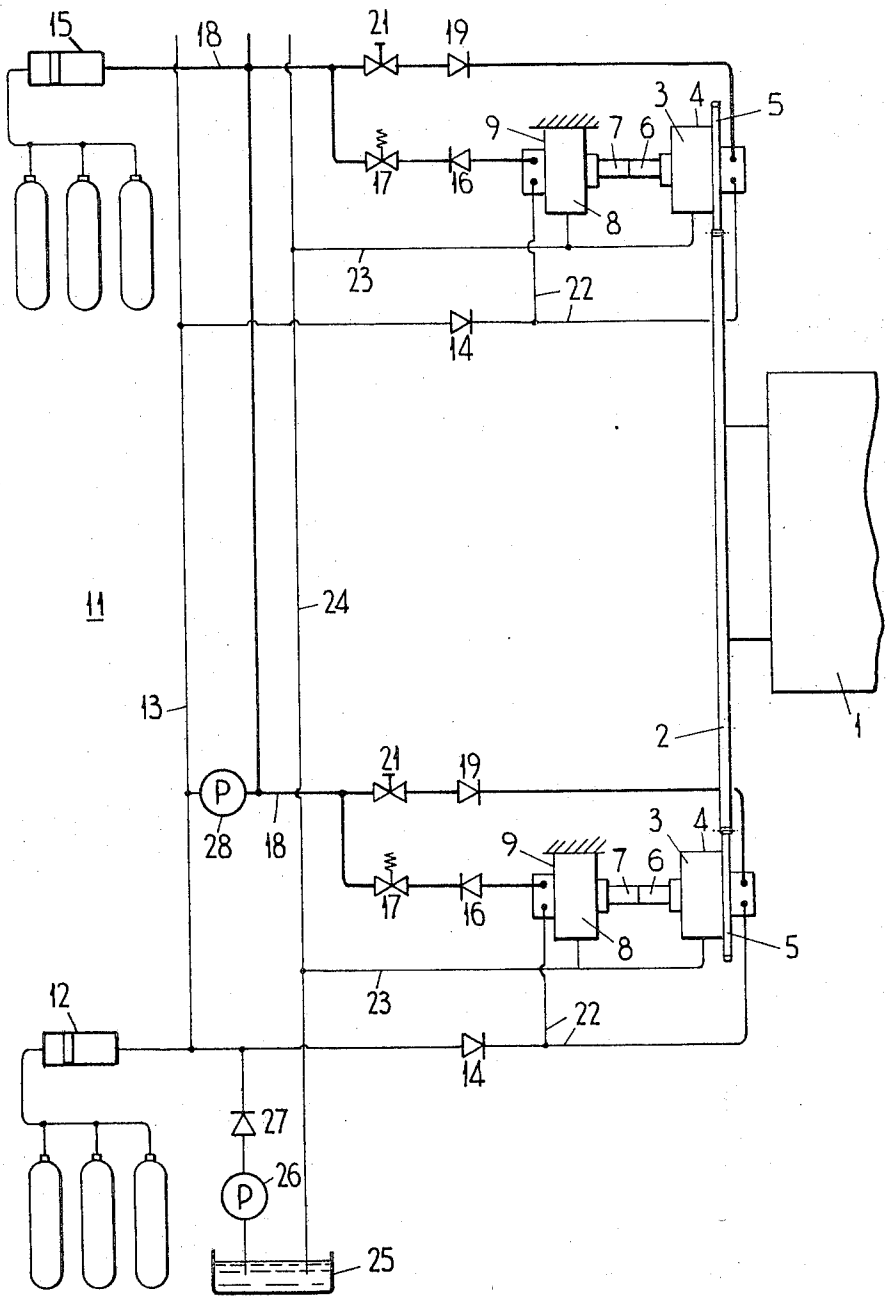
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VARIABLE SPEED DRIVES

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VARIABLE SPEED DRIVES

Alan Henry Butler, Orpington, England, assignor to The General Electric Company Limited, London, England

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This invention relates to a rotary output device, that is to say a motor unit or a pump unit of the kind having one member which rotates with respect to another when the device is operating to provide the required output, and relates also to arrangements incorporating such devices.

In the case of a pump the output is provided by the flow of fluid through the pump and in the case of a motor the output is provided by the power developed by the motor.

According to one aspect of the invention in a rotary output device of the kind having a first member which is rotatable with respect to a second member when the device is operating to provide a required output, the second member is itself mounted for rotation about an axis coincident with the axis of the first member, and means are provided for controlling the rotation of the second member so as to vary the output of the device.

Where the device is provided by a constant output speed motor, the invention provides a way of varying the effective output speed of the motor, and in the case of a pump having a first member designed to be rotated at a constant speed in use of the pump, the invention provides a way of controlling the rate of flow of fluid through the pump.

One particular application of the invention is in a winch arrangement of the kind which is adapted to be connected via a winch drum and cable to a load member which may fluctuate from time to time, said winch arrangement being controlled by a hydraulic fluid circuit.

According, therefore, to another aspect of the invention, in such a winch arrangement, the hydraulic fluid circuit includes a drive assembly comprising a hydraulic motor unit and a hydraulic pump unit, each unit having a pair of relatively rotatable members, one member of one unit being connected to one member of the other unit, and the other members of the units being connected between a fixed support and the winch drum in such a manner that in operation of the hydraulic fluid circuit, the motor unit provides a substantially constant torque to said drum, and any power in excess of that required to provide said substantially constant torque to the drum is used to drive the hydraulic pump, the unit which is connected to the winch drum providing the rotary output device in accordance with the first aspect of the invention.

It will be appreciated that with the hydraulic circuit described above the power provided by the motor is shared between the winch drum and the pump; however when the winch drum is stationary or rotating at a constant low speed due to the load member being steady, the constant torque to the drum is provided merely by the reaction between the pair of relatively rotatable members of the motor unit, and therefore substantially all of the power of the motor unit will be used to drive the pump. If now the load member fluctuates in a way which would tend to produce a slackening of the cable, and causes the winch drum to haul in cable, the power provided by the motor unit will be divided between the winch drum and pump unit, in a ratio which is dependent upon the amount of power required by the winch drum to correct for the fluctuation in the load member. Thus the output of the pump will be decreased. Similarly if the load member fluctuates in such a way that the cable acts on the winch drum to cause it to pay out cable, the drum rotation provides extra power over that provided by the motor unit and thus this extra power adds to the motor unit power to increase the output of the pump unit.

In one arrangement of motor and pump units, the hydraulic motor unit may have its casing and output shaft, constituting the pair of relatively rotatable members, connected to the winch drum and the input shaft of a hydraulic pump unit respectively, the pump casing being fixed.

In another arrangement, the hydraulic pump unit may have its input shaft and casing connected to the winch drum and the output shaft of the hydraulic motor unit respectively, the motor casing being fixed.

The hydraulic circuit may include a plurality of drive assemblies each comprising a hydraulic motor having a hydraulic pump associated therewith and each being similarly coupled to the winch drum, either directly or through suitable gearing.

The hydraulic fluid circuit may also be provided with a high-pressure and a low-pressure side.

It will be appreciated that suitable valves would also be provided in the hydraulic fluid circuit to ensure its correct working.

A further pump unit may be provided between the low-pressure and high-pressure sides of the circuit, the further pump being operable to make up efficiency losses in the circuit.

Each hydraulic motor and pump arrangement may be connected together through gearing or the motor and pump may be of different sizes to reduce efficiency losses in the circuit.

In order that the invention may be readily understood, one winch arrangement embodying the invention will now be described, by way of example, with reference to the accompanying drawing, which is a schematic diagram of the arrangement.

Referring to the drawing, the winch arrangement comprises a rotatable winch drum **1** which rigidly carries a spur gear **2** at one of its ends. A plurality of drive assemblies, each comprising a hydraulic motor **3** connected to a pump **8**, are mounted on a suitable support structure (not shown) and are disposed at equal intervals around the circumference of the spur gear **2** (only two assemblies being shown in the drawing for the sake of clarity). The motor casing **4** of each motor **3** rigidly carries a spur gear **5** which meshes with the spur gear **2**. The output shaft **6** of each motor **3** is directly coupled to the input shaft **7** of the pump **8** and the casing **9** of each pump is fixed to a suitable support structure (not shown). The hydraulic motors **3** and pumps **8** form part of a hydraulic fluid circuit, generally denoted **11** in which the high pressure lines have been shown thicker than the low pressure lines.

Referring now to the hydraulic circuit **11**, a low pressure accumulator **12** feeds the pump **8** from a common supply line **13** via non-return valves **14**. The pumps **8**, when operating, are arranged to feed fluid at high pressure to the high-pressure side of the circuit which includes a high pressure accumulator **15**, via non-return valves **16** and pressure relief valves **17**, and the high-pressure side of the circuit is arranged to feed the motors **3** through a high pressure line **18** via non-return valves **19**. A flow control valve **21** is provided in the line **18** between the accumulator **15** and each motor **3** to ensure a constant fluid input to the motors so that the motors provide a constant output torque and constant speed, and hence a constant power to the spur gear **2** of the winch drum **1**.

The spent pressure fluid from the motors **3** is fed back to the low pressure supply via lines **22** for recirculation through the pumps **8**, and any leakage of pressure fluid from the motors and pumps is fed via lines **23** and **24** to

a reservoir 25 where it is fed back to the low pressure supply via a pump 26 and a non-return valve 27. A further pump 28 is provided between the low pressure supply line 13 and the high pressure supply line 18 which is operable to make up for any efficiency losses in the high pressure circuit.

In operation of the winch arrangement when the load member is steady, the torque applied to the winch drum 1 by its cable is balanced out by the torque applied to the drum via the casings 4 of the hydraulic motors 3 via the spur gears 5 and 2. Thus the drum 1 and hence the motor casings 4 may be rotating at a low constant speed or may be at zero revolutions and therefore substantially no power is being used by the drum, but instead is being used to drive the pumps 8 in a constant direction at a substantially constant speed via the shafts 6 and 7 of the motors 3 and pumps 8 respectively.

If now the load member fluctuates and subjects the winch drum to an increased load, the drum accelerates in one rotational direction to unwind the cable, since the torque then applied to the winch drum by the cable exceeds the constant torque applied via the motors 3. The motor casings 4 will therefore be rotated in one direction by the winch drum. In this situation the direction of rotation of the shafts 6 of the motors 3 relatively to their motor casings 4 is the same as the direction of rotation of the motor casings 4 and therefore the speed of the pumps 8 is effectively increased. Thus additional power is supplied to the motors 3, this regenerative power being absorbed by the pumps 8 which supply an increased variable amount of high pressure fluid to the high-pressure side of the circuit depending on the speed of rotation of the motor casings 4, and the arrangement is such that the resisting torque of the pumps is constant with the result that a constant torque is applied through the motor casings 4 to the winch drum 1. Similarly, if the load member fluctuates to subject the winch drum 1 to a decrease in load, the drum accelerates in its other rotational direction to take up the slack in the cable, since the constant torque applied to the drum then exceeds that applied to the load member. The direction of rotation of the motor casings 4 is then in opposition to the direction of rotation of their shafts 6 and therefore the speed of the pumps 8 is effectively decreased. Thus the power of the motors 3 is being divided between the winch drum 1 and pumps 8 up to the limiting case where the total power of the motors 3 is being used to rotate the winch drum 1. This of course would mean that the pumps 8 would be rendered inoperative and the whole of the power was being absorbed by the drum.

It will be appreciated that the motor and pump arrangements could be mounted within the winch drum if desired and that the shafts 6 and 7 of the motors and pumps could be coupled together through gearing or other suitable means to provide a ratio between the motors and pumps or the motor and pump units could be of different capacities to assist the further pump 28 in making up for efficiency losses in the hydraulic circuit, in which case the capacity of the further pump 28 could be decreased. Also the positions of the hydraulic motor and pump units could be changed so that the pump unit was connected between the motor and the winch drum. With the pump unit between the motor and winch drum, if the pump casing was connected to the output from the motor then under steady conditions of the load member the input shaft of the pump connected to the winch drum would be stationary and the pump casing would be rotating at the speed of the motor. If now the load member fluctuated the winch drum would cause the input shaft of the pump to rotate in one direction or the other but would not affect the speed of the pump casing. Thus, the only inertia to overcome in such an arrangement would be that of the pump input shaft.

I claim:

1. A winch arrangement comprising a fixed support, a winch drum mounted on the fixed support, a support cable wound on said winch drum and connectable to a load member which may fluctuate from time to time, and a hydraulic fluid circuit for controlling the winch drum, said hydraulic fluid circuit including at least one drive assembly which comprises a hydraulic motor unit having a pair of relatively rotatable members and a hydraulic pump unit also having a pair of relatively rotatable members, one member of one unit being connected to one member of the other unit and the other members of the units being connected between the fixed support and the winch drum so that in operation of the hydraulic fluid circuit, the motor unit provides a substantially constant torque to said drum, and any power in excess of that required to provide said substantially constant torque to the drum is used to drive the hydraulic pump.

2. A winch arrangement as claimed in claim 1, in which the hydraulic motor unit comprises a casing and an output shaft, and the hydraulic pump unit comprises a casing and an input shaft, said casing and shaft in each case constituting the pair of relatively rotatable members, and the casing and output shaft of the hydraulic motor unit are connected to the winch drum and input shaft of the hydraulic pump unit, respectively, the pump casing being fixed on said fixed support.

3. A winch arrangement as claimed in claim 1, in which the hydraulic motor unit comprises a casing and an output shaft and the pump unit comprises a casing and input shaft, said casing and shaft in each case constituting the pair of relatively rotatable members, and the hydraulic pump unit has its input shaft and casing connected to the winch drum and the output shaft of the hydraulic motor unit, respectively, the motor casing being fixed.

4. A winch arrangement as claimed in claim 1, in which the hydraulic fluid circuit includes a plurality of drive assemblies each comprising a hydraulic motor having a hydraulic pump associated therewith and each being similarly coupled to the winch drum, either directly or through suitable gearing.

5. A winch arrangement as claimed in claim 4, in which the hydraulic fluid circuit is provided with a high-pressure and a low-pressure side.

6. A winch arrangement as claimed in claim 4, in which a further pump unit is provided between the low-pressure and high-pressure sides of the circuit, the further pump being operable to make up efficiency losses in the circuit.

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EVON C. BLUNK, *Primary Examiner.*
H. C. HORNSBY, *Assistant Examiner.*