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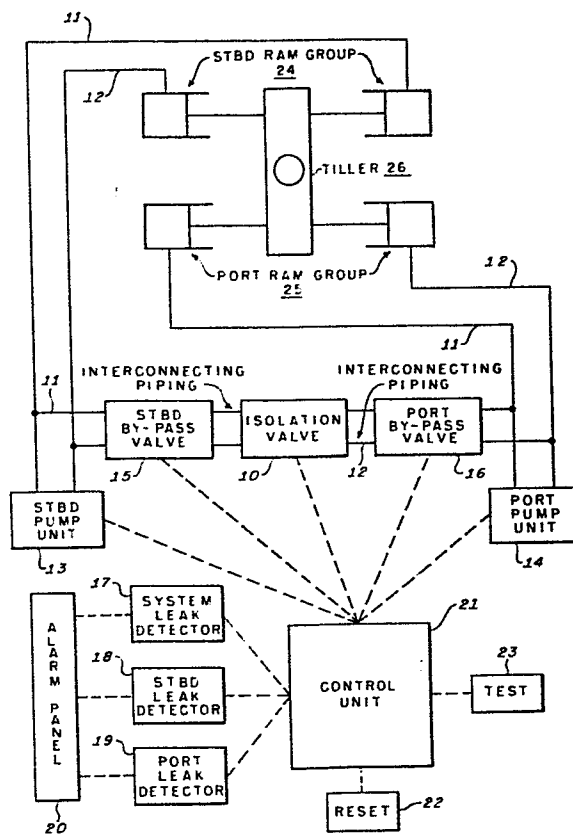
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(54) Device for isolating one circuit in a double hydraulic circuit for ship-steering systems.

(57) Apparatus for automatically or remotely dividing a two pump unit hydraulic steering system, upon detection of dangerous loss of fluid, into two independent steering systems in order to maintain steering capacity utilises an isolation valve (10) for blocking interconnecting piping (11, 12) in conjunction with by-pass valves (15, 16) for relieving resistance by one ram group (24) to motion of another (25). The valves (15, 16) and the pump units (13, 14) are regulated automatically or remotely by a control unit (21) in response to detection of fluid loss to achieve steering by the ram group on the loss-free side.

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HYDRAULIC STEERING ISOLATION APPARATUS

This invention relates generally to hydraulic steering systems.

Much of the steering gear presently utilised aboard ships comprises two pump units one usually located on the vessel's port side, and the other on the starboard. These units are interconnected to drive a common set of hydraulic rudder actuators. Due to the common connection, a loss of fluid can render both pumps inoperable. Most such systems include manually operated valves that allow the pump units to be isolated and the hydraulic actuators to be separated into two independent steering systems. However, during failure, the journey to the steering gear chamber to shift valves wastes precious time which may jeopardise the vessel's safety. In a catastrophic incident, such disabling loss of fluid resulted in a super tanker running aground, breaking in two, and spilling its cargo of oil into the sea. The cost resulting from the ship's destruction and the pollution damage to fishing grounds and recreational areas has been estimated at hundreds of millions of U.S. dollars. In recent years the size of the world's tanker fleet has doubled, totalling more than 7,000 vessels. Such a fleet possesses enormous destructive potential.

Accordingly, in recognition of the potentially catastrophic consequences of present day marine steering gear deficiencies, an object of the present invention is to provide an apparatus for automatically or remotely dividing a two pump unit hydraulic steering system, upon detection of dangerous loss of fluid, into two independent steering systems, in order to maintain steering capability.

The invention is defined in the appended claims and it will be seen that when a dangerous loss of fluid in the steering system is sensed, an isolation valve is activated by a control unit so as to block the interconnecting piping, thus dividing the system in two. The pump unit associated with the leak-free side of the system is operated, and a

by-pass valve is activated which relieves resistance by the ram group associated with the leaking side to motion imparted by the ram group associated with the leak-free side, thus maintaining steering capability on the leak-free side of the system.

In a preferred embodiment of the invention, loss of fluid is sensed by a leak detection tank employing a float-type switch. The by-pass valves each comprise a solenoid pilot operated directional control valve, and the isolation valve comprises a pilot operated directional control valve. The control unit comprises conventional electrohydraulic devices for regulating the operations of the system.

A hydraulic steering system in accordance with the present invention will now be described in greater detail, by way of example, with reference to the accompanying sole figure of drawings which is a schematic diagram of the system.

The system comprises an apparatus, with test facility, for detecting a dangerous fluid loss in the hydraulic steering system which has two pump units, two reservoirs, two ram groups, and interconnecting piping which couples each of the pump units to each of the ram groups. Upon detecting such a loss, the system is automatically or remotely divided into two independent steering systems, in order to maintain steering capability. Upon repair of the leak, the system can be returned to normal operation.

More specifically, the system comprises an isolation valve 10, capable of activation and deactivation, which upon activation blocks interconnecting pipes 11 and 12 between a starboard pump unit 13 and a port pump unit 14, and which upon deactivation unblocks these pipes. A starboard by-pass valve 15, capable of activation and deactivation, is provided and upon activation, couples the interconnecting pipes 11 and 12 on the starboard side of the isolation valve, and upon deactivation uncouples these pipes. A port by-pass valve 16, capable of activation and deactivation, is also provided and upon activation couples the interconnecting pipes 11 and 12

on the port side of the isolation valve, and upon
deactivation uncouples these pipes. A system leak detector
17 senses any dangerous loss of fluid in the system. A
starboard leak detector 18 senses any dangerous loss of
5 fluid in the isolated starboard steering system, and a
port leak detector 19 senses any dangerous loss of fluid
in the isolated port steering system. An alarm panel 20,
responsive to each of the leak detectors, 17, 18 and 19,
provides an alert for each dangerous loss of fluid detected.
10 A control unit 21, responsive to each of the leak detectors
17, 18 and 19, regulates the starboard pump unit 13, the
port pump unit 14, the isolation valve 10, the starboard
by-pass valve 15, and the port by-pass valve 16. A reset
mechanism 22, upon activation, returns the isolated steering
15 system, through the control unit, to normal operation. A
test mechanism 23, upon activation, supplies a simulated
dangerous loss of fluid signal to the control unit.

The steering system generally operates on only one
pump unit at a time. When deactivated, a pump unit does
20 not permit the entrance of fluid. Assuming, without loss
of generality, that the steering system is initially
operating on the starboard pump unit 13, and that loss of
fluid is occurring in the system, the invention functions as
follows. The system leak detector 17 ultimately senses a
25 dangerous loss of fluid, and alarm panel 20 reacts by
providing an alert. In response to the sensing of a
dangerous loss of fluid, the isolation valve 10 and port
by-pass valve 16 are activated through the control unit 21.
The activated isolation valve 10 blocks the interconnecting
30 pipes 11 and 12 between the starboard pump unit 13 and the
port pump unit 14, dividing the steering system in two.
The activated port by-pass valve 16 couples the inter-
connecting pipes 11 and 12 on the port side of isolation
valve 10.

35 Assuming a leak in the piping on the port side of
isolation valve 10, the starboard leak detector 18 will
fail to sense a dangerous loss of fluid, and steering is
now conducted on the starboard side of the system by the

starboard pump unit 13 operating a starboard ram group 24. The activated port by-pass valve 16, which couples the interconnecting pipes 11 and 12 on the port side of the isolation valve 10, relieves resistance by a port ram group
5 25 to the motion imparted by the starboard ram group 24 to a tiller 26, by permitting fluid in the port ram group to circulate between the rams.

Assuming, alternatively, a leak in the piping on the starboard side of the isolation valve 10, the starboard leak
10 detector 18 ultimately senses a dangerous loss of fluid, and alarm panel 20 reacts by providing an alert. Through control unit 21, in response to the sensing of the starboard leak, the starboard pump unit 13 is deactivated, the port pump unit 14 is activated, the starboard by-pass valve 15 is
15 activated, and the port by-pass valve 16 is deactivated. Steering is now conducted on the port side of the system by the port pump unit 14 operating the port ram group 25. The activated starboard by-pass valve 15, which couples the interconnecting pipes 11 and 12 on the starboard side of
20 isolation valve 10, relieves resistance by the starboard ram group 24 to the motion imparted by the port ram group 25 to the tiller 26, by permitting fluid in the starboard ram group to circulate between the rams.

Assuming that the steering system is initially
25 operating on the port pump unit 14, the sequence of events, in response to a loss of fluid, is completely analogous to that described above.

Upon repair of the leak, the reset mechanism 22 is actuated so as to return, through the control unit 21, the
30 isolated steering system to normal operation by deactivating the isolation valve 10, and whichever by-pass valve had been activated. The test mechanism 23 permits a check of the system by supplying a simulated dangerous loss of fluid signal to the control unit 21.

35 In a preferred embodiment of the invention, each of the by-pass valves 15 and 16 comprises a solenoid pilot operated directional control valve (pilot refers to

regulation of the valve by hydraulic pressure). The isolation valve 10 comprises a pilot operated directional control valve, and each of the leak detectors 17, 18 and 19 comprises a tank employing a float-type level switch.

5 The alarm panel comprises lights and horns which simultaneously provide a visual and audio alert of the particular dangerous loss of fluid. Both the test and reset mechanisms comprise toggle switches and associated circuitry. The control unit 21 comprises conventional

10 hydraulic and electrical devices for regulating the operation of the system as described above. In particular, the control unit 21 comprises a pilot pressure pump unit which supplies hydraulic pressure for regulating the isolation and by-pass valves 15 and 16. The electric

15 circuitry of the control unit 21 comprises a time delay relay, responsive to the system leak detector 17 and operable to initiate isolation of the steering system only after an appropriate delay, to preclude mere sloshing of fluid from precipitating such action. The electric and

20 hydraulic couplings between the various components of the system comprise conventional devices.

The operations of the control unit 21 are carried out automatically in response to the various leak detectors 17, 18 and 19, or remotely in response to the various alerts

25 provided by the alarm panel 20, or partly automatically and partly remotely.

CLAIMS

1. Isolation apparatus for an hydraulic fluid steering system of the type having a starboard and a port side; a starboard and a port pump unit, each capable of activation and deactivation and only one of which is normally operating
5 at a time; a starboard and a port ram group; and inter-connecting piping, which couples each of the pump units to each of the ram groups; characterised in that the apparatus comprises isolating means (10), capable of activation and deactivation, for blocking the interconnecting piping (11,
10 12) between the pump units (13, 14) upon activation, and unblocking the interconnecting piping (11,12) upon de-activation, so that upon activation, the steering system is divided into independent starboard and port steering system; starboard by-pass means (15), capable of activation and de-
15 activation, for coupling the interconnecting piping (11,12) on the starboard side of the steering system upon activation, and uncoupling the interconnecting piping (11, 12) on the starboard side of the steering system upon deactivation, so that upon activation, in conjunction with activation of the
20 isolating means (10), resistance by the starboard ram group (24) to motion by the port ram group (25) is relieved; port by-pass means (16), capable of activation and deactivation, for coupling the interconnecting piping (11,12) on the port side of the steering system upon activation, and uncoupling
25 the interconnecting piping (11, 12) on the port side of the steering system upon deactivation, so that upon activation, in conjunction with activation of the isolating means (10), resistance by the port ram group (25) to motion by the starboard ram group (24) is relieved; and control means (21)
30 for remotely activating and deactivating the isolating means (10), the starboard by-pass means (15), the port by-pass means (16), the starboard pump unit (13), and the port pump unit (14).
2. Isolation apparatus for an hydraulic fluid steering
35 system of the type having a starboard and a port side, a starboard and a port pump unit, each capable of activation

and deactivation and only one of which is normally operating at a time; a starboard and a port ram group; and inter-connecting piping, which couples each of the pump units to each of the ram groups; characterised in that the apparatus
5 comprises isolating means (10), capable of activation and deactivation, for blocking the interconnecting piping (11, 12) between the pump units (13, 14) upon activation, and unblocking the interconnecting piping (11, 12) upon deactivation, so that upon activation, the steering system
10 is divided into independent starboard and port steering systems; starboard by-pass means (15), capable of activation and deactivation, for coupling the interconnecting piping (11, 12) on the starboard side of the steering system upon activation, and uncoupling the interconnecting piping (11,
15 12) on the starboard side of the steering system upon deactivation, so that upon activation, in conjunction with activation of the isolating means (10), resistance by the starboard ram group (24) to motion by the port ram group (25) is relieved; port by-pass means (16) capable of
20 activation and deactivation, for coupling the inter-connecting piping (11, 12) on the port side of the steering system upon activation, and uncoupling the interconnecting piping (11,12) on the port side of the steering system upon deactivation, so that upon activation, in conjunction with
25 activation of the isolating means (10), resistance by the port ram group (25) to motion by the starboard ram group (24) is relieved and control means (21) for activating and deactivating the isolating means (10), the starboard by-pass means (15), the port by-pass means (16), the starboard
30 pump unit (13), and the port pump unit (14) so that in response to a fluid leak on a first side of the steering system the control means (21) automatically activates the isolating means (10), automatically deactivates the pump unit on said first side, automatically activates the pump
35 unit on the second side of the steering system, automatically deactivates the by-pass means on said second side of the steering system, and automatically activates the by-pass means on said first side of the steering system, in order

that steering can be maintained by the ram group associated with said second side.

3. Isolation apparatus for an hydraulic fluid steering system of the type having a starboard and a port side; a
5 starboard and a port pump unit, each capable of activation and deactivation and only one of which is normally operating at a time; a starboard and a port ram group; and inter-connecting piping, which couples each of the pump units to each of the ram groups; characterised in that the apparatus
10 comprises isolating means (10), capable of activation and deactivation, for blocking the interconnecting piping (11, 12) between the pump units (13, 14) upon activation, and unblocking the interconnecting piping (11,12) upon de-activation, so that upon activation, the steering system is
15 divided into independent starboard and port steering systems; starboard by-pass means (15), capable of activation and deactivation, for coupling the interconnecting piping (11, 12) on the starboard side of the steering system upon activation, and uncoupling the interconnecting piping (11,
20 12) on the starboard side of the steering system upon deactivation, so that upon activation, in conjunction with activation of the isolating means (10), resistance by the starboard ram group (24) to motion by the port ram group (24) is relieved; port by-pass means (16), capable of
25 activation and deactivation, for coupling the inter-connecting piping (11, 12) on the port side of the steering system upon activation, and uncoupling the interconnecting piping (11, 12) on the port side of the steering system upon deactivation, so that upon activation in conjunction with
30 activation of the isolating means (10), resistance by the port ram group (25) to motion by the starboard ram group (24) is relieved; and control means (21) for activating and de-activating the isolating means (10), the starboard by-pass means (15), the port by-pass means (16) the starboard pump
35 unit (13), and the port pump unit (14), so that in response to a fluid leak in the steering system, the control means (21) automatically activates the isolating means (10), automatically activates the by-pass means on the side of

the steering system associated with the nonoperating pump unit, and is capable of remotely activating and deactivating the starboard by-pass means (15), the port by-pass means (16), the starboard pump unit (13), and the port pump unit (14).

4. Isolation apparatus for an hydraulic fluid steering system of the type having a starboard and a port side; a starboard and a port pump unit, each capable of activation and deactivation and only one of which is normally operating at a time; a starboard and a port ram group; and inter-connecting piping, which couples each of the pump units to each of the ram groups, characterised in that the apparatus comprises isolating means (10), capable of activation and deactivation, for blocking the interconnecting piping (11, 12) between the pump units (13, 14) upon activation, and unblocking the interconnecting piping (11, 12) upon deactivation, so that upon activation, the steering system is divided into independent starboard and port steering systems; starboard by-pass means (15), capable of activation and deactivation, for coupling the interconnecting piping (11, 12) on the starboard side of the steering system upon activation, and uncoupling the interconnecting piping on the starboard side of the steering system upon deactivation, so that upon activation, in conjunction with activation of the isolating means (10), resistance by the starboard ram group (24) to motion by the port ram group (25) is relieved; port by-pass means (16), capable of activation and deactivation, for coupling the interconnecting piping (11, 12) on the port side of the steering system upon activation, and uncoupling the interconnecting piping (11, 12) on the port side of the steering system upon deactivation, so that upon activation, in conjunction with activation of the isolating means (10), resistance by the port ram group (25) to motion by the starboard ram group (24) is relieved; and control means (21) for activating and deactivating the isolating means (10), the starboard by-pass means (15) and the port by-pass means (16), so that in response to a fluid leak in the steering system, the control means (41) automatically activates the

isolating means (10), automatically activates the by-pass means on the side of the steering system associated with the nonoperating pump unit, and is capable of remotely activating and deactivating the starboard by-pass means (15) and the port by-pass means (16).

5 5. Apparatus according to claim 1 characterised in that it further comprises leak detector means (17) for sensing a fluid leak on a first side of the steering system; and alarm means (20) responsive to the leak detector means (17)
10 for providing an alert to the fluid leak.

6. Apparatus according to claim 2 characterised in that it further comprises leak detector means (17), coupled to the control means, for sensing a fluid leak on the first side of the steering system.

15 7. Apparatus according to claim 3 characterised in that it further comprises system leak detector means (17), coupled to the control means, for sensing a fluid leak in the steering system; starboard leak detector means (18) for sensing a fluid leak in the starboard steering system; port
20 leak detector means (19) for sensing a fluid leak in the port steering system; and alarm means (20) responsive to the system leak detector means (17), the starboard leak detector means (18), and the port leak detector means (19) for providing an alert to the respective fluid leaks.

25 8. Apparatus according to claim 4 characterised in that it further comprises system leak detector means (17), coupled to the control means (21) and operable to sense a fluid leak in the steering system; starboard leak detector means (18) for sensing a fluid leak in the starboard steering system;
30 port leak detector means (19) for sensing a fluid leak in the port steering system; and alarm means (20) responsive to the system leak detector means (17), the starboard leak detector means (18), and the port leak detector means (19), for providing an alert to the respective fluid leaks.

35 9. Apparatus according to any of the preceding claims, characterised in that it further comprises reset means (22), capable of activation, for automatically returning, upon activation, the steering system to normal operation by deactivating the isolating means (10) and deactivating the

starboard and port by-pass means (15, 16).

10. Apparatus according to any of the preceding claims,
characterised in that it further comprises test means (23)
capable of activation, coupled to the control means (21)
5 and operable to supply, upon activation, a simulated leak
of fluid signal to the control means.

11. Apparatus according to any of the preceding claims,
characterised in that the isolating means (10) comprises a
pilot operated directional control valve and in that the
10 port and starboard by-pass means (15, 16) each comprises
a solenoid pilot operated directional control valve.

