April 29, 1947. H. SINCLAIR 2,419,919

TURBINE TYPE DUAL HYDRAULIC COUPLING

Filed Feb. 4, 1944 2 Sheets-Sheet 1

Fig. 1.

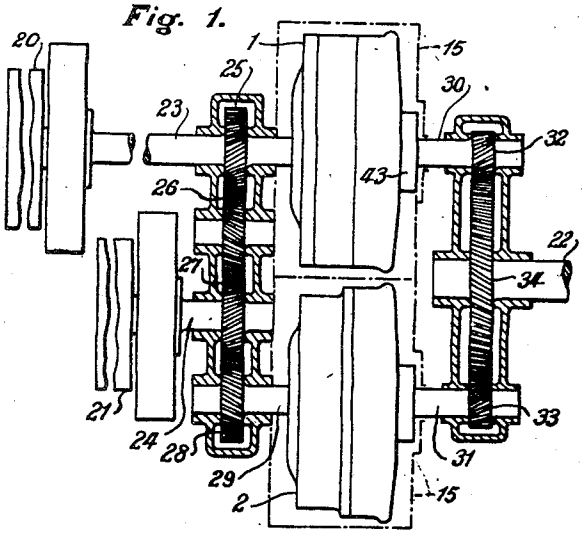


Fig. 4.

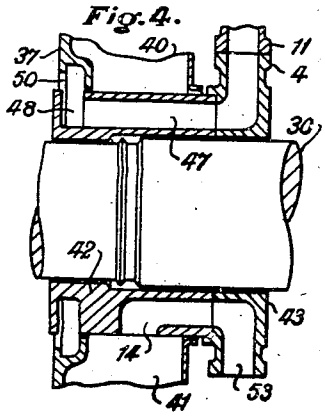


Fig. 3.

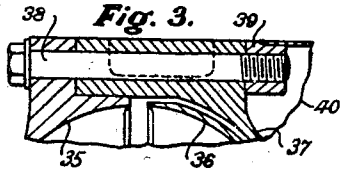


Fig. 2.

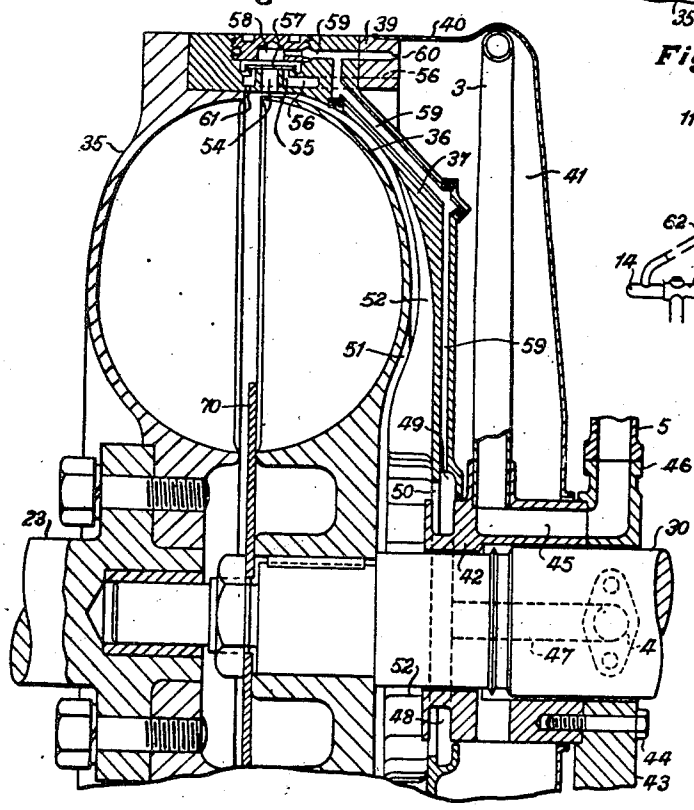
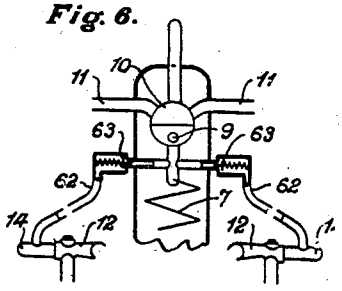


Fig. 6.



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TURBINE TYPE DUAL HYDRAULIC COUPLING

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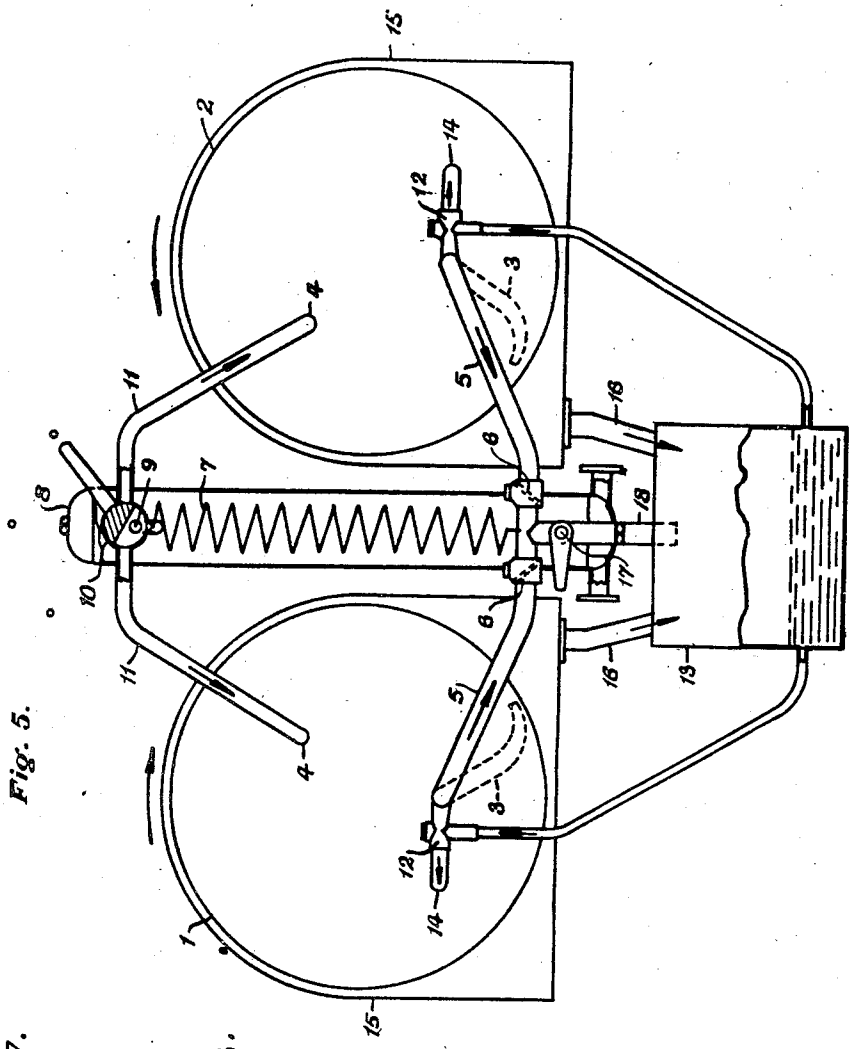
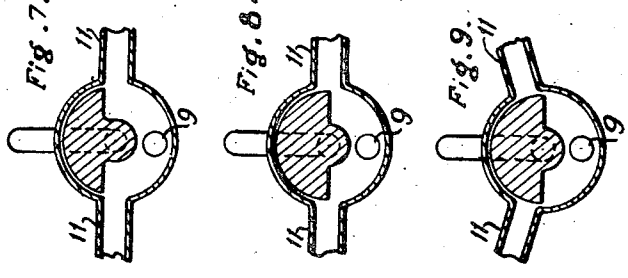


Fig. 5.



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TURBINE TYPE DUAL HYDRAULIC COUPLING

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This invention relates to reversing gearing, selecting gearing or change-speed gearing of the kind including two hydraulic couplings arranged respectively in two alternative power-transmission paths of the gearing and provided with control means operable for varying their liquid content for the purpose of establishing one or other of the alternative power paths. An example of such a gearing is disclosed in my United States Patent No. 1,768,938.

An object of this invention is to provide an improved arrangement of this kind, which is relatively simple in design and easy to control.

A further object is to enable such an arrangement to be provided in which the hydraulic couplings are of compact design and the total quantity of working liquid required is relatively small.

Another object is to allow either of the couplings to be rapidly filled when desired, so as to enable a selected power path to be established with only a short delay.

Another object is to enable the output element of the gearing to be driven in either direction at speeds below that corresponding to the speed of the input element.

Another object is to provide for the cooling of the working liquid under any desired conditions of operation.

Another object is to enable, where couplings which do not have pressure-tight glands are used, liquid that drains from the couplings when the gearing is stationary to be returned to the couplings without the aid of a separate pump.

According to this invention, each of said hydraulic couplings is provided with a liquid transfer chamber separate from its working chamber, and arranged to rotate with the driving element of the coupling, means employing the energy of motion of liquid in the working chamber for transferring liquid therefrom to said transfer chamber, and a scoop in said transfer chamber; the delivery duct of each scoop is adapted to supply two filling ducts branching to the respective working circuits of the two couplings; and valve means are provided operable for alternatively throttling or closing said filling ducts. The scoops may be fixed, said valve means being adapted, when in a neutral condition, to throttle or interrupt the flow of liquid through both of the filling ducts simultaneously to such an extent that a substantial part of the liquid discharged from the working circuits is retained in the transfer chambers.

In applying the improved arrangement to marine reversing gearing, for example, where diameter and length are limited, the effective capacity of each transfer chamber need not be more than one-quarter of the normal maximum liquid content of the working chamber (namely the liquid content that gives minimum slip at normal speed and load).

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A common cooler may be arranged to cool the working liquid from either coupling.

An embodiment of the invention as applied to marine reversing gearing will be described by way of example with reference to the accompanying diagrammatic drawings in which:

Fig. 1 is a plan, partly in section, of only the main elements of the marine power plant,

Fig. 2 is a longitudinal section of part of one of the hydraulic couplings appearing in Fig. 1,

Fig. 3 is a longitudinal section of a detail of the same coupling, the section plane being circumferentially displaced from that of Fig. 2,

Fig. 4 is a longitudinal section of another detail, the section plane being at right angles to that of Fig. 2,

Fig. 5 is a hydraulic circuit diagram of the couplings appearing in Fig. 1,

Fig. 6 shows a modification of part of Fig. 5, and

Figs. 7, 8 and 9 are sections of three alternative arrangements of a control valve.

Referring to Fig. 1, two motors 20 and 21 are arranged to drive a single propeller shaft 22 through combined drive-uniting and reversing gearing having two input shafts 23 and 24 directly coupled to the motors. A gear-wheel 25 fast on the shaft 23 meshes with an idler wheel 26 which in turn meshes with a gear-wheel 27 fast on the shaft 24. Shaft 23 forms the driving element of a forward-drive hydraulic coupling 1; and wheel 27 is in mesh with a wheel 28 fast on a shaft 29 which is the driving element of a reverse-drive hydraulic coupling 2. The output shafts 30 and 31 of these hydraulic couplings are fast respectively with pinions 32 and 33 which mesh with a gear-wheel 34 fast on the propeller shaft 22. Wheels 25, 27 and 28 are of the same diameter. It will thus be apparent that the two motors rotate in the same direction, while the driving elements of the two hydraulic couplings rotate at equal speeds in opposite directions, so that the propeller shaft can be reversed by emptying one of the couplings and filling the other.

These couplings are basically of the type shown in Fig. 1 of the specification of my Patent No. 1,859,607. Figs. 2, 3 and 4 show the ahead coupling 1. A vaned impeller 35 is fixed to the driving

shaft 23, and a vaned runner 36 is fixed to the output shaft 30. A dished inner shell 37 is fastened by bolts, such as 38 (Fig. 3), to the impeller, forming therewith a working chamber for coupling liquid. The bolts 38 are screwed into a ring 39 to which is welded the flange of an outer drum-shaped shell 40, spaced from the inner shell 37 to form a liquid-transfer chamber 41. Since in this embodiment the diameter and length of the coupling are limited by the need for saving space, the effective capacity of the transfer chamber for receiving liquid discharged centrifugally from the working chamber is only about one-quarter of the normal maximum liquid content of the working chamber. A manifold sleeve 42 surrounds part of the output shaft 30, being fixed to a stationary bracket 43 by screws such as 44. A stationary scoop tube 3 is mounted on the sleeve 42 with its mouth near the periphery of the shell 40, and this tube communicates by a delivery passage 45 with a pipe connection 46 on the bracket 43.

An inlet pipe connection 4 on the bracket 43, communicates by a passage 47 with a circumferential groove 48 in the sleeve 42. This groove registers with a channel 49 formed in the boss of the inner shell 37. The inner wall of this channel is spaced farther from the sleeve 42 than is the outer wall so as to leave an annular gap 50 through which liquid can overflow from the channel into the space 51 between the shell 37 and the back of the runner 36 and so enter the working circuit through the gap between the impeller and the runner, being assisted by vanes 52 on the interior of the shell 37.

A second inlet pipe connection 53 on the bracket 43 communicates with a passage 14 in the sleeve 42 opening directly into the liquid-transfer chamber 41.

The coupling is provided with a plurality of uniformly distributed automatic valves housed in the shell 37 for rapidly exhausting liquid from the working chamber to the liquid-transfer chamber 41. Each of these valves has a radial port 54 leading from the working chamber and surrounded by an annular port 55 communicating by a passage 56 with the transfer chamber 41. A disk 57 is adapted to seat over these ports and seal them under the influence of liquid pressure developed in a chamber 58 by centrifugal force acting on a column of liquid contained in a duct 59 leading from the channel 49 to the chamber 58. A restricted leakage nozzle 60 branches from the radially outermost part of the duct 59 and opens to the transfer chamber 41. A restricted port 61 leads directly from the working chamber to the transfer chamber through the passage 56. A baffle 70 of known type is fixed to the hub of the runner.

In operation, as long as liquid is supplied to the coupling through the inlet passage 47, the radial ducts 59 are kept filled and the valves 57 are held by the liquid pressure on their seatings, closing the ports 54. The incoming liquid overflows from the channel 49 and is forced into the working circuit by the vanes 52. A relatively small flow of liquid escapes continuously through the ports 61 to the transfer chamber 41, so as to enable hot oil in the working circuit to be replaced by incoming cool oil. When the supply through the inlet passage 47 ceases, the liquid in the radial ducts 59 escapes to the transfer chamber by the leaks 60 with the result that the valves 57 open and allow the working chamber

to exhaust rapidly to the transfer chamber through the passage 56.

The astern coupling 2 is similar to the ahead coupling 1 except that the scoop faces the other way and the working circuit is slightly smaller, so as to reduce windage losses in normal running. The transfer chambers of the two couplings are however, of the same diameter and the two scoops are arranged to scoop at the same radius.

Referring now to Fig. 5, the scoops 3 of both couplings deliver liquid through pipes 5 and non-return valves 6 to the coil 7 of a cooler 8. The cooler outlet 9 connects through a 2-way control valve 10 (Fig. 7) and two pipes 11 to the inlet connections 4.

When the coupling impellers are rotating in the directions shown by the arrows and the control valve 10 is set to neutral, owing to the similarity of the two transfer chambers and scoops, the liquid divides about equally between the two couplings and the quantity in the working circuit of each is so reduced that when the motors are idling with the propeller stationary the torque is balanced, the power consumption under this condition being unimportant. The circulation is maintained through the ports 61, the scoops 3 and the cooler which keeps the temperature-rise down to normal.

When the control valve is moved to "ahead," the pumping action of both scoops together quickly fills the ahead coupling 1. When the astern coupling empties, its non-return valve 6 closes and the coupling runs empty. Similarly, when the control valve is moved from "ahead" to "astern," the ahead coupling 1 rapidly empties and transfers its contents to the astern coupling 2.

Each scoop 3 is also arranged to feed an ejector 12 which can suck liquid from a sump 13 and deliver it to the transfer chamber by the passage 14. Each coupling is housed in a casing 15 connected by a drain 16 to the sump 13. A normally closed dumping valve 17 is provided in a branch 18 leading from the inlet end of the cooler coil 7 to the sump.

For shutting down, the control valve 10 is set to neutral. When standing each coupling retains about one-third of the working quantity of oil, hence one-third drains to the sump 13, through the clearance spaces between the sleeves 45 and the shells 40 and the shafts 30 and 31.

On starting and warming up the engines, each scoop 3 develops pressure which operates its ejector 12 and sucks up oil from the sump, hence each coupling shortly contains 50% of the total oil and is ready for service. If the engines are started up without prior warming there is enough oil to charge one coupling sufficiently to attain immediately somewhere about two-thirds of normal speed of the propeller while the ejectors soon complete the filling operation.

The system is self-contained, being independent of any auxiliary oil pump for starting, stopping and manoeuvring. In emergency, the oil can be transferred quickly to the sump by operating the dumping valve 17, e. g. in case of engine trouble. A hand pump may be used for initial charging of couplings sufficient to prime the ejectors when the engines are re-started, after an emergency shut-down.

The control valve 10 may be arranged as shown in Fig. 8, so that, when in its neutral position, the flow to each of the pipes 11 is throttled to such an extent that a ring of liquid builds up in the liq-

uid-transfer chambers owing to the back pressure on the scoops. In this way the quantity of liquid in the working circuits of the couplings is substantially reduced when these couplings are required to operate under stalling conditions. Alternatively the control valve 10 may be modified, as shown in Figs. 6 and 9, so that when it is in the mid position no liquid can flow to either pipe 11. In order to maintain a cooling circulation in this case, one or two restricted by-pass circuits may branch from the cooler outlet, in front of the control valve, and lead to one or both of the liquid-transfer chambers of the couplings. As shown in Fig. 6, two branch pipes 62, each provided with a spring-loaded non-return valve 63, lead from the cooler outlet to the two inlet connections 14 respectively of the two couplings.

I claim:

1. Power-transmission gearing providing two alternative power-transmission paths each including a hydraulic coupling of the kinetic type provided with a vaned driving element, a liquid-transfer chamber which is separate from its working chamber and which is arranged to rotate with said driving element, said working chamber having means employing the energy of motion of liquid therein for transferring liquid therefrom to said transfer chamber, a scoop in said transfer chamber, means for holding said scoop stationary when it is operating, and inlet means for delivering liquid into said working chamber, the gearing also including two delivery ducts leading from said scoops respectively and capable of supplying two filling ducts branching to said two inlet means respectively, and valve means operable for alternatively throttling said filling ducts.

2. Power-transmission gearing providing two alternative power-transmission paths each including a hydraulic coupling of the kinetic type provided with a vaned driving element, a liquid-transfer chamber which is separate from its working chamber and which is arranged to rotate with said driving element, said working chamber having means employing the energy of motion of liquid therein for transferring liquid therefrom to said transfer chamber, a fixed scoop in said transfer chamber, and inlet means for delivering liquid into said working chamber, the gearing also including two delivery ducts leading from said scoops respectively and capable of supplying two filling ducts branching to said two inlet means respectively, and valve means operable when in a neutral condition to throttle the flow of liquid through both of said filling ducts simultaneously to such an extent that a substantial part of the liquid discharged from said working circuits is retained in said transfer chambers, said valve means also being capable of throttling either of said filling ducts while leaving the other of said filling ducts unthrottled.

3. Power-transmission gearing providing two alternative power-transmission paths each including a hydraulic coupling of the kinetic type provided with a vaned driving element, a working chamber and a liquid-transfer chamber capable of storing liquid while causing it to rotate with said driving element, said working chamber having means employing the energy of motion of liquid therein for transferring liquid therefrom to said transfer chamber, and inlet means for delivering liquid to said working chamber, the gearing also including a scoop in each of said liquid-transfer chambers and restrained from rotating while scooping, and control means operable for delivering liquid discharge from both of said scoops selectively to either of said inlet means by virtue of the energy of motion of the liquid in said liquid-transfer chambers.

4. Power-transmission gearing providing two alternative power-transmission paths each including a hydraulic coupling of the kinetic type provided with a vaned driving element, a vaned driven element, an inner shell covering the back of said driven element and fixed to said driving element so as to form therewith a working chamber, an outer shell constrained to rotate with said driving element and co-operating with said inner shell to form a liquid-transfer chamber, the partition between said chambers having a port for exhausting liquid from said working chamber by virtue of its energy of motion, a driven shaft penetrating both of said shells, a fixed sleeve surrounding said shaft and penetrating both of said shells, and a scoop on said sleeve in said transfer chamber, said sleeve having a delivery duct leading from said scoop to the outside of the coupling and a filling duct leading from the outside of the coupling to the interior of said working chamber, the gearing also including a sump arranged to collect surplus liquid that leaks along said sleeves when the gearing is at rest, two delivery ducts leading from said scoops respectively and each capable of supplying either of said two filling ducts, valve means operable for alternatively throttling the supplies to said filling ducts, an ejector serving to suck liquid from said sump when energised from at least one of said delivery ducts, and means for conveying the delivery from said ejector to the interior of at least one of said couplings.

5. Power-transmission gearing providing two alternative power-transmission paths each including a hydraulic coupling of the kinetic type provided with a vaned driving element, a liquid-transfer chamber which is separate from its working chamber and which is arranged to rotate with said driving element, said working chamber having means employing the energy of motion of liquid therein for transferring liquid therefrom to said transfer chamber, a scoop in said transfer chamber, and inlet means for delivering liquid into said working chamber, the gearing also including two delivery ducts leading from said scoops respectively and capable of supplying two filling ducts branching to said two inlet means respectively, control valve means operable for alternatively throttling said filling ducts, a sump, dumping valve means operable for connecting said scoops to said sump, and ejector means capable of being energised from at least one of said scoops for transferring liquid from said sump to at least one of said couplings.

6. Power-transmission gearing providing two alternative power-transmission paths each including a hydraulic coupling of the kinetic type provided with a vaned driving element, a liquid-transfer chamber which is separate from its working chamber, which is arranged to rotate with said driving element and which is capable of storing liquid discharged thereto from said working chamber, a scoop in said transfer chamber, and a filling duct for the working chamber, said gearing also including a liquid cooler having an inlet and an outlet, valve means for connecting said outlet alternatively to said two filling ducts, and two ducts each including a non-return valve connecting said two scoops respectively to said cooler inlet.

7. Power-transmission gearing providing two

alternative power-transmission paths each including a hydraulic coupling of the kinetic type provided with a vaned driving element, a liquid-transfer chamber which is separate from its working chamber which is arranged to rotate with said driving element, the maximum effective storage capacity of which is substantially less than the normal maximum liquid content of said working chamber, and which is arranged to receive liquid directly from said working chamber while the coupling is operating, a scoop in said transfer chamber, and inlet means for delivering liquid into said working chamber, the gearing also including two delivery ducts leading from said scoops respectively, each containing a non-return valve and capable of supplying two filling ducts branching to said two inlet means respectively, and valve means operable for alternatively throttling said filling ducts.

8. Power-transmission gearing providing two alternative power-transmission paths each including a hydraulic coupling of the kinetic type provided with a vaned driving element, a liquid-transfer chamber which is separate from its working chamber which is arranged to rotate with said driving element, and the maximum effective storage capacity of which is of the order of one-quarter of the normal maximum liquid content of said working chamber, said working chamber having means employing the energy of motion of liquid therein for transferring liquid therefrom to said transfer chamber, a scoop in said transfer chamber, and inlet means for delivering liquid into said working chamber, the gearing also including two delivery ducts leading from said scoops respectively and capable of supplying two filling ducts branching to said two inlet means respectively, valve means operable for alternatively throttling said filling ducts, a sump serving to collect liquid leaking from said couplings when the gearing comes to rest, and means for raising liquid from said sump to at least one of said couplings when the gearing is restarted.

9. Power-transmission gearing providing two alternative power-transmission paths each including a hydraulic coupling of the kinetic type provided with a vaned driving element, a liquid-transfer chamber which is separate from its working chamber and which is arranged to rotate with said driving element, said working chamber having means employing the energy of motion of liquid therein for transferring liquid therefrom to said transfer chamber, a scoop in said transfer chamber, and inlet means for delivering liquid into said working chamber, the gearing also including two delivery ducts leading from said scoops respectively and capable of supplying two filling ducts branching to said two inlet means respectively, and valve means including a control member operable for simultaneously and partially throttling said filling ducts when said control member is in a neutral condition and for alternatively throttling the one and the other of said filling ducts as said control member is displaced in two senses respectively from said neutral position.

10. Power-transmission gearing including a gear selecting hydraulic coupling provided with a vaned driving element, a liquid-transfer chamber which is separate from its working chamber and which is arranged to rotate with said driving element, said working chamber having means employing the energy of motion of liquid therein for transferring liquid therefrom to said transfer chamber, a scoop in said transfer chamber, and inlet means for delivering liquid into said working chamber, a cooler having an inlet connected to said scoop and an outlet connected through a control valve to said inlet means, and a by-pass circuit of restricted flow capacity branching between the outlet of said cooler and said valve and leading to one of said working and transfer chambers.

11. Reversing gearing comprising a forward-drive hydraulic coupling and a reverse-drive hydraulic coupling for establishing alternative power paths through said gearing, each of said couplings being provided with a vaned driving element, a liquid-transfer chamber which is separate from its working chamber and which is arranged to rotate with said driving element, said working chamber having means employing the energy of motion of liquid therein for transferring liquid therefrom to said transfer chamber, a fixed scoop in said transfer chamber, and inlet means for delivering liquid into said working chamber, the gearing also including two delivery ducts leading from said scoops respectively and capable of supplying two filling ducts branching to said two inlet means respectively, and valve means operable when in a neutral condition to throttle the flow of liquid through both of said filling ducts simultaneously to such an extent that a substantial part of the liquid discharged from said working circuits is retained in said transfer chambers, said valve means also being capable of throttling either of said filling ducts while leaving the other of said filling ducts unthrottled, and the working chamber of said forward-drive coupling being larger than the working chamber of said reverse-drive coupling, while said two transfer chambers are of the same diameter and said scoops are arranged to scoop at the same radius.

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