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[54] CONTROL APPARATUS FOR LIMITING THE POWER RECEIVED BY A PLURALITY OF ADJUSTABLE HYDRAULIC PUMPS

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[58] **Field of Search** 417/213, 216, 218, 222, 270, 417/280, 282, 286, 287, 293, 294, 426; 91/506

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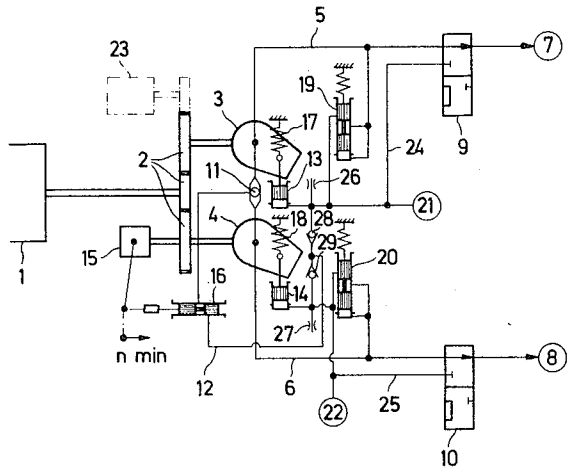
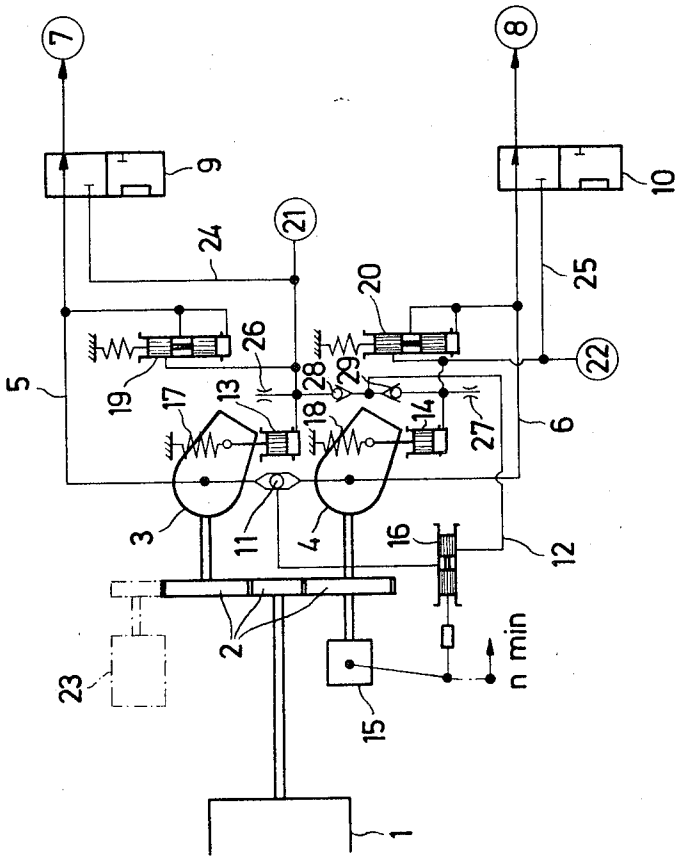
[57] **ABSTRACT**

Two pumps are driven by a prime mover and their delivery rate is controlled by a centrifugal governor which controls a valve. Upon a decrease in speed, the valve opens and the highest output pressure from the pumps is applied via individual nonreturn valves to actuate biased pistons for adjusting the pump rates.

4 Claims, 1 Drawing Figure





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CONTROL APPARATUS FOR LIMITING THE POWER RECEIVED BY A PLURALITY OF ADJUSTABLE HYDRAULIC PUMPS

FIELD OF THE INVENTION

The invention relates to a control apparatus for limiting the total power received by a plurality of adjustable hydraulic pumps driven by a prime mover which may be speed-regulated.

BACKGROUND OF THE INVENTION

It is known to provide control apparatus comprising a device which responds to the speed of the prime mover and acts on the adjusting device of an adjustable pump. The adjusting device can be influenced from outside for regulating the response thereof. The adjustment takes place by means of a control of the output pressure of the hydraulic pumps supplied through a control valve to a control pressure circuit so as to reduce the rate of delivery when the speed of the prime mover drops.

Such apparatus are intended to prevent the overloading of prime movers, such as speed-regulated prime movers, and nevertheless guarantee full utilization of the installed power capacity of the prime mover over as wide a range as possible.

In control apparatus intended for a single hydraulic pump, it is known to use a centrifugal governor to control the hydraulic pump driven by the internal combustion engine so as to reduce the output as soon as the load rises above the maximum output torque of the internal combustion engine.

It is also known to adjust double pumps jointly as soon as the total of the loads of the individual pumps exceeds the maximum output torque of the internal combustion engine driving the double pumps jointly. The operating pressures of the individual pumps acts on a common piston arrangement, preferably stepped pistons, which is a component part of the adjusting device, common to the double pumps. In this manner only a simultaneous adjustment of the double pumps by equal amounts is possible. This disadvantage is not obviated by an apparatus already proposed, wherein each delivery circuit is provided with a pressure regulator in order to provide individual control of the operating pressures. This has the disadvantage that if, for example, one of the pumps is set back to the zero position, the other pump cannot be supplied with the full power of the internal combustion engine, since the general design of the installation must be such that all the pumps driven by the same internal combustion engine can operate at maximum rate of delivery.

In the case of a control system for transmission units in motor vehicles, wherein each side of the vehicle is driven by the engine via a corresponding continuously variable transmission unit, it is known in response to overloading of the vehicle engine and/or the transmission unit to reduce the transmission ratios in the same proportion. This is effected by a control of adjustable hydraulic pumps in the transmission units by means of a control pressure circuit which brings about proportional adjustment of the hydraulic pumps through a mechanical linkage. Individual control of the hydraulic pumps is not possible.

OBJECTS AND SUMMARY OF THE INVENTION

The object of the invention is to improve a control apparatus of the type mentioned initially, wherein overloading of the prime mover is prevented, in such a manner that the power of the prime mover can be fully utilized in every operating state of the individual pumps.

This is achieved according to the invention in a control apparatus of the type mentioned initially by providing each pump with a corresponding adjusting means which is independent of that of the other pumps and may be of different design. A control valve is responsive to the speed-dependent device and is associated jointly with all the adjusting devices with the interposition of a nonreturn valve leading to an auxiliary control-pressure circuit. The adjusting means may comprise in a manner known per se a hydraulic piston responsive to the auxiliary control pressure and a biasing spring which may have a controllable characteristic.

In such apparatus, each pump can be adjusted independently of the others. If one of the pumps is set to have zero stroke, the full power of the prime mover can be supplied to the other pumps. Since the power taken from the prime mover is not controlled by the total outputs of the pumps but by the speed of the motor, the power actually available therefrom is taken into account, even if temporarily further units have to be driven by the same motor.

The invention makes it possible for pumps of different sizes to be driven simultaneously by the same prime mover with the use of one and the same control apparatus. Furthermore, if the adjusting means associated with the different pumps have different characteristics, it is possible to make one of the pumps respond first or to a higher degree when overloading of the prime mover occurs.

In an embodiment of the invention, individual valves for limiting the maximum delivery pressure are associated with the delivery circuits of the pumps so that each delivery pressure can be limited independently of the other circuits.

According to a further feature of the invention, the pressure in the control-pressure circuit is taken by way of a two-way or by way of nonreturn valves from the highest delivery pressure of the pumps at each moment. This removes the need for a special auxiliary feed pump for the control pressure circuit.

An embodiment of the invention is described hereinafter with reference to the drawing which shows diagrammatically a control apparatus for two pumps.

An internal combustion engine **1** by way of an intermediate gear **2** drives pumps **3** and **4**, which supply pressure oil through delivery conduits **5** and **6** to consumers **7** and **8**, which are independent of one another. The pumps can be cut off from the consumers by shutoff valves **9** and **10**. A two-way valve **11** connects the one of delivery conduits **5** and **6** having the higher pressure to a control valve **16** which supplies control-pressure oil by way of a conduit **12** and nonreturn valves **28, 29** to pump-adjusting means **13** and **14** in response to a centrifugal governor **15** driven by engine **1** through intermediate gear **2**. The adjusting characteristics of pumps **3** and **4** are determined by the design of return springs **17** and **18** of the adjusting means (**13, 17; 14, 18**). Furthermore, each circuit has its own maximum operating pressure determined by pressure valves **19** and **20**. At **21, 22**, control or regulating devices are connected which permit individual regulation of pump adjusting means **13, 14**. Shown in broken lines is an additional unit **23** coupled to intermediate gear **2** for reducing the power delivered by engine **1**, the control apparatus of the invention still protecting engine **1** from overload. The invention can also be used for pumps **3, 4** of different sizes and for more than two pumps.

The apparatus described operates as follows:

Engine **1** is kept by a speed governor (not shown) at about maximum speed, the governor increasing the supply of fuel as the load increases. If maximum power of engine **1** has been attained and the load increases further, the speed drops, governor **15** responds and operates valve **16** which opens control pressure circuit **12**. Adjusting means **13, 14** cuts down pumps **3** and **4** in accordance with the characteristics of return spring **17** and **18** to prevent overloading of engine **1**. When the load drops again, the speed rises and pumps **3, 4** are turned up again.

If consumer **7** is cut off from pump **3** by valve **9**, pump **3** actuates adjusting means **13, 17** by way of conduit **24** and sets it back owing to the dynamic pressure building up at the throttle **26** until the resulting pressure is in equilibrium with spring **17**. Throttle **26** is adjusted to make pump **3** return almost to zero position and deliver only leakage and lubricating oil at relatively low pressure. Since the total load on engine **1** has now decreased, the circuit **6** of pump **4** can take a correspondingly greater load before the control apparatus of the invention responds.

If both consumers 7 and 8 are cut off from pumps 3 and 4 by valves 9 and 10, both pumps 3 and 4 are cut down to approximately zero, the zero position of pump 4 being determined by the setting of throttle 27.

If the load of consumer 7 rises, the pressure in conduit 5 increases until it reaches the value set at pressure valve 19. On further increase, the pistons of pressure valve 19 are moved so as to connect conduit 5 with adjusting device 13 and cut down pump 3 as described hereinbefore.

Nonreturn valves 28, 29 are essential to the operation of the control apparatus, since they make possible regulation of adjusting means 13, 17; 14, 18 when centrifugal governor 15 responds without removing the possibility of individual and independent regulation of each pump in a desired manner, for example, by means of regulating and control devices 21, 22. The function of nonreturn valves 28, 29 would have to be taken over by throttle valves if the apparatus were so modified that with falling pressure on adjusting means 13, 14, the pumps are cut back to reduce the output.

What is claimed is:

1. The combination comprising a plurality of hydraulic pumps driven by a prime mover, each of said pumps having individual and independent means for adjusting the output thereof, said pumps being connected through hydraulic output circuits to a like number of energy-consuming devices whereby each of said devices is associated in an energy-receiving relation with a corresponding one of said pumps, hydraulic control circuits connected to said adjusting means, control means responsive to the speed of said prime mover, and a normally closed control valve interconnecting said control circuits and said output circuits, said control means being connected to said control valve, whereby said valve is opened by said control means when the speed of said prime mover falls below a predetermined value, and whereby said adjusting means are actuated to effect a reduction of pump output, said control valve being connected to said circuits through nonreturn valves arranged to permit flow from said output circuits to said control circuits.

2. Apparatus as claimed in claim 1, comprising valve means for limiting the pressure in at least one of said output circuits, said valve means being normally closed and interposed between said one output circuit and the control circuit of the pump associated with said one output circuit, said valve means including means responsive to the pressure of said one output circuit, whereby said valve means will open and actuate the control means of said associated pump to reduce the output of said associated pump when said pressure rises to a predetermined maximum.

3. Apparatus as claimed in claim 1, and wherein said nonreturn valves include a valve unit connected to the inlet of said control valve, said unit having a branch connection to each of said output circuits and including nonreturn means arranged to permit flow only in directions from each of said output circuits to said control valve, whereby when said control valve is in open position it will transmit pressure from that output circuit having the highest pressure.

4. Apparatus as claimed in claim 3, and wherein said nonreturn valves include a valve assembly connected to the outlet of said control valve, said assembly having a branch connection to each of said control circuits, and comprising nonreturn means arranged to permit flow only in directions to each of said control circuits from said control valve.

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