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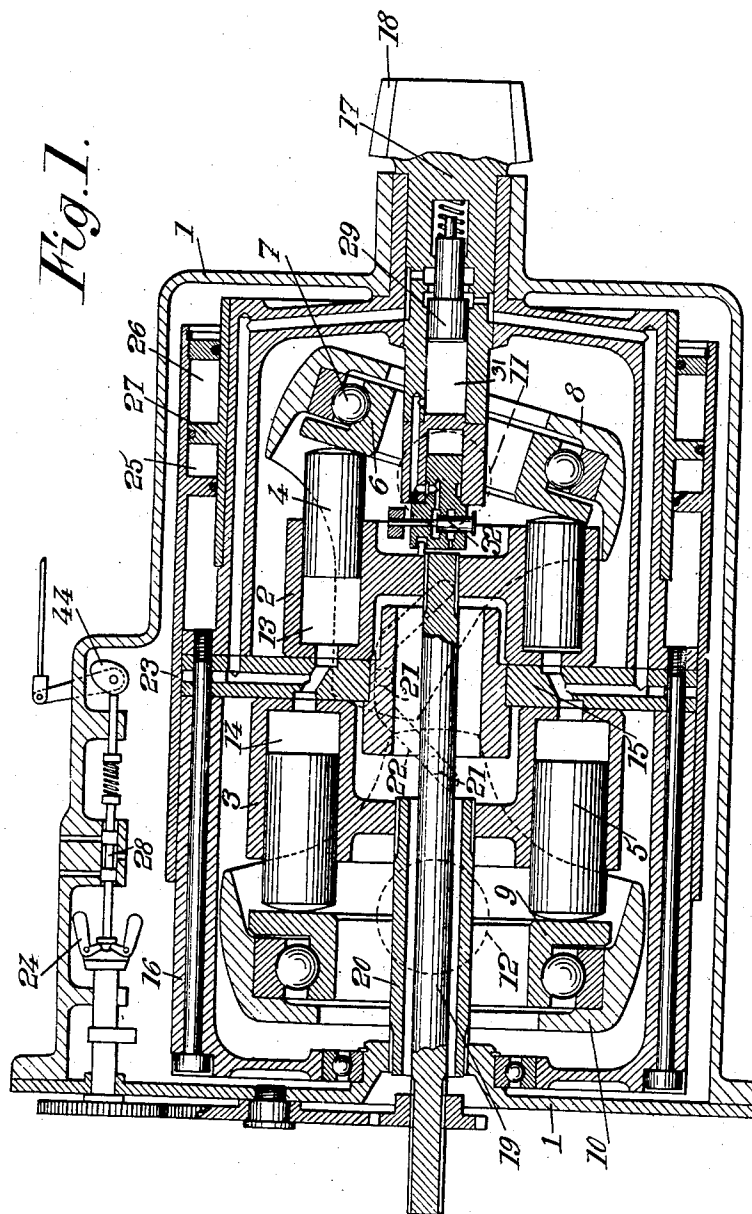
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HYDRAULIC PUMP AND MOTOR VARIABLE SPEED DRIVES

Filed July 13, 1955

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HYDRAULIC PUMP AND MOTOR VARIABLE SPEED DRIVES

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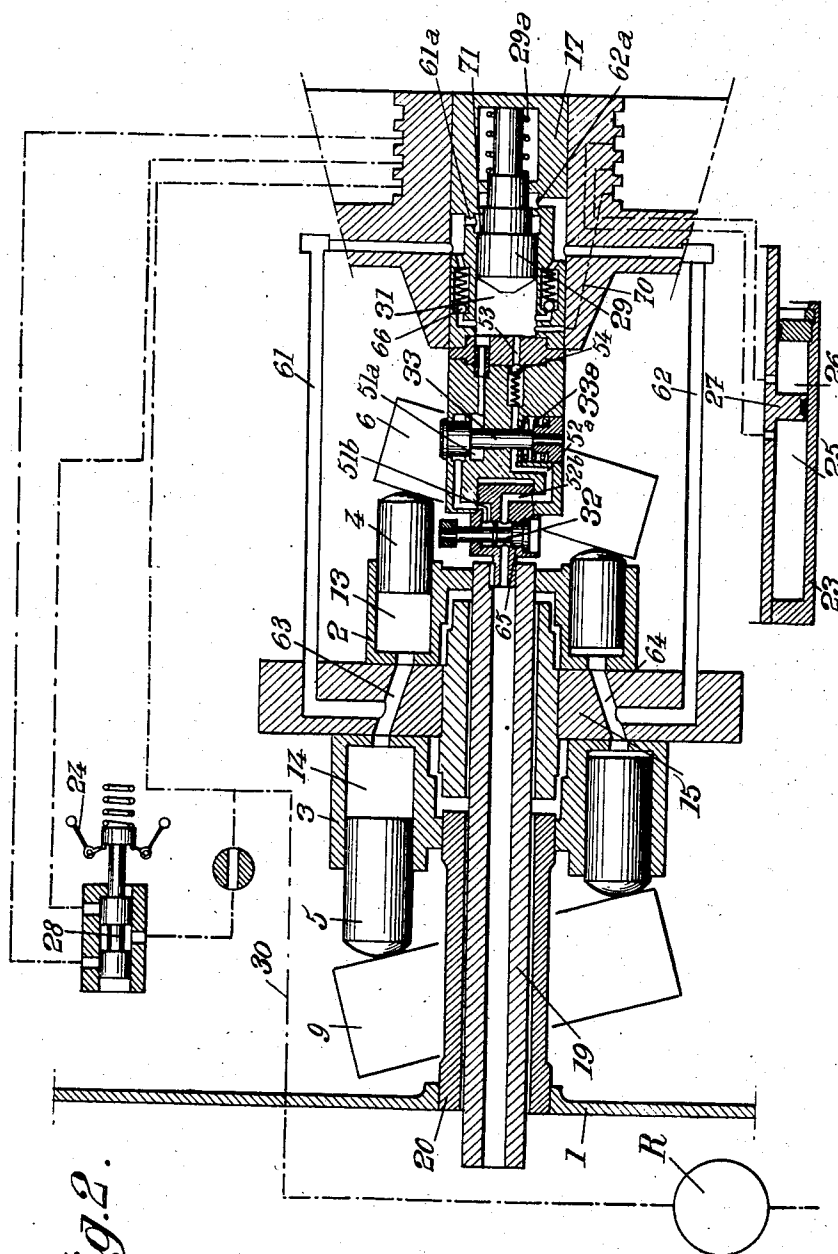


Fig. 2.

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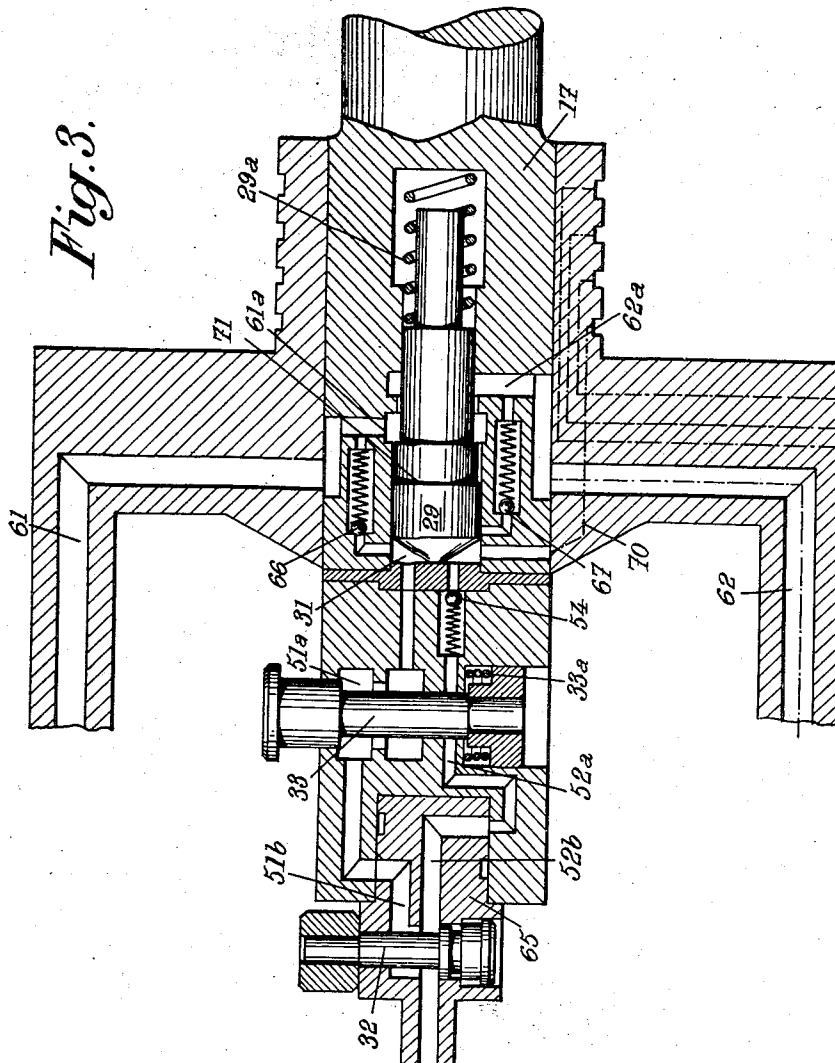
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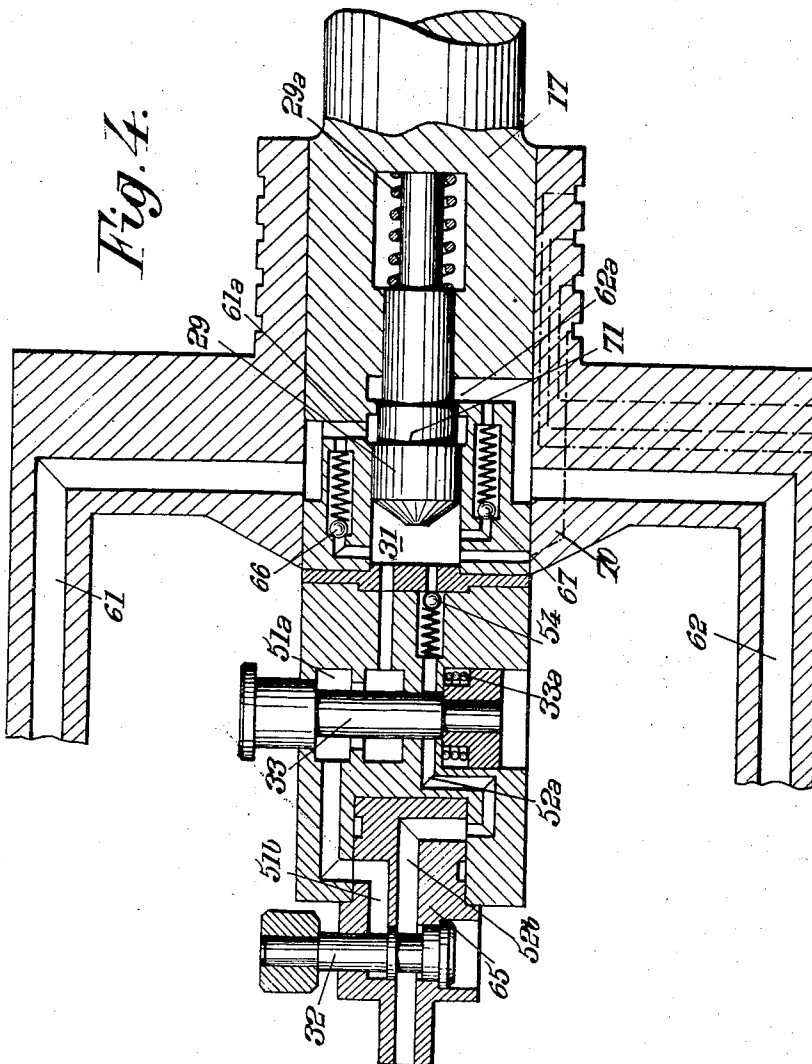
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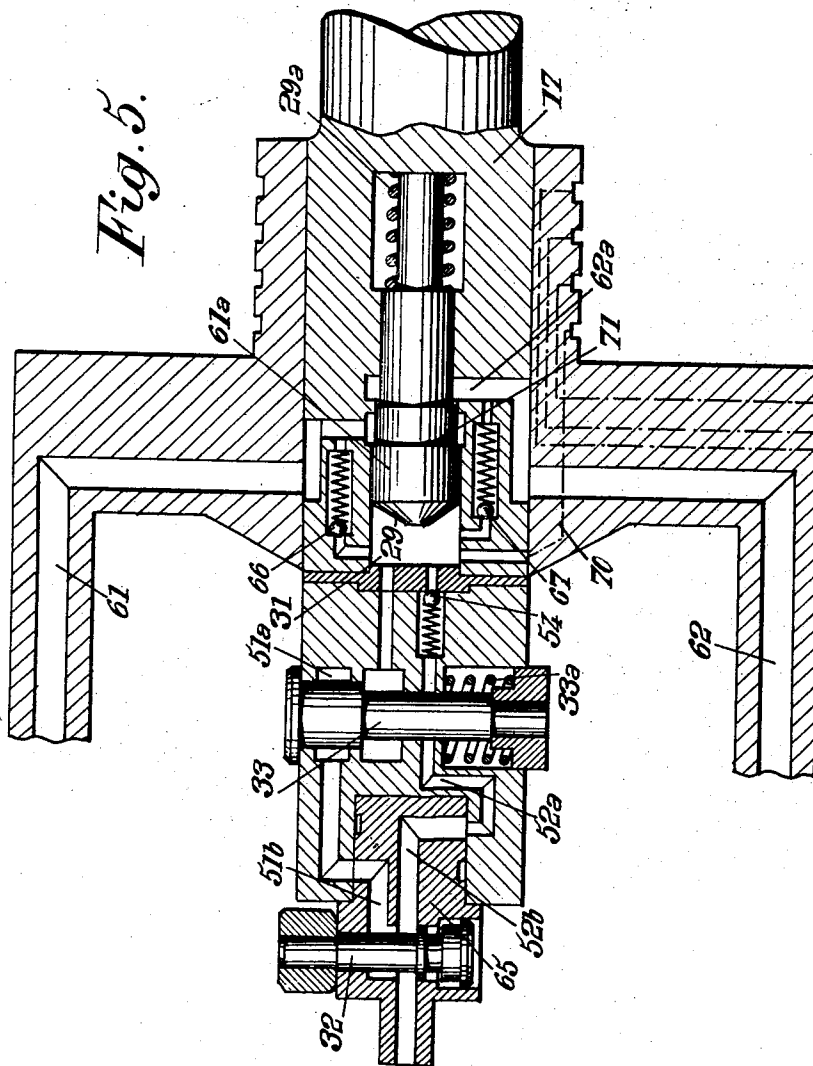
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HYDRAULIC PUMP AND MOTOR VARIABLE SPEED DRIVES

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4 Claims. (Cl. 60—53)

The present invention relates to hydraulic pump and motor variable speed drives of the type including two barrels fitted with cylinders interconnected by a valve plate and containing plungers which cooperate with respective swashplates of variable inclination.

The object of this invention is to provide a drive of this type, especially for use on a motor vehicle, which is better adapted to meet the requirements of practice than those used at the present time.

A preferred construction of a hydraulic variable speed drive made according to the present invention will be hereinafter described with reference to the accompanying drawings, given merely by way of example and in which:

Fig. 1 is a diagrammatic axial sectional view of a hydraulic variable speed drive made according to my invention.

Fig. 2 shows the lay-out of the hydraulic circuits of a modification.

Figs. 3, 4 and 5 show, on an enlarged scale, a portion of the structure of Fig. 2, with the parts in different relative positions, respectively.

The hydraulic variable speed drive, in all modifications, includes a fixed casing 1 in which are located two barrels 2 and 3 each of which includes a plurality of plungers. For instance, barrel 2 includes nine plungers 4 disposed at equal intervals and barrel 3 also includes nine plungers 5 disposed in a likewise fashion.

The plungers 4 of barrel 2 cooperate with a swashplate 6 mounted with the interposition of ball bearings 7 on a support 8 (Fig. 1) the inclination of which can be modified as will be explained hereinafter.

The plungers 5 of barrel 3 cooperate with a swashplate 9 carried by an oscillating support 10 (Fig. 1) similar to support 8.

The oscillation axes of supports 8 and 10 are diagrammatically shown on Fig. 1 at 11 and 12 respectively.

The respective cylinders 13 and 14 of barrels 2 and 3 are filled with a liquid and they are interconnected through a distributing plate or valve plate 15 in each face of which are provided two distinct grooves extending along two respective portions of a circumference each equal to a little less than 180°, the radius of the grooves located on one face of plate 15 being equal to that of the circumference along which are located the passages provided in the respective cylinders 13 or 14, for connecting said cylinders with said grooves. Each semi-circular groove is connected with the corresponding groove located on the opposed side of plate 15 through a passage 63 or 64 extending across said plate 15. Thus every cylinder 13 of barrel 2, whatever be its angular position, is in communication with one half of the cylinders 14 of barrel 3 (this half varying of course when barrel 2 and valve plate 15 are rotating with respect to barrel 3).

The driving element of the hydraulic variable speed drive is constituted by one of the barrels, i. e. barrel 2, mounted on a rotating shaft 19 which constitutes the driving shaft of the hydraulic variable speed drive. The other

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barrel, to wit 3, is fixed in position, being secured to casing 1 through a tube 20 coaxially surrounding driving shaft 19.

The oscillating supports 8 and 10 of swashplates 6 and 9 respectively are carried by a rotating cage 16 (Fig. 1) which constitutes the driven element of the device, said cage being fixed to a driven shaft 17 on which is for instance mounted a pinion 18 (Fig. 1) to transmit the movement thereof.

The principle of operation of such a hydraulic variable speed drive is as follows:

It will first be supposed that swashplate 6 is given the maximum angle of inclination with respect to shaft 17 and that swashplate 9 is at right angles to the axis of shaft 19 (this position being shown by Fig. 1). Due to the rotating movement of barrel 2, plungers 4 should, due to their cooperation with swashplate 6, have reciprocating movements in their respective cylinders 13 which would result in a circulation of liquid between the cylinders 14 of fixed barrel 3 and the cylinders 13 of rotating barrel 2. But since swashplate 9 is in a plane at right angles to the axis of rotation, plungers 5 are all in the same position in their respective cylinders 14 and cannot move therein so that no liquid circulation is possible and plungers 4 cannot slide in cylinders 13. As a consequence of this, swashplate 6 is caused to rotate together with barrel 2. Since the support 8 of swashplate 6 can only pivot with respect to cage 16 about an axis 11 at right angles to the axes of the shafts 19 and 17, cage 16 is driven in rotation by said support 8.

The rotation movement of driving shaft 19 is therefore directly transmitted to driven shaft 17.

If now swashplate 9 is gradually inclined with respect to the axes of the shafts 19 and 17, the plungers 5 of fixed barrel 3 can reciprocate in the cylinders 14 of said barrel with an amplitude which depends upon the inclination of said swashplate 9. A liquid circulation then takes place between cylinders 13 and 14 and cage 16 is then driven in rotation at a speed different from that of shaft 19 and which depends upon the ratio of the total variation of volume of cylinders 13 to the total variation of volume of cylinders 14, which finally depends upon the ratio of the inclinations of swashplates 6 and 9.

Advantageously, the inclinations of these two swashplates are interrelated and for instance, as shown by Fig. 1, each of the oscillating supports 8 and 10 carries a finger 21, these two fingers 21 moving in a control slideway 22 provided in a sliding sleeve 23.

Thus, sleeve 23 controls, through slideway 22, the inclinations of the two swashplates, in accordance with the shape of said slideway 22.

Advantageously, sleeve 23 is automatically positioned by a centrifugal governor 24 which controls the feed of a liquid under pressure to either of two annular chambers 25 and 26 disposed on either side of an annular flange 27 rigid with cage 16 and forming a partition between said two chambers.

For this purpose, governor 24 actuates a slide valve 28 arranged to control the feed of said liquid under pressure to said chambers 25 and 26 (Fig. 2).

In order to have no torque transmitted from the driving shaft to the driven shaft, the cylinders 13 the plungers 4 of which are moving outwardly must be placed directly in communication with the cylinders 13 the plungers 4 of which are moving inwardly, since, in this case, there is a circulation of liquid between the cylinders of each barrel 2 or 3 but no circulation from one barrel to the other. To obtain this result, I provide two conduits 61 and 62, 61 being connected at one end thereof with passage 63 in valve plate 15, and 62 at one end thereof with passage 64. The two other ends 61a and 62a of said

conduits open in a cylindrical recess provided in driven shaft 17. A piston valve 29 is slidable in said cylindrical recess. Said valve 29, when moved to the left, as shown by Fig. 3, by the action of a return spring 29a, opens the communication between the ends 61a and 62a of conduits 61 and 62. On the contrary, when the liquid pressure in a chamber 31 formed by the left hand end of the above mentioned cylindrical recess is sufficiently high, piston valve 29 is pushed toward the right into the position illustrated by Figs. 2 and 4, and it cuts off the communication between the conduit ends 61a and 62a.

Liquid under pressure is supplied to chamber 31 from a source of liquid under pressure, as diagrammatically shown at R on Fig. 2, through a conduit 70 and a pressure line 30 extending between said source R and said conduit 70.

According to my invention, the pressure in chamber 31 is controlled through automatic means responsive to variations of the speed of rotation of driving shaft 19, such means being adapted to open valve 29 when the speed of rotation of said shaft 19 is below a given value. For this purpose, a centrifugally operated valve 32 slidable in a direction at right angles to the axis of shaft 19 is mounted in the portion 51b of a circuit 51a-51b forming a communication between chamber 31 and the inside of shaft 19, which is hollow so that liquid can leak out from said chamber 31. For this purpose a piece 65, fixed at the end of shaft 19 and provided with said passage 51b, is rotatably fitted in the end of shaft 17 so that said passage 51b is constantly in communication with a passage 51a provided in the end part of shaft 17 and opening into chamber 31. Said valve 32, which is normally held by the pressure in chamber 31 in closing position, is adapted, when the action of the centrifugal force is sufficiently high, to stop said circuit 51a-51b whereby no liquid can then flow therethrough from chamber 31. In this case, the pressure in said chamber rises sufficiently to push valve 29 toward the right hand side of Figs. 1 and 2, thus cutting off the short-circuiting communication between conduits 61 and 62.

Advantageously, according to the embodiment illustrated by Figs. 2, 3, 4 and 5, another means for controlling the position of valve 29 is similarly mounted in said leak passage 51a-51b, so as to cut off the above mentioned short-circuiting connection when said driven shaft 17 is rotating at a sufficient speed.

A torque can be transmitted by the variable speed drive from the driven shaft to the driving shaft when initially stationary provided that the driven shaft is rotating at a sufficient speed (case when the engine of a vehicle is started by letting said vehicle run down a hill under the effect of gravity). For this purpose, a second centrifugally operated valve 33 is mounted in the portion 51a of passage 51a-51b in series with the first mentioned centrifugal valve 32.

The maximum pressure that can exist in chamber 31 is determined by a spring loaded discharge valve 54 interposed between chamber 31 and a discharge passage 52a-52b formed partly in shaft 17 and partly in part 65.

When both the driving shaft 19 and the driven shaft 17 are stationary or are rotating at low speed, there is no centrifugal force acting on valves 32 and 33 to hold them in closed position. Therefore, if no other action was exerted on at least one of said valves, the liquid fed to chamber 31 through conduit 70 would be able to escape freely from said chamber to the outside through passage 51a-51b and the inside of hollow shaft 19 and in these conditions no pressure could build up in chamber 31. Advantageously however, as shown by the drawing, a spring 33a is inserted between one of the above mentioned valves, for instance 33, and the part in which it is mounted (in this case the end of driven shaft 17) so as to urge said valve toward the closing position thereof. Thus, in order to escape from chamber 31,

the liquid therein must have a given pressure to act on the enlarged head of the valve 33 so as to open passage 51a. This initial pressure is of course lower than that capable of pushing back valve 29 toward the right against the action of spring 29a. Owing to the fact that there is always at least said initial pressure in chamber 31, this chamber is capable, if some liquid has leaked out from the circuit including cylinders 13 and 14, passages 63 and 64 and conduits 61 and 62, of supplying liquid to compensate for the leaks, this liquid flowing from chamber 31, past check valves 66 and 67, into conduits 61 and 62.

It will be understood that when one of the valves 32 and 33 is in the closing position, as no liquid can flow out through passage 51a-51b, the pressure in chamber 31, constantly supplied with liquid under pressure from source R through conduits 30 and 70, builds up to the value determined by discharge valve 54, this value of the pressure in chamber 31 being capable of pushing back piston valve 29 toward the right against the action of spring 29a.

With such an arrangement, when the driving shaft 19 is running at low speed, for instance at idling speed, slide valves 32 and 33, under the effect of the pressure existing in chamber 31, are in opening position (as shown by Fig. 3) so that liquid can leak out from chamber 31 through passage 51a-51b and the return spring of valve 29 brings this valve into the position where conduits 61 and 62 are connected together. When the speed of driving shaft 19 is increased (Fig. 4), slide valve 32 closes the portion 51b of the liquid leak passage 51a-51b and therefore causes valve 29 to cut off the connection between conduits 61 and 62. The device then transmits torque from the driving shaft to the driven shaft. Valve 33 then comes into closing position, the whole being then as shown by Fig. 2.

If, for some reason, the engine is to be started by imparting rotation to the driven shaft, then, as soon as said driven shaft is running at sufficient speed it causes valve 33 to come into closing position, as shown by Fig. 5; valve 29 cuts off the connection between conduits 61 and 62 and the variable speed drive couples the driving shaft with the driven shaft. After the engine has been started and when it is running at sufficient speed, the parts are in the position shown by Fig. 2.

It should also be pointed out that piston 29 is a differential piston since it is subjected on the one hand to the pressure in chamber 31 acting on its left hand face and pushing it toward the right and on the other hand to the pressure in conduit 61a acting on the shoulder 71 of said piston to push it toward the left. Under normal working conditions, as illustrated by Fig. 2, the effect of the pressure in conduit 61 on said shoulder 71, which is added to the action of spring 29a, is not sufficient to overcome the action of the pressure in chamber 31 and the parts remain in the positions illustrated by Fig. 2. But if the vehicle on which the device is mounted is very suddenly stopped, for instance by braking, the pressure in conduit 61 rises instantaneously and becomes sufficient to overcome the action of the pressure in chamber 31. Conduits 61 and 62 are then placed in communication with each other, which corresponds to placing the variable speed drive in neutral. Valves 32 and 33 open because the centrifugal force has been suddenly reduced. The engine on which the driving shaft 19 is mounted can therefore keep running at low speed without being stalled as a consequence of the sudden stopping of the vehicle.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of my invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What I claim is:

1. A hydraulic variable speed drive which comprises,

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in combination, a frame, two barrels including each a circular row of cylinders, pistons slidable in said cylinders respectively, said barrels having a common axis, one of said barrels being rotatable in said frame about its axis, a driving shaft rotatable in said frame operatively connected with said mentioned barrel for driving it, means carried by said frame for supporting the other of said barrels in line with the first mentioned one, a structure rotatable in said frame about the common axis of said barrels, a valve plate carried by said structure for interconnecting the cylinders of said respective barrels, the two opposed faces of said valve plate being in sliding contact with the ends of the cylinders of said two barrels respectively, each face of said valve plate being provided with two separate grooves extending over two circular arcs each of a little less than 180° concentric with said barrels, said ends of said cylinders being provided with passages for connecting the insides of said cylinders with one or the other of said grooves on each side of said valve plate, said valve plate being provided with passages extending from one face to the other and connecting each groove in one of said faces with a corresponding groove on the other face, two swashplates carried by said structure and in cooperating contact each with the ends of the above mentioned pistons slidable in each of said barrels respectively, said swashplates being pivotable in said structure about respective axes intersecting the common axis of said barrels at right angles thereto, means for controlling the inclinations of said swashplates with respect to said common axis, a driven shaft in line with said driving shaft operatively connected with said structure so as to rotate together therewith, two conduits provided in said structure and said driven shaft and each connected at one end with one of said passages in said valve plate respectively, said driven shaft being provided with a cylindrical recess, the respective other ends of said conduits opening into said recess, a piston valve slidable in said cylindrical recess for controlling the communication between said last mentioned ends of said two conduits, resilient means interposed between said piston valve and a part of said driven shaft for urging said piston valve toward the position thereof where it uncovers both of said last mentioned conduit ends simultaneously, said recess forming a chamber on the side of said piston valve opposed to that on which are located said conduit ends, a liquid feed line opening into said chamber, means for constantly feeding liquid under pressure through said feed line to said chamber, a discharge conduit in said driven shaft leading out from said chamber, a discharge valve in said discharge conduit mounted to open in response to the action thereon of pressure in said chamber, resilient means

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in cooperating relation with said discharge valve to prevent opening thereof for pressures in said chamber below a given minimum, a part operatively connected with said driving shaft for rotation together therewith, said part being rotatably fitted in said driven shaft, said part and said driven shaft being provided with corresponding passages forming together a leak circuit between said chamber and the outside of said part, and a centrifugal slide valve movably guided in said part across said passage located in said part, to close said leak circuit in response to the action of the centrifugal force exerted on said slide valve when said driving shaft is rotating at a speed above a given value, whereby the pressure in said chamber is kept sufficient to cause said piston valve to separate said two conduits from each other, said centrifugal slide valve being mounted to be responsive to the liquid pressure in said circuit so as to be brought into circuit opening position by said pressure when said driving shaft is stationary or rotating at a speed below said given value, whereby the pressure in said chamber is then allowed to drop sufficiently to enable said piston valve to be moved by said resilient means into the position where it connects said two conduits together.

2. A hydraulic variable speed drive according to claim 1 in which said piston valve is provided with a shoulder opposed to the end face of said piston valve forming one wall of said chamber, one of said conduits opening into a portion of said cylindrical recess where said shoulder is located so as to subject said shoulder to the action of the pressure in said last mentioned conduit.

3. A hydraulic variable speed drive according to claim 1 further including a centrifugal slide valve movably guided in said driven shaft across said passage forming in said driven shaft a portion of said leak circuit, to close said circuit in response to the centrifugal force exerted on said slide valve when said driven shaft is rotating at a speed above a given value.

4. A hydraulic variable speed drive according to claim 3 further including resilient means for urging one of said centrifugal slide valves, with respect to the element in which it is slidable, in the same direction as the centrifugal force, so as to keep always at least a minimum pressure in said chamber.

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