

Dec. 26, 1939.

J. J. LOW

2,185,015

HYDRAULIC SYSTEM AND FLUID CONTROL DEVICE THEREFOR

Filed Jan. 2, 1937

2 Sheets-Sheet 1

Fig. 1.

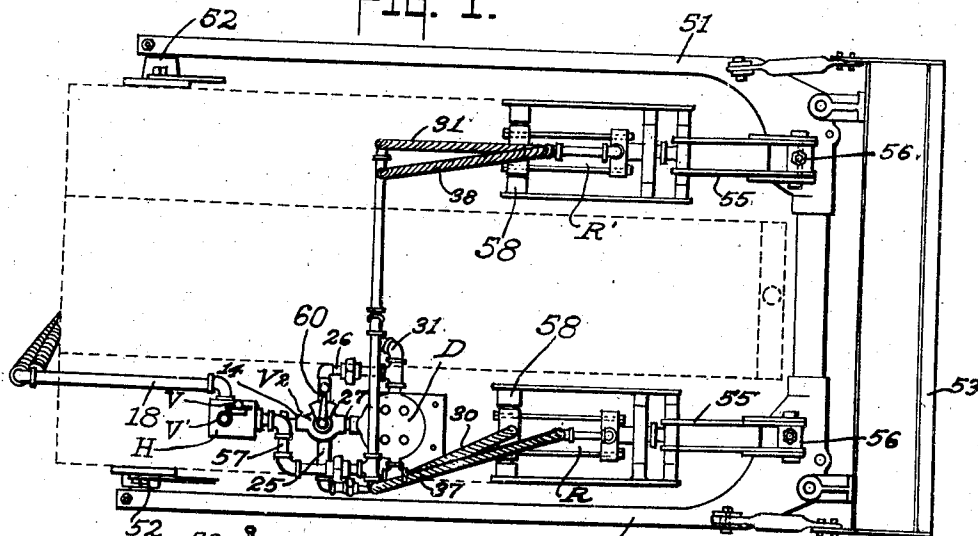


Fig. 2.

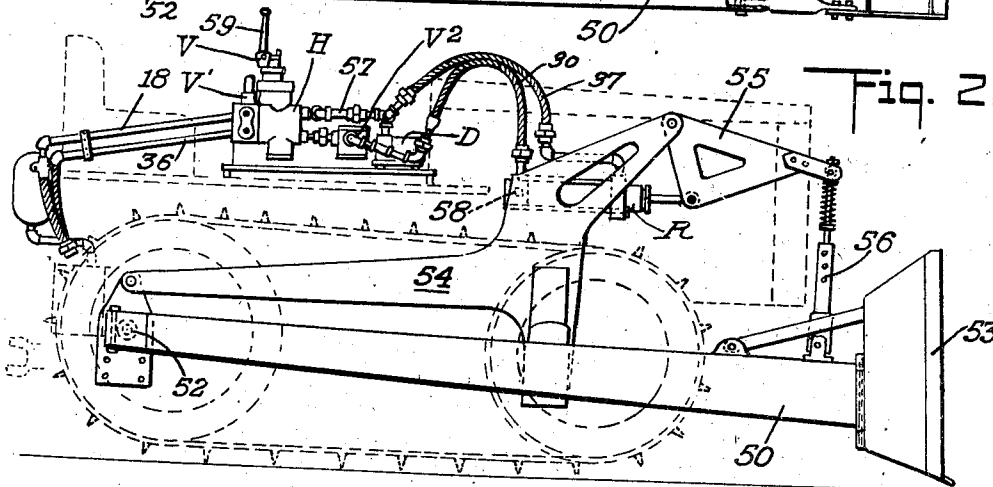
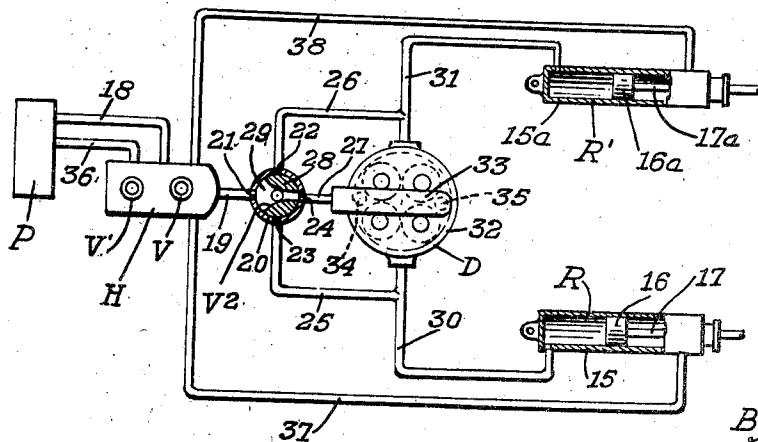


Fig. 3.



Inventor.
John J. Low
By Edwin J. Jones
Attorney.

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2 Sheets-Sheet 2

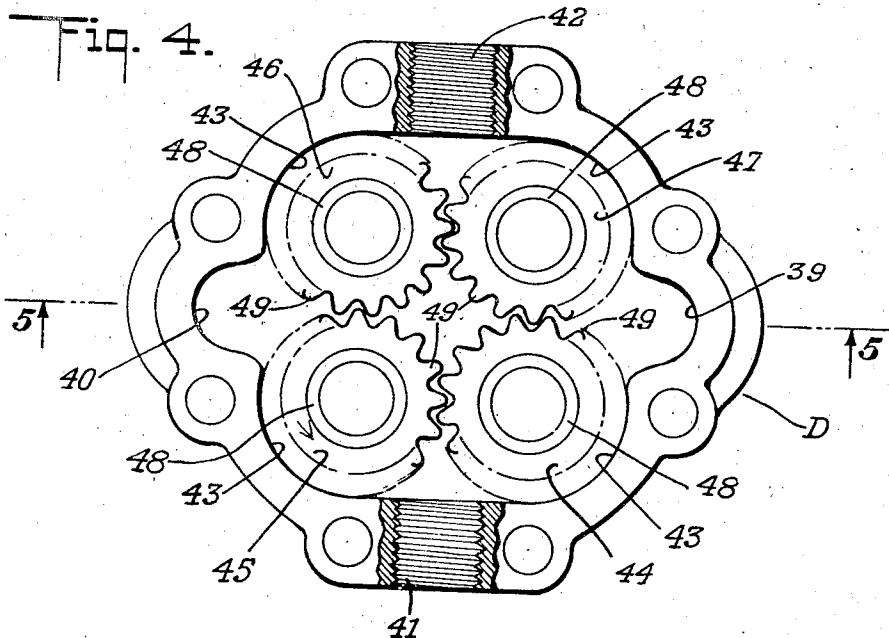
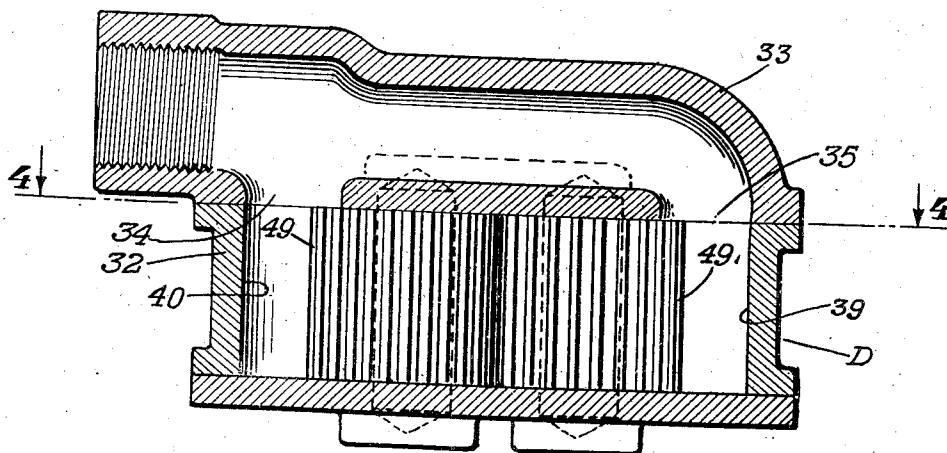


Fig. 5.



Inventor.
John J. Low
By Edwin D. Jones,
Attorney.

UNITED STATES PATENT OFFICE

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HYDRAULIC SYSTEM AND FLUID CONTROL
DEVICE THEREFORJohn Judson Low, Los Angeles, Calif., assignor
to Kay-Brunner Steel Products Inc., a corpora-
tion of Delaware

Application January 2, 1937, Serial No. 118,745

10 Claims. (Cl. 60—52)

My invention relates to that type of road building machines which embodies a tractor, carrying an earth moving implement and two mechanisms operable by two hydraulic rams for elevating and tilting the implement to various positions of adjustment in the performance of various road building operations under forward movement of the tractor.

It is a purpose of my invention to provide a hydraulic system for the rams of a road building machine of the character above described, embodying a fluid control device which renders it possible in such a system to control the volume and pressure of a fluid as delivered to the two rams in such manner that the earth moving implement can be moved to any predetermined end to end horizontal or tilted position, and then bodily elevated or lowered while maintaining its end to end position fixedly and irrespective of the variation in the earth load or other lifting resistance imposed lengthwise on the implement.

It is also a purpose of my invention to provide as an article of manufacture, a fluid control device which whether used in a hydraulic system for road building machines or any other mechanism, is operable automatically to equalize the distribution in volume of a pressure fluid to a plurality of rams or other fluid responsive devices, and to so vary the pressures of the fluid as delivered to the respective rams, that irrespective of the differences in resistance offered to movement of the individual rams uniformity in movement of all of the rams is effected.

I will describe only one form of hydraulic system, one form of fluid control device therefor, and one form of road building machine embodying the two, and will then point out the novel features thereof in claims.

In the accompanying drawings:

Fig. 1 is a view showing in top plan one form of hydraulic system and fluid control device embodying my invention as applied to a road building machine of the bull dozer type.

Fig. 2 is a view showing the hydraulic system and machine in side elevation.

Fig. 3 is a view showing diagrammatically the hydraulic system of Figs. 1 and 2.

Fig. 4 is an enlarged sectional view of the fluid control device taken on the line 4—4 of Fig. 5.

Fig. 5 is a vertical sectional view of the fluid control device taken on the line 5—5 of Fig. 4.

With specific reference to the drawings, and particularly to Fig. 3, I have here shown a hydraulic system in which is incorporated two hydraulic rams R and R' each comprising a cylinder

15 or 15^a and a piston 16 or 16^a movable therein and having a rod 17 or 17^a extending from the forward end of the cylinder which is adapted for operative connection to a mechanism (not shown in this figure) for actuating the latter, as will be described hereinafter.

Communicating with the rear and front ends, respectively, of the cylinders 15 and 15^a are the fluid pressure and suction lines leading from and to a fluid pressure pump P for supplying to the cylinders any suitable fluid, such as oil, and withdrawing the same from the cylinders to effect operation of the pistons 16 and 16^a in the actuation of the mechanisms to which the rods 17 and 17^a are adapted to be connected.

The pressure line comprises a pipe 18 leading from the pressure side of the pump P to a housing H for a control valve V of any suitable construction and a conventional relief valve V'. From the housing H a pipe 19 extends to the housing 20 of a three-way valve V². This housing 20 is provided with four ports 21, 22, 23 and 24, the port 21 communicating with the pipe 19, and the ports 22, 23 and 24 communicating, respectively, with pipes 26, 25, and 27. A valve plug 28 is manually rotatable in the housing 20 to cause a tapered port 29 therein to place either pipe 25, 26 or 27 in communication with the pipe 19. The pipes 25 and 26 lead, respectively, to pipes 30 and 31, and the latter in turn lead to the rear ends of the cylinders 15 and 15^a.

The pipes 30 and 31 are connected at diametrically opposite points to the stator 32 of a fluid control device designated generally at D. The pipe 27 is connected to a pipe 33 forming a part of the stator 32 and provided with outlets 34 and 35 leading to certain inlets of the control device, as will be later described. The suction line of the hydraulic system comprises a pipe 36 leading from the suction side of the pump P to the housing H. From this housing two pipes 37 and 38 lead to the forward ends of the respective cylinders 15 and 15^a.

Referring now to Figs. 4 and 5, the stator 32 of the fluid control device D consists of three parts suitably bolted together, with the pipe 33 cast integral with the upper part and shaped to provide the outlets 34 and 35 leading downwardly into the stator. At these two points the inner side wall of the stator is cupped outwardly to provide two diametrically opposed inlets 40 and 39 through which fluid from the outlets 34 and 35 enters the stator. These inlets 39 and 40 are at right angles to a pair of outlets 41 and 42 into which latter the pipes 30 and 31 extend. Be-

tween the inlets 39 and 40 and the outlets 41 and 42 the inner side wall of the stator is cupped outwardly to form four arcuate pockets 43.

The fluid control device also includes a rotor 5 housed within the stator and made up of four elements 44, 45, 46, and 47. Each element is journaled on an axle 48 mounted in the upper and lower walls of the stator, and the periphery of each element is formed with radially disposed 10 and axially extending vanes 49. The diameters of the rotor elements and their mounting are such that the vanes of one element constantly mesh with the vanes of an adjacent element, in the manner illustrated in Fig. 4. Also, their axes 15 of rotation are situated to cause the vanes to have a close or wiping contact with the walls of the pockets 33 for the purpose of preventing reverse flow of fluid around the elements when they are at a standstill. As is also shown in Fig. 4, 20 the vanes 49 are so shaped that there is a slight back lash between intermeshing vanes in order that a fluid entering between the vanes will not be compressed by the vanes to impede rotation of the elements, but will advance between the 25 vanes as they move forward.

The operation of the hydraulic system is as follows:

With the valve V^2 in the position shown in Fig. 1, opening of the control valve V causes fluid 30 under pressure to pass from the housing H through the pipe 19, port 29, pipes 27 and 33 and into the stator 32 through the inlets 39 and 40, and outwardly from the stator through the outlets 41 and 42. Under the pressure fluid admitted 35 to these inlets the rotor elements 44 and 46 are propelled in a clockwise direction, while the elements 45 and 47 are propelled in a counterclockwise direction, all as when viewed in Figure 4. Such directional rotation is effected because 40 at each point of meshing of the elements 44 and 47 and the elements 45 and 46, the fluid can only have propelling action against a single vane tending to rotate the elements inwardly at the point of meshing, while on the peripheries of 45 each pair of elements at corresponding points in advance of the meshing thereof, the fluid in each instance acts on a vane to propel the elements outwardly at the point of meshing.

Thus, with the fluid acting on one vane to 50 propel the elements inwardly away from the inlets, and acting on two vanes to propel the elements outwardly toward the inlets, the elements will be propelled in the latter direction.

As the elements of each pair 44, 47 and 45, 46 55 are propelled by the fluid as described, and the vanes of the elements of each pair constantly mesh with the vanes of the corresponding elements of the other pair, propulsion of one pair effects propulsion of the other pair so that all 60 four elements rotate at the same speed irrespective of the volume and pressure of the fluid admitted to the two inlets. Thus, with the elements so propelled, the fluid is carried by the 65 vanes around the outer edges of the elements where they traverse the pockets 43, and discharged into the outlets 41 and 42 for conveyance to the ram cylinders 15 and 15^a through the pipes 30 and 31.

By virtue of the fact that the four elements rotate 70 in unison the volume of fluid discharged to the two outlets and, hence, to the two ram cylinders, is at all times equal. Therefore, if the resistance offered to movements of the pistons 16 and 16^a forwardly, is the same, the degree of 75 movement of the pistons will be the same to

identically move whatever two mechanisms are 5 connected to the rods 17 and 17^a. However, if these resistances differ, then in order to establish and maintain uniformity in movement of the two mechanisms, it is necessary to increase 10 the pressure of the fluid supplied to the ram cylinder for that mechanism which offers the greatest resistance, until the resistance differential is nullified, when uniformity in movement of the two mechanisms is established.

In my control device such resistance differential 15 is nullified automatically by the action of the rotor elements with respect to the fluid, in the following manner: Depending upon to which piston is offered the lesser resistance determines 20 the decrease in fluid pressure necessary to operate that piston, and, as a consequence, the pressure necessary to propel those two rotor elements 44 and 45 or 46 and 47 supplying fluid 25 pressure to that piston, is correspondingly decreased. This leaves acting on that same pair of elements an excess or surplus pressure which is not lost but transmitted through the other pair of elements to assist propulsion of the latter and 30 thereby boost the pressure transmitted to the other piston an amount sufficient to nullify the resistance differential and thereby effect uniform movement of the two pistons.

If it is desired to advance one piston while 35 maintaining the other fixed to effect operation of the respective mechanism and yet maintain the other at rest, by turning the valve V^a to place the pipe 19 in communication with the 40 pipe 25 or 26 fluid can be bypassed around the control device D and supplied to the respective cylinder in such additional volume and pressure as to effect the desired forward movement of the respective piston. Although the pipes 30 45 and 31 remain in communication with the control device D, the fluid acting on the rotor elements inwardly through the outlets 41 and 42, is ineffective to actuate the elements because of the resistance offered by the solid fluid head 50 trapped in the pipe 27. In consequence, fluid cannot pass through the control device so that whatever additional fluid is supplied to one cylinder does not increase that previously supplied to the other.

In Figs. 1 and 2, I have shown a practical 55 adaptation of my hydraulic system and control device to a road building machine of the bulldozer type, although it is to be understood that I do not wish to be restricted or limited to this adaptation. The machine shown includes two 60 pusher arms 50 and 51 pivoted as at 52 on the tractor, and bridged at their forward ends by an earth moving implement such as the moldboard 53. Two mechanisms are provided for lifting the pusher arms to elevate and lengthwise 65 tilt the moldboard 53. Each mechanism comprises a frame 54 upon which is fulcrumed a lever 55 operatively connected to the respective pusher arm by a link 56.

The same reference characters designating the 70 respective parts of the hydraulic system and control device of Figs. 3, 4 and 5, have been employed in Figs. 1 and 2, although as applied to the machine the system differs in the showing of certain of the pipes as being made of rigid and flexible sections so as to render them applicable to 75 the machine, and the pipes 37 and 38 as connected to the housing H through a pipe 57.

As shown in Figs. 1 and 2, the piston rods 17 and 17^a are pivotally connected at their forward ends to the levers 55, while the cylinders 15 and 75

15^a are pivotally mounted as at 58 on the frames 54. The other parts of the hydraulic system are supported on the tractor in any suitable manner at the rear of the rams, with the valves V and V² within convenient reach of the operator and provided with suitable operating levers 59 and 60.

In operation of the two implement elevating mechanisms, both mechanisms can be simultaneously actuated to lift the moldboard 53 horizontally from end to end to any elevation required to perform a particular earth moving operation under forward movement of the tractor, by turning of the valve V² to supply fluid to the control device D when, by the inherent function of this device to equalize the volume of fluid delivered to the two ram cylinders, both mechanisms will be moved the same degree to elevate the ends of the moldboard the same distance.

If, during such lifting operation, a load of earth or rock is imposed on the moldboard, which varies in weight from end to end of the moldboard so that the resultant load on one end thereof is greater than that on the other end to produce a resistance differential to the two mechanisms, the control device will, in the manner previously described, nullify this differential to cause the moldboard to be elevated evenly from end to end and thus maintain its horizontal position.

When it is required to tilt the moldboard from end to end in the performance of other forms of earth moving operations, the valve V² is turned to supply additional fluid to one ram cylinder or the other, depending upon which end is to be lifted, thereby actuating the respective mechanism to elevate the corresponding end of the moldboard. During this operation the other end of the moldboard remains undisturbed for the respective ram cylinder cannot be supplied with additional fluid.

If, while tilted, it is required to elevate the moldboard, the valve V² is turned to again supply fluid to the control device D when the two mechanisms will again be simultaneously actuated to elevate the two ends of the moldboard the same distance but without disturbing their relative positions so that the moldboard remains in tilted position. Manifestly, by operation of the single valve V², the two mechanisms can be actuated separately and jointly in such manner that the moldboard can be moved to or from horizontal or tilted position, and then elevated or lowered while maintaining its end to end position fixedly and irrespective of the variation in earth load imposed lengthwise on the moldboard.

To lower the moldboard 53 after it has been raised, the valve V² is moved to the position shown in Fig. 3 thereby allowing fluid from the rear ends of the cylinders to pass through the pipes 30 and 31 and into the control device D causing rotation of the elements 44, 45, etc., in directions opposite to those in which they rotated when fluid was admitted to the device from pipe 33. Thus the fluid can pass from the device into the pipe 27 and thence through the valve V² and into the housing H through the pipe 19.

I claim:

1. In combination; a source of pressure fluid; a plurality of rams each having a cylinder and a piston in the cylinder; pressure and suction lines connecting said source to said cylinders; and a control device in the pressure line between said source and said cylinders and having parts rotatable by the fluid for equalizing the volume

of the fluid delivered to the cylinders of all of said rams.

2. In combination; a source of pressure fluid; a plurality of rams each having a cylinder and a piston in the cylinder; pressure and suction lines connecting said source to said cylinders; and a control device in the pressure line between said source and said cylinders and having parts rotatable by the fluid for equalizing the volume of the fluid delivered to the cylinders of all of said rams, said parts being so interconnected that the pressure of the fluid as transmitted to each cylinder varies directly with the resistance opposing movement of the respective piston in such manner as to effect uniformity in movement of all of the pistons irrespective of the differences in resistance opposing movement of the respective pistons.

3. In combination; a source of pressure fluid; a plurality of rams each having a cylinder and a piston in the cylinder; pressure and suction lines connecting said source to said cylinders; a control device in the pressure line between said source and said cylinders and having parts movable by the fluid for equalizing the volume of the fluid delivered to the cylinders of all of said rams, said parts being so interconnected that the pressure of the fluid as transmitted to each cylinder varies directly with the resistance opposing movement of the respective piston in such manner as to effect uniformity in movement of all of the pistons irrespective of the differences in resistance opposing movement of the respective pistons; and valved means in the pressure line between said source and said device for bypassing the fluid around the device to any of the cylinders for varying the volume of fluid supplied thereto and said valved means coacting with said device to simultaneously discontinue fluid supply to the other cylinders.

4. In combination; a source of pressure fluid; two rams each having a cylinder and a piston in the cylinder; pressure and suction lines connecting said source to the cylinders; and a control device in the pressure line between the cylinders and said source having parts rotatable by the fluid and interconnected to equalize the volume of fluid supplied to the two cylinders, and to vary the respective fluid pressures when and in accordance with any difference in resistance offered to the pistons so that uniform piston movement is effected irrespective of the resistance differential.

5. In combination; a source of pressure fluid; two rams each having a cylinder and a piston in the cylinder; pressure and suction lines connecting said source to the cylinders; a control device in the pressure line between the cylinders and said source having parts movable by the fluid and interconnected to equalize the volume of fluid supplied to the two cylinders, and to vary the respective fluid pressures when and in accordance with any difference in resistance offered to the pistons so that uniform piston movement is effected irrespective of the resistance differential; and valved means in the pressure line operable to bypass fluid from said source around said device to either of said cylinders for increasing the fluid supplied to either cylinder, and said valved means coacting with said device to simultaneously discontinue fluid supply to the other cylinder.

6. A fluid control device, comprising; a stator having at least two fluid inlets and at least two fluid outlets; and a rotor comprising a plurality

of elements so constructed and so arranged in the stator between said inlets and outlets that a pressure fluid entering said inlets will so propel the elements as to equalize the volume of that fluid as emitted from the outlets and prevent fluid leaving either outlet from returning and passing to the other outlet or to either inlet.

6 7. A fluid control device, comprising; a stator having at least two fluid inlets and at least two 10 fluid outlets; a rotor comprising a plurality of elements so constructed and so arranged in the stator between said inlets and outlets that a pressure fluid entering said inlets will so propel the elements as to equalize the volume of that 15 fluid as emitted from the outlets; and vanes interconnecting the elements so that they rotate together and in such directions that the fluid leaving either outlet cannot return and pass to the other outlet or to either inlet.

20 8. A fluid control device, comprising; a stator having at least two fluid inlets and at least two fluid outlets; and a rotor comprising four elements in the stator between the inlets and outlets, said elements being arranged in pairs and having peripheral vanes meshing with each other and with the vanes of the other pair, and said elements so arranged with respect to the inlets that a pressure fluid entering the inlets impinges on the vanes of adjacent elements to rotate the

latter in such direction that the fluid leaving either outlet cannot return and pass to the other outlet or to either inlet.

9. A fluid control device, comprising; a stator having a pair of opposed inlets, a pair of opposed 5 outlets at right angles to the inlets, and one arcuate pocket between adjacent inlets and outlets; and a rotor comprising four elements one in each of the pockets rotatable about an axis 10 which is parallel to the axes of the other elements and of a diameter to have wiping contact with the wall of its respective pocket; and vanes on the periphery of each element meshing with the vanes of adjacent elements along lines coinciding with the axes of the inlets and the outlets 15 so that a pressure fluid entering the inlets impinges on the vanes of adjacent elements to rotate the latter in such directions that the fluid leaving either outlet cannot return and pass to the other outlet or to either inlet.

20 10. In combination; a source of constant fluid pressure; a plurality of motors; pressure and suction lines connecting said source to the motors; and a control device in the pressure line having parts rotatable by the fluid to maintain 25 constant the volume of fluid delivered to the respective motors independent of relative variations in the resistances of the respective motors.

JOHN JUDSON LOW.