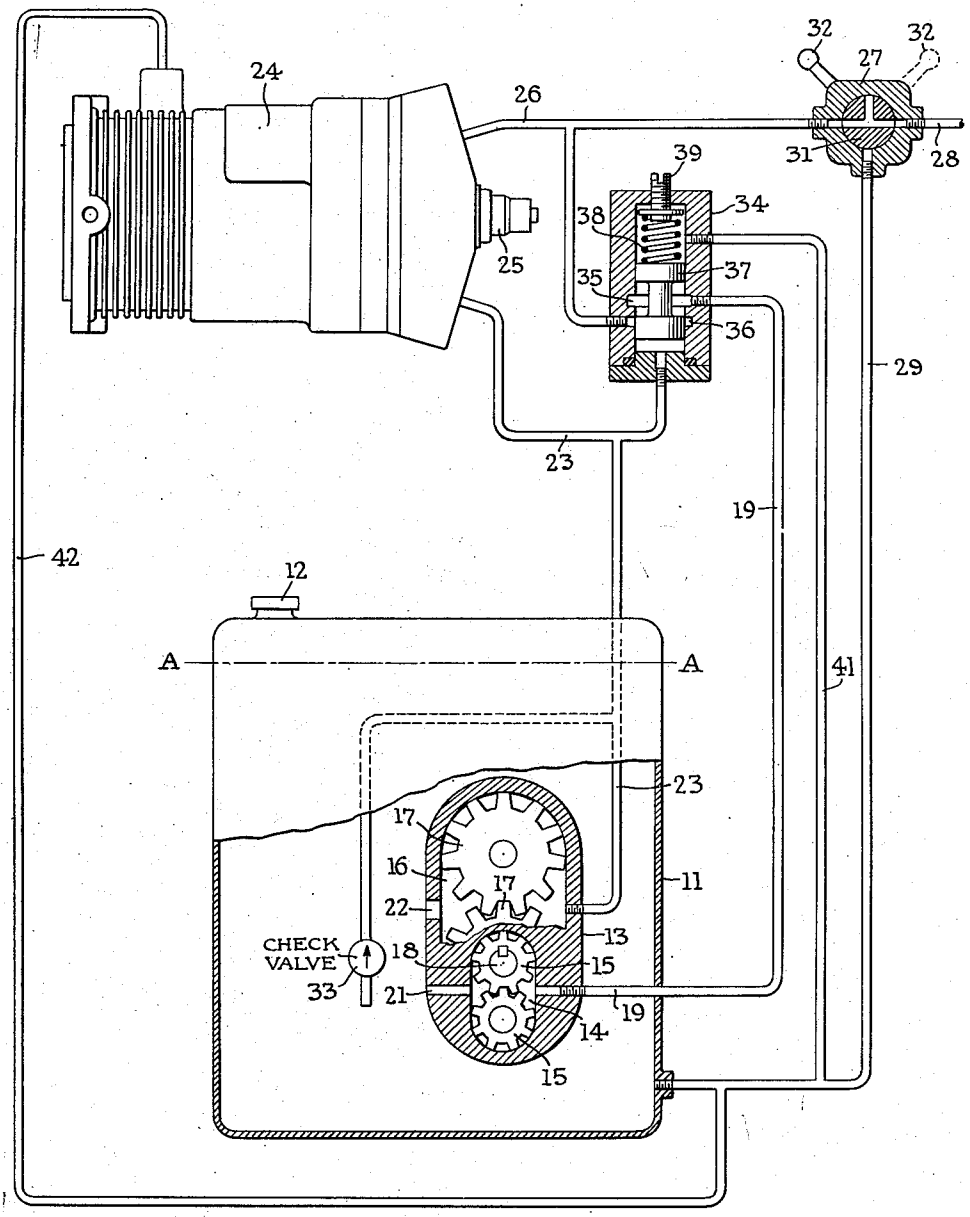
May 25, 1954 M. W. HUBER 2,679,206

HYDRAULIC SYSTEM WITH SELF-PRESSURIZED PUMP INLET

Filed Dec. 21, 1950 2 Sheets-Sheet 1

Fig. 1



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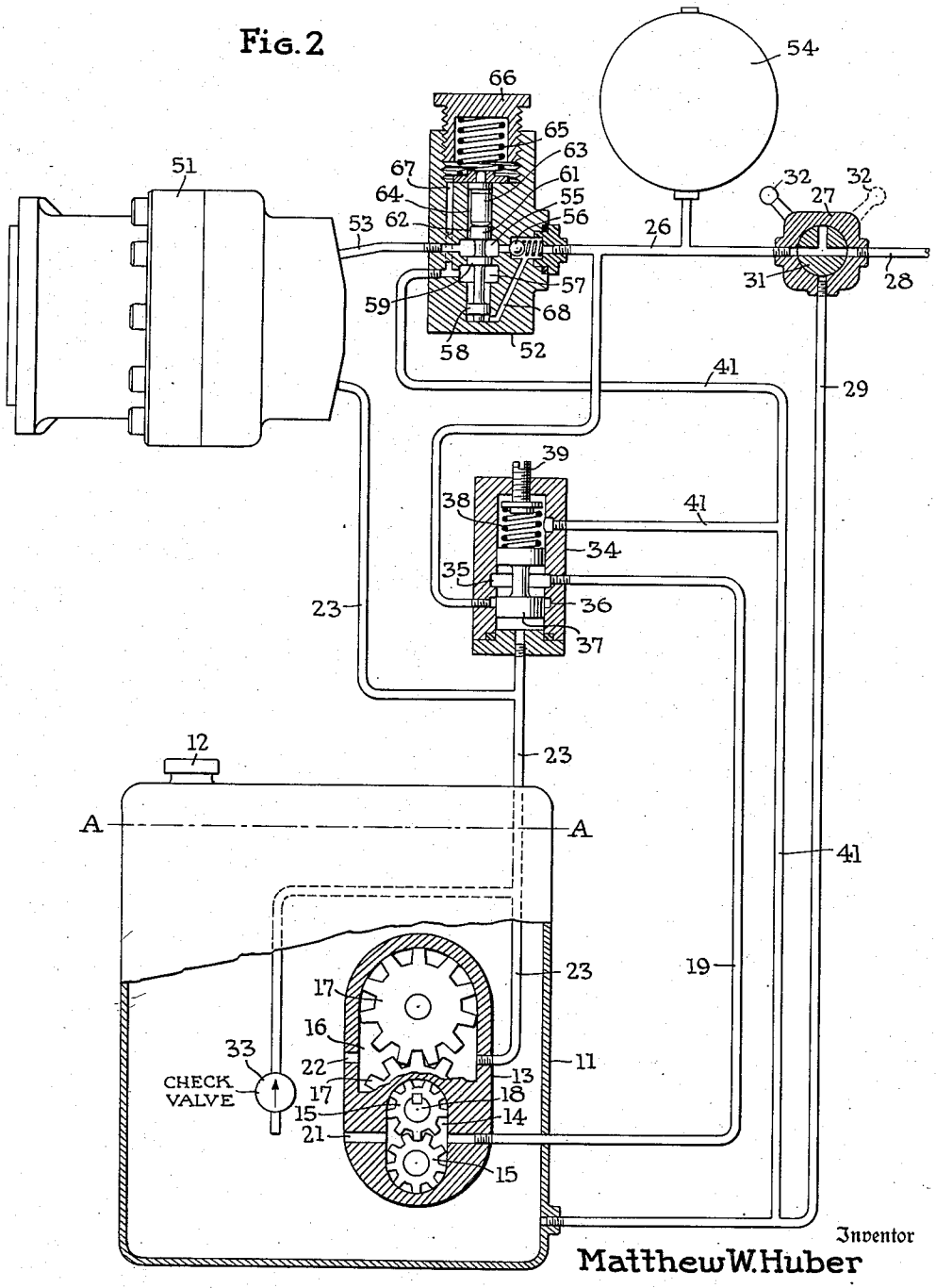
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Fig. 2



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HYDRAULIC SYSTEM WITH SELF-PRESSURIZED PUMP INLET

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4 Claims. (Cl. 103—5)

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This invention relates to hydraulic circuits and particularly to such circuits as are used on airplanes as a source of power for parasite devices.

In this field of use the low barometric pressure at high altitudes makes it important to deliver hydraulic liquid under pressure to the intake of the main pump. According to the invention this is done by a pump submerged in the oil sump. This has the incidental advantage that the sump is operated at atmospheric pressure so that under high altitude conditions the oil frees itself of most of the air which tends to become dissolved therein.

In all cases it is desirable, and with certain types of main pump it is necessary, to deliver the oil at substantially constant pressure to the inlet of the main pump.

The invention meets this requirement, even under the difficult conditions recently created by the use of jet engines. These engines, unlike the old type reciprocating engines, require no warm-up period. As a consequence in cold climates the hydraulic system must start up in fully operative condition with the hydraulic liquid cold and hence relatively viscous, as compared with its condition after a reasonable period of operation. The invention meets also these conditions, which greatly impair the stability of performance of conventional systems.

At least two types of main hydraulic pump are in common use. One is controlled by a device which varies pump displacement progressively in response to the discharge pressure developed by the pump. Several such pumps differing in design are known, and one characterized by a remarkably uniform discharge pressure over its entire range of performance from zero to full delivery is shown in the patent to Huber No. 2,433,222 dated December 23, 1947. Another type of installation is characterized by the use of a pump of constant displacement whose effective output is controlled by a by-passing unloader controlled by pressure in an accumulator. Such an unloader arrangement is shown in the patent to Huber and Huber No. 2,473,953 dated June 21, 1949.

While the first type of pump is usually preferable, the invention is applicable with either, and indeed can be used with any pump whose effective output can be varied in some way in response to discharge pressure, so as to assure maintenance of approximately constant discharge pressure.

The invention will now be described as embodied with each of the two types of pump specifically mentioned above, reference being made to the accompanying drawings, in which:

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Fig. 1 is a diagram, part in section and part in elevation, of a hydraulic circuit embodying the invention, and including a positive displacement variable delivery pump, as the main pump.

Fig. 2 is a similar diagram of a circuit including as the main pump a constant delivery positive displacement pump with a by-pass unloader responsive to discharge pressure.

A sump or tank 11 is vented to atmosphere at 12 and normally is nearly liquid-filled, say to the level A—A. Mounted in the sump 11 and submerged in the liquid (which is customarily an oil having good lubricating properties) is a hydraulically driven inlet booster pump, whose housing is indicated at 13. In chamber 14 of housing 13 is the hydraulic pump-driving motor comprising two meshing pinions 15. In chamber 16 of the same housing is the booster pump comprising two larger meshing pinions 17. As shown, the upper pinion 15 and the lower pinion 17 are fixed to a common shaft 18. The motor has a tubular inlet connection 19 and a discharge port 21 which leads to the interior of sump 11. The pump has an inlet port 22 below the surface of liquid in sump 11 and a tubular discharge connection 23.

If liquid under pressure is delivered through connection 19 to the motor, the pump will discharge liquid through connection 23 in greater volume, but at reduced pressure as compared with the liquid flowing through the motor. In the absence of friction and slip, a simple proportional relation between pressures and volumetric rates would exist but both are present and must be allowed for in the design, as will be explained.

Connection 23 leads to the inlet of pump 24, which is a positive displacement variable delivery pump illustrated as of the type shown in Patent 2,433,222, and so having a controller partly shown at 25 responsive to pressure in discharge connection 26, and operating to vary the delivery of pump 24 so as to maintain the pressure in connection 26 substantially constant while the pump runs.

Connection 26 leads to the body 27 of a selector valve, to which are connected a tubular line 28 leading to the device to be controlled (not shown) and a tubular exhaust line 29 leading to sump 11. The plug 31 of valve 27 is turned by handle 32.

In the full line position of handle 32 valve 27 connects lines 26 and 28. When handle 32 is swung to the dotted line position, the valve blanks line 26 and connects together 28 and 29.

A check valve 33 is provided to permit pump 24 to draw liquid from sump 11 at any time when

the effective displacement of pump 24 exceeds that of pump 16—17. The design is such that when the gear motor-pump is functioning normally, its output tends to exceed slightly the demand of pump 24 for liquid and so normally develops in line 23 a pressure which holds check valve 33 closed. The motive liquid delivered by line 19 to motor 14—15 is tapped off from the high pressure discharge line 26 of pump 24.

Assume for discussion that pump 24, running continuously, maintains a pressure of 3000 p. s. i. in line 26 and that a pressure of 100 p. s. i. is to be maintained in line 23. Except for friction and slip, pump 16—17 should have a displacement per revolution 30 times that of motor 14—15, so that the pressure developed by the booster pump would be 1/30 of the pressure in line 26 or 100 p. s. i. Actually, a suitable correction factor must be introduced, and it is desirable to over-correct so that pressure in line 23 tends to exceed 100 p. s. i. To assure that pressure in line 23 is maintained constant at the desired value of 100 p. s. i., a regulator is used to control the flow of hydraulic liquid through the motor.

This regulator has a body 34 with an axial bore closed at least at one end and having two annular groove ports, namely port 35 (connected to line 19) and port 36 (connected to line 26). A piston valve 37 is so formed that in its lowermost position it freely connects ports 35 and 36, but as it moves upward it gradually throttles this connection. Valve 37 is urged to its lowermost position by a coil compression spring 38 whose stress is adjusted by turning thrust screw 39. A branch of line 23 leads to the space within the bore at the end remote from spring 38.

The arrangement is such that as pressure in line 23 rises above that desired, flow from line 26 to line 19 is progressively throttled, with the result that pressure in line 23 is maintained nearly constant despite varying demands of pump 24 for liquid.

The line 41 is simply an overflow connection which returns to sump 11 any liquid leaking past valve 37. The line 42 is provided to return to sump 11 liquid by-passed by pump 24 for cooling and lubricating purposes.

Modified embodiment, Fig. 2

In Fig. 2, all parts which are identical with parts in Fig. 1 are identified by the same reference numerals.

For the pump 24 are substituted a constant delivery positive displacement pump 51 (which requires no by-pass connection 42), an unloader 52 interposed between the discharge 53 of pump 51 and high-pressure line 26, and a pressure accumulator 54 connected with line 26.

The pump 51 may be any positive displacement type, and the accumulator 54 may be chosen from a wide range of such devices, conveniently one having a pneumatic cushion separated from the hydraulic liquid by a rubber-like diaphragm.

The unloader may be of various types but is shown as conforming to Patent 2,473,953, and is constructed as follows. In the drawing the numeral 52 is applied to the body of the unloader which is generally cylindrical in form and has an axial cylindrical bore closed at one end (the lower end in Fig. 2). Two annular groove ports encircle the bore. The first is a high pressure port 55 which is in free constant communication with pump discharge line 53 and also in communication with high pressure line 26 through a ball check valve 56. A spring clearly shown in the drawing seats valve 56 but does not load it to any significant extent. The second port 57 is connected with drain line 41.

A piston valve unit reciprocable in said bore comprises in one piece a piston head 58 which is always below port 57, a valve head 59 which in the lowermost position of the unit obstructs flow between ports 55 and 57, and an upper head 61 which is always above port 55 and is formed at one side with a restricted port 62. A pilot valve 63 having a restricted port 64 which extends along its side from the lower end to a point below its upper end reacts downward on the valve unit under the urge of coil compression spring 65.

A combined spring seat and closure 66 is threaded into the upper end of housing 52 and may be turned to adjust the stress on spring 65. The space above pilot valve 63 and around spring 65 is vented by passage 67 to the sump via drain line 41. A port 68 admits pressure fluid from line 26 to the space below piston head 58.

Operation

Whether the arrangement of Fig. 1 or Fig. 2 is used, the pump 24 of the former or the pump 51 of the latter runs continuously and maintains in line 26 a high and substantially uniform pressure here assumed to be 3000 p. s. i. Assuming that it is required that line 23 be maintained at 100 p. s. i., the displacement of pump 16—17 per revolution advisably would be somewhat less than 30 times the displacement of motor 14—15, the departure from the 30 to 1 ratio being intended to compensate for the pressure loss caused by friction and slip.

Spring 38 would normally be so adjusted that ports 35 and 36 are in free communication so long as pressure in line 23 does not exceed 100 p. s. i., but if this pressure exceeds this value, this communication is throttled. Other adjustments and proportions may be adopted to meet special conditions.

In any case the regulator 34 gives flexibility of adjustment, and stable control of pump inlet pressure will be established quickly after the pump is put into operation.

Two variable delivery pump systems have been illustrated and others are known and may be used similarly. Other types of motor-driven booster pumps may be substituted, but the one shown is believed to be the simplest available.

Venting of the sump to atmosphere is desirable because it permits the hydraulic liquid to free itself of air, this action being particularly effective at high altitudes.

I claim:

1. In a hydraulic system the combination of a sump; a high pressure delivery line; a continuously operating high pressure displacement pump provided with regulating means, the pump having an inlet and a connection through which it delivers to the high pressure delivery line under control of said regulating means, the regulating means being responsive to pressure in said delivery line and serving to maintain that pressure substantially constant; a hydraulic motor interposed in a flow path from said delivery line to said sump; a hydraulic booster pump connected to be driven by said motor and arranged to draw liquid from said sump and deliver it under pressure to the inlet of said high pressure pump; a flow regulating valve interposed in the flow path through said motor; and means responsive to the pressure developed by the booster pump and serving to adjust said flow-regulating valve.

2. The combination defined in claim 1 in which the booster pump and the hydraulic motor are each of the positive displacement type and the two are positively connected whereby there is a fixed ratio of the volumetric displacement rate of the pump to that of the motor and this ratio is so chosen as to exceed the ratio of the regulated discharge pressure of the high pressure displacement pump to the desired inlet pressure thereof.

3. The combination defined in claim 1 in which the booster pump and the hydraulic motor are each of the positive displacement type and the two are positively connected whereby there is a fixed ratio of the pressure delivered by the booster pump to the motive pressure effective in the hydraulic motor and the parts are so proportioned that the pressure developed by the booster pump is sufficient to close said flow regulating valve slightly, when the viscosity of the hydraulic liquid is normal.

4. In a hydraulic system the combination of a sump; a high pressure delivery line; a continuously operating high pressure displacement pump provided with regulating means, the pump having an inlet and a connection through which it delivers to the high pressure delivery line under control of said regulating means, the regulating means being responsive to pressure in said delivery line and serving to maintain that pressure substantially constant; a pressure reducing hydraulically operated booster pump unit connected to be driven by motive fluid tapped from said high pressure line, and to deliver hydraulic liquid from said sump to said inlet at reduced pressure and increased volume as compared with said motive fluid; and pressure operated valve means responsive to said reduced pressure and serving to regulate the flow of said motive fluid.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,218,565	Vickers	Oct. 22, 1940