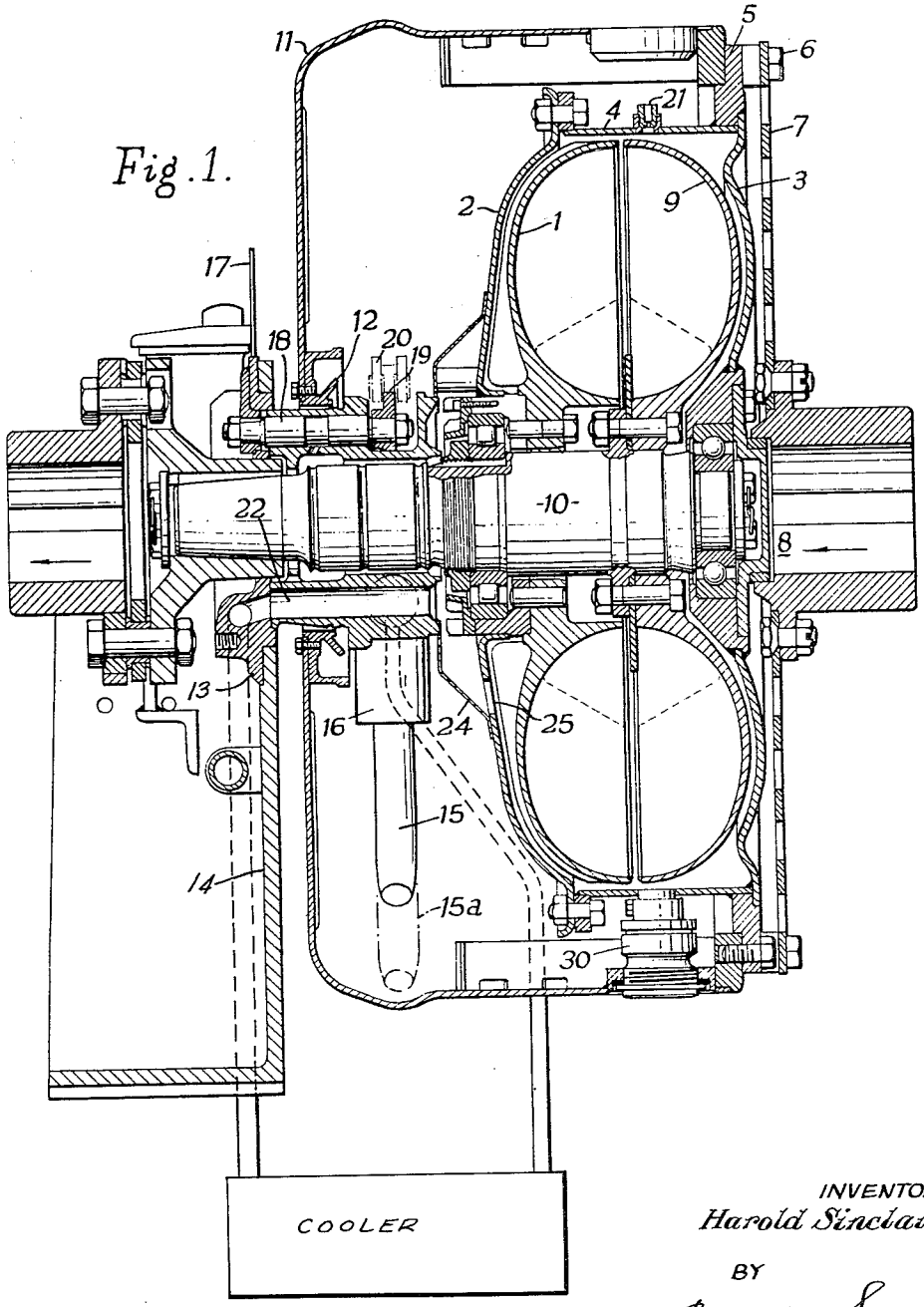
Oct. 25, 1960 H. SINCLAIR 2,957,312

HYDRAULIC TURBO COUPLINGS

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Fig. 1.



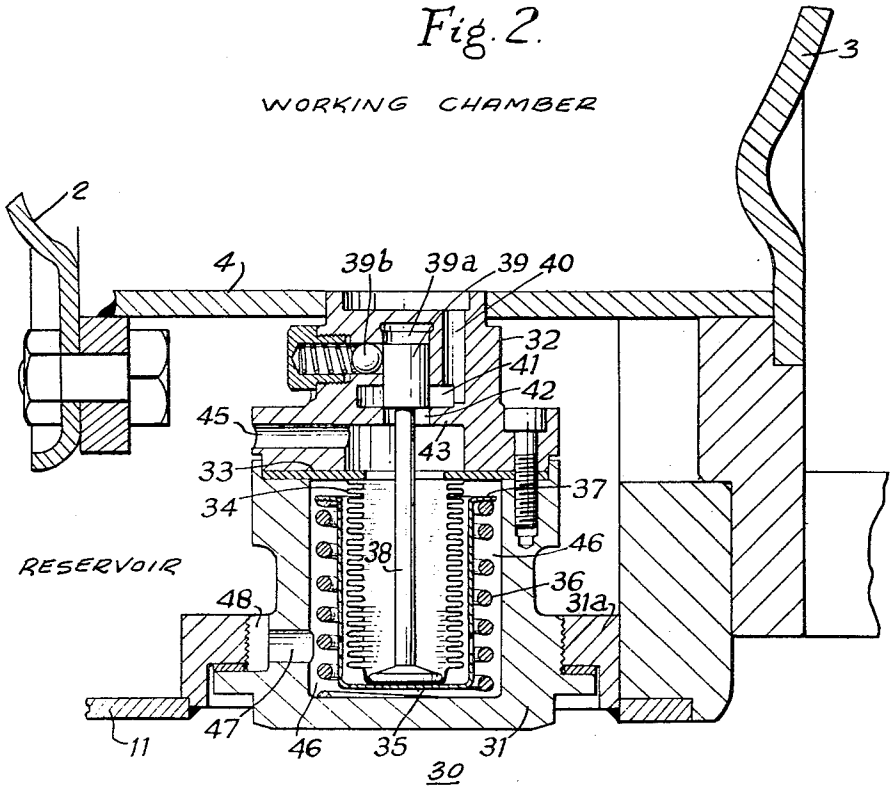
INVENTOR
Harold Sinclair
BY
Benjamin Sweedler
ATTORNEY

Oct. 25, 1960 H. SINCLAIR 2,957,312

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Fig. 2.



INVENTOR
Harold Sinclair
BY
Benjamin Sweedler
ATTORNEY

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HYDRAULIC TURBO COUPLINGS

Harold Sinclair, Magnolia House, 4, Clarence Crescent, Windsor, England

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5 Claims. (Cl. 60—54)

This invention relates to hydraulic turbo couplings of the Fottinger type comprising vaned impeller and runner elements in which provision is made for varying the degree of filling of the working circuit whereby to vary the torque-transmitting capability of the coupling and therewith the slip in the coupling, and in which during operation of the coupling there is flow of working liquid from the working circuit through restricted ports.

In one form of coupling of this type, the liquid flows through said ports to a rotatable reservoir chamber in which is provided an adjustable scoop tube that serves to return liquid from the reservoir chamber via a cooler to the working circuit, and the adjustment of which scoop determines the degree of filling of the working circuit.

In another coupling of the said type a fixed scoop tube provided in a scoop tube chamber serves to return working liquid via an external fixed reservoir to the working circuit, the degree of filling of which is determined by the setting of an adjustable weir or liquid-displacing member associated with a fixed weir in a gravity tank, or by the adjustment of an adjustable weir type suction nozzle associated with a filling pump situated in a sump.

In such couplings the rate of flow of liquid from the working circuit, through the restricted ports, varies at any given coupling speed in according with the pressure acting on the liquid, being dependent inter alia upon the quantity of liquid in the working circuit. When the centrifugal weight is high, as when the working circuit is full, the pressure therein is high, and there is a higher rate of flow through the said ports than there is when the centrifugal weight is lower, as when the working circuit is substantially or partly empty.

The circulation of liquid between the working circuit and the reservoir chamber therefore increases when the filling of the working circuit is increased, and decreases when the filling is decreased. This however is the opposite of what is required for the purpose of cooling the working liquid since when driving a load having a constant torque characteristic more heat is generated when the working circuit is only partly full than when the working circuit is full, due to the much higher slip in the partly filled working circuit. The object of the invention is to provide a coupling of the type referred to, in which this disadvantage is reduced or overcome.

According to the invention, automatically operated valve means are provided for increasing the effective flow area through said ports as the degree of filling of the working chamber decreases, and vice versa. If the coupling is of the form in which a rotatable reservoir chamber with an adjustable scoop tube therein is provided, the effective flow area through said ports may be controlled in dependence on the degree of filling of the rotatable reservoir chamber, which varies in the opposite sense to the filling of the working chamber.

The said valve may be arranged to be actuated by a pressure-responsive device, e.g. a bellows or diaphragm, responsive to change in pressure consequent upon change in the degree of filling of the working chamber, whereby the effective area of the restricted ports is increased when the liquid pressure within the working chamber decreases due to a reduction in the degree of filling of the working chamber, and vice versa.

In another form of the invention said valve means may be arranged to be actuated by a change in the relative dimensions of parts of the coupling. Such change in relative dimensions may result from a change in pressure due to a changed degree of filling of the working chamber, or of the rotatable reservoir chamber where provided. The change in relative dimensions may alternatively or additionally be arranged to result from a change in temperature of said parts, where the flow area of the ports is increased in response to a rise in temperature and vice versa.

The said valves may be arranged always to be open to some extent so as to permit the required restricted flow of working liquid from the working circuit. It is however feasible to employ valves that are closed for a large filling of the working circuit and which open progressively as the degree of filling is reduced, the ports controlled by said valves being additional to ports of restricted area that are continuously open. An example of this last-mentioned arrangement will now be described in detail with reference to the accompanying drawings, Figure 1 of which shows a turbo coupling according to the invention in sectional elevation, and Figure 2 of which is a sectional view of a valve, on a larger scale than Figure 1.

Referring to the drawing, the hydraulic turbo coupling illustrated comprises a vaned impeller 1 bolted to an inner casing comprising end parts 2 and 3 and a cylindrical part 4, the wall 3 being connected via a ring 5 and bolts 6 to the periphery of a driving plate 7 the inner periphery of which is bolted to a flange on an input shaft 8. A vaned runner 9 is bolted to a flange on an output shaft 10 which is journalled within the hubs of the walls 2 and 3 of the inner casing. A reservoir casing 11 is fixed at its edge to the ring 5, so as to be rotatable with the driving plate 7 and impeller 1, a labyrinth oil seal 12 being provided between the inner periphery of the reservoir casing 11 and a stationary scoop tube manifold 13 supported by a bracket 14. Within the reservoir 11 is a scoop tube 15 movable longiudinally in a guide 16 and operable by means of a lever 17 carried by a pin 18 that projects through the manifold and is operatively connected to the scoop tube 15, in conventional manner, by levers 19 and 20.

The inner casing is provided with, say, three restricted nozzles 21 uniformly spaced around the inner casing, so that during the operation of the coupling working liquid flows from the working circuit within the inner casing, through the nozzles 21 to the reservoir casing 11 where it forms a ring of liquid adjacent the cylindrical outer wall of the reservoir casing. The scoop tube picks up liquid from the said ring and transfers it via a duct (shown in Fig. 1) in the manifold to a cooler (shown in Fig. 1) where it returns via a further duct 22 to the interior of a casing 24 and thence via ports 25 to the working circuit.

The turbo coupling as so far described is of known construction. During its normal operation there is a continuous flow of working liquid out of the working circuit via the restricted nozzles 21 and a continuous flow back to the working circuit via the ports 25. Adjustment of the scoop tube by means of the lever 17 changes the distance of the scooping lip of the scoop tube from the periphery of the reservoir casing and so

changes the thickness of the ring of oil in the reservoir casing, so as to change the degree of filling of the working circuit.

The centrifugal pressure of the liquid within the casing 2, 3, 4 varies with the degree of filling of the working circuit. This pressure is greatest when the filling of the working circuit is a maximum and decreases as the degree of filling of the working circuit decreases, so that correspondingly the rate of flow of liquid through the restricted nozzles 21 then decreases.

In order to remedy this basic shortcoming of turbo couplings having such restricted nozzles, and in accordance with the invention in one aspect, the inner casing is provided with one or more valves which are responsive to the centrifugal pressure of the liquid in the rotatable reservoir casing, so that the flow area through the valve or valves increases as the degree of filling of the working circuit is decreased.

One of the said valves is shown in elevation at 30 at the lower part of Figure 1, and in section on a larger scale in Fig. 2, which illustrates the valve in the operating condition at normal speed of rotation with the working chamber filled and the reservoir chamber 11 almost empty. The valve 30 comprises a housing 31 which is screwed into a ring 31*a* welded into a circular hole formed in the reservoir casing 11. Between the inner open end of the housing 31 and a valve body 32 bolted thereto is clamped a flat ring 33 to which is secured in fluid-tight manner, by high temperature solder, one end of a bellows 34, the other end of which is closed. A compression spring 36 is provided between the outer end of the housing 31 and a flange 37 on a cap 35, which applies the force of the spring 36 tending to contract the bellows 34. The outer end of the stem 38 of the piston valve 39 is flattened to form a bearing surface to transmit the centrifugal load on the valve 39 to the closed end of the bellows 34 and the cap 35 and thence to the spring 36. The valve 39 slides in a cylindrical recess 39*a* in the valve body 32. A duct 40 provides communication between the interior of the inner casing and a space 41, which when the piston 39 is in a radially inner position with respect to the position shown, communicates with the interior of the rotatable reservoir 11 of the coupling via an opening 42 in a wall 43 of the valve body 32 and a duct 45. The space between the wall 43 and the ring 33 is in permanent communication with the interior of the bellows 34, which remains continuously filled with liquid while the coupling is in operation. The space 46 between the cap 35 and the housing 31 is in permanent communication via ducts 47 and 48 with the outer ring of liquid in the reservoir 11.

In the normal operation of the coupling, the scoop tube is fully inserted into the reservoir 11 as shown in broken lines at 15*a* (Fig. 1), so that the working circuit is full and the reservoir 11 is almost empty, there being in the reservoir only the thin residual ring of oil produced by leakage through the restricted nozzles 21. The pressure of the liquid in this ring is communicated to the space 46, and since this pressure is low, the centrifugal weight of the valve members 38, 39, the liquid within the bellows, also the weight of the cap 35 maintains the piston valve 39 in its radially outermost position, as shown in Fig. 2, in which it closes the opening 42 and no liquid can flow from the working circuit through the valve elements 39 and 42.

When the scoop tube 15 is retracted say half-way, the ring of liquid in the reservoir chamber 11 thickens, with a corresponding decrease in the quantity of liquid in the working circuit. The centrifugal pressure tending to force liquid through the nozzles 21 is thus reduced, and the rate of flow through these nozzles falls. However, the centrifugal pressure of the thicker ring of liquid in the reservoir chamber 11 results in an increased pressure in the space 46, so that the bellows 34 is compressed and the piston 39 is moved radially inwards, away from the opening 42. Liquid can now flow from the working circuit to the reservoir chamber 11 not only through the permanently open nozzles 21 but also through the valves 30 via the path 40, 41, 42 and 45, so that with appropriate design of the valve elements 39 and 42 and bellows 34 and selection of the spring 36 the total rate of flow is greater than before, notwithstanding the decreased pressure of the liquid in the working circuit. When the scoop tube is further retracted the piston 39 opens further, thus increasing or substantially maintaining the increased rate of circulation of liquid between the working circuit and the reservoir 11.

If desired the valves 30 may be arranged to be slightly open even with the scoop tube fully inserted, so that working liquid flows at all times through the valves 30, and the nozzles 21 can be eliminated.

If desired the movement of the piston valve 39 may be damped, e.g., by frictional means, such as a spring loaded ball 39*b* bearing on the piston valve.

I claim:

1. A hydraulic turbo coupling comprising vaned impeller and runner elements defining a working circuit, means for varying the degree of filling of the working circuit independently of the speed of said impeller element to vary the torque-transmitting capability obtainable at each impeller speed, means for supplying working liquid continuously to said working circuit during operation of the coupling, restricted ports communicating with said working circuit through which ports during operation of the coupling working liquid flows continuously from the working circuit, and means operable in response to changes in the degree of filling of the working circuit to increase the restricted flow of working liquid from said working circuit as the degree of filling of the working circuit decreases and to decrease the restricted flow of working liquid from said working circuit as the degree of filling of the working circuit increases.

2. A hydraulic turbo coupling according to claim 1 wherein said means operative in response to changes in the degree of filling of the working circuit is a valve which is supplementary to said restricted ports and wherein said restricted ports are of constant flow area.

3. A hydraulic turbo coupling comprising vaned impeller and runner elements defining a working circuit, means for varying the degree of filling of the working circuit independently of the speed of said impeller element to vary the torque-transmitting capability obtainable at each impeller speed, means for supplying working liquid continuously to said working circuit during operation of the coupling, restricted ports communicating with said working circuit through which ports during operation of the coupling working liquid flows continuously from the working circuit, a rotatable reservoir chamber for receiving working liquid from said working circuit, and means operative in response to the pressure of the liquid in said rotatable reservoir chamber to increase the restricted flow of working liquid from said working circuit as the degree of filling of the working circuit decreases and to decrease the restricted flow of working liquid from said working circuit as the degree of filling of the working circuit increases.

4. A hydraulic turbo coupling comprising vaned impeller and runner elements defining a working circuit, means for varying the degree of filling of the working circuit independently of the speed of said impeller element to vary the torque-transmitting capability obtainable at each impeller speed, means for supplying working liquid continuously to said working circuit during operation of the coupling, restricted ports communicating with said working circuit through which ports during operation of the coupling working liquid flows continuously from the working circuit, and means for increasing the restricted flow of working liquid from said working circuit as the degree of filling of the working circuit decreases, said last mentioned means being also operative to decrease the restricted flow of working liquid from said working circuit

as the degree of filling of the working circuit increases.

5. A hydraulic turbo coupling comprising vaned impeller and runner elements defining a working circuit, means for varying the degree of filling of the working circuit independently of the speed of said impeller element to vary the torque-transmitting capability obtainable at each impeller speed, means for supplying working liquid continuously to said working circuit during operation of the coupling, restricted ports communicating with said working circuit through which ports during operation of the coupling working liquid flows continuously from the working circuit, a rotatable reservoir chamber for receiving working liquid from said working circuit, and means

operative in response to the quantity of liquid in said rotatable reservoir chamber to increase the restricted flow of working liquid from said working circuit as the degree of filling of the working circuit decreases and to decrease the restricted flow of working liquid from said working circuit as the degree of filling of the working circuit increases.

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