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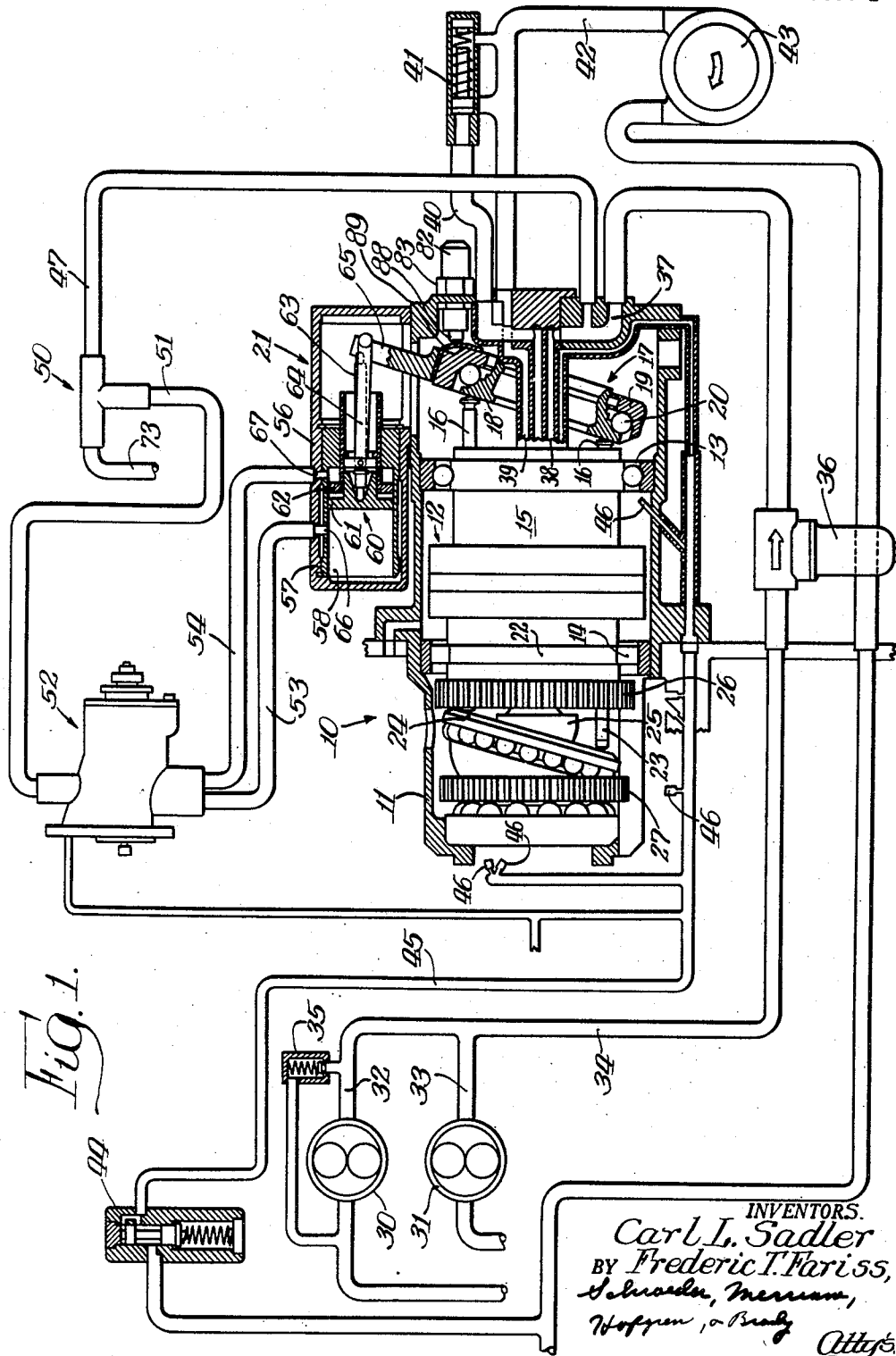
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CONTROL FOR VARIABLE DISPLACEMENT PUMP

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2 Sheets-Sheet 1



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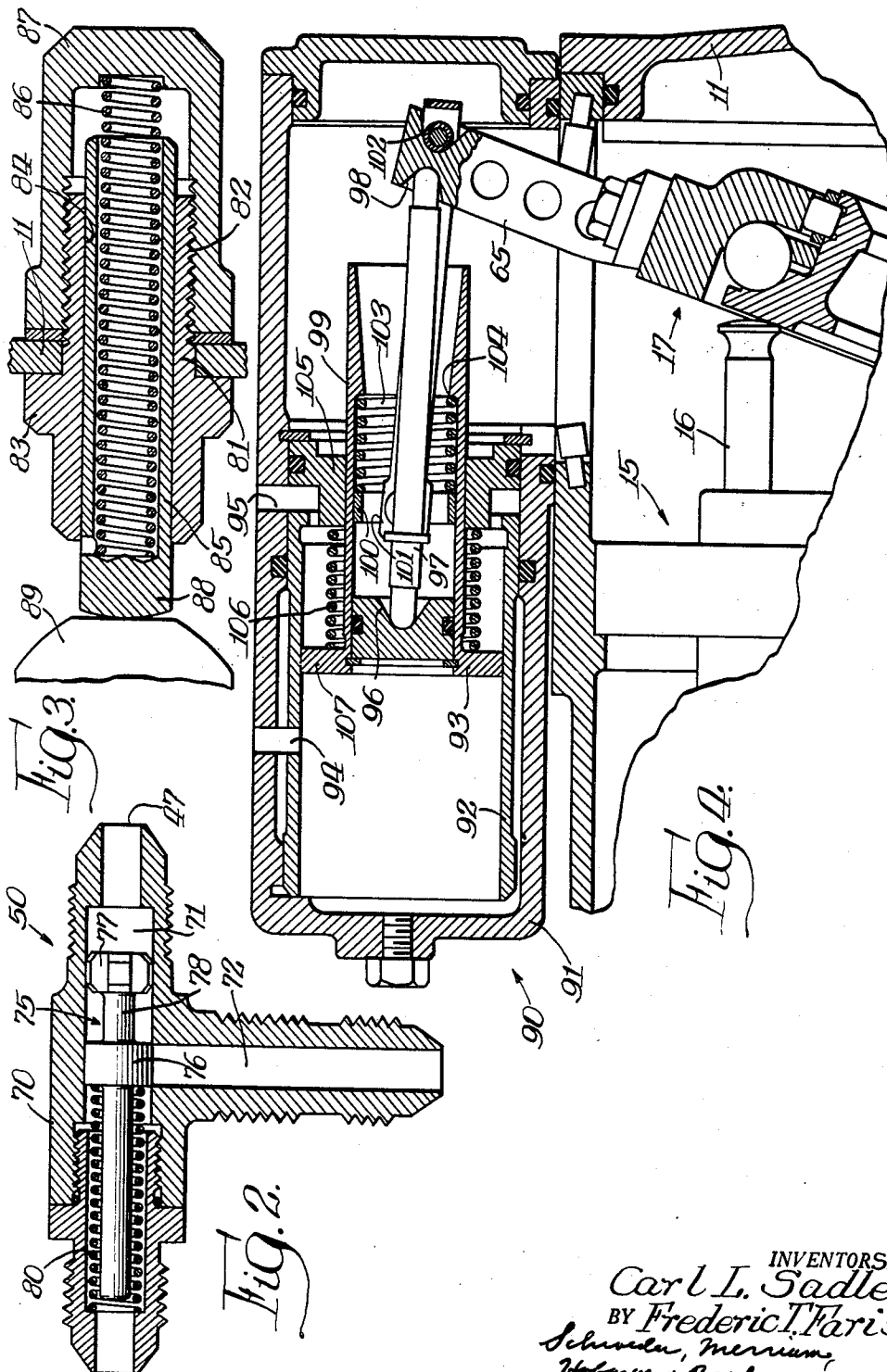
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2,941,480

CONTROL FOR VARIABLE DISPLACEMENT PUMP

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This invention relates to control means and more particularly to a control for a variable displacement pump.

It is the general object of this invention to produce a new and improved control for a variable displacement pump.

It is a more specific object of the invention to provide a control for a variable displacement pump wherein the displacement of the pump is controlled by means of a control fluid pressure responsive device operable to move the displacement varying means for the pump to at least one of two extreme positions and to provide such a pump with means biasing the displacement varying means toward the other extreme position together with means for diverting control fluid pressure from the device operated thereby whenever the control fluid pressure drops below a predetermined minimum.

Another object of the invention is to provide a control for a variable displacement wobbler type pump which is provided with a control fluid pressure operated device for moving the wobbler and with means biasing the wobbler toward neutral or zero displacement position together with means for diverting control fluid pressure from said pressure operated device whenever the control fluid pressure drops below a predetermined minimum, thereby to permit the biasing means to move the wobbler toward neutral or zero displacement position.

A further and more specific object of the invention is to produce a control for a multiple piston wobbler type pump which includes a hydraulic piston and cylinder device connected to the wobbler to adjust the position thereof and thus vary the displacement of the pump in response to the introduction of control fluid under pressure to the cylinder, together with means constantly biasing the wobbler toward neutral or zero displacement position, and with further means serving to divert control fluid from the cylinder whenever the pressure of said control fluid drops below a predetermined maximum, thereby permitting the biasing means to move the wobbler toward said position.

Yet another object of the invention is to produce a multiple piston wobbler type pump adapted to be driven from a source of power, with the pump having control means operated by fluid pressure generated by a pressure producing means also operated by the power source, with the pump and control being so constructed and arranged as to automatically return the wobbler to approximately neutral or zero displacement position each time the pump is stopped.

Other and further objects and advantages of the invention will be readily apparent from the following description and drawings, in which:

Fig. 1 is a schematic view of a hydraulic transmission and control embodying the invention;

Fig. 2 is an enlarged sectional view of a shuttle valve employed in the invention;

Fig. 3 is an enlarged sectional view of one form of wobbler biasing means; and

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Fig. 4 is an enlarged sectional view of another form of wobbler biasing means and also showing the control piston and cylinder assembly.

While this invention is susceptible of embodiments in many different forms, there are shown in the drawings and will herein be described in detail several embodiments, with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiments illustrated. The scope of the invention will be pointed out in the appended claims.

While it will be readily apparent to those skilled in the art that the invention of the present application is readily adaptable for a number of uses, it has, for the purposes of illustration, been shown and will hereafter be described as employed in conjunction with a hydraulic transmission for producing a constant speed of a driven element from a variable speed driving element of the general type more fully described and claimed in the copending application of Carl L. Sadler et al., Serial No. 259,872, filed December 4, 1951, now Patent No. 2,803,112.

Referring now to Fig. 1 of the drawings, there is shown a hydraulic transmission generally designated 10 including a casing 11 enclosing a cylinder block 12 rotatably mounted in the casing on bearings 13 and 14. The right-hand portion of the cylinder block comprises a pump 15 including a plurality of axial cylinders in each of which a piston 16 is reciprocable, with the cylinders being arranged in an annular row about the center of the cylinder block. Means in the form of a wobbler 17 is provided for varying the displacement of the pump 15, with the wobbler having a face 18 contacting the convex ends of the piston 16 and rotatably supported upon the body portion 19 of the wobbler by means of bearings 20. It will be understood that as the cylinder block is rotated and the pistons contact the face 18, the pistons are reciprocated in the cylinder with the amount of reciprocation, and hence the displacement of the pump, being dependent upon the angular relation of the wobbler to the axis of rotation of the cylinder block. Control means, generally designated 21, are provided for moving the wobbler from one extreme position wherein the wobbler is tilted to its maximum angle in one direction and hence produces an underdrive to another extreme position wherein the wobbler is tilted at its maximum angle in the other direction and thus produces an overdrive.

Hydraulic fluid discharged from the pump 12 is directed into a multiple cylinder motor 22, with the motor having a piston 23 reciprocable in each of its cylinders and bearing at their outer ends against a fixed angle swash plate 24 secured to a driven shaft 25.

The cylinder block 12 is rotated from a source of power by means of a drive gear 26 secured thereto and such rotation of the cylinder block produces rotation of a driven gear 27 secured to the shaft 25 at a speed equal to or greater or less than the speed of rotation of the drive gear, depending upon the angular position of the wobbler 17. Thus, with the wobbler in neutral or zero displacement position the pump and motor pistons are locked together, thus producing a 1 to 1 drive. Tilting of the wobbler in either direction from neutral position will produce either an overdrive or an underdrive of the driven shaft 25 depending upon the direction of tilting.

The contact between the outer ends of each of the pistons 16 and the face 18 of the wobbler serves to move the pistons on their discharge strokes, and a source of fluid pressure is provided for moving the piston on their intake or suction strokes, with such fluid being directed into a valve chamber located centrally between the pump and motor as more fully described in said co-

pending application of Carl L. Sadler et al. The source of fluid pressure on the aforesaid application, however, is a gear type make up pump which, if desired, may be constructed as a part of the hydraulic transmission. In the present instance the transmission is designed to drive an alternator generator at a constant speed from an aircraft engine regardless of the speed of the engine and, as shown in the accompanying drawings, such make up fluid under pressure is received from a pair of pumps 30 and 31 which serve not only to provide make up fluid but also as general lubricating pumps for the aircraft engine. The pumps 30 and 31 discharge into passages 32 and 33, respectively, each of which connects to a jet or main fluid passage 34. Means in the form of a relief valve 35 are provided for preventing the generation of excessive pressure in the main passage 34 by the pumps, it being preferable to set the relief valve to open at about 250 p.s.i.

The passage 34 directs the oil through an oil filter 36 and thence into a passage 37 formed in the end of the casing 11. The passage 37 connects with a make up passage 38 which extends inwardly to the central valve chamber previously mentioned and serves to direct oil thereinto under pressure for moving all of the pistons on one of their strokes and also for making up losses of fluid due to leakage and the like. Excess fluid directed into the valve chamber is returned through passage 39 which connects to a conduit 49 terminating in a pressure regulating valve 41. The valve 41 is set to maintain a pressure differential of approximately 150 p.s.i. between the pressure in the conduit 40 and that in a blow-by conduit 42. The conduit 42 connects with the valve 41 and passes the oil through a cooler 43 and thence into a pressure reducing valve 44 to the lubricating conduit 45. The conduit 45 is provided with a number of jets 46 which direct lubricating oil against various moving parts of the transmission.

The passage 37 in the end of the casing also connects with a passage 47 which leads to a shuttle valve 50 and thence via a passage 51 to a governor 52. The governor is mounted to be driven by the driven shaft 25 of the transmission and is provided with valve means for directing hydraulic fluid into or draining it from passages 53 and 54 for the purpose of regulating the control device 21 and hence the wobbler position. As the specific construction of the governor 52 forms no part of the present invention and is fully described in the said copending application of Carl L. Sadler et al. and will not be further described herein.

The control 21 comprises a casing 56 having a sleeve 57 therein defining a cylinder 58 within the casing. A piston 60 is reciprocable in the cylinder 58, with the piston being made up of a face portion 61 and a second portion 62. The portion 61 is connected to a first member 63 while the portion 62 is connected to a second member 64, with the member 64 contacting opposite sides of an arm 65 fixed to the wobbler so as to clamp the arm therebetween. The passages 53 and 54 open through ports 66 and 67, respectively, in the sleeve, with the ports being located on opposite sides of the piston 60, and relative variations of pressure in the passages 53 and 54 serves not only to move the piston 60 in both directions within its cylinder, but also to urge the piston parts 61 and 62 together, thus clamping the members carried thereby against the arm 65 of the wobbler.

Where the fluid pressure necessary to hold the pistons in the pump against the wobbler and those in the motor against the swash plate is derived from remote pressure producing means such as the pump 30 and 31, particularly where such pumps serve also as lubricating pumps for the aircraft engine, it often occurs that such pressure does not reach the valve in the chamber and thus is not effective to move the pistons outwardly against the wobbler or swash plate until a period of time after the engine has been started. When an aircraft engine operating with

a transmission of the type herein shown is shut down, the governor 52 senses the decreasing speed of the driven element and thus tends to move the wobbler toward maximum stroke producing position. Thus, in the transmission described in the previously mentioned copending application, when the transmission is stopped the wobbler is in full stroke position and remains in that position on a subsequent start up. During the initial period of the start up, however, where the make up pressure producing means are remotely located as in the present case, no fluid is supplied to the valve chamber to move the pistons outwardly against the wobbler for some time and then the pressure comes as a rather heavy surge. This surge tends to move the pistons outwardly very rapidly against the wobbler and because of the turning moment applied against the rotatable portion of the wobbler carrying the face 18, a counter-rotating moment is applied against the pistons. This moment or force has been sufficiently intense as to bend or even snap one of the pistons, particularly the one which extends outwardly from the cylinder block the farthest on the initial receipt of fluid pressure.

According to this invention, however, means are provided for insuring that the wobbler is always in neutral or substantially neutral position upon start up of the engine. To this end means are provided which constantly bias the wobbler toward neutral position so that when the transmission is stopped, the wobbler is then moved to zero displacement or small negative angle position, that is, approximately normal to the axis of rotation of the cylinder block. Merely to provide a spring, however, to urge the wobbler toward neutral position would not be sufficient inasmuch as movement of the wobbler entails movement of the pistons 60 and such movement is difficult if not impossible (unless great force is applied to the wobbler) due to the presence of fluid within the cylinder 58. Therefore, means are provided for diverting control fluid from the cylinder 58 and draining such fluid therefrom in order to permit the wobbler biasing means to achieve the desired neutralizing of the wobbler when the transmission is stopped.

The shuttle valve 50 is provided for the purpose of diverting fluid from the cylinder 58 and comprises (as best seen in Fig. 2) a generally T-shaped casing 70 having a passage 71 extending therethrough, with the passage connecting the one end to the passage 47 and also to a second passage 72 in the casing, with the latter passage being connected to the passage 51 leading to the governor. The passage 71 also connects to a drain passage 73. Slidable in the passage 71 is a valve 75 having a piston portion 76 formed at one end thereof and a land portion 77 at the other end conducted to the piston portion by a reduced portion 78 of the valve. A spring 80 seats in the casing 70 and bears against one side of the piston portion 76 of the valve so as to constantly urge the valve to the right (as seen in Fig. 2) to a position moving the piston portion 76 so that interconnection is provided between the left-hand end of the passage 71 which is connected to the drain passage 73 and the passage 72 which is connected to the passage 51. Thus, when no control pressure exists in the passage 47 the valve is moved to the position just described so as to permit drainage of fluid in the passage 51 and hence from the cylinder 58. When control fluid pressure has been generated by the pumps 30 and 31 and raises the shuttle valve 50, the valve 75 is moved to the left (again referring to Fig. 2) to a position where the piston portion 76 is to the left of the passage 72, thus establishing communication between the source of control fluid pressure, the governor 52 and the cylinder 58.

With control fluid pressure diverted from the cylinder 58, means are provided for moving the wobbler toward neutral position, which means may obviously take a number of forms. One such form is shown in Figs. 1 and 3 which comprises a fitting 81 having a reduced external

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threaded end portion 82 to which is secured a nut 83 to hold the fitting 81 in position in an opening in the casing 11. The fitting 81 is hollow to provide a cylinder 84 in which is slidably mounted a plunger 85. The plunger is preferably hollow and located inside of the plunger is a spring 86 bearing at one end against an end cap 87 for the cylinder and at the other end against the head 88 of the plunger to urge the plunger against a curved fender 89 secured to the wobbler 17. The fender 89 is provided with a convex surface contacting the head 88 of the plunger so as to permit easy sliding movement therebetween as the plunger is rotated.

A second form of means for biasing the wobbler toward neutral position is shown in Fig. 4. As shown in that figure the control 90, comparable to the control 21 previously mentioned, is provided with a casing 91 carrying a sleeve 92 and a piston 93 is reciprocable in the cylinder formed by the interior of the sleeve. The casing is provided with ports 94 and 95, comparable to the previously described ports 66 and 67, and the piston 93 is provided on its reverse side with a recess 96 in which one end of a member 97 is seated, with the other end of the member being seated in a recess 98 on one side of the arm 65 of the wobbler. The piston is provided with a sleeve portion 99 in which is located a ring member 100 pivotally carrying a second member 101, with the opposite end of the member 101 being seated in a recess 102 on the opposite side of the arm 65 from the recess 98. A spring 103 seats on a shoulder 104 formed on the interior of the sleeve 99 and bears against the ring member 100 so as to urge the member 101 in a direction against the member 97, thus to clamp the ends of the arm 65 between the two members. The particular clamping means for holding the end of the wobbler are more fully described and are claimed in the pending application of Donald L. Cauble filed on August 10, 1953, as Serial No. 373,237, now Patent No. 2,860,517.

Fixedly secured within the casing 91 is a circular fitting 105 which reciprocably carries the sleeve 99 and against which one end of a compression spring 106 bears. The opposite end of the spring 106 bears against a flange 107 formed on the piston 93 and thus constantly urges the piston to the left, thus biasing movement of the wobbler toward zero displacement or neutral position.

The general operation of the biasing means of Figs. 3 and 4 is substantially the same and the shuttle valve 50 would be used with either modification. Thus, on shut down of the aircraft engine the governor 52 would, upon first sensing the decrease in speed of the driven element, direct more fluid to the cylinder at the left-hand side of the piston, thus tending to move the wobbler to a position increasing the displacement of the pump. The deceleration of the aircraft engine of course decelerates the pumps 30 and 31, reducing the control pressure produced thereby until the point is reached where the force of the spring 80 in the shuttle valve is sufficient to overcome the control pressure and thus establish communication between the passage 51 and the drain 73. At this point all fluid pressure is relieved from within the cylinder at the left-hand side of the piston whereupon the springs 106 or 86 may tilt the wobbler toward a position normal to the axis of rotation of the cylinder block, thus to a neutral or zero displacement position or even to negative angle position. The wobbler therefore would remain in such neutral position for such period after a subsequent start up of the engine and hence of the transmission until the control fluid pressure was sufficient to overcome the spring 80 and permit control fluid to be directed by the governor into the cylinder in the control devices 21 and 90. At that time, however, the control fluid will have already been directed into the valving chamber in the transmission and thus will have urged the pistons outwardly against the wobbler.

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Because of the fact that the wobbler is then in neutral position, not only are no pistons forced a large distance outwardly before contacting the wobbler, but the bending moment induced on the pistons is greatly lessened, thus reducing or substantially eliminating possibilities of damage on start up.

We claim:

1. In a hydraulic transmission having an input adapted to be connected to a source of power and an output, said transmission including a pump having a plurality of pistons reciprocable in a rotatable barrel and a wobbler movable to vary the displacement of the pump to change the ratio of output speed to input speed, said transmission including a pressure producing device driven by said source for providing lubricating and control fluid under pressure and being connected to said pump to urge the pistons against the wobbler; a control comprising: a fluid pressure operated device connected to the wobbler, passage means connecting the pressure producing device to the pressure operated device downstream of the connection to the pump, said pressure operated device being operable to move the wobbler toward maximum displacement in response to control fluid pressure, means biasing the wobbler toward minimum displacement, and a valve in said passage means movable from a first position connecting the pressure operated device to said pressure producing device to a second position connecting the pressure operated device to a drain, resilient means urging said valve to said second position, and means responsive directly to the pressure in said passage means to move the valve to said first position in opposition to said biasing means.

2. In a hydraulic transmission having an input adapted to be connected to a source of power and an output, said transmission including a pump having a plurality of pistons reciprocable in a rotatable barrel and a wobbler movable to vary the displacement of the pump to change the ratio of output speed to input speed, said transmission including a pressure producing device driven by said source for providing lubricating and control fluid under pressure and connected to said pump to urge the pistons against the wobbler; a control of the character described comprising: a fluid pressure operated device connected to the wobbler, passage means connecting the pressure producing device to the pressure operated device downstream of the connection to the pump, said pressure operated device being operable to move the wobbler toward maximum displacement in response to control fluid pressure, means biasing the wobbler toward minimum displacement, and a valve in said passage means movable from a first position connecting the pressure operated device to said pressure producing device to a second position connecting the pressure operated device to a drain, a spring constantly urging said valve to said second position and a piston portion of said valve having a face exposed directly to the pressure produced in said passage means and operable upon said pressure reaching a predetermined minimum to overcome said spring and move said valve to said first position.

References Cited in the file of this patent

UNITED STATES PATENTS

2,026,776	Douglas	Jan. 7, 1936
2,093,690	Wiedmann	Sept. 21, 1937
2,299,234	Snader et al.	Oct. 20, 1942
2,403,913	Ellis	July 16, 1946
2,502,546	Adams	Apr. 4, 1950
2,669,935	Tucker	Feb. 23, 1954
2,712,300	Ifield	July 5, 1955
2,727,525	Harris	Dec. 20, 1955
2,731,569	Cardillo et al.	Jan. 17, 1956