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Outboard motor

Abstract

An outboard motor includes an upper case, a lower case, a transmission, a clutch, a cooling water passage, a first pump, and a second pump. The transmission is operable to transmit the driving force of the engine. The clutch is connected to the transmission. The cooling water passage is connected to the engine. The cooling water passage is located in the upper case and the lower case. The first pump is connected to the transmission via the clutch. The first pump is driven by the driving force of the engine to send cooling water to the engine through the cooling water passage. The second pump is connected to the transmission. The second pump is driven by the driving force of the engine to send the cooling water to the engine through the cooling water passage.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS
(1) This application claims the benefit of priority to Japanese Patent Application No. 2022-075993 filed on May 2, 2022. The entire contents of this application are hereby incorporated herein by reference.
BACKGROUND OF THE INVENTION
1. Field of the Invention
(2) The present invention relates to an outboard motor.
2. Description of the Related Art
(3) An outboard motor includes a cooling water passage and a pump for supplying cooling water to the engine. A water intake is provided at the bottom of the outboard motor, and the cooling water passage is connected to the engine and the water intake. The pump delivers the cooling water to the engine through the cooling water passage.
(4) For example, the outboard motor disclosed in JP-A-2016-5927 includes a first pump and a second pump. The first pump and the second pump are connected to the drive shaft. The drive shaft

is connected to the crankshaft of the engine. The driving force from the engine rotates the drive shaft to drive the first pump and the second pump. Thus, the first pump and the second pump send the cooling water to the engine through the cooling water passage.

(5) As mentioned above, if the water pump is driven by the driving force from the engine, the water pump will be driven whenever the engine is rotating, so even if cooling is not required, the cooling water will be supplied to the engine. In addition, since the amount of cooling water supplied changes according to the rotational speed of the engine, it is not easy to supply the engine with an amount of cooling water suitable for cooling the engine.

SUMMARY OF THE INVENTION

(6) Preferred embodiments of the present invention supply an appropriate amount of cooling water to outboard motors to cool engines of the outboard motors.

(7) An outboard motor according to a preferred embodiment of the present invention includes a bracket, an upper case, a lower case, a transmission, a clutch, a cooling water passage, a first pump, and a second pump. The outboard motor is attached to a watercraft via the bracket. The upper case is below the engine. The lower case is below the upper case. The transmission is operable to transmit the driving force of the engine. The clutch is connected to the transmission. The cooling water passage is connected to the engine. The cooling water passage is located in the upper case and the lower case. The first pump is connected to the transmission via the clutch. The first pump is driven by the driving force of the engine to send cooling water to the engine through the cooling water passage. The second pump is connected to the transmission. The second pump is driven by the driving force of the engine to send cooling water to the engine through the cooling water passage.

(8) In an outboard motor according to a preferred embodiment of the present invention, connection and disconnection between the first pump and the transmission are switched by the clutch. Thus, the clutch switches between a state in which the cooling water is supplied to the engine by both the first pump and the second pump, and a state in which the cooling water is supplied to the engine only by the second pump. Thus, an appropriate amount of cooling water is supplied to the engine to cool the engine.

(9) The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a side view of an outboard motor according to a preferred embodiment of the present invention.

(2) FIG. **2**A is an enlarged side view showing a portion of the outboard motor.

(3) FIG. **2**B is an enlarged side view showing a portion of the outboard motor.

(4) FIG. **2**C is an enlarged side view showing a portion of the outboard motor.

(5) FIG. **3** is a block diagram showing a cooling system of an outboard motor according to a first preferred embodiment of the present invention.

(6) FIG. **4** is a block diagram showing the cooling system of an outboard motor according to a second preferred embodiment of the present invention.

(7) FIG. **5** is a diagram showing a first example of an arrangement of a first pump and a second pump.

(8) FIG. **6** is a diagram showing a second example of the arrangement of the first pump and the second pump.

(9) FIG. **7** is a diagram showing a third example of the arrangement of the first pump and the

second pump.

(10) FIG. **8** is a diagram showing a fourth example of the arrangement of the first pump and the second pump.

(11) FIG. **9** is a diagram showing a fifth example of the arrangement of the first pump and the second pump.

(12) FIG. **10** is a diagram showing a sixth example of the arrangement of the first pump and the second pump.

(13) FIG. **11** is a diagram showing a seventh example of the arrangement of the first pump and the second pump.

(14) FIG. **12** is a diagram showing an eighth example of the arrangement of the first pump and the second pump.

(15) FIG. **13** is a diagram showing a ninth example of the arrangement of the first pump and the second pump.

(16) FIG. **14** is a diagram showing a tenth example of the arrangement of the first pump and the second pump.

(17) FIG. **15** is a diagram showing an eleventh example of the arrangement of the first pump and the second pump.

(18) FIG. **16** is a diagram showing a twelfth example of the arrangement of the first pump and the second pump.

(19) FIG. **17** is a diagram showing a thirteenth example of the arrangement of the first pump and the second pump.

(20) FIG. **18** is a diagram showing a fourteenth example of the arrangement of the first pump and the second pump.

(21) FIG. **19** is a block diagram showing a cooling system of an outboard motor according to a third preferred embodiment of the present invention.

(22) FIG. **20** is a diagram showing a fifteenth example of the arrangement of the first pump and the second pump.

(23) FIG. **21** is a diagram showing a sixteenth example of the arrangement of the first pump and the second pump.

(24) FIG. **22** is a diagram showing a seventeenth example of the arrangement of the first pump and the second pump.

(25) FIG. **23** is a diagram showing an eighteenth example of the arrangement of the first pump and the second pump.

(26) FIG. **24** is a diagram showing a nineteenth example of the arrangement of the first pump and the second pump.

(27) FIG. **25** is a diagram showing a twentieth example of the arrangement of the first pump and the second pump.

(28) FIG. **26** is a diagram showing a twenty-first example of the arrangement of the first pump and the second pump.

(29) FIG. **27** is a diagram showing a twenty-second example of the arrangement of the first pump and the second pump.

(30) FIG. **28** is a diagram showing a twenty-third example of the arrangement of the first pump and the second pump.

(31) FIG. **29** is a diagram showing a twenty-fourth example of the arrangement of the first pump and the second pump.

(32) FIG. **30** is a diagram showing a twenty-fifth example of the arrangement of the first pump and the second pump.

(33) FIG. **31** is an enlarged side view showing a portion of an outboard motor according to a fourth preferred embodiment of the present invention.

(34) FIG. **32** is a block diagram showing the cooling system of the outboard motor according to the

fourth preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(35) Preferred embodiments of the present invention will be described below with reference to the drawings. FIG. **1** is a side view of an outboard motor **1** according to a preferred embodiment. The outboard motor **1** includes a bracket **2**, an engine **3**, a transmission mechanism **4**, an engine cowl **5**, an upper case **6**, and a lower case **7**. The outboard motor **1** is attached to a watercraft via the bracket **2**.

(36) The engine **3** generates thrust to propel the watercraft. The engine **3** includes a crankshaft **11**. The crankshaft **11** extends in the vertical direction of the outboard motor **1**. The transmission mechanism **4** transmits the driving force of the engine **3** to a propeller **12**. The transmission mechanism **4** includes a drive shaft **8**, a propeller shaft **9**, and a shift mechanism **10**. The drive shaft **8** is connected to the crankshaft **11**. The drive shaft **8** extends in the vertical direction of the outboard motor **1**. The drive shaft **8** extends downward from the engine **3**.

(37) The propeller shaft **9** extends in the front-rear direction of the outboard motor **1**. The propeller shaft **9** is connected to the drive shaft **8** via the shift mechanism **10**. The propeller **12** is attached to the propeller shaft **9**. The shift mechanism **10** switches the transmission direction of rotation from the drive shaft **8** to the propeller shaft **9**. As a result, the watercraft is switched between forward and reverse.

(38) Specifically, the shift mechanism **10** includes a forward gear **41**, a reverse gear **42**, and a clutch **43**. The clutch **43** engages the forward gear **41** in the forward position shown in FIG. **2**A. As a result, the propeller shaft **9** rotates forward. The clutch **43** engages the reverse gear **42** in the reverse position shown in FIG. **2**B. As a result, the reverse gear **42** is connected to the propeller shaft **9** to connect the drive shaft **8** to the propeller shaft **9** via the reverse gear **42**. As a result, the propeller shaft **9** rotates in the reverse direction.

(39) The propeller shaft **9** is not connected to either the forward gear **41** or the reverse gear **42** when the clutch **43** is in the neutral position shown in FIG. **2**C. Thus, the drive shaft **8** and the propeller shaft **9** are disconnected. As described above, the shift mechanism **10** is in a driving state in which the driving force from the drive shaft **8** is transmitted to the propeller shaft **9** when the clutch **43** is in the forward position or the reverse position. When the clutch **43** is in the neutral position, the shift mechanism **10** is in a neutral state in which the driving force from the drive shaft **8** is not transmitted to the propeller shaft **9**.

(40) The engine **3** is disposed in the engine cowl **5**. The upper case **6** is disposed below the engine **3**. The lower case **7** is disposed below the upper case **6**. The drive shaft **8** is disposed in the upper case **6** and the lower case **7**. The propeller shaft **9** and the shift mechanism **10** are disposed in the lower case **7**. Specifically, the lower case **7** includes a torpedo portion **13**. The torpedo portion **13** has an outwardly bulging shape. The propeller shaft **9** and the shift mechanism **10** are disposed in the torpedo portion **13**. A cavitation plate **14** is connected to the lower case **7**. The cavitation plate **14** protrudes rearward from the lower case **7**.

(41) FIG. **3** is a block diagram showing a cooling system and a drive system of the outboard motor **1** according to a first preferred embodiment of the present invention. A dashed arrow in FIG. **3** indicates the cooling system of the outboard motor **1**. As shown in FIG. **3**, the engine **3** includes a water jacket **15**. The cooling water flowing through the water jacket **15** cools the engine **3**. The outboard motor **1** includes a cooling water passage **16** and a drain passage **17**. The cooling water passage **16** and the drain passage **17** are connected to the water jacket **15** of the engine **3**. The cooling water passage **16** and the drain passage **17** are disposed in the upper case **6** and the lower case **7**, for example.

(42) The cooling water is supplied from the outside of the outboard motor **1** to the water jacket **15** of the engine **3** through the cooling water passage **16**. The cooling water is discharged from the water jacket **15** to the outside of the outboard motor **1** through the drain passage **17** and a drain port **18**. The drain port **18** is provided in the lower case **7**, for example. Alternatively, the drain port **18**

may be provided in the upper case **6**.

(43) The cooling water passage **16** includes a water intake **21**, a first passage **22**, and a second passage **23**. The outboard motor **1** includes a first pump **25** and a second pump **26**. The water intake **21** is provided in the lower case **7**. The water intake **21** communicates with the outside of the outboard motor **1**. The cooling water is drawn into the cooling water passage **16** from the outside of the outboard motor **1** through the water intake **21**.

(44) The first passage **22** is connected to the water intake **21**. The first pump **25** is provided in the first passage **22**. The second passage **23** is connected to the water intake **21**. The second pump **26** is provided in the second passage **23**. The first passage **22** and the second passage **23** are connected to the water jacket **15**. The first pump **25** sends the cooling water to the engine **3** through the first passage **22**. The second pump **26** sends the cooling water to the engine **3** through the second passage **23**.

(45) In FIG. **3**, solid arrows indicate the drive system of the outboard motor **1**. As shown in FIG. **3**, the outboard motor **1** includes a clutch **28**. The clutch **28** is connected to the transmission mechanism **4**. The first pump **25** is connected to the transmission mechanism **4** via the clutch **28**. The second pump **26** is connected to the transmission mechanism **4**.

(46) Specifically, the first pump **25** is connected between the engine **3** and the shift mechanism **10** in the transmission mechanism **4** via the clutch **28**. The second pump **26** is connected between the engine **3** and the shift mechanism **10** in the transmission mechanism **4**. For example, the first pump **25** is connected to the crankshaft **11** or the drive shaft **8** via the clutch **28**. The second pump **26** is connected to the crankshaft **11** or the drive shaft **8**.

(47) The clutch **28** is, for example, a centrifugal clutch. Alternatively, the clutch **28** may be an electromagnetic clutch or a torque limiter. The clutch **28** is switched between an engaged state and a disengaged state according to the engine speed. The clutch **28** connects the first pump **25** to the transmission mechanism **4** in the engaged state. The clutch **28** disconnects the first pump **25** from the transmission mechanism **4** in the disengaged state.

(48) For example, if the clutch **28** is a centrifugal clutch, the clutch **28** is maintained in the disengaged state when the engine speed is less than a predetermined threshold. When the engine speed reaches or exceeds the predetermined threshold, the clutch **28** is switched to the engaged state. If the clutch **28** is an electromagnetic clutch, the engine speed is detected by a sensor. The clutch **28** is electrically controlled by a command signal from controller **40** shown in FIG. **1** according to the engine speed detected by the sensor. Thus, the clutch **28** is switched between the engaged state and the disengaged state according to the engine speed.

(49) In the first preferred embodiment, both the first pump **25** and the second pump **26** are positive displacement pumps. When the clutch **28** is in the engaged state, the driving force from the engine **3** is transmitted to the first pump **25** via the transmission mechanism **4** and the clutch **28**. Thus, the first pump **25** is driven by the driving force of the engine **3** to send the cooling water to the engine **3** through the cooling water passage **16**. When the clutch **28** is in the disengaged state, the driving force from the engine **3** is not transmitted to the first pump **25** and the first pump **25** is not driven.

(50) The second pump **26** is always connected to the transmission mechanism **4**. Therefore, the driving force from the engine **3** is always transmitted to the second pump **26** while the engine **3** is being driven. Thus, the second pump **26** is driven by the driving force of the engine **3** to send the cooling water to the engine **3** through the cooling water passage **16**.

(51) In the first preferred embodiment, when the engine speed is in the low speed range, the clutch **28** disconnects the first pump **25** and the transmission mechanism **4**, and the second pump **26** is driven. Thus, the first pump **25** is not driven, and the cooling water is sent to the engine **3** only by the second pump **26**. When the engine speed is in the high speed range, the clutch **28** connects the first pump **25** and the transmission mechanism **4**, and the first pump **25** and the second pump **26** are driven. Thus, the cooling water is sent to the engine **3** by both the first pump **25** and the second pump **26**.

(52) The low speed range is a range in which the engine speed is equal to or less than the above threshold. The low speed range is, for example, a speed range of the engine **3** when the engine **3** is sufficiently cooled by the cooling water supplied only by the second pump **26**. The high speed range is a range in which the engine speed is greater than the threshold described above.
(53) In the first preferred embodiment, when the engine speed is in the low speed range, the first pump **25** is not driven and the cooling water is sent to the engine **3** only by the second pump **26**. As a result, overcooling of the engine **3** is suppressed. Further, since the first pump **25** is not driven, loss of driving force of the engine **3** is suppressed.
(54) When the engine speed is in the high speed range, the cooling water is sent to the engine **3** by both the first pump **25** and the second pump **26**. A positive displacement pump has low pump efficiency in a high speed range, but a sufficient amount of cooling water is supplied to the engine **3** by sending the cooling water to the engine **3** by both the first pump **25** and the second pump **26**.
(55) FIG. **4** is a block diagram showing the cooling system and the drive system of the outboard motor **1** according to a second preferred embodiment of the present invention. The configurations of the cooling system and the drive system in the second preferred embodiment are the same as the configurations of the cooling system and the drive system in the first preferred embodiment. In the second preferred embodiment, the first pump **25** is a positive displacement pump and the second pump **26** is a non-positive displacement pump. The second pump **26** is, for example, a centrifugal pump. Alternatively, the second pump **26** may be another type of non-positive displacement pump, such as an axial pump. Other configurations of the outboard motor **1** according to the second preferred embodiment are the same as those of the outboard motor **1** according to the first preferred embodiment.
(56) In the second preferred embodiment, when the engine speed is in the low speed range, the clutch **28** connects the first pump **25** and the transmission mechanism **4**, and the first pump **25** and the second pump **26** are driven. Thus, the cooling water is sent to the engine **3** by both the first pump **25** and the second pump **26**.
(57) When the engine speed is in the high speed range, the clutch **28** disconnects the first pump **25** and the transmission mechanism **4**, and the second pump **26** is driven. Thus, the first pump **25** is not driven, and the cooling water is sent to the engine **3** only by the second pump **26**.
(58) The low speed range is, for example, a speed range in which the pump efficiency of a non-positive displacement pump is low. The high speed range is, for example, a speed range in which the pump efficiency of a non-positive displacement pump is high. In the second preferred embodiment, the cooling water is sent to the engine **3** by both the first pump **25** and the second pump **26** when the engine speed is in the low speed range. Although the second pump **26**, which is a non-positive displacement pump, has a low pump efficiency in the low speed range, an appropriate amount of cooling water is supplied to the engine **3** by driving the first pump **25** which is a positive displacement pump. Also, even if the second pump **26** is disposed at a position higher than the water surface, the first pump **25** supplies priming water for the second pump **26** to the second pump **26**.
(59) When the engine speed is in the high speed range, the first pump **25** is not driven and the cooling water is sent to the engine **3** only by the second pump **26**. Although the first pump **25**, which is a positive displacement pump, has a low pump efficiency in the high speed range, the first pump **25** is not driven, and the cooling water is sent to engine **3** by the second pump **26** which is a non-positive displacement pump and has a high pump efficiency in the high speed range. Thus, the loss of the driving force of the engine **3** is suppressed.
(60) FIGS. **5** to **18** are diagrams showing examples of an arrangement of the first pump **25** and the second pump **26** in the first preferred embodiment and the second preferred embodiment. FIG. **5** shows a first example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **5**, in the first example, the first pump **25** is disposed above the cavitation plate **14**. The first pump **25** is disposed above the waterline L**1**. The second pump **26** is disposed above a lower end

2A of the bracket **2**. The second pump **26** is disposed directly below the crankshaft **11**.

(61) FIG. **6** shows a second example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **6**, in the second example, the first pump **25** is disposed below the cavitation plate **14**. The second pump **26** is disposed directly below the crankshaft **11**.

(62) FIG. **7** shows a third example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **7**, in the third example, the first pump **25** and the second pump **26** are disposed above the cavitation plate **14**.

(63) FIG. **8** shows a fourth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **8**, in the fourth example, the first pump **25** is disposed above the cavitation plate **14**. The second pump **26** is disposed below the cavitation plate **14**.

(64) FIG. **9** shows a fifth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **9**, in the fifth example, the first pump **25** and the second pump **26** are disposed below the cavitation plate **14**.

(65) FIG. **10** shows a sixth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **10**, the transmission mechanism **4** includes an intermediate shaft **31** and a link mechanism **32** in the sixth example. The intermediate shaft **31** is offset with respect to the drive shaft **8**. The intermediate shaft **31** is connected to the drive shaft **8** via the link mechanism **32** such as gears or a belt. The second pump **26** is coaxial with the intermediate shaft **31**. The second pump **26** is connected to the intermediate shaft **31**. The first pump **25** and the second pump **26** are disposed above the cavitation plate **14**.

(66) FIG. **11** shows a seventh example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **11**, in the seventh example, the second pump **26** is connected to the intermediate shaft **31** as in the sixth example. The first pump **25** is disposed below the cavitation plate **14**. The second pump **26** is disposed above the cavitation plate **14**.

(67) FIG. **12** shows an eighth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **12**, in the eighth example, the drive shaft **8** includes a first drive shaft **8**A and a second drive shaft **8**B. The first drive shaft **8**A is connected to the crankshaft **11**. The second drive shaft **8**B is connected to the propeller shaft **9** via the shift mechanism **10**. The first drive shaft **8**A and the second drive shaft **8**B are offset with respect to each other. The transmission mechanism **4** includes a link mechanism **33**. The second drive shaft **8**B is connected to the first drive shaft **8**A via the link mechanism **33** such as gears or a belt. The first pump **25** is connected to the second drive shaft **8**B. In the eighth example, the arrangement of the first pump **25** and the second pump **26** is the same as in the first example.

(68) FIG. **13** shows a ninth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **13**, in the ninth example, similarly to the eighth example, the first pump **25** is connected to the second drive shaft **8**B. The second drive shaft **8**B is connected via the link mechanism **33** to the first drive shaft **8**A. In the ninth example, the arrangement of the first pump **25** and the second pump **26** is the same as in the second example.

(69) FIG. **14** shows a tenth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **14**, in the tenth example, the first pump **25** and the second pump **26** are connected to the second drive shaft **8**B. In the tenth example, the arrangement of the first pump **25** and the second pump **26** is the same as in the third example.

(70) FIG. **15** shows an eleventh example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **15**, in the eleventh example, the first pump **25** and the second pump **26** are connected to the second drive shaft **8**B. In the eleventh example, the arrangement of the first pump **25** and the second pump **26** is the same as in the fourth example.

(71) FIG. **16** shows a twelfth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **16**, in the twelfth example, the first pump **25** and the second pump **26** are connected to the second drive shaft **8**B. In the twelfth example, the arrangement of the first pump **25** and the second pump **26** is the same as in the fifth example.

(72) FIG. **17** shows a thirteenth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **17**, in the thirteenth example, the first pump **25** is connected to the second drive shaft **8**B. The second pump **26** is connected via the intermediate shaft **31** to the first drive shaft **8**A. In the thirteenth example, the arrangement of the first pump **25** and the second pump **26** is the same as in the sixth example.
(73) FIG. **18** shows a fourteenth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **18**, in the fourteenth example, the first pump **25** is connected to the second drive shaft **8**B. The second pump **26** is connected via the intermediate shaft **31** to the first drive shaft **8**A. In the fourteenth example, the arrangement of the first pump **25** and the second pump **26** is the same as in the seventh example.
(74) FIG. **19** is a block diagram showing the cooling system and the drive system of the outboard motor **1** according to a third preferred embodiment of the present invention. As shown in FIG. **19**, in the third preferred embodiment, the first pump **25** is connected to the drive shaft **8** or the crankshaft **11** via the clutch **28**. The second pump **26** is connected to the propeller shaft **9**. The first pump **25** is a positive displacement pump. The second pump **26** is a non-positive displacement pump. Other configurations of the outboard motor **1** according to the third preferred embodiment are the same as those of the outboard motor **1** according to the first preferred embodiment.
(75) When the clutch **28** is in the engaged state, the driving force from the engine **3** is transmitted to the first pump **25** via the transmission mechanism **4** and the clutch **28**. Thus, the first pump **25** is driven by the driving force of the engine **3** to send the cooling water to the engine **3** through the cooling water passage **16**. When the clutch **28** is in the disengaged state, the driving force from the engine **3** is not transmitted to the first pump **25** and the first pump **25** is not driven.
(76) The second pump **26** is always connected to the propeller shaft **9**. Therefore, when the engine **3** is running and the shift mechanism **10** is in the driving state, the driving force from the engine **3** is always transmitted to the second pump **26**. Thus, the second pump **26** is driven by the driving force of the engine **3** to send the cooling water to the engine **3** through the cooling water passage **16**.
(77) However, even if the engine **3** is driven, the driving force from the engine **3** is not transmitted to the propeller shaft **9** when the shift mechanism **10** is in the neutral state. Therefore, when the shift mechanism **10** is in the neutral state, even if the engine **3** is driven, the driving force from the engine **3** is not transmitted to the second pump **26** and the second pump **26** is not driven.
(78) In the third preferred embodiment, the clutch **28** connects the first pump **25** and the drive shaft **8** and the first pump **25** and the second pump **26** are driven when the shift mechanism **10** is in the driving state and the engine speed is in the low speed range. Thus, the cooling water is sent to the engine **3** by both the first pump **25** and the second pump **26**.
(79) When the shift mechanism **10** is in the driving state and the engine speed is in the high speed range, the clutch **28** disconnects the first pump **25** and the drive shaft **8**, and the second pump **26** is driven. Thus, the first pump **25** is not driven, and the cooling water is sent to the engine **3** only by the second pump **26**.
(80) When the shift mechanism **10** is in the neutral state, the clutch **28** connects the first pump **25** and the drive shaft **8** and the first pump **25** is driven regardless of the engine speed. Thus, the second pump **26** is not driven, and the cooling water is sent to the engine **3** only by the first pump **25**.
(81) In the third preferred embodiment, when the shift mechanism **10** is in the driving state, a state in which the cooling water is supplied to the engine **3** by both the first pump **25** and the second pump **26** and a state in which the cooling water is supplied to the engine **3** only by the second pump **26** are switched according to the engine speed. Thus, an appropriate amount of cooling water is supplied to the engine **3** to cool the engine **3**. Moreover, the loss of the driving force of the engine **3** is suppressed.
(82) When the shift mechanism **10** is in the neutral state, no driving force is transmitted to the

propeller shaft **9**, but cooling water is sent to the engine **3** by the first pump **25**. Thus, for example, even when the engine **3** is idling, an appropriate amount of cooling water is supplied to the engine **3** to cool the engine **3**.

(83) FIGS. **20** to **27** are diagrams showing examples of the arrangement of the first pump **25** and the second pump **26** in the third preferred embodiment. As shown in FIGS. **20** to **27**, in the examples of the arrangement of the first pump **25** and the second pump **26** in the third preferred embodiment, the second pump **26** is connected to the propeller shaft **9** and is disposed in the torpedo portion **13**.

(84) FIG. **20** shows a fifteenth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **20**, in the fifteenth example, the first pump **25** is disposed directly below the crankshaft **11**.

(85) FIG. **21** shows a sixteenth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **21**, in the sixteenth example, the first pump **25** is disposed above the cavitation plate **14**.

(86) FIG. **22** shows a seventeenth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **22**, in the seventeenth example, the first pump **25** is disposed below the cavitation plate **14**.

(87) FIG. **23** shows an eighteenth example of the arrangement of the first pump **25** and the second pump **26**. As shown in FIG. **23**, in the eighteenth example, the first pump **25** is connected to the drive shaft **8** via the intermediate shaft **31**, as in the sixth example. The first pump **25** is disposed above the cavitation plate **14**.

(88) FIGS. **24** to **27** show nineteenth to twenty-second examples of the arrangement of the first pump **25** and the second pump **26**. As shown in FIGS. **24** to **27**, in the nineteenth to twenty-second examples, the drive shaft **8** includes the first drive shaft **8**A and the second drive shaft **8**B as in the eighth example.

(89) FIG. **24** shows the nineteenth example of the arrangement of the first pump **25** and the second pump **26**. In the nineteenth example, the first pump **25** is disposed directly below the crankshaft **11**.

(90) FIG. **25** shows the twentieth example of the arrangement of the first pump **25** and the second pump **26**. In the twentieth example, the first pump **25** is connected to the second drive shaft **8**B. The first pump **25** is disposed above the cavitation plate **14**.

(91) FIG. **26** shows the twenty-first example of the arrangement of the first pump **25** and the second pump **26**. In the twenty-first example, the first pump **25** is connected to the second drive shaft **8**B. The first pump **25** is disposed below the cavitation plate **14**.

(92) FIG. **27** shows the twenty-second example of the arrangement of the first pump **25** and the second pump **26**. In the twenty-second example, the first pump **25** is connected via the intermediate shaft **31** to the first drive shaft **8**A. The first pump **25** is disposed above the cavitation plate **14**.

(93) FIG. **28** shows a twenty-third example of the arrangement of the first pump **25** and the second pump **26**. In the twenty-third example, the second pump **26** is connected to the lower end of the first drive shaft **8**A. Other configurations of the twenty-third example are the same as those of the eighth example shown in FIG. **12**.

(94) FIG. **29** shows a twenty-fourth example of the arrangement of the first pump **25** and the second pump **26**. In the twenty-fourth example, the second pump **26** is connected to the lower end of the first drive shaft **8**A. Other configurations of the twenty-fourth example are similar to those of the ninth example shown in FIG. **13**.

(95) FIG. **30** shows a twenty-fifth example of the arrangement of the first pump **25** and the second pump **26**. In the twenty-fifth example, the first pump **25** is connected via the clutch **28** to the lower end of the first drive shaft **8**A. Other configurations of the twenty-fifth example are similar to those of the nineteenth example shown in FIG. **24**.

(96) FIG. **31** is a side view showing a portion of an outboard motor **1** according to a fourth preferred embodiment of the present invention. The outboard motor **1** according to the fourth

preferred embodiment includes twin rotation propellers. As shown in FIG. **31**, the outboard motor **1** includes a first drive shaft **102**, a second drive shaft **103**, a first propeller shaft **104**, a second propeller shaft **105**, a shift mechanism **106**, and a gear mechanism **107**.

(97) The first drive shaft **102** is connected to the engine **3** and extends vertical direction of the outboard motor **1**. The second drive shaft **103** is provided separately from the first drive shaft **102**. The second drive shaft **103** is disposed below the first drive shaft **102** and extends in the vertical direction of the outboard motor **1**. The first propeller shaft **104** extends in the front-rear direction of the outboard motor **1**. The second propeller shaft **105** is coaxial with the first propeller shaft **104** on the outer peripheral side of the first propeller shaft **104**. The second propeller shaft **105** is rotatable with respect to the first propeller shaft **104**. A first propeller **108** is connected to the first propeller shaft **104**. A second propeller **109** is connected to the second propeller shaft **105**. The fins of the second propeller **109** are twisted in the opposite direction to the fins of the first propeller **108**.

(98) The shift mechanism **106** includes a first gear **111**, a second gear **112**, a third gear **113**, and a clutch **114**. The second gear **112** is coaxial with the first drive shaft **102**. The first gear **111**, the second gear **112**, and the third gear **113** are bevel gears, for example. The second gear **112** is connected to the first drive shaft **102**. The third gear **113** is coaxial with the second drive shaft **103**. The third gear **113** is rotatable with respect to the second drive shaft **103**. The first gear **111** is disposed between the second gear **112** and the third gear **113** and meshes with the second gear **112** and the third gear **113**.

(99) The clutch **114** is connected to an actuator **115** and operated by the actuator **115**. The clutch **114** switches engagement and disengagement between the second gear **112** and the second drive shaft **103** and engagement and disengagement between the third gear **113** and the second drive shaft **103**.

(100) The gear mechanism **107** transmits the rotation of the second drive shaft **103** to the first propeller shaft **104** in a predetermined rotational direction, and transmits the rotation of the second drive shaft **103** to the second propeller shaft **105** in a direction opposite to the predetermined rotational direction. The gear mechanism **107** includes a first gear **121**, a second gear **122**, and a third gear **123**.

(101) The clutch **114** switches the shift mechanism **106** between a driving state and a neutral state. The shift mechanism **106** transmits the driving force from first drive shaft **102** to the second drive shaft **103** in the driving state. The driving state includes a forward state and a reverse state.

(102) In the forward state, the clutch **114** engages the second gear **112** and the second drive shaft **103** and disengages the third gear **113** and the second drive shaft **103**. Thus, the rotation of the first drive shaft **102** is transmitted to the second drive shaft **103** in the same rotational direction. The rotation of the second drive shaft **103** is transmitted to the first propeller **108** via the first gear **121** and the second gear **122** of the gear mechanism **107** and the first propeller shaft **104**. Also, the rotation of the second drive shaft **103** is transmitted to the second propeller **109** via the first gear **121** and the third gear **123** of the gear mechanism **107** and the second propeller shaft **105**. Thus, the first propeller **108** and the second propeller **109** rotate in the forward directions. The forward directions of the first propeller **108** and the second propeller **109** are opposite to each other.

(103) In the reverse state, the clutch **114** disengages the second gear **112** and the second drive shaft **103** and engages the third gear **113** and the second drive shaft **103**. As a result, the rotation of the first drive shaft **102** is transmitted to the second drive shaft **103** via the second gear **112**, the first gear **111**, and the third gear **113** in the direction opposite to the rotation of the first drive shaft **102**. The rotation of the second drive shaft **103** is transmitted to the first propeller **108** via the first gear **121** and the second gear **122** of the gear mechanism **107** and the first propeller shaft **104**. Also, the rotation of the second drive shaft **103** is transmitted to the second propeller **109** via the first gear **121** and the third gear **123** of the gear mechanism **107** and the second propeller shaft **105**. As a result, the first propeller **108** and the second propeller **109** rotate in the reverse directions.

(104) In the neutral state, the clutch **114** disengages the second gear **112** and the second drive shaft

103 and disengages the third gear **113** and the second drive shaft **103**. The shift mechanism **106** does not transmit the driving force from the first drive shaft **102** to the second drive shaft **103** in the neutral state. Contrary to the above, the rotation directions of the first propeller **108** and the second propeller **109** may be opposite to those described above in the forward state and the reverse state. Other configurations of the outboard motor **1** according to the fourth preferred embodiment are the same as those of the outboard motor **1** according to the above-described first preferred embodiment.

(105) FIG. **32** is a block diagram showing the cooling system and the drive system of the outboard motor **1** according to the fourth preferred embodiment. As shown in FIG. **32**, the first pump **25** is connected to the first drive shaft **102** via the clutch **28** in the fourth preferred embodiment. The second pump **26** is connected to the second drive shaft **103**. The first pump **25** is a positive displacement pump. The second pump **26** is a non-positive displacement pump.

(106) As shown in FIG. **31**, for example, the first pump **25** is disposed above the cavitation plate **14**. The first pump **25** is disposed above the waterline L**1**. The second pump **26** is disposed below the cavitation plate **14**. The second pump **26** is disposed below the waterline L**1**. Alternatively, the first pump **25** and the second pump **26** may be disposed as in the first to twenty-fifth examples described above.

(107) When the clutch **28** is in the engaged state, the driving force from the engine **3** is transmitted to the first pump **25** via the transmission mechanism **4** and the clutch **28**. Thus, the first pump **25** is driven by the driving force of the engine **3** to send the cooling water to the engine **3** through the cooling water passage **16**. When the clutch **28** is in the disengaged state, the driving force from the engine **3** is not transmitted to the first pump **25** and the first pump **25** is not driven.

(108) The second pump **26** is always connected to the second drive shaft **103**. Therefore, when the engine **3** is running and the shift mechanism **106** is in the driving state, the driving force from the engine **3** is always transmitted to the second pump **26**. Thus, the second pump **26** is driven by the driving force of the engine **3** to send the cooling water to the engine **3** through the cooling water passage **16**.

(109) However, even if the engine **3** is driven, the driving force from the engine **3** is not transmitted to the second drive shaft **103** when the shift mechanism **106** is in the neutral state. Therefore, when the shift mechanism **106** is in the neutral state, the driving force from the engine **3** is not transmitted to the second pump **26** even if the engine **3** is being driven, and the second pump **26** is not driven.

(110) In the fourth preferred embodiment, when the shift mechanism **106** is in the driving state and the engine speed is in the low speed range, the clutch **28** connects the first pump **25** and the first drive shaft **102**, and the first pump **25** and the second pump **26** are driven. Thus, the cooling water is sent to the engine **3** by both the first pump **25** and the second pump **26**.

(111) When the shift mechanism **106** is in the driving state and the engine speed is in the high speed range, the clutch **28** disconnects the first pump **25** and the first drive shaft **102**, and the second pump **26** is driven. Thus, the first pump **25** is not driven, and the cooling water is sent to the engine **3** only by the second pump **26**.

(112) When the shift mechanism **106** is in the neutral state, the clutch **28** connects the first pump **25** and the first drive shaft **102** and the first pump **25** is driven regardless of the engine speed. Thus, the second pump **26** is not driven, and the cooling water is sent to the engine **3** only by the first pump **25**.

(113) In the fourth preferred embodiment, when the shift mechanism **106** is in the driving state, the state in which the cooling water is supplied to the engine **3** by both the first pump **25** and the second pump **26** and the state in which the cooling water is supplied to the engine **3** only by the second pump **26** are switched according to the engine speed. Thus, an appropriate amount of cooling water is supplied to the engine **3** to cool the engine **3**. Moreover, the loss of the driving force of the engine **3** is suppressed.

(114) When the shift mechanism **106** is in the neutral state, no driving force is transmitted to the second drive shaft **103**, but the cooling water is sent to the engine **3** by the first pump **25**. Thus, for example, even when the engine **3** is idling, an appropriate amount of cooling water is supplied to the engine **3** to cool the engine **3**.
(115) Although preferred embodiments of the present invention have been described above, the present invention is not limited to the above preferred embodiments, and various modifications are possible without departing from the gist of the present invention.
(116) The configuration of the outboard motor **1** is not limited to that of the above preferred embodiments, and may be modified. The configuration of the cooling water passage **16** is not limited to that of the above preferred embodiments, and may be modified. For example, the number of water intakes is not limited to one, and may be two or more. The first passage **22** and the second passage **23** may be connected to separate water intakes. The first passage **22** and the second passage **23** do not have to join downstream of the pumps **25** and **26**. That is, the first passage **22** and the second passage **23** may be connected to the water jacket **15** of the engine **3** independently of each other.
(117) In the above preferred embodiments, the clutch **28** is switched according to the engine speed. However, the clutch **28** may be switched based on a parameter such as the cooling water temperature of the engine **3**, the exhaust temperature, or the oil temperature.
(118) While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

Claims

1. An outboard motor comprising: a bracket to mount the outboard motor on a watercraft; an engine; an upper case below the engine; a lower case below the upper case; a transmission to transmit a driving force of the engine; a clutch connected to the transmission; a cooling water passage connected to the engine and located in the upper case and the lower case; a first pump connected to the transmission via the clutch and driven by the driving force of the engine to send cooling water to the engine via the cooling water passage; and a second pump connected to the transmission and driven by the driving force of the engine to send the cooling water to the engine through the cooling water passage.
2. An outboard motor comprising: a bracket to mount the outboard motor on a watercraft; an engine; an upper case below the engine; a lower case below the upper case; a transmission to transmit a driving force of the engine; a clutch connected to the transmission; a cooling water passage connected to the engine and located in the upper case and the lower case; a first pump connected to the transmission via the clutch and driven by the driving force of the engine to send cooling water to the engine via the cooling water passage; and a second pump connected to the transmission and driven by the driving force of the engine to send the cooling water to the engine through the cooling water passage; wherein the first pump and the second pump are positive displacement pumps; when a rotation speed of the engine is in a lower speed range, the clutch disconnects the first pump and the transmission and the second pump is driven; and when the rotation speed of the engine is in a higher speed range, the clutch connects the first pump and the transmission and the first pump and the second pump are driven.
3. An outboard motor comprising: a bracket to mount the outboard motor on a watercraft; an engine; an upper case below the engine; a lower case below the upper case; a transmission to transmit a driving force of the engine; a clutch connected to the transmission; a cooling water passage connected to the engine and located in the upper case and the lower case; a first pump connected to the transmission via the clutch and driven by the driving force of the engine to send

cooling water to the engine via the cooling water passage; and a second pump connected to the transmission and driven by the driving force of the engine to send the cooling water to the engine through the cooling water passage; wherein the first pump is a positive displacement pump; the second pump is a non-positive displacement pump; when a rotational speed of the engine is in a lower speed range, the clutch connects the first pump and the transmission and the first pump and the second pump are driven; and when the rotation speed of the engine is in a higher speed range, the clutch disconnects the first pump and the transmission and the second pump is driven.

4. An outboard motor comprising: a bracket to mount the outboard motor on a watercraft; an engine; an upper case below the engine; a lower case below the upper case; a transmission to transmit a driving force of the engine; a clutch connected to the transmission; a cooling water passage connected to the engine and located in the upper case and the lower case; a first pump connected to the transmission via the clutch and driven by the driving force of the engine to send cooling water to the engine via the cooling water passage; and a second pump connected to the transmission and driven by the driving force of the engine to send the cooling water to the engine through the cooling water passage; wherein the transmission includes: a first shaft connected to the engine; a shifter connected to the first shaft; and a second shaft connected to the shifter; the shifter is switchable between a driving state in which the first shaft and the second shaft are connected and a neutral state in which the first shaft and the second shaft are disconnected; the first pump is connected to the first shaft; and the second pump is connected to the second shaft.

5. The outboard motor according to claim 4, wherein the first shaft is a drive shaft extending downward from the engine and located in the upper case and the lower case; and the second shaft is a propeller shaft connected to the drive shaft via the shifter, extends in a front-rear direction of the outboard motor, and is located in the lower case.

6. The outboard motor according to claim 4, wherein the transmission includes: a drive shaft extending downward from the engine and located in the upper case and the lower case; and a propeller shaft connected to the drive shaft, extends in a front-rear direction of the outboard motor, and is located in the lower case; the drive shaft includes: a first drive shaft connected to the engine; and a second drive shaft connected to the first drive shaft via the shifter; the first shaft is the first drive shaft; and the second shaft is the second drive shaft.

7. The outboard motor according to claim 4, wherein the first pump is a positive displacement pump; the second pump is a non-positive displacement pump; when the shifter is in the driving state and a rotational speed of the engine is in a lower speed range, the clutch connects the first pump and the first shaft and the first pump and the second pump are driven; when the shifter is in the driving state and the rotational of the engine is in a higher speed range, the clutch disconnects the first pump and the first shaft and the second pump is driven; and when the shifter is in the neutral state, the clutch connects the first pump and the first shaft and the first pump is driven.