INVENTOR

BERTRAM ANTHONY PEASTER
HYDRAULIC CONSTANT SPEED DEVICES

Bertram Anthony Peaster, Codsall, England, assignor to Integral Limited, Wolverhampton, England, a British company

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Hydraulic constant speed devices are used, among other purposes, for driving an alternator in an aircraft and the constant speed unit is required to maintain constant the frequency of the current supplied by the alternator notwithstanding variations in speed of the aircraft engine.

The hydraulic constant speed device according to the invention comprises a hydraulic pump including means for varying its delivery by controlling the spill of liquid from the pump cylinders to the inlet of the pump during the discharge strokes of the pump plungers, a hydraulic motor driven by the liquid delivered by the pump, means for generating a variable hydraulic signal pressure representative of the speed of the hydraulic motor, and a device responsive to said signal pressure for adjusting the spill controlling means so as to maintain the speed of the hydraulic motor at a predetermined value.

The hydraulic constant speed device according to the invention will now be described in detail, by way of example, with reference to the accompanying diagrammatical drawings, in which:

Fig. 1 shows diagrammatically the complete apparatus, and Figure 2 is a detail view showing the signal pressure generator.

The apparatus shown in Fig. 1 comprises a variable delivery hydraulic pump 1, which is of the general character described in U.S. application No. 644,122/57 now abandoned and is driven at variable speed by an engine, not shown, a hydraulic motor 2 driven by the liquid delivered by the pump and an alternator 3 driven by the hydraulic motor. The hydraulic motor includes a device indicated diagrammatically at 4 for generating in a signal line a hydraulic pressure proportional to the speed of the motor. Liquid discharged by the hydraulic motor is returned to the inlet of the pump through a line 6.

As shown in more detail in Fig. 2, the signal pressure generator 4 comprises a rotor 40 fixed to the shaft 41 of the hydraulic motor 2 and rotating in a fixed casing 42. The rotor 40 is formed with a passage 43 having an inlet 44 communicating, via the line 45 (Fig. 1) with the return line 6 to the inlet of the pump 1. The passage 43 has an outlet 47 (Fig. 2) communicating with the outer periphery of the casing in the casing 42 in which the rotor 40 is accommodated, which recess in turn communicates with the signal line 5. The pressure difference $P_0 - P_1$, $P_0$ being the pressure in the signal line and $P_1$ the pressure at the inlet to the signal pressure generator 4, is of course proportional to the square of the speed of rotation of the shaft 41 of the hydraulic motor.

The pump comprises a number of plungers 10 (two of which only are shown) arranged in a circle and mounted for reciprocation in cylinders in a pump casing 100. Each cylinder has a rear portion 9 and a front portion 8. Each plunger has a central bore 11 and a lateral spill port 12. The plungers are reciprocated by a swash plate 13 fixed on a driving shaft 113. Liquid enters the interior 110 of the casing from an inlet 25 and is drawn into the bore 11 of each plunger on the suction stroke thereof. The liquid is discharged on the delivery strokes of the plungers through discharge valves 26 to an annular space 140 communicating with a delivery line 14. Associated with each plunger 10 is a spill valve constituted by a sleeve 24 surrounding the plunger. When the sleeves 24 occupy the position shown in the drawing, which is the position corresponding to maximum delivery of the pump, each plunger 10 will commence to deliver liquid as soon as its forward end enters the front portion 90 of its associated cylinder. When, however, the sleeves 24 are shifted to the right from the position shown, the spill port 12 of each plunger will be unmasked as soon as it leaves the front end of the rear portion 9 of the associated cylinder and liquid will be split until such time as the spill port 12 has been masked by the sleeve 24. Delivery of the pump is thus varied by adjustment of the quantity of liquid split at the start of the delivery strokes of the plungers and will decrease progressively as the sleeves 24 are moved further to the right from the position shown.

The spill valves 24 are connected to a plate 15 loaded by a spring 16 and attached by a rod 17 to a differential servo piston 18. The left hand face of the piston 18 is subject, through a duct 118 communicating with the space 140, to the pump delivery pressure and the other face of the piston 18 is subject to the lower end of the hydraulic conduit 19 connected in an outlet conduit 19 connected to the delivery line 14 of the pump by a conduit 7 containing a restrictor 20. Flow of liquid out of the conduit 19 is controlled by half-bail valve 8 mounted on the upper end of a beam 21 pivoted at 22.

The upper end of the beam 21 is subject, through the half-bail valve 8, to the pressure in the conduit 19 and to a counteracting balancing pressure exerted on the beam by a differential piston 23 subject through a conduit 27 to the pump delivery pressure. The lower end of the beam is subject at its left hand side to the pressure of a spring 28 exerted on the beam through a plunger 29, subject at its left hand side to the pressure $P_1$, and at its right hand side to the signal pressure $P_0$ in the line 5 which is exerted on the beam through a piston 30. A screw 31 permits an adjustment of the loading of the spring 28.

If the speed of the hydraulic motor rises above a predetermined value determined by the loading of the spring 28, the resulting increase in signal pressure in the line 5 will cause the beam 21 to rock clockwise about its pivot 22, so causing the valve 8 to increase the flow from the conduit 19, reducing the pressure at the right hand side of the servo piston 18 and causing the servo piston to move to the right in order to decrease the delivery of the pump. When the pump delivery has fallen sufficiently to restore the speed of the hydraulic motor to the predetermined value, the beam 21 returns to its initial position and thus terminates movement of the servo piston 18. Similarly, if the speed of the hydraulic motor falls below the predetermined value, the beam 21 will rock counterclockwise so causing the valve 8 to reduce the flow from the conduit 19, whereupon the servo piston 18 will move to the left to increase the delivery of the pump until the motor speed has been restored to the predetermined value.

In the arrangement illustrated, in which the differential piston 23 is subject to the pump delivery pressure, there may be a slight delay, due to the resistor 20, in re-establishment of equal pressures on the two sides of the beam when there is a change in pump delivery pressure as the result, for example, of a change in loading on the alternator. This delay can be avoided by subjecting the differential piston 23 at both sides to the servo pressure in the conduit 19 instead of to the pump delivery pressure. This result can be achieved by substituting the conduit 50, shown dotted in Fig. 1, for the conduit 27.
Also, if so desired, the piston 23, 29, 30 can be replaced by diaphragms and associated push rods for transmitting pressure from the diaphragms to the beam.

What I claim as my invention and desire to secure by Letters Patent is:

1. A hydraulic constant speed unit, for use in driving an alternator at constant speed notwithstanding variations in speed of a prime mover driving the unit, said unit comprising a prime mover driven hydraulic pump and a hydraulic motor driven by said pump and adapted to drive the alternator, the improvement comprising, discharge and return fluid connections between the pump and motor whereby said pump may drive said motor, and control means for said pump for adjusting the same to drive said motor at constant speed, said pump including pump cylinders, pump plungers reciprocable in said cylinders to pump fluid to said motor, means for reciprocating the plungers, spill sleeves associated with said plungers and movable in relation to said plungers to adjust the spill of fluid from the cylinders and thereby to adjust the delivery of the pump, a servo piston connected to said spill sleeves, a conduit for supplying fluid at pump discharge pressure from said discharge connection to one side of the servo piston, an outlet conduit from said discharge connection communicative with the other side of the servo piston and permitting restricted flow of fluid from said discharge connection to said other side of the servo piston, and means normally balancing said servo piston against the fluid pressures acting on its opposite sides, said servo piston adjusting said spill sleeves to vary the delivery of the pump in response to changes in flow pressure in said outlet conduit and said control means including an adjustable flow control valve controlling the flow of fluid from said outlet conduit, a signal pressure generator driven by said motor and arranged to develop a hydraulic signal pressure which varies with the speed of said motor, means biasing said flow control valve in one direction and means applying said signal pressure to said valve in the opposite direction, said valve moving in response to variations in said signal pressure to vary the fluid pressure in said outlet conduit and thereby causing said servo piston to adjust the pump delivery to maintain said motor running at constant speed.

2. A hydraulic constant speed unit as claimed in claim 1, wherein the flow control valve is mounted on one end of a pivoted beam subject at the other end to said hydraulic signal pressure and wherein said biasing means is a spring acting on said other end of the beam in opposition to said signal pressure.

3. A hydraulic constant speed unit as claimed in claim 2, comprising balancing means exerting on said first named end of the beam, a balancing pressure counteracting the pressure exerted on the flow control valve by the fluid in the outlet conduit.

4. A hydraulic constant speed unit as claimed in claim 3, wherein said balancing means comprises a pressure responsive device having faces of differential area and conduits exposing said faces of said responsive device to the fluid pressure in the discharge connection.

5. A hydraulic constant speed unit as claimed in claim 3, wherein said balancing means comprises a pressure responsive device having faces of differential area and conduits exposing said faces of said responsive device to the fluid pressure in the outlet conduit.

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