

DESCRIPTION

MARINE REDUCTION AND REVERSE GEAR AND HYDRAULIC DEVICE OF MARINE REDUCTION AND REVERSE GEAR

Technical Field

[0001]

The present invention relates to an art of a marine reduction and reverse gear apparatus.

In more detail, the present invention relates to a technical art of a hydraulic device of a marine reduction and reverse gear apparatus in which outlet ports for hydraulic oil and for lubricating oil are collected at one position without any complex branched passage so as to facilitate piping work.

Furthermore, the present invention relates to a technical art of a marine reduction and reverse gear apparatus having an electricity generator for inboard power supply, intended to ensure efficient electric power supply in correspondence to purposes of the supplied electric power.

Background Art

[0002]

Conventionally, there is a marine propulsion system including an engine and a marine reduction and reverse gear apparatus for power transmission. The marine reduction and reverse gear apparatus reduces a driving power of the engine and then drives a screw connected to the reduction and reverse gear apparatus by the power.

The marine reduction and reverse gear apparatus is provided therein with hydraulic clutches for forward and reverse propulsion, for PTO output and for the like, and is provided on an upper surface of its housing case with a hydraulic pressure control mechanism for controlling these hydraulic clutches (for example, see Patent Literature 1).

In such a ship which drives an engine for driving a propeller, the output of the engine, in any rotational speed range, includes a surplus relative to load on the ship, unless the

rotational speed reaches its maximum. Therefore, in some of the ships, each propulsion system is provided with an electricity generator which converts a part of output of the engine into electric power for inboard use or for charging a battery (for example, see Patent Literature 2).

Patent Literature 1: the Japanese Patent Laid Open Gazette 2006-112471

Patent Literature 2: the Japanese Patent Laid Open Gazette 2008-30749

Disclosure of Invention

Problems to Be Solved by the Invention

[0003]

The hydraulic pressure control mechanism includes a hydraulic oil passage and a lubricating oil passage, each of which is provided with hydraulic pressure detection means including a plurality of pressure sensors, such as an alarm sensor and a stop sensor. Some kinds of pressure sensors may be added or omitted in correspondence to different specifications of the ship equipped with the marine reduction and reverse gear apparatus. Therefore, an additional piping work corresponding to the difference of the ship in specifications is required to branch a piping passage from the hydraulic oil passage or the lubricating oil passage and to connect it to the pressure sensor.

[0004]

In this case, the pressure sensors are attached in a limited space above the upper surface portion of the housing case, and on the other hand, the hydraulic circuit has locationally preset portions to be connected to the hydraulic sensors. As a result, a portion of the hydraulic circuit for extracting hydraulic oil or lubricating oil is limited in location, thereby complicating layout of the piping passages.

Further, if a different kind of pressure sensor is added because of change of specifications of the ship, at an operator's request or for another reason, the piping passages must be reviewed every time of the addition of the pressure sensor, and a new portion for extracting hydraulic oil or lubricating oil must be provided in the hydraulic

circuit, thereby increasing the number of parts and the number of manufacture processes, so that there is room for economic improvement.

[0005]

On the other hand, in the case that a reduction and reverse gear apparatus is provided with an electricity generator as described in the Patent Literature 1, the generator must be selected to have a capacity corresponding to electric power for driving implements consuming comparatively great electricity, e.g., a side thruster and an anchor-hoisting winch.

It results in that the electricity generator should also perform insufficient electric power supply to implements consuming comparatively small electricity, e.g., for inboard lighting or as a power source for operation devices.

Further, if a separate power generation equipment for supplying small electric power is required to be provided on the reduction and reverse gear apparatus so as to dissolve the inefficiency, there is difficulty and economic problem in ensuring a space for mounting the equipment in the ship.

[0006]

Therefore, a purpose of the present invention is to provide a hydraulic device of a marine reduction and reverse gear apparatus, in which extraction ports for hydraulic oil and lubricating oil are collected at one position without complex branched passages so as to facilitate work for piping for a hydraulic pressure detection means including a plurality of pressure sensors.

[0007]

Further, another purpose of the present invention is to provide a marine reduction and reverse gear apparatus having an electricity generator for inboard power supply, in which electric power is supplied efficiently in correspondence to uses thereof without an additional separate power generation equipment.

Means for Solving the Problems

[0008]

The present invention provides the following means for solving the above-mentioned problems.

[0009]

As claimed in claim 1, a hydraulic device of a marine reduction and reverse gear apparatus includes forward and reverse hydraulic clutches, a selector valve operated for engaging and disengaging the forward and reverse hydraulic clutches, a hydraulic pressure source, a hydraulic oil passage extending between the hydraulic pressure source and the selector valve, a lubricating oil passage, a communication passage extending from the hydraulic oil passage to the lubricating oil passage, an oil passage for detecting a pressure of the hydraulic oil passage, an oil passage for detecting a pressure of the lubricating oil passage, and pressure detection means for detecting the pressures. The marine reduction and reverse gear apparatus has a surface for mounting hydraulic instruments thereon, and the hydraulic device further includes a source pressure distribution plate, to which the oil passage for detecting the pressure of the hydraulic oil passage and the oil passage for detecting the pressure of the lubricating oil passage are connected. The source pressure distribution plate is disposed on a substantially center portion of a surface of the marine reduction and reverse gear apparatus, and the selector valve and the pressure detection means are disposed on the surface so as to surround the source pressure distribution plate.

[0010]

As claimed in claim 2, the hydraulic device further includes an instrument distribution plate arranged adjacent to the source pressure distribution plate, and communicated with the source pressure distribution plate through piping. A plurality of pressure detection means for detecting pressure of the lubricating oil passage are disposed on the instrument distribution plate.

[0011]

As claimed in claim 3, a marine reduction and reverse gear apparatus includes an input shaft for receiving a driving power of an engine, an output shaft for transmitting the driving power to a propeller, a first PTO output shaft connected to a main electricity

generator so as to transmit the driving power to the main electricity generator, a countershaft for reversing and transmitting the driving power to the output shaft, and a housing case supporting the input shaft, the output shaft, the first PTO output shaft and the countershaft, so that the input shaft is arranged in parallel between the first PTO output shaft and the countershaft. The marine reduction and reverse gear apparatus further includes a second PTO output shaft provided in parallel on an outer side portion of the housing case outward from the countershaft, and the second PTO output shaft is connected to an auxiliary electricity generator for small electric power supply.

[0012]

As claimed in claim 4, the marine reduction and reverse gear apparatus further includes an opening provided in a side surface of the housing case outward from the countershaft, a second PTO housing case supporting the second PTO output shaft and detachably attached to the opening, and a gear through which the second PTO output shaft is interlockingly connected to the countershaft.

[0013]

As claimed in claim 5, the first PTO output shaft, the input shaft and the countershaft are aligned on the same slanted surface which becomes lower as approaching the countershaft, and the second PTO output shaft is disposed slantwise upward from the countershaft.

[0014]

As claimed in claim 6, the housing case is divided into upper and lower parts by a parting face on which respective axes of the first PTO output shaft, the input shaft and the countershaft are joined to each other, and the first PTO output shaft, the input shaft and the countershaft are rotatably supported on the parting face.

Effect of the Invention

[0015]

The present invention brings the following effects.

[0016]

According to claim 1, ports for extracting the hydraulic oil and lubricating oil can be disposed on the upper surface for mounting hydraulic instruments thereon around the source pressure distribution plate, so as to shorten the pipings therefrom to relevant instruments such as pressure sensors, thereby reducing the number of parts and the number of manufacture processes. Further, the source pressure distribution plate facilitates addition of a pressure sensor or pressure sensors.

[0017]

According to claim 2, the plurality of pressure detection means can be connected easily without any complex piping member.

[0018]

According to claim 3, electric power can be supplied efficiently without additionally providing a power generation equipment in correspondence to how it is used, thereby improving economical efficiency.

[0019]

According to claim 4, the marine reduction and reverse gear apparatus can easily be provided with the second PTO output shaft for the auxiliary electricity generator without elaborate change of design.

[0020]

According to claim 5, the second PTO output shaft can be disposed within the lateral width of the housing case so that the marine reduction and reverse gear apparatus does not have to form an additional sideward projecting part, thereby compacting the housing case.

[0021]

According to claim 6, the first PTO output shaft, the input shaft and the countershaft can easily be installed into the housing case, thereby reducing the number of assembly processes and thereby reducing costs.

Brief Description of the Drawings

[0022]

Fig. 1 is a perspective rear view of an entire construction of a marine reduction and reverse gear apparatus according to an embodiment of the present invention.

Fig. 2 is a rear view of the entire construction of the marine reduction and reverse gear having a hydraulic device.

Fig. 3 is a plan view of the entire construction.

Fig. 4 is an enlarged fragmental view of the marine reduction and reverse gear apparatus.

Fig. 5 is a hydraulic circuit diagram of the hydraulic device.

Fig. 6 is a plan view of a source pressure distribution plate.

Fig. 7 is a side view of an instrument distribution plate when viewed along arrows C in Fig. 4.

Fig. 8 is a conventional hydraulic circuit diagram.

Fig. 9 is a sectional side view of the marine reduction and reverse gear apparatus when viewed along arrows B in Fig. 2.

Fig. 10 is a sectional plan view of a gear arrangement of the marine reduction and reverse gear apparatus.

Fig. 11 is a perspective view of the gear arrangement.

Fig. 12 is a perspective view of surroundings of a second PTO output shaft.

Fig. 13 is a plan view of the surroundings of the second PTO output shaft.

Figs. 14 (a), (b), (c) and (d) are sectional views of the second PTO output shaft, when viewed along arrows D, E, F and G in Fig. 13, respectively.

Figs. 15 (a) and (b) are sectional rear views of the second PTO output shaft and a countershaft, showing their arrangement relations, (a) showing them in 1500 rpm style, and (b) showing them in 1800 rpm style.

Fig. 16 is a perspective rear view of an entire construction of a marine reduction and reverse gear apparatus provided with an observation window according to another embodiment of the present invention.

Fig. 17 (a) is a plan view of the observation window, and Fig. 17 (b) is a rear view of the observation window.

Fig. 18 is a perspective view of an alternative observation window.

Description of Notations

[0023]

- 1 marine reduction and reverse gear apparatus
- 2 input shaft
- 3 output shaft
- 4 first PTO output shaft
- 5 second PTO output shaft
- 6 countershaft
- 7 housing case
- 10 hydraulic device mounting surface
- 27 reverse gear
- 30 second PTO gear
- 31a opening
- 35 lower housing case
- 51 source pressure distribution plate
- 52a pressure sensor (pressure detection means)
- 52b pressure sensor (pressure detection means)
- 54 instrument distribution plate
- 202 hydraulic pump (hydraulic source)
- 203 forward friction clutch (hydraulic clutch)
- 204 reverse friction clutch (hydraulic clutch)
- 206 forward-reverse selector valve
- 210a hydraulic oil passage
- 303 lubricating oil passage
- 303a lubricating oil passage
- 309 communication passage
- 502 propeller

- 503 main electricity generator
- 504 auxiliary electricity generator

Best Mode for Carrying out the Invention

[0024]

Next, explanation will be given on embodiments of the present invention.

Firstly, explanation will be given on a hydraulic device of a marine reduction and reverse gear apparatus.

Fig. 1 is a perspective rear view of an entire construction of a marine reduction and reverse gear apparatus according to an embodiment of the present invention. Fig. 2 is a rear view of the entire construction of the marine reduction and reverse gear apparatus having a hydraulic device. Fig. 3 is a plan view of the entire construction. Fig. 4 is an enlarged fragmental view of the marine reduction and reverse gear apparatus. Fig. 5 is a hydraulic circuit diagram of the hydraulic device. Fig. 6 is a plan view of a source pressure distribution plate. Fig. 7 is a side view of an instrument distribution plate when viewed along arrows C in Fig. 4. Fig. 8 is a conventional hydraulic circuit diagram.

[0025]

[Marine reduction and reverse gear apparatus 1]

Firstly, referring to Figs. 1 to 4, explanation will be given on an entire construction of a marine reduction and reverse gear apparatus 1 having a hydraulic device of the present invention. Hereinafter, right and left directions are defined on an assumption that an arrow A in Figs. 1, 3 and 4 is directed forward.

The marine reduction and reverse gear apparatus 1 is directly connected to an output shaft of an engine 501 (see Fig. 9), and includes an input shaft 2 for receiving driving power of the engine, a gear mechanism for reducing and reversing the inputted driving power, an output shaft 3 for transmitting the power to a propeller 502 (see Fig. 9), a first PTO output shaft 4 for transmitting the power to a main electricity generator 503 (see Fig. 9), a second PTO output shaft 5 for transmitting the power to an auxiliary electricity

generator 504 (see Fig. 9), a countershaft 6 arranged between the input shaft 2 and the second PTO output shaft 5, and a housing case 7 rotatably supporting the input shaft 2, the output shaft 3, the first PTO output shaft 4, the second PTO output shaft 5 and the countershaft 6 through respective bearings (not shown).

[0026]

The marine reduction and reverse gear apparatus 1 has the housing case 7, and the input shaft 2 and the output shaft 3 are inserted into the lateral center portion of the housing case 7 to be aligned in parallel and downward in this order. The first PTO output shaft 4 is inserted into the housing case 1 on the left side of the input shaft 2, and the countershaft 6 is inserted into the housing case 1 on the right side of the input shaft 2, so that the first PTO shaft 4, the input shaft 2 and the counter shaft 6 are aligned in parallel and rightwardly downward in this order when viewed in front.

[0027]

At the upper right side of the countershaft 6, the second PTO output shaft 5 is detachably attached to a side surface portion of the housing case 7. The input shaft 2, the output shaft 3, the first PTO output shaft 4, the second PTO output shaft 5 and the countershaft 6 are drivingly connected to one another through a plurality of gear mechanisms in the housing case 7. Therefore, in the housing case 7, the inputted power of the input shaft 2 is transmitted through the output shaft 3 to the propeller.

[0028]

The input shaft 2, counter shaft 6 and first PTO shaft 4 are provided thereon with respective hydraulic clutches, i.e., a forward friction clutch 203, a reverse friction clutch 204 and a PTO friction clutch 213 (see Fig. 5).

[0029]

By engagement/disengagement switching operation of the forward and reverse friction clutches 203 and 204, the rotational direction of the output shaft 3, meshing with the input shaft 2 and the countershaft 6 through the gear mechanisms, is switched so as to switch the forward/reverse traveling of the ship. By engagement/disengagement switching operation of the PTO friction clutch 213 provided on the first PTO output shaft 4, the

operation of the main electricity generator is switched on or off.

[0030]

Hydraulic instruments required for operating the forward friction clutch 203, reverse friction clutch 204 and PTO friction clutch 213 are disposed on an upper surface of the housing case 7.

[0031]

More specifically, as shown in Figs. 3 and 4, the housing case 7 is formed thereon with a hydraulic instrument mounting surface 10, on which a later-discussed source pressure distribution plate 51 is provided on a center portion of an upper surface of the hydraulic device mounting surface 10, and relief valves, selector valves and the like are disposed around the source pressure distribution plate 51.

[0032]

The source pressure distribution plate 51 serves as a place where ports for extracting hydraulic oil and lubricating oil, having source pressure, are collected. As shown in Fig. 5, a communication passage 309 communicates a hydraulic oil passage 210a with a lubricating oil passage 303a. A piping serving as a bypass passage 307a is branched from a hydraulic oil side portion of the communication passage 309 so as to introduce the hydraulic oil having the source pressure to the source pressure distribution plate 51. A piping serving as a bypass passage 307b is branched from a lubricating oil side portion of the communication passage 309 so as to introduce the lubricating oil having the source pressure to the source pressure distribution plate 51.

[0033]

The source pressure distribution plate 51 is surrounded by a pressure sensor 52a, serving as pressure detection means, disposed forward therefrom, a second relief valve 305 disposed rearward therefrom, a forward-reverse selector valve 206 and an electromagnetic-controlled pilot valve 209 disposed rightward therefrom, and pressure indicators 53a and 53b, serving as pressure indication means, disposed leftward therefrom. These instruments surrounding the source pressure distribution plate 51 are connected to the source pressure distribution plate 51 through respective pipings including a piping

passage 307c. Namely, hydraulic pressure to be led to the plurality of hydraulic pressure detection means, including the pressure sensor 52a, and lubricating oil are delivered from outlet ports which are collected on the source pressure distribution plate 51.

[0034]

[Hydraulic control mechanism 100]

Next, referring to Fig. 5, explanation will be given on an entire construction of hydraulic circuit of a hydraulic control mechanism 100.

The hydraulic circuit of the hydraulic control mechanism 100 mainly includes a hydraulic oil supply circuit 200 and a lubricating oil supply circuit 300.

[0035]

Firstly, explanation will be given on the hydraulic oil supply circuit 200.

The hydraulic oil supply circuit 200 has two systematic hydraulic oil routes 210 and 212.

A pair of hydraulic pumps 202 pump hydraulic oil filtered by respective suction filters 201 so as to deliver pressurized hydraulic oil to the respective hydraulic oil routes 210 and 212.

[0036]

One hydraulic oil route conducts hydraulic oil through the hydraulic oil passage 210a to the pilot valve 209 and the forward-reverse selector valve 206, and then supplies the hydraulic oil to either of the forward friction clutch 203 and the reverse friction clutch 204 through respective hydraulic oil passages 210b.

[0037]

The other route conducts hydraulic oil through a hydraulic oil passage 212a to an electromagnetic-controlled clutch on/off valve 215, and then supplies the hydraulic oil to either of the PTO friction clutch 213 and a neutral brake 216 through respective hydraulic oil supply passages 212c and 212b.

[0038]

A pair of pressure sensors 52c are provided to detect respective pressures of hydraulic oil in respective hydraulic oil passages 210b between the forward-reverse selector valve

206 and the respective forward and reverse friction clutches 203 and 204.

[0039]

The two hydraulic oil routes (passages) 210 (210a) and 212 (212a) are provided with respective first relief valves 205 branched from respective portions thereof serving as discharge oil passages of the respective hydraulic pumps 202.

[0040]

Each of the relief valves 205 is supplied with a backpressure, i.e., the pressure of hydraulic (pressurized) oil delivered from the hydraulic pumps 202, and has a spring so that each relief valve 205 drains excessive hydraulic oil to an oil tank 207 when the backpressure exceeds a pressure set by its spring.

[0041]

Next, explanation will be given on the lubricating oil supply circuit 300.

The lubricating oil supply circuit 300 has a lubricating oil route 303.

In the lubricating oil supply circuit 300, a surplus of the hydraulic oil mainly used for actuating the forward or reverse friction clutch 203 or 204 is sent as lubricating oil to lubricated parts such as bearing parts. A part of the lubricating oil is conducted to the later-discussed source pressure distribution plate 51, and is drained to the oil tank 207 when its pressure is larger than a pressure set by the second relief valve 305.

[0042]

The lubricating oil supply circuit 300 includes a drain oil passage 304 for draining the hydraulic oil discharged from the PTO friction clutch 213 and/or the neutral brake 216, or the hydraulic oil, whose pressure is higher than a set pressure of a third relief valve 306, to the oil tank 207.

[0043]

The communication passage 309 is branched from the hydraulic oil passage 210a. A hydraulic oil pressure regulating valve 208a, an oil filter 302 and an oil cooler 301, which are discussed later, are connected to the communication passage 309 in this order.

[0044]

The hydraulic oil having passed through the hydraulic oil pressure regulating valve

208a is filtered by the oil filter 302, is cooled by the oil cooler 301, and then reaches a lubricating oil passage 303b. The hydraulic oil reaching the lubricating oil passage 303b is divided so that one part thereof is supplied as lubricating oil at the pressure set by the second relief valve 305 through a lubricating oil passage 303c to a plurality of bearing parts provided in the housing case 7, and the other part thereof is drained to the oil tank 207.

[0045]

The bypass passage 307a is branched from the communication passage 309 at the upstream side of the hydraulic oil pressure regulating valve 208a, and is connected to the source pressure distribution plate 51.

Two systematic routes of branching (oil) passages are provided within the source pressure distribution plate 51. One route is connected to the bypass passage 307a, a piping passage 307e communicated with the pressure sensor 52a, and a piping passage 307d communicated with the pressure indicator 53a. The other route is connected to the bypass passage 307b, a piping passage 307f communicated with a plurality of pressure sensors 52b, a piping passage 308 communicated with the second relief valve 305, and the piping passage 307c communicated with the pressure indicator 53b. The bypass passage 307b is communicated with the lubricating oil passage 303.

[0046]

Namely, the bypass passage 307b is branched via the other route in the source pressure distribution plate 51 to the piping passage 308 and to a plurality of detection passages. The detection passages are connected to the respective pressure sensors 52b for detecting pressure (source pressure) of lubricating oil in the lubricating oil route 303, and to the pressure indicator 53b. The piping passage 308 is connected to the second relief valve 305.

An instrument distribution plate 54 is disposed between the pipes to respective pressure sensors 52b and the source pressure distribution plate 51 so as to facilitate piping to the pressure sensors 52b.

[0047]

A branched passage (oil passage) having a plurality of extraction ports is provided in the instrument distribution plate 54. One of the extraction ports is connected through the piping passage 307f to the source pressure distribution plate 51 and is communicated with the bypass passage 307b, and the other extraction ports are connected to the respective pressure sensors 52b through respective piping members 55 (see Fig. 7).

[0048]

[Method for switching forward and reverse friction clutches 203 and 204]

Next, explanation will be given on switching of the forward friction clutch 203 and the reverse friction clutch 204.

The switching operation of the forward and reverse friction clutches 203 and 204 is performed by the forward-reverse selector valve 206, and the switching operation of the forward-reverse selector valve 206 is performed by the pilot valve 209.

[0049]

Each of the forward-reverse selector valve 206 and the pilot electromagnetic valve 209 can be switched among three positions, i.e., a clutch neutral position N, a forward clutch communication position F and a reverse clutch communication position R, the forward and reverse clutch communication positions F and R being disposed at left and right sides of the neutral position. The pilot valve 209 is communicated at an outlet port thereof with a left or right operation port of the forward-reverse selector valve 206.

[0050]

The pilot valve 209, when being at the clutch neutral position N, communicates the left and right operation ports of the forward-reverse selector valve 206 with the oil tank 207 so as to switch the forward-reverse selector valve 206 to the clutch neutral position N, so that the forward friction clutch 203 and the reverse friction clutch 204 are communicated with the oil tank 207, thereby disengaging the forward and reverse friction clutches 203 and 204.

[0051]

The pilot valve 209, when being switched to the forward clutch communication position F, communicates the hydraulic oil passage 210a with the right operation port of

the forward-reverse selector valve 206, so as to cause a pilot pressure for switching the forward-reverse selector valve 206 to the forward clutch communication position F. Therefore, the hydraulic oil passage 210a is communicated through the forward-reverse selector valve 206 with the forward friction clutch 203, thereby engaging the forward friction clutch 203.

[0052]

On the other hand, the pilot valve 209, when being switched to the reverse clutch communication position R, communicates the hydraulic oil passage 210a with the left operation port of the forward-reverse selector valve 206, so as to cause a pilot pressure for switching the forward-reverse selector valve 206 to the reverse clutch communication position R. Therefore, the hydraulic oil passage 210a is communicated through the forward-reverse selector valve 206 with the reverse friction clutch 204, thereby engaging the reverse friction clutch 204.

[0053]

The hydraulic oil supply circuit 200 is provided therein with a clutch delay valve 208b which prevents the forward or reverse friction clutch 203 or 204 on the turn from being suddenly engaged.

[0054]

As mentioned above, the hydraulic oil pressure regulating valve 208a is connected to the communication passage 309 so as to regulate the pressure of hydraulic oil by use of hydraulic oil from an on/off selector valve 211 formed integrally with the forward-reverse selector valve 206.

[0055]

The on/off selector valve 211 can be switched among three positions, i.e., a center neutral position N and left and right communication positions T, and is formed integrally with the forward-reverse selector valve 206 so as to be switched together with the forward-reverse selector valve 206.

[0056]

In this regard, when the forward-reverse selector valve 206 is set at the neutral position

N, the on/off selector valve 211 is also set at the neutral position N so as to communicate a back chamber of the release engage valve 208b with the oil tank 207 so that hydraulic oil (pressurized oil) is not supplied to the back chamber.

[0057]

Therefore, in this case, a spool of the hydraulic oil pressure regulating valve 208a is greatly withdrawn, so that the hydraulic oil pressure regulating valve 208a functions as a relief valve with low relief pressure, whereby hydraulic oil (pressurized oil) from the hydraulic pumps 202 is released from the communication passage 309 through the hydraulic oil pressure regulating valve 208a and is sent to the lubricating oil passage 303.

[0058]

On the other hand, when the forward-reverse selector valve 206 is switched to the forward clutch communication position F or the reverse clutch communication position R, the on/off selector valve 211 is switched to corresponding one of the communication positions T so as to communicate the back chamber of the release engage valve 208b with the hydraulic oil passage 210a, so that hydraulic oil is supplied to the back chamber.

[0059]

Therefore, this hydraulic oil gradually increases the relief pressure, so that each of the forward friction clutch 203 and the reverse friction clutch 204 is operated for its engagement by gradual increase of hydraulic pressure, thereby being prevented from being suddenly engaged.

[0060]

[Method for switching PTO friction clutch 213]

Next, explanation will be given on switching of the PTO friction clutch 213.

The switching operation of the PTO friction clutch 213 is performed by the clutch on/off valve 215.

A communication passage 310 is branched from the hydraulic oil passage 212a between the hydraulic pumps 202 and the clutch on/off valve 215, and a hydraulic oil regulating valve 214a is disposed on an intermediate portion of the communication passage 310. The hydraulic oil released from the hydraulic oil regulating valve 214a is

drained through a lubricating oil passage 304a, the third relief valve 306 and a lubricating oil passage 304b to the oil tank 207.

[0061]

The clutch on/off valve 215 can be switched among three positions, i.e., a clutch neutral position N, a clutch engaging communication position Y and a clutch disengaging communication position Z. The clutch on/off valve 215 is communicated at an outlet side port thereof through the hydraulic oil supply passage 212c with the PTO friction clutch 213, or through the hydraulic oil supply passage 212b with the neutral brake 216.

[0062]

The clutch on/off valve 215, when being at the clutch neutral position N, communicates the PTO friction clutch 213 and the neutral brake 216 with the oil tank 207, thereby disengaging the clutch and releasing the brake.

[0063]

The clutch on/off valve 215, when being switched to the clutch engaging communication position Y, communicates the hydraulic oil passage 212a with the hydraulic oil supply passage 212c so as to supply hydraulic oil to the PTO friction clutch 213, thereby engaging the PTO friction clutch 213, and simultaneously, communicates the hydraulic oil supply passage 212b with the oil tank 207, thereby releasing the neutral brake 216.

[0064]

Similarly to the forward and reverse friction clutches 203 and 204, to prevent the PTO friction clutch 213 on the turn from being suddenly engaged, a clutch delay valve 214b is provided with the hydraulic oil regulating valve 214a between the hydraulic oil passage 212a and the lubricating oil passage 304a. A back chamber of the release engage valve 214b is communicated with the hydraulic oil supply passage 212c to the PTO friction clutch 213.

[0065]

In this regard, the clutch on/off valve 215, when being at the clutch neutral position N or the clutch disengaging communication position Z, communicates the back chamber of

the release engage valve 214b with the oil tank 207 through the hydraulic oil supply passage 212c. In this case, the relief pressure of the hydraulic oil regulating valve 214a is low. When the clutch on/off valve 215 is set at the clutch neutral position N, hydraulic oil delivered from the hydraulic pumps 202 to the communication passage 310 is drained through the hydraulic oil regulating valve 214a to the lubricating oil passage 304a. When the clutch on/off valve 215 is set at the clutch disengaging communication position Z, a surplus of hydraulic oil applying the neutral brake 216 is drained through the hydraulic oil regulating valve 214a to the lubricating oil passage 304a.

[0066]

On the other hand, when the clutch on/off valve 215 is switched to the clutch engaging communication position Y, the PTO friction clutch 213 is communicated with the back chamber of the release engage valve 214b. When the PTO friction clutch 213 is going to be engaged, the hydraulic oil is supplied to the back chamber of the release engage valve 214b so that the relief pressure of the hydraulic oil regulating valve 214a is increased gradually so as to increase operation pressure to the PTO friction clutch 213, thereby preventing the clutch from being suddenly engaged.

[0067]

When the clutch on/off valve 215 is switched to the clutch disengaging communication position Z, the hydraulic oil passage 212a is communicated with the hydraulic oil supply passage 212b so as to apply the neutral brake 216. Simultaneously, the PTO friction clutch 213 is communicated with the oil tank 207 so as to be disengaged.

[0068]

The above-mentioned hydraulic control mechanism 100, in this embodiment, has the source pressure distribution plate 51, on which extraction ports for detecting pressures of the hydraulic oil and of the lubricating oil are collected, thereby facilitating attachment of pressure sensors and pressure indicators, and shortening pipes.

[0069]

[Source pressure distribution plate 51 and instrument distribution plate 54]

Next, referring to Figs. 3, 4, 6 and 7, explanation will be given on details of the source

pressure distribution plate 51 and the instrument distribution plate 54. Hereinafter, right and left directions are defined on an assumption that an arrow A in Figs. 3, 4 and 6 is directed forward.

The source pressure distribution plate 51 is made of a rectangular parallelepiped member, and is formed therein with a plurality of oil passages 60 and 61. The external form of the source pressure distribution plate 51 is not limited to that of this embodiment, and it may alternatively be polygonal, cylindrical or another form only if it can have the plurality of oil passages.

[0070]

As shown in Fig. 6, a front portion of the source pressure distribution plate 51 has extraction ports 60a, 60b and 60c opened on side and upper surfaces thereof and is provided therein with the oil passage 60 communicating with the extraction ports 60a, 60b and 60c. A rear portion of the source pressure distribution plate 51 has extraction ports 61a, 61b and 61c opened on side and upper surfaces thereof and is provided therein with the oil passage 61 communicating with the extraction ports 61a, 61b and 61c.

[0071]

The extraction port 60a is connected to the bypass passage 307a, is led to the communication passage 309 (see Fig. 5), and then is communicated with the hydraulic oil pressure regulating valve 208a. The extraction port 60b is connected to the pressure sensor 52a through the piping passage 307e, and the extraction port 60c is connected to the pressure indicator 53a through the piping passage 307d.

On the other hand, the extraction port 61a is connected to the bypass passage 307b and is led to the lubricating oil passage 303b (see Fig. 4). The extraction port 61b is connected to the second relief valve 305 through the piping passage 308, the extraction port 61c is connected to the pressure sensor 52b through the piping passage 307c, and an extraction port 61d is connected to the pressure indicator 53b through the piping passage 307c.

[0072]

As shown in Fig. 4, the source pressure distribution plate 51 is detachably attached to

the center portion of the upper surface of the housing case 7 by bolts or the like. The source pressure distribution plate 51 is provided forward therefrom with the pressure sensor 52a, rearward therefrom with the second relief valve 305, rightward therefrom with the forward-reverse selector valve 206 and the pilot electromagnetic valve 209, leftward therefrom with the pressure indicators 53a and 53b, and leftwardly forward therefrom with the pressure sensor 52b.

[0073]

Accordingly, the pressure sensors, the pressure indicators, the selector valve and the like are arranged so as to surround the source pressure distribution plate 51, thereby shortening pipes, facilitating connection of the instruments, and reducing pressure loss.

[0074]

As mentioned above, according to the present invention, in the hydraulic device of the marine reduction and reverse gear apparatus 1, including the forward and reverse friction clutches (hydraulic clutches) 203 and 204 and the forward-reverse selector valve (selector valve) 206 operated for engaging and disengaging the friction clutches (hydraulic clutches) 203 and 204, the hydraulic oil passage 210a extends between the forward-reverse selector valve (selector valve) 206 and the hydraulic pumps (hydraulic pressure sources) 202, and the communication passage extends from the hydraulic oil passage 210a to the lubricating oil passage 303a. The piping passage (oil passage) 307e for detecting the pressure of the hydraulic oil passage 210a and the piping passage (oil passage) 307f for detecting the pressure of the lubricating oil passage are connected to the source pressure distribution plate 51, the source pressure distribution plate 51 is disposed on the substantially center portion of the hydraulic instrument mounting surface 10 of the marine reduction and reverse gear 1, and the forward-reverse selector valve (selector valve) 206 and the pressure detection means, including the pressure sensors 52a, 52b, ... are disposed on the hydraulic instrument mounting surface 10 so as to surround the source pressure distribution plate 51.

[0075]

Therefore, due to the piping of the bypass passage 307a branching from the hydraulic

oil portion of the communication passage 309 communicating the hydraulic oil passage 210a with the lubricating oil passage 303a, the hydraulic oil having the source pressure is introduced into the source pressure distribution plate 51. On the other hand, due to the piping of the parallel passage 307b branching from the lubricating oil portion of the communication passage 309, the lubricating oil having the source pressure is introduced into the source pressure distribution plate 51.

[0076]

Due to these bypass passages 307a and 307b, the extraction ports for hydraulic oil having the source pressures in the two hydraulic oil routes and for lubricating oil having the source pressure can be collected onto the source pressure distribution plate 51. Accordingly, the pipes to the instruments, such as the pressure sensor 52a, arranged on the upper surface of the housing case 7, is shortened and no complex piping route is required, thereby economically reducing the number of parts and the number of assembly processes.

[0077]

In a conventional hydraulic circuit as shown in Fig. 8, the pressure sensors 52a and 52b, the pressure indicators 53a and 53b and the like are scattered on pipes, and require respective extraction ports for hydraulic oil and lubricating oil, thereby greatly complicating piping routes. However, in the present embodiment, by providing the source pressure distribution plate 51, the pipes to the pressure sensors 52a and 52b, the pressure indicators 53a and 53b and the like can be collected into the vicinity of the source pressure distribution plate 51.

[0078]

As a result, the piping routes for hydraulic oil and lubricating oil are simplified, thereby facilitating work for piping for the detection of the pressure sensors 52a and 52b, and thereby economically reducing the number of assembly processes.

[0079]

In future case that an additional pressure sensor or the like is needed in correspondence to change of specification of the marine reduction and reverse gear apparatus 1 or the like,

a new pipe can be easily connected to a spare extraction port opened on the source pressure distribution plate 51 or easily branched and passed through the source pressure distribution plate 51. If a sensor is removed, the outlet port can be closed by a plug or the like.

[0080]

The plurality of pressure sensors 52b for detecting pressure in the lubricating oil passage 303 are attached to only the instrument distribution plate 54, and the pressure sensor 52b are communicated through the instrument distribution plate 54 and the source pressure distribution plate 51 to the bypass passage 307b.

[0081]

Referring to Fig. 7, the instrument distribution plate 54 is a rectangular member which is L-like shaped when viewed in front, and is provided in one side portion thereof with a through hole 54a which is extended along the lengthwise direction of the one side portion of the instrument distribution plate 54. One end of the through hole 54a is communicated through the piping passage 307f with the source pressure distribution plate 51 (see Fig. 4), and the other end of the through hole 38a is closed by a plug or the like.

[0082]

A plurality of communication holes 54b (see Fig. 4) extend perpendicular to the through hole 54a, and are opened on an upper surface of the instrument distribution plate 54 at predetermined intervals. The communication holes 54b are communicated through the piping members 55 with the pressure sensors 52b, and the pressure sensors 52b are provided on the apparatus distribution plate 54 sideward from the respective communication holes 54b so as to be aligned in parallel. Accordingly, the source pressure distribution plate 51 is communicated with the pressure sensors 52b through the through hole 38a, the communication holes 54b and the piping members 55.

[0083]

As mentioned above, the instrument distribution plate 54 is arranged in the vicinity of the source pressure distribution plate 51 and is communicated through the piping with the source pressure distribution plate 51, and the plurality of pressure sensors (pressure

detection means) 52b for the detection of pressure in the lubricating oil passage 303 are disposed on the instrument distribution plate 54, whereby the pressure sensors 52b can economically be connected to the lubricating oil passage 303 without any complex piping member.

[0084]

Another spare communication hole 54b may be provided in the instrument distribution plate 54 to correspond to future addition of a pressure sensor or the like according to change of specification of the marine reduction and reverse gear apparatus 1 or for another reason, thereby requiring no other additional extraction hole for the additional pressure sensor.

[0085]

Next, explanation will be given on electric power supply of the marine reduction and reverse gear.

Fig. 1 is a perspective rear view of an entire construction of a marine reduction and reverse gear apparatus according to an embodiment of the present invention. Fig. 2 is a rear view of the entire construction. Fig. 9 is a sectional side view of the entire construction. Fig. 10 is a sectional plan view of a gear arrangement of the marine reduction and reverse gear apparatus. Fig. 11 is a perspective view of the gear arrangement. Fig. 12 is a perspective view of surroundings of a second PTO output shaft. Fig. 13 is a plan view of the surroundings of the second PTO output shaft. Figs. 14 are sectional views of the second PTO output shaft. Figs. 15 show arrangement relation between the second PTO output shaft and a countershaft.

Fig. 16 is a perspective rear view of an entire construction of a marine reduction and reverse gear apparatus provided with an observation window according to another embodiment of the present invention. Figs. 17 are plan and rear views of the observation window. Fig. 18 is a perspective view of an alternative observation window.

[0086]

[Housing case 7]

Firstly, referring to Figs. 1 and 2, explanation will be given on construction of the

housing case 7 of the marine reduction and reverse gear apparatus 1.

[0087]

As shown in Fig. 2, in the housing case 7, the input shaft 2, the output shaft 3, the first PTO output shaft 4, the second PTO output shaft 5 and the countershaft 6 are rotatably supported and extended in the fore-and-aft direction. The housing case 7 is vertically dividable into three parts, i.e., an upper housing case 31, a center housing case 32 and a lower housing case 33.

[0088]

The upper housing case 31 and the center housing case 32 have a downwardly rightward slanted parting face therebetween. The first PTO output shaft 4, the input shaft 2 and the countershaft 6 are rotatably supported on the parting face through respective bearings so that they are aligned in this order from the left side. Namely, the first PTO output shaft 4, the input shaft 2 and the countershaft 6 are arranged in parallel so as to have their respective axes on the parting face. The input shaft 2 is arranged at the lateral center of the housing case 7, and the output shaft 3 is disposed in parallel below the input shaft 2.

[0089]

The output shaft 3 is arranged on a lateral center portion of a parting face between the center housing case 32 and the lower housing case 33, so as to be rotatably supported longitudinally horizontally in a lateral center portion of the housing case 7 through bearings.

[0090]

A second PTO housing case 35 is disposed on a right side portion of the upper housing case 31, and the second PTO output shaft 5 is rotatably supported through bearings on a parting face between the upper housing case 31 and the second PTO housing case 35.

[0091]

[Gear arrangement]

Next, referring to Figs. 9 to 11, explanation will be given on a gear arrangement housed in the housing case 7.

[0092]

The input shaft 2 is projected forward from the housing case 7 and is connected to the output shaft of the engine. In the housing case 7, the input shaft 2 is fixedly provided thereon with a PTO output gear 17 and a forward gear 19 aligned in this order from the front side, and is relatively rotatably provided thereon with a forward pinion gear 20 rearward from the forward gear 19. The PTO output gear 17 is meshed at an upper left portion thereof with a first PTO gear 18 fixed on the first PTO output shaft 4, and the forward gear 19 is meshed at a lower right portion thereof with a reverse gear 27 fixed on the countershaft 6. The reverse gear 27 is meshed at an upper right portion thereof with a second PTO gear 30 fixed on the second PTO output shaft 5.

[0093]

The input shaft 2 is provided with the hydraulic clutch (forward friction clutch) 203 between the forward gear 19 and the forward pinion gear 20. The countershaft 6 is relatively rotatably provided thereon with a reverse pinion gear 29 rearward from the reverse gear 27, and is provided with the hydraulic clutch (rearward friction clutch) 204 between the reverse gear 27 and the reverse pinion gear 29. The first PTO shaft 4 is provided with the hydraulic clutch (PTO friction clutch) 213 rearward from the first PTO gear 18.

[0094]

The forward pinion gear 20 and the reverse pinion gear 29 are meshed with an output gear 21 fixed on the output shaft 3. The output shaft 3 is projected rearward from the housing case 7 and is connected to the screw 502.

[0095]

The first PTO output shaft 4 has a rear portion projected rearward from the housing case 7 and connected to the main electricity generator 503.

[0096]

The second PTO output shaft 5 is extended through the second PTO gear 30, and the second PTO output shaft 5 is connected to the auxiliary electricity generator 504 at an end portion thereof opposite to the second PTO gear 30. As discussed later, the second PTO

output shaft 5 is detachably attached to the housing case 7.

[0097]

In this gear arrangement, when the hydraulic clutch 203 is engaged and the hydraulic clutch 204 is disengaged, the driving power of the engine 501 is transmitted from the input shaft 2 through the forward pinion gear 20 to the output gear 21, and the output shaft 3 is rotated in the opposite direction to the input shaft 2.

[0098]

Further, when the hydraulic clutch 203 is disengaged and the hydraulic clutch 204 is engaged, the driving power of the engine 501 is transmitted from the forward gear 19 on the input shaft 2 to the reverse gear 27 and then transmitted from the reverse pinion gear 29 on the countershaft 6 to the output gear 21, and the output shaft 3 is rotated in the same direction with the input shaft 2.

[0099]

On the other hand, the driving power of the engine 501 is constantly transmitted through the PTO output gear 17 to the first PTO gear 18. When the hydraulic clutch 213 is engaged, the driving power is transmitted to the main electricity generator 503, and when the hydraulic clutch 213 is disengaged, the driving power is not transmitted to the main electricity generator 503.

[0100]

The construction of the first PTO output shaft 4 in this embodiment with the hydraulic clutch 213 for on/off switching of transmission of the driving power to the main electricity generator 503 is not limitative. Namely, alternatively, the first PTO output shaft 4 may be provided without the hydraulic clutch 213, so as to constantly transmit the driving power to the main electricity generator 503.

[0101]

The driving power of the engine 501 is transmitted through the forward gear 19 and the reverse gear 27 to the second PTO gear 30, and the second PTO output shaft 5 drives the auxiliary electricity generator 504.

[0102]

[Second PTO housing case 35]

Next, referring to Figs. 12 to 15, explanation will be given on the second PTO housing case 35 incorporating the second PTO gear 30 and the second PTO output shaft 5 . Hereinafter, right and left directions are defined on an assumption that an arrow A in Figs. 12 and 13 is directed forward.

[0103]

The above-mentioned right side portion of the upper housing case 31 is formed with a fore-and-aft elongated rectangular opening 31a substantially upward from the countershaft 6 (see Fig. 13), and the opening 31a is closed by the second PTO housing case 35.

[0104]

Namely, the second PTO housing case 35 is detachably fixed to the upper housing case 31, the second PTO output shaft 5 is rotatably supported through bearings by the second PTO housing case 35, and the second PTO gear 30 is fixed on the second PTO output shaft 5 and meshed with the reverse gear 27 on the countershaft 6.

[0105]

The second PTO housing case 35 is mainly formed by a casing member 36, which forms a main body, and a front lid member 37 and a rear lid member 38, which are provided at front and rear ends of the casing member 36.

[0106]

The casing member 36 is formed integrally with a fore-and-aft elongated rectangular basal part 36a and with a shaft cover part 36b, which is formed on the center of a plane surface of the basal part 36a so as to extend along the elongated direction of the basal part 36a.

[0107]

The shaft cover part 36b is shaped into a half part of a cylindrical member divided into halves along the axis, and is formed at front and rear ends thereof with holder parts 36c and 36d for fixedly holding respective bearings 16.

[0108]

In this regard, as shown in Fig. 14(a), the holder part 36d is formed in a substantially half doughnut-like shape when viewed in front so as to have concentric inner and outer peripheral surfaces 36f and 36g. The inner peripheral surface 36f is semicircular and has substantially the same dimension as the external dimension of the bearing 16. The outer peripheral surface 36g is semicircular and has substantially the same dimensions as the external dimensions of the later-discussed rear lid member 38. The holder part 36d is provided therein with a plurality of tapped holes, which are aligned radially with respect to the common center, on a rear surface of the holder part 36d between the inner peripheral surface 36f and the outer peripheral surface 36g, and the rear lid member 38 is attached through these tapped holes to the rear portion of the casing member 36.

[0109]

As shown in Fig. 14(b), the shaft cover part 36b is protuberantly formed on the vertical center portion of the basal part 36a so as to have a semicircular section whose inner diametrical dimension is slightly larger than the sectional dimension of the second PTO output shaft 5. As shown in Fig. 14(c), the shaft cover part 36b is formed at a front portion thereof with an expanded part 36e that is expanded outward so as to have a polygonal sectional shape, thereby being prevented from interfering with the second PTO gear 30.

[0110]

Furthermore, the holder part 36c shown in Fig. 14(d) is provided on a front end surface of the expanded part 36e. The holder part 36c is formed in a substantially half doughnut-like shape when viewed in front so as to have concentric inner and outer peripheral surfaces 36h and 36i. The inner peripheral surface 36h is semicircular so as to have substantially the same dimension as the external dimension of the bearing 16. The outer peripheral surface 36i is semicircular so as to have substantially the same dimension as the external dimension of the later-discussed front lid member 37. The holder part 36c is provided with a plurality of tapped holes, which are aligned radially with respect to the common center, on a front surface of the holder part 36c between the inner peripheral surface 36h and the outer peripheral surface 36i, and the front lid member

37 is attached through these tapped holes to the front portion of the casing member 36.

[0111]

On the other hand, the upper housing case 31 is provided forward and backward from the opening 31a therein with respective semicircular recesses 31b and 31c having substantially the same dimensions as the external dimensions of the respective bearings 16 when viewed in front. The casing member 36 is attached to the upper housing case 31 so as to close the opening 31a, so that the recesses 31b and 31c coincide to the respective inner peripheral surfaces 36h and 36f provided in the respective front and rear holder parts 36c and 36d, thereby forming circular through holes.

[0112]

The front lid member 37 is a discoid member having a cylindrical projection part 37a projecting slightly from the rear surface of the front lid member 37, as shown in Fig 13. The external dimension of the projection part 37a is substantially the same as the external dimension of the corresponding bearing 16.

[0113]

The front lid member 37 is provided with a plurality of through holes aligned peripherally at regular intervals. The front lid member 37 is detachably attached to the front portion of the casing member 36 by fastening members, such as bolts, through the through holes, and the projection part 37a is fitted onto the inner peripheral surface 36h of the holder part 36c so as to restrain movement of the bearing 16 in the axial direction.

[0114]

The rear lid member 38 is a discoid member that is provided in the center portion thereof with the through hole 38a having substantially the same dimension as the external dimension of the second PTO output shaft 5. The rear lid member 38 is provided with a cylindrical projection part 38b projecting slightly from the rear surface thereof. The external dimension of the projection part 38b is substantially the same as the external dimension of the corresponding bearing 16.

[0115]

The rear lid member 38 is provided therein with a plurality of through holes aligned

peripherally at regular intervals. The rear lid member 38 is detachably attached to the rear portion of the casing member 36 by fastening members, such as bolts, through these through holes, and the projection part 38b is fitted onto the inner peripheral surface 36f of the holder part 36d so as to restrain movement of the bearing 16 in the axial direction.

[0116]

Due to the second PTO housing case 35 having the above construction, the second PTO output shaft 5 is detachably attached to the right side portion of the upper housing case 31, and the second PTO gear 30 is meshed with the reverse gear 27 through the opening 31a.

[0117]

In this regard, the bearings 16 and the second PTO gear 30 are previously fixed on the second PTO output shaft 5, and each of the bearings 16 is clamped between each of the inner peripheral surfaces 36h and 36f provided in the respective front and rear holder parts 36c and 36d of the second PTO housing case 35 and each of the recesses 31b and 31c provided on the opening 31a, thereby journaling the second PTO output shaft 5 in the upper housing case 31.

[0118]

Then, the front and rear lid members 37 and 38 are attached so as to locate the second PTO output shaft 5 in the longitudinal direction, thereby surely meshing the second PTO gear 30 with the reverse gear 27.

[0119]

Incidentally, this embodiment is easily changeable to another specification having another high-speed driven auxiliary electricity generator 504. For example, the construction mainly shown in this embodiment in which the auxiliary electricity generator 504 is driven at 1500 rpm (see Fig. 15(a)) can be changed to another construction in which the auxiliary electricity generator 504 is driven at 1800 rpm (see Fig. 15(b)).

[0120]

In this regard, to ensure a high rotational speed, the number of teeth of the second PTO gear 30 must be reduced so as to reduce the radius. Therefore, the second PTO output shaft 5 is supported more close to the countershaft 6 so as to mesh the second PTO gear

30 with the reverse gear 27.

[0121]

Therefore, only the required things are that the front and rear lid members 37 and 38 for axially locating the second PTO output shaft 5 are exchanged for another rear lid member 38 whose through hole 38a and projection part 38b are more close to the countershaft 6, and another front lid member 37 whose projection part 37a is more close to the countershaft 6, and that the second PTO housing case 35 supporting the second PTO output shaft 5 on which another second PTO gear 30 having fewer teeth is supported is fixed to the upper housing case 31.

[0122]

Even in this case, the casing member 36 does not need to change its external shape, however, this alternative construction can be easily realized by simply changing positions, dimensions and the like in forming the holder parts 36c and 36d and the inner peripheral surfaces 36f and 36h on the casing member 36 and in forming the recesses 31b and 31c on the upper housing case 31.

[0123]

A sealing member 39 is provided in the through hole 38a of the rear lid member 38. The second PTO output shaft 5 is extended rearward through the through hole 38a and is connected at an end portion thereof to the input shaft 2 of the auxiliary electricity generator 504.

[0124]

As mentioned above, the marine reduction and reverse gear apparatus 1 including the input shaft 2, the output shaft 3, the first PTO shaft 4, the countershaft 6, the housing case 7, and the second PTO shaft. The input shaft receives the driving power of the engine 501. The output shaft 3 transmits the driving power, which is speed-reduced and reversed, to the propeller 502. The first PTO output shaft 4 is connected to the main electricity generator 503 so as to transmit the driving power to the main electricity generator 503. The countershaft 6 reverses and transmits the driving power to the output shaft 3. The housing case 7 supports the input shaft 2, the output shaft 3, the first PTO

output shaft 4 and the countershaft 6, so that the input shaft 2 is arranged in parallel between the first PTO output shaft 4 and the countershaft 6. In the main reduction and reverse gear apparatus 1, the second PTO output shaft 5 is provided in parallel on the outer side portion of the housing case 7 outward from the countershaft 6, and the second PTO output shaft 5 is connected to the auxiliary electricity generator 504 for small electric power supply. Accordingly, electric power used for the ship can be supplied without additionally providing a power generation equipment in correspondence to how it is used, thereby improving economical efficiency.

[0125]

In this regard, the main electricity generator 503 must have a large generation capacity for driving equipments consuming a lot of electricity, e.g., a side thruster and an anchor-hoisting winch. If only the main electricity generator 503 is used to supply electric power for all items of the ship as usual, it results in that the main electricity generator 503 should also perform insufficient electric power supply for comparatively small electricity consumption, e.g., for inboard lighting or as a power source for operating operation devices.

[0126]

Therefore, according to the present invention, for small electric power supply, the auxiliary electricity generator 504 whose generation capacity is considerably small is additionally provided so that either of the generators 503 and 504 is selectively operated in correspondence to how the electric power is used, thereby improving efficiency in supply of electric power.

[0127]

The auxiliary electricity generator 504 is connected to the marine reduction and reverse gear apparatus 1 having the main electricity generator 503 connected thereto, so that the engine 501 serves as a common power source for both the generators 503 and 504, thereby requiring no additional equipment, such as an engine, to serve as a power source of the auxiliary electricity generator 504.

[0128]

The opening 31a is provided in the side surface of the housing case 7 outward from the countershaft 6, the second PTO housing case 35 supporting the second PTO output shaft 5 is detachably attached to the opening 31a, and the second PTO output shaft 5 is interlockingly connected to the countershaft 6 through the gears (the second PTO gear 30 and the reverse gear 27). Accordingly, the main reduction and reverse gear apparatus 1 can be easily provided with the second PTO output shaft 5 for the auxiliary electricity generator 504 without elaborate change of design.

[0129]

The first PTO output shaft 4, the input shaft 2 and the countershaft 6 are arranged on the same slanted surface that becomes lower as approaching the countershaft 6, and the second PTO output shaft 5 is disposed slantwise upward from the countershaft 6. Accordingly, the second PTO output shaft 5 can be disposed within the lateral width of the housing case 7 so that the marine reduction and reverse gear apparatus 1 does not have to form an additional sideward projecting part, thereby compacting the housing case 7.

[0130]

Furthermore, the housing case 7 is divided into upper and lower parts by a parting face on which respective axes of the first PTO output shaft 4, the input shaft 2 and the countershaft 6 are joined to each other, and the first PTO output shaft 4, the input shaft 2 and the countershaft 6 are rotatably supported on the parting face. Accordingly, the first PTO output shaft 4, the input shaft 2 and the countershaft 6 can easily be installed into the housing case 7, thereby reducing the number of assembly processes and thereby reducing costs.

[0131]

[Observation window 41]

Next, referring to Figs. 16 to 18, explanation will be given on an observation window 41 that is another embodiment of the present invention. Hereinafter, right and left directions are defined on an assumption that an arrow A in Figs. 16 to 18 is directed forward.

[0132]

The observation window 41 is constructed with the opening 31a when the auxiliary electricity generator 504 is not provided at an operator's request or for another reason. The observation window 41 mainly includes a basal member 42 and two lid members 43.

[0133]

The basal member 42 is a plate member elongated in the fore-and-aft direction, and is formed on a center portion thereof with a rectangular step part 42a. Furthermore, two square openings 42b are formed in a surface of the step part 42a so as to be aligned in the elongated direction of the basal member 42, thereby constituting the observation window 41.

[0134]

The lid members 43, each of which is a rectangular plate member, are fixed to the respective square openings 42b by fastening members such as bolts.

[0135]

Due to the inspection window 41 constructed as mentioned above, daily inspection, check of the inside of the marine reduction and reverse gear apparatus 1 when being suddenly troubled, or the like can be performed easily only by detaching the lid members 43. Further, due to the basal member 42 provided onto the opening 31a of the upper housing case 31, the surroundings of the opening 31a can be improved in rigidity.

[0136]

In another alternative embodiment, a slidable lid member 44 may be provided.

In this regard, as shown in Fig. 18, a pair of upper and lower rectangular members 45, L-like shaped when viewed in section, are extended in the fore-and-aft direction so as to face their recesses to each other, and are fixed onto the upper and lower surfaces of the step part 42a of the basal member 42, and the rectangular lid member 44 is provided so as to be slidable longitudinally in the recesses.

[0137]

According to the construction, when an operator inspects the inside of the marine reduction and reverse gear apparatus 1 or in another case, it is not necessary to loosen a

plurality of bolts for detaching the lid member 44, thereby improving maintenanceability.

Industrial Applicability

[0138]

The technical arts regarding piping passages of a hydraulic device and regarding input and output shafts for transmitting inboard power supply according to the present invention is widely adaptable to marine reduction and reverse gear apparatuses.

Claims

1. A marine reduction and reverse gear apparatus, comprising:
 - an input shaft for receiving a driving power of an engine;
 - an output shaft for transmitting the driving power, which is speed-reduced and reversed, to a propeller;
 - a first PTO output shaft connected to an electricity generator so as to transmit the driving power to the electricity generator;
 - a countershaft for reversing and transmitting the driving power to the output shaft;
 - a housing case supporting the input shaft, the output shaft, the first PTO output shaft and the countershaft, wherein the input shaft is arranged in parallel between the first PTO output shaft and the countershaft; and
 - a second PTO output shaft provided in parallel on an outer side portion of the housing case outward from the countershaft,
 - characterized in that the first PTO output shaft, the input shaft and the countershaft are aligned on the same slanted surface that becomes lower as approaching the countershaft, and wherein the second PTO output shaft is disposed slantwise upward from the countershaft.
2. The marine reduction and reverse gear apparatus according to claim 1, further comprising:
 - an opening provided in a side surface of the housing case outward from the countershaft;
 - a second PTO housing case supporting the second PTO output shaft and detachably attached to the opening; and
 - a gear through which the second PTO output shaft is interlockingly connected to the countershaft.
3. The marine reduction and reverse gear apparatus according to claim 1 or 2, further comprising:
 - forward and reverse hydraulic clutches;

a selector valve operated for engaging and disengaging the forward and reverse hydraulic clutches;

a hydraulic pressure source;

a hydraulic oil passage extending between the hydraulic pressure source and the selector valve;

a lubricating oil passage;

a communication passage extending from the hydraulic oil passage to the lubricating oil passage;

an oil passage for detecting a pressure of the hydraulic oil passage;

an oil passage for detecting a pressure of the lubricating oil passage;

pressure detection means for detecting the pressures;

a mounting surface of the marine reduction and reverse gear apparatus for mounting hydraulic instruments thereon; and

a source pressure distribution plate, to which the oil passage for detecting the pressure of the hydraulic oil passage and the oil passage for detecting the pressure of the lubricating oil passage are connected,

wherein the source pressure distribution plate is disposed on a substantially center portion of the mounting surface, and the selector valve and the pressure detection means are disposed on the mounting surface so as to surround the source pressure distribution plate.

4. The marine reduction and reverse gear according to claim 3, further comprising:

an instrument distribution plate arranged adjacent to the source pressure distribution plate, and communicated with the source pressure distribution plate through piping, and

a plurality of pressure detection means for detecting pressure of the lubricating oil passage, wherein the plurality of pressure detection means are disposed on the instrument distribution plate.

5. A marine reduction and reverse gear apparatus, comprising:

an input shaft for receiving a driving power of an engine;

an output shaft for transmitting the driving power, which is speed-reduced and reversed, to a propeller;

a first PTO output shaft connected to an electricity generator so as to transmit the driving power to the electricity generator;

a countershaft for reversing and transmitting the driving power to the output shaft;

a housing case supporting the input shaft, the output shaft, the first PTO output shaft and the countershaft, wherein the input shaft is arranged in parallel between the first PTO output shaft and the countershaft; and

a second PTO output shaft provided in parallel on an outer side portion of the housing case outward from the countershaft,

characterized in that the housing case is divided into upper and lower parts by a parting face on which respective axes of the first PTO output shaft, the input shaft and the countershaft are joined to each other, and the first PTO output shaft, the input shaft and the countershaft are rotatably supported on the parting face.

6. The marine reduction and reverse gear apparatus according to claim 5, further comprising:

an opening provided in a side surface of the housing case outward from the countershaft;

a second PTO housing case supporting the second PTO output shaft and detachably attached to the opening; and

a gear through which the second PTO output shaft is interlockingly connected to the countershaft.

7. The marine reduction and reverse gear apparatus according to claim 5 or 6, further comprising:

forward and reverse hydraulic clutches;

a selector valve operated for engaging and disengaging the forward and reverse hydraulic clutches;

a hydraulic pressure source;

a hydraulic oil passage extending between the hydraulic pressure source and the selector valve;

a lubricating oil passage;

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a communication passage extending from the hydraulic oil passage to the lubricating oil passage;

an oil passage for detecting a pressure of the hydraulic oil passage;

an oil passage for detecting a pressure of the lubricating oil passage;

pressure detection means for detecting the pressures;

a mounting surface of the marine reduction and reverse gear apparatus for mounting hydraulic instruments thereon; and

a source pressure distribution plate, to which the oil passage for detecting the pressure of the hydraulic oil passage and the oil passage for detecting the pressure of the lubricating oil passage are connected,

wherein the source pressure distribution plate is disposed on a substantially center portion of the mounting surface, and the selector valve and the pressure detection means are disposed on the mounting surface so as to surround the source pressure distribution plate.

8. The marine reduction and reverse gear according to claim 7, further comprising:

an instrument distribution plate arranged adjacent to the source pressure distribution plate, and communicated with the source pressure distribution plate through piping, and

a plurality of pressure detection means for detecting pressure of the lubricating oil passage, wherein the plurality of pressure detection means are disposed on the instrument distribution plate.