Oct. 20, 1936. F. V. BROWN 2,057,934

MULTIPLE PUMP PARTICULARLY FOR REVERSIBLE FLOW SYSTEMS

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FIG. 1.

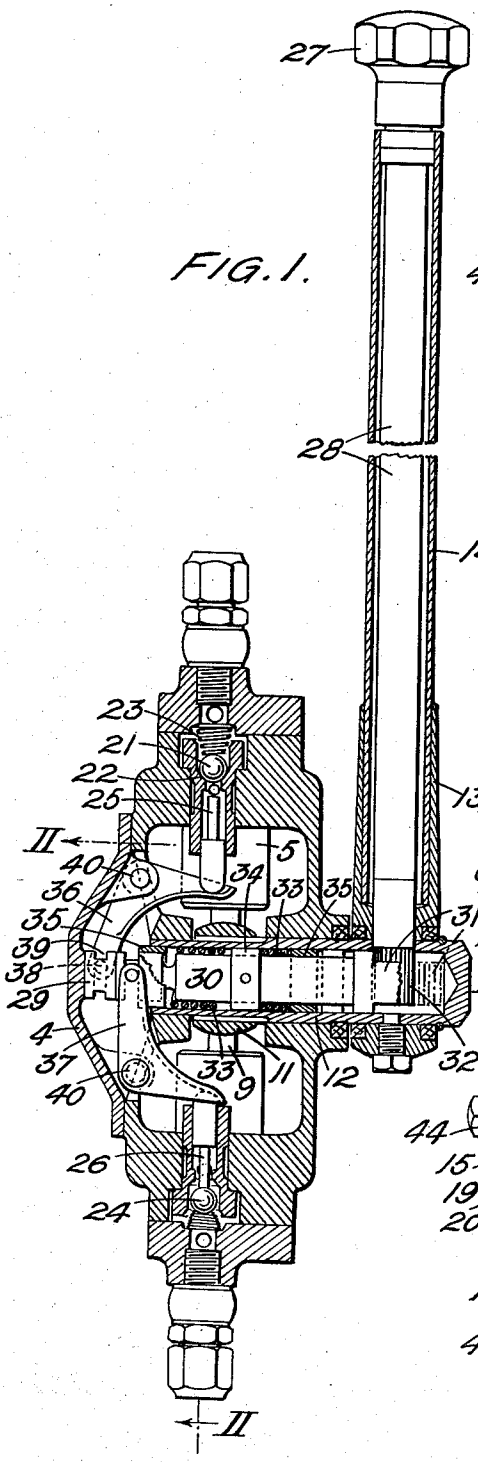


FIG. 3.

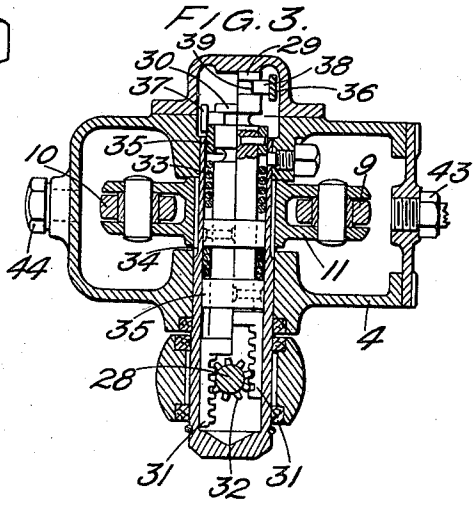
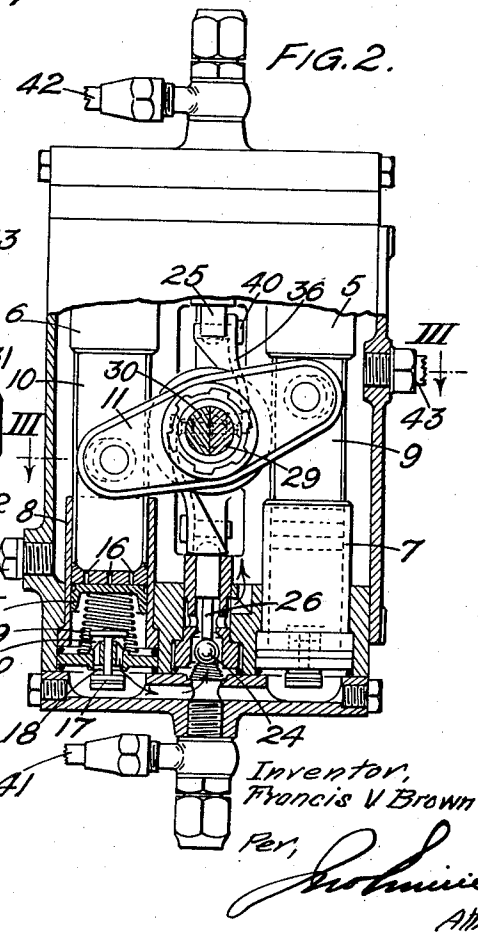


FIG. 2.



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FIG. 4.

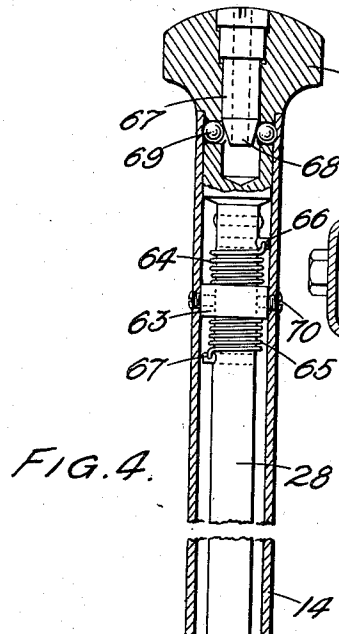


FIG. 6.

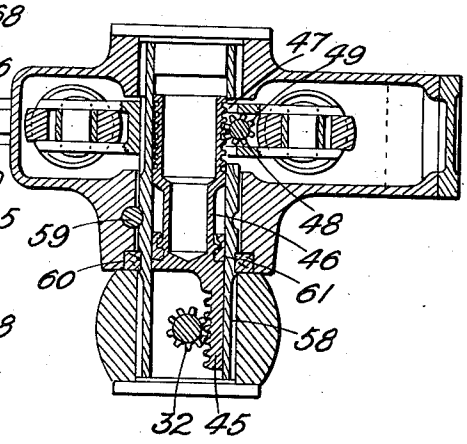
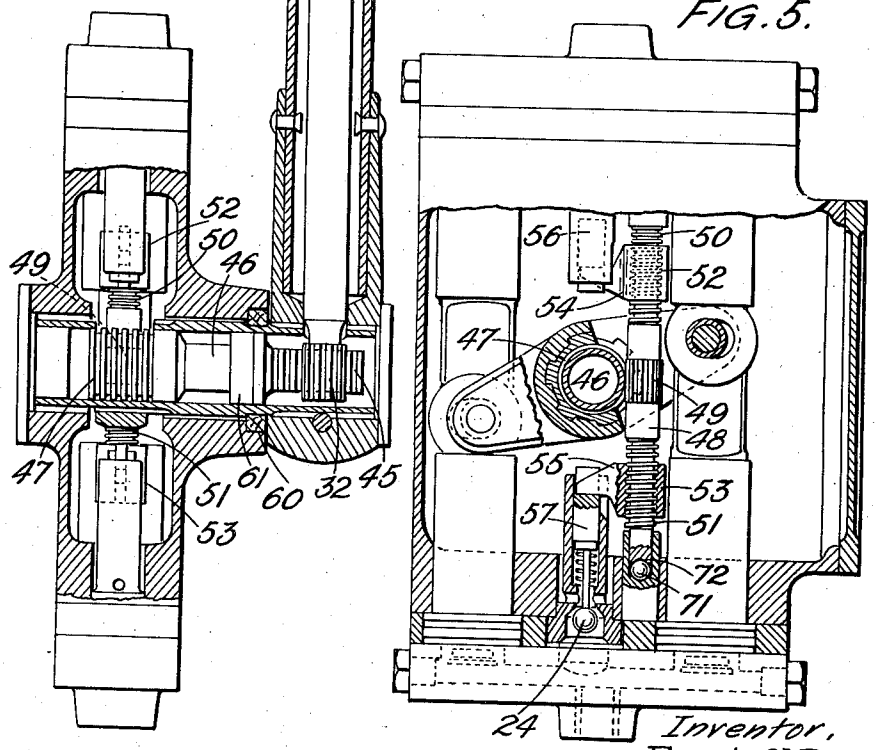


FIG. 5.



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UNITED STATES PATENT OFFICE

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MULTIPLE PUMP PARTICULARLY FOR REVERSIBLE FLOW SYSTEMS

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11 Claims. (Cl. 103—41)

This invention relates to fluid pressure generators, particularly for use in connection with reversible flow systems such as hydraulic systems where one operation requires flow in a circuit in one direction, and a similar operation is required to cause a flow in the opposite direction in the circuit. There may be many examples of such circuits but the particular case we have in mind in connection with this invention, and to which the invention is particularly adapted, is the case where a hydraulic jack-like element is to be operated under the influence of a pressure generator, and the jack is either to be expanded or contracted positively by pressure; such a jack may, for example, form the operative element of a retractable aircraft undercarriage, a tail plane adjusting device, raising and lowering gear for any purpose. The invention may also perhaps be applied in other circumstances, where a generator of reversible pressure is required.

According to this invention, a pressure generator comprises at least two pumps which may be of reciprocating, semi-rotary or rotary type actuated by a lever adapted to be manually reciprocated or rocked, and valves associated with the pumps control the flow therefrom and are themselves controlled by an adjustable handle or the like associated with the lever. According to a further feature of the invention, a pump has a lever with a knob mounted on the end of it, which will normally be grasped to work the pump, the knob is partially rotatable about the longitudinal axis of the lever, and a spindle within or parallel with the lever conveys the rotary movement of the knob to a member or members which are substantially coaxial with the axis about which the lever operates, these members in turn operating valves controlling the output of pumps directly operated by the lever.

In order that it may be clearly understood and more readily carried into effect, the invention is hereinafter described with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a sectional elevation of a fluid pressure generator according to the present invention;

Figure 2 is a section taken on the line 2—2 of Figure 1, looking in the direction of the arrow;

Figure 3 is a section taken on the line 3—3 of Figure 2, looking in the direction of the arrow; while

Figures 4, 5 and 6 correspond with Figures 1, 2 and 3 and illustrate a modified form of the invention.

In carrying the invention into effect according to Figures 1, 2 and 3, which illustrate an embodiment of the invention devised particularly as a pressure generator adapted to operate an aircraft retractable undercarriage, the generator unit comprises a box-like casing 4 containing four cylinders 5, 6, 7 and 8 in two opposed pairs. The opposed cylinders 5, 7 and 6, 8 are coaxial and contain pistons having common rods 9 and 10, respectively, so that the in-stroke of one piston is the out-stroke of the other. The cylinders are parallel and the piston rods 9 and 10 are interconnected and are operated by a rocker 11, which preferably is forked at its ends as shown in Figure 3 to provide a bearing for the rods. The rocker is capable of moving about an axis provided by the pump spindle 12 in the form of a tubular member projecting from the wall of the casing 4. On the projecting end of this spindle there is carried radially a comparatively long lever the rocking of which oscillates the rods 9 and 10 in opposite directions. For the sake of convenience, the lever may comprise the two parts 13 and 14. The cylinders 5, 6, 7 and 8 are each provided with inlet and outlet valves. The inlet valve in accordance with acknowledged practice in fluid pressure generators comprises the loose piston cup 15 spring-pressed towards the piston, see for example the arrangement of the cylinder 8 and cooperating parts shown in Figure 2, the arrangement being such that fluid entering through the ports 16 passes the cup 15 by causing it to turn in at the lip. The outlet valve disposed in the end of the cylinder is designed to function as a non-return valve and has a head 17 so placed as to close the opening 18 when the pressure inside and outside the cylinder is in equilibrium, and so prevent fluid flowing back from the system into the cylinder on the return stroke. The inlet valve is urged by the spring 19, while the outlet valve is closed by the spring 20, when the pressures in the system are in equilibrium or when the pressure in the cylinder is less than that throughout the rest of the system. The pairs of cylinders 5 and 6 communicate through their outlet valves with an escape valve preferably having the form of the ball 21 spring-pressed on to its seat 22 by means of the spring 23; the pistons 7 and 8 similarly communicating with the escape valve comprised by the spring-pressed ball 24. The ball valves 21 and 24 are adapted to be raised from their seats by means of tappets 25 and 26 respectively. The ball valve 24 is shown in Figures 2 and 3 in the raised position, and when these conditions prevail the cylinders 7 and 8 will not function as pumps for the fluid will pass out from the cylinders through the openings 18 and then back through the raised ball valve 24 into the interior of the casing 4. The invention is closely concerned with the operation of the tappets 25 and 26. The long lever is provided with a knob 27 fast with the spindle 28. The knob 27 and spindle 28 are rotatable, the latter passing into the pump spindle 12, which as hereinbefore mentioned is hollow or of tubular form. The pump spindle 12 houses two sliding selectors

29 and 30, which for the greater part are semi-circular in cross-section so as to form virtually a cylindrical assembly. The selectors 29 and 30 at one end are each provided with inwardly directed racks 31 for engagement with a pinion 32 fast on the spindle 28. In Figure 1 of the drawings the end of the selector 30 is shown broken away to reveal the pinion 32. Springs 33 under compression are spaced by the sliding collar 34 and fixed collars 35 so as to ensure that when the knob 27 is released the selectors 29 and 30 shall assume a central or neutral position of rest. The ends of the selectors 29 and 30 remote from the racks are in articulated connection with bell-crank levers 36 and 37 by means of locating pins 38 engaging the groove 39; rocking of the bell-crank levers about their fixed pivots 40 according to the displacement of one or other of the selector arms 29 or 30 effecting actuation of the tappet 25 or 26.

Initial adjustment of the system is such that when the selectors 29 and 30 are centralized by the springs 33 to assume a neutral position, the ball valves 21 and 24 are held off their seats and in this position the pipelines and pumps can all breathe freely; moreover, movement of the lever with the selectors 29 and 30 in a neutral position produces no effective result. If the knob 27 be now rotated one way the spindle 28 rotates with it; the racks 31 are oppositely moved by means of the pinion 32, as a result of which the selectors 29 and 30 move accordingly to turn the bell-crank levers 36 and 37 and either open or close one or other of the ball valves 21 or 24. Oscillation of the lever 13 produces a double acting flow from the cylinders 5 and 6 or 7 and 8, the direction of course depending upon which valves are selected for closure and opening. Thus, if, as shown in the drawings, the knob 27 has been rotated in an anticlockwise direction so as to move the bell-crank lever 37 by its selector 30 to push the ball 24 off its seat, the cylinders 7 and 8 will be ineffective, with the result that there will be no building up of pressure in the pipeline 41 but fluid will be under pressure in the pipeline 42. The arrangement may be such that all four cylinders 5, 6, 7 and 8 may be rendered operative, two for one purpose and two for another perhaps entirely different purpose, and of course suitable indications in the proximity of the knob 27 may show what selections are given for particular positions. From the casing 4 the two pipelines 41 and 42 will normally lead, although of course this depends on the precise number of cylinders, and these two pipelines may connect for example to opposite ends of a two-way hydraulic jack. In this case, when the knob 27 is fully rotated one way, pumping will be to one side of the jack, and when rotated the other way to the other side, in each case the idle side being free for pressure flow or escape. In such a system any suitable supply reservoir or the like may be provided for topping up, a connecting nipple 43 being provided for a pipeline leading therefrom; similarly, any desired draining plugs such as 44, bleeder or like devices may of course appropriately be adopted.

In the modified arrangement illustrated with reference to Figures 4, 5 and 6, there is shown an alternative embodiment of the invention in which modifications are made in the apparatus for selecting which of the ball valves 21 or 24 shall be off the seating, and further embraces means for returning the selector mechanism to a predetermined idle position. The pinion 32 fast on the spindle 28 engages a toothed rack 45 to impart axial movement to a single selector 46 which is formed with a circular rack 47, with the result that reciprocating movement of the selector 46 imparts rotary movement to the shaft 48 positively through a spur pinion 49 cut or formed thereon. The shaft 48 has the spur pinion 49 disposed substantially centrally for engagement with the teeth 47 of the selector bar and has cut at each end a multiple start worm thread of through hand, as indicated at 50 and 51 and nuts 52 and 53 are positively moved longitudinally by rotation of the shaft, the nuts having projecting pieces 54 and 55 respectively for operating the tappets 56 and 57 to control the position of the valves 21 and 24, of which only that indicated by the reference numeral 24 appears in Figure 5.

For the purpose of facilitating assembly, the selector bar 46 is housed within a tubular bearing bush 58 and is retained in position by locking pins 59, which prevents axial movement of the bush relatively to the housing by virtue of its engagement with registering grooves in the co-operating surfaces of the bush and housing. Incidentally, it may here be mentioned that a similar method may be used for securing the handle boss to the bush 58 (see Figure 4). A packing washer such as 60 is provided to prevent leakage of oil between the bearing bush 58 and body of the device, while a similar packing 61 is provided between the selector bar 46 and the interior of the bush.

Regarding now the means for returning the selector bar to a predetermined idle position, there is shown in Figure 4 an arrangement by which coil springs operate against one another. Surrounding the spindle 28 and fixed in relation to the outer tube 14 is a collar 63 provided on each side with a fixed anchorage for oppositely arranged coil springs 64 and 65. The other ends of these springs bear against abutments 66 and 67 respectively, which are fixed in relation to the spindle 28, with the result that when the knob 27 is rotated in the direction of the arrow the spring 65 is in effect wound up while the spring 64 is unwound. Consequently, when the handle is released the two springs assist one another in returning the spindle 28 to the predetermined idle position. When the handle is turned in a direction opposite to that indicated by the arrow the springs 64 and 65 operate in a similar manner but in the opposite direction.

Figure 4 also illustrates a convenient method of mounting the spindle 28 so as to prevent axial displacement of it in relation to the tubular outer part 14. According to this arrangement the knob 27 is fastened by a bolt 67 extending substantially axially through it, the bolt 67 having a tapered end 68 adapted to engage balls 69 provided in apertures in a part of the knob disposed inside the tubular part 14 and press them into grooves or recesses provided internally of the tubular part 14. The operation for removing the spindle 28 therefore makes it necessary first to remove the small set screws 70 securing the collar 63, whereafter on slightly slackening the bolt 67 sufficiently to allow the balls 69 to disengage from the grooves in the tubular part 14, the spindle may be at once withdrawn.

In an alternative method of operating the tappets 56 and 57, the worm parts 50 and 51 may be dispensed with and nuts 52 and 53 replaced by sleeves bearing directly upon the plain surfaces of the shaft 48. The tappet-engaging projection of each sleeve being received within a slot in the tappet housing is prevented from rota-

tion (as are the nuts 52 and 53 described with reference to Figure 5), and a cam surface is provided on the sleeve against which bears a pin or projection carried by the shaft 48, with the result that rotation of the shaft causes the pin or projection to ride up the cam and move the sleeve and tappet-operating projection accordingly in an axial direction.

As a convenient method of mounting the shaft 48, there is shown in Figure 5 an arrangement in which the ends of the shaft 48 are carried by cups 71 fixed to the body of the device, a ball 72 being interposed between the ends of the shaft and the cup.

It will be appreciated that modifications may be made without departing from the scope of the invention; for example, in some cases it may be desirable to provide ball escape valves having the function of the ball valves 21 and 24 in conjunction with each cylinder. Moreover, the construction of the inlet and outlet valves associated with each cylinder may be varied provided their function be the same as that of the arrangement described.

Although the pressure-augmenting device hereinbefore described is particularly adapted for use in conjunction with an aircraft retractable undercarriage, it is obvious that it is equally applicable for use in any device requiring a remotely controllable and fluid-actuated extensible element.

What I claim is:—

1. A pressure generator including a multiple pump comprising at least two oppositely acting pumps, a by-pass valve controlling the operative function of each pump, a spindle common to and serving to actuate the multiple pump, a lever mounted to operate the spindle, and means extending through the spindle and axially thereof for simultaneously controlling said by-pass valves, and means carried by said lever for actuating said by-pass valve controlling means.

2. A multiple pump including at least two oppositely acting pumps, a by-pass valve for each pump, a spindle mounted for rotary oscillation, means connected to the spindle for simultaneously operating the pumps, a lever connected to and operating the spindle, selector means operative longitudinally of the spindle, connections between the selector means and by-pass valves to operate said valves in the movement of the selector means, and an element mounted for rotation in the lever and operative beyond the free end of the latter for actuating the selector means.

3. A construction as defined in claim 2, wherein the connection between the element and selector means is through the medium of a rack and pinion.

4. A construction as defined in claim 2, wherein the selector means is movable axially of the spindle and is made up of two oppositely moving parts, each controlling one of the by-pass valves.

5. A pressure generator including a casing, a multiple pump therein including at least two pairs of pumps, a spindle mounted for rotary oscillation in the casing between the pumps and extending beyond the casing, a lever mounted on the extended end of the spindle for operating the same, a member carried by the spindle for operating the pumps simultaneously, a by-pass valve between each pair of pumps and each by-passing the pair of pumps adjacent thereto when opened, a selecting means movable axially of the spindle and operative to open and close the by-pass valves, and a member extending longitudinally of the lever and operative beyond the free end of the latter for actuating the selecting means.

6. A plurality of pumps having independent outlets, a by-pass controlling valve for each outlet, a spindle intermediate the pumps, a connection between the spindle and pumps for operating the pumps in the movement of the spindle, a lever for operating the spindle, selectors movable longitudinally of the spindle, a connection between each selector and one of the by-pass valves for operating the latter in the movement of the selector, and means carried by the spindle operating lever for actuating the selectors.

7. A plurality of pumps having independent outlets, a by-pass control valve for each outlet, a spindle intermediate the pumps, a connection between the spindle and pumps for operating the pumps in the movement of the spindle, a lever for operating the spindle, selectors movable longitudinally of the spindle, a connection between each selector and one of the by-pass valves for operating the latter in the movement of the selector, and means carried by the spindle operating lever for actuating the selectors, said means extending longitudinally of the lever.

8. A pressure generator comprising opposed pumps having independent outlets, by-pass valves for the outlets, a spindle mounted for oscillation, a pump operating member carried by the spindle, selectors moving axially of the spindle, means intermediate each selector and one of the by-pass valves for operating the by-pass valve in the movement of the selector, a manually operable lever connected to the spindle and movable for operating the pumps, and an element extending longitudinally of the lever and independently rotatable with respect thereto, said element being connected to and serving to operate the selectors for by-pass valve control in the rotation of the element.

9. A construction as defined in claim 8, wherein the connection between the element and selectors is in the form of a pinion carried by the element cooperating with rack bars formed on the selectors.

10. A construction as defined in claim 8, wherein the connection between the element and selectors is in the form of a pinion carried by the element cooperating with rack bars formed on the selectors, the pinion being interposed between the rack bars of the selectors to operate the selectors in opposite directions in the rotation of the element.

11. A pressure generator comprising pump cylinders, pistons in said cylinders, a spindle mounted for oscillation intermediate the pump cylinders, a member carried by the spindle and connected to the pistons for operating the same in the movement of the spindle, a hand lever connected to the spindle for actuating the same and thereby the pistons, a by-pass valve controlling the outlet from each pump cylinder, relatively slidable selectors mounted for movement in the spindle, a connection between each selector and a by-pass valve for controlling that valve in the movement of the selector, a rod mounted for rotative movement in the lever and operative from beyond the free end of the lever, and a pinion carried by the rod and cooperating with rack bars formed on the selectors, the rack bars of the selectors being disposed on opposite sides of the pinion to move the selectors in relatively opposite directions in the rotation of the rod.

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