United States Patent [19]

Nelson

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[45] Aug. 7, 1973

[54] **POWER TRANSMISSION SYSTEM**

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[52] **U.S. Cl.** ..... **115/35 R,** 74/665 K, 74/665 M

[51] **Int. Cl.** **B63h 25/42**

[58] **Field of Search** ..... 115/34, 35; 74/665 K, 665 M

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Assistant Examiner—Carl A. Rutledge
Attorney—Robert L. Parker, Richard D. Seibel et al.

[57] **ABSTRACT**

A steerable power transmission system particularly useful for driving and steering a small boat is described. A central steering shaft, a drive tube, a fixed inner housing, and a rotatable outer housing are coaxial. The propeller shaft extends from the outer housing transverse to the common axis. The steering shaft is connected to the outer housing for pivoting it and the propeller axis. The propeller shaft is connected to a bevel gear that engages a pair of contra-rotating bevel ring gears on opposite sides thereof so that the drive torque is balanced. Means are provided for driving each of the ring gears from the drive tube and each of these means includes an overrunning clutch that permits its respective ring gear to run relatively faster than the other ring gear so that the outer housing can be pivoted with nominal torque on the steering shaft. The arrangement permits the outer housing and hence propeller axis to be rotated 360° in either direction, thereby giving an inboard motor boat many of the advantages of an outboard motor.

19 Claims, 3 Drawing Figures

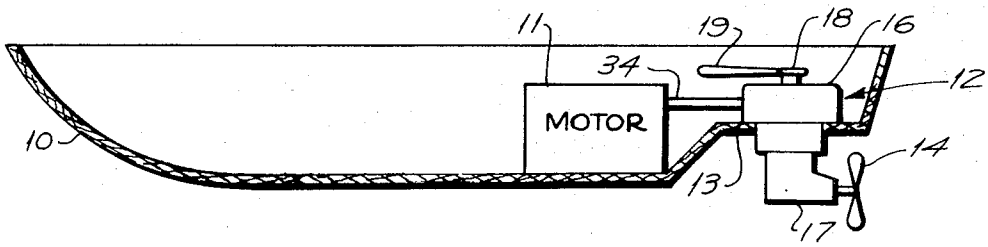


FIG. 1

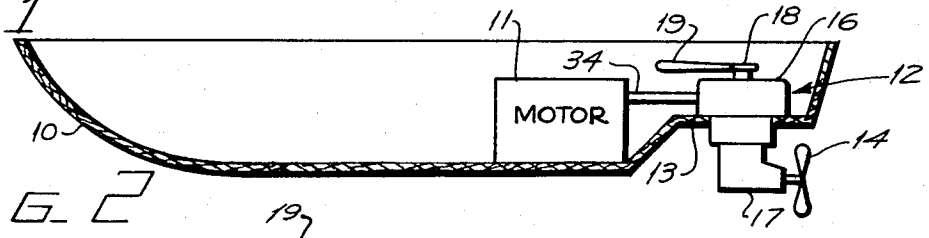

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FIG. 2

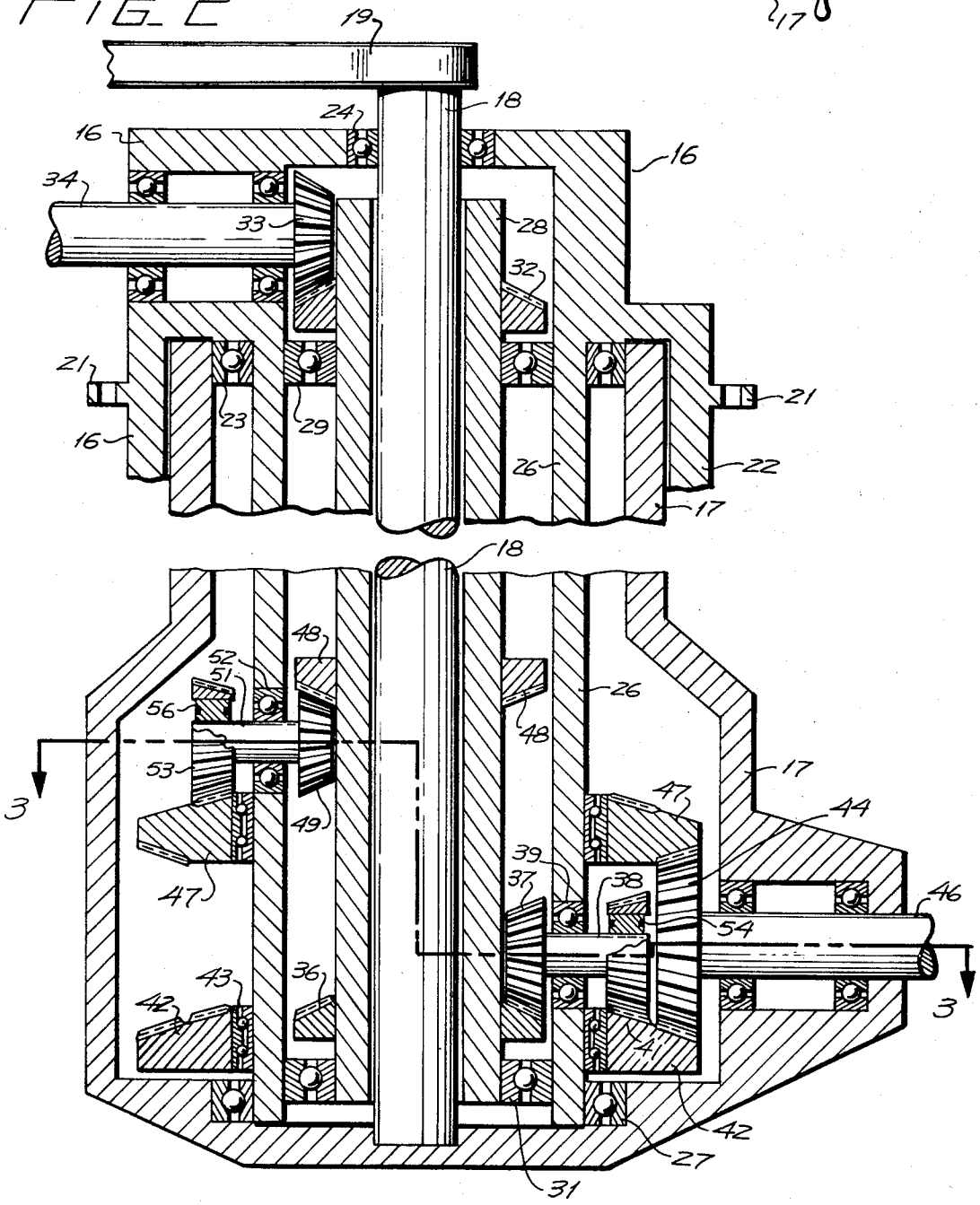

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Fig. 5

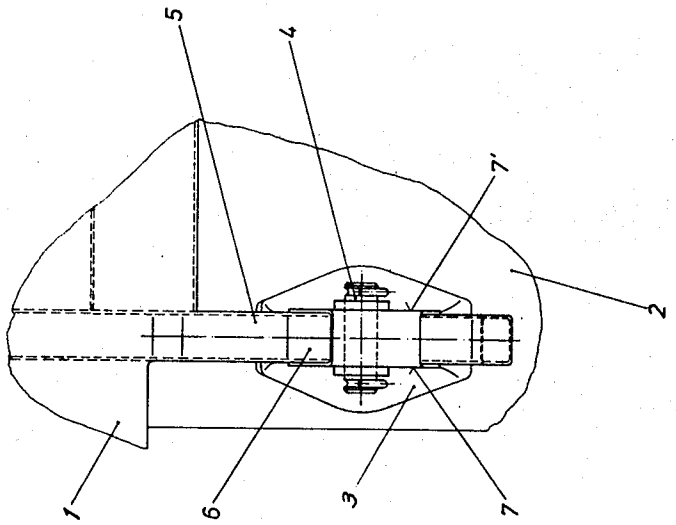
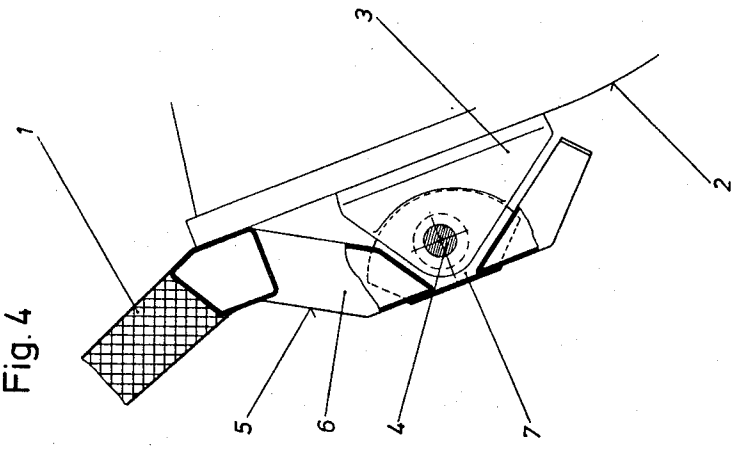


Fig. 4



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POWER TRANSMISSION SYSTEM

Background

In the field of small boats, outboard motors have been used on the boat transom; inboard motors have been used with a fixed propeller shaft; and inboard-outboard arrangements have been used with an inboard motor and steerable drive arrangement supporting the propeller. Outboard motors have limited power and are found undesirable by many people because of their relatively unattractive appearance on an otherwise handsome boat. Outboard motors are often advantageous since the entire motor and propeller combination can be skewed so that the propeller is driving in a direction off of the axis of the boat. This provides very responsive steering and enables outboard motor boats to turn in very short distances.

Inboard motor boats have considerably more power available because of the size of marine engines that can be mounted within the hull at a more advantageous position relative to the center of buoyancy. The typical inboard motor boat has a propeller on a shaft that is aligned with the axis of the boat. A rudder is usually located immediately aft of the propeller for optimum steering with minimized rudder area. Although such inboard arrangements have considerably more power than outboards, steering of the boat is not nearly as responsive.

Inboard-outboard arrangements have been used in an effort to combine the best of both systems. In these an inboard motor of relatively high power is advantageously located relative to the center of buoyancy of the boat. The output from this marine engine is coupled to a steerable drive arrangement extending out of the transom of the boat so that the structure mounting the propeller can be skewed relative to the boat axis and very responsive steering obtained. The inboard-outboard arrangements are subject to difficulties since the high power levels in the steerable mechanisms require great mechanical complexity and a corresponding degradation in reliability. The complexity of the drive and steering arrangement also makes the inboard-outboard arrangement relatively expensive.

It is recognized that it is desirable to provide an inboard power system for boats wherein the driving propeller can be readily steered to acquire the responsive steering of an outboard motor system. Preferably complex mechanisms are avoided for minimizing expense and enhancing reliability. The system for driving the propeller should be balanced so that no more torque is required for steering in one direction than the other. It is also desirable that the steering arrangement have the ability to be rotated a full 360° to avoid reverse shifting mechanisms, if possible.

BRIEF SUMMARY OF THE INVENTION

Therefore, in practice of this invention according to a presently preferred embodiment, there is provided a steerable power transmission system wherein the output shaft has a bevel gear engaging a pair of contra-rotating ring gears for balanced torque; a drive tube transverse to the axis of the bevel gear is coaxial with the ring gears; means are provided for driving each of the ring gears in opposite directions from the drive tube, including an over-running clutch for permitting either ring gear to run relatively faster than the other ring gear thereby permitting the output shaft to be pivoted around the axis of the drive tube.

DRAWINGS

These and other features and advantages of the invention will be appreciated as the same becomes better understood by reference to the following detailed description of a presently preferred embodiment when considered in connection with the accompanying drawings wherein:

FIG. 1 illustrates semi-schematically a boat equipped with a power transmission system constructed according to principles of this invention;

FIG. 2 illustrates in semi-schematic vertical cross section the power transmission system of FIG. 1; and

FIG. 3 is a transverse cross section along line 3—3 of FIG. 2.

DESCRIPTION

FIG. 1 illustrates in longitudinal cross section a small boat **10** constructed so as to be driven by a power transmission system constructed according to principles of this invention. The hull of the boat is shown only generally and the entire figure is a semi-schematic arrangement of structures readily implemented by one skilled in the art. A suitable marine engine **11** such as a gasoline or diesel motor is mounted at some convenient location within the hull for aligning the center of gravity and center of buoyancy.

A power transmission **12** is mounted in an aft portion of the boat. In the illustrated arrangement the boat has a raised portion **13** in the bottom of the hull for mounting the transmission. Such an arrangement is employed so that the driving propeller **14** does not extend an excessive distance beyond the bottom of the hull, thereby limiting the draft of the boat. If desired the power transmission can be arranged to extend through the usual bottom of the hull or, as will be apparent, it can be arranged on an extension beyond the transom. Such a transmission can be used in the front or middle of the boat if desired. This can make a very versatile work boat.

The power transmission has a fixed housing **16** that is connected to and through the raised portion **13** of the hull in any suitable manner that inhibits leakage of water into the boat. A rotatable housing **17** extends below the fixed housing and is free to rotate or pivot about a vertical axis as hereinafter described in greater detail. The propeller **14** is mounted transverse to the axis of rotation of the rotatable housing **17**. A steering shaft **18** extends upwardly from the fixed housing **16** and has its lower end (not shown in FIG. 1) connected to the rotatable housing **17**. A tiller **19** is connected to the steering shaft for steering the power transmission system and hence the boat. It will be apparent that the tiller **19** is merely a schematic representation and that preferably a wheel and conventional drive linkage is used. Such a steering arrangement can be employed with any desired mechanical advantage or with hydraulic power boosters if desired.

FIG. 2 is a semi-schematic illustration in vertical cross section through the power transmission system of FIG. 1. In the illustration of FIG. 2 the center portion is broken away to enable showing the upper and lower portions in greater detail. The power transmission can be of any arbitrary length desired.

FIG. 3 is also a semi-schematic illustration in horizontal cross section through the power transmission. The cross section of FIG. 3 is taken along the staggered line 3—3 through the lower part of the transmission as shown in FIG. 2.

In the power transmission system a number of bearings are required for supporting rotatable parts. In the illustrations these are indicated only schematically and it will be understood that such bearings may also include means for accommodating thrust as well as lateral loads on the parts being supported. It will also be apparent that a number of seals will be required in a power transmission system employed in a boat, to keep out water. The only high speed dynamic seal required is around the propeller shaft itself and all other seals are static or low speed. A movable seal is needed between the outer housing **17** and the fixed housing **16**, but this need rotate only at very low rates such as used for steering. Sealing is simplified by running the transmission full of oil. Such arrangements are well within the skill of the art and the details are generally omitted from the description and drawings since there would merely be a tendency to confuse and obscure the meaningful description. It will also be immediately apparent that no means for assembling and disassembling the power transmission are described or illustrated herein since there will also be apparent to one skilled in the art and would obscure the operating mechanisms.

The fixed housing **16** may be connected to the hull of the boat by a flange **21** and preferably includes a downwardly extending portion **22** which extends through the hull for mechanical connection and which may also provide additional rotational and thrust bearing support (not shown) for the rotatable housing **17** which receives the principal force exerted by the propeller. The rotatable housing is also supported at its upper end by a suitable bearing **23** which permits it to rotate about a vertical axis. It is only in the regions where sealing or bearing support is required that the rotatable housing needs to be round, and it will be apparent that streamlining of the housing is ordinarily desirable in marine applications.

The fixed housing includes a vertically extending inner housing tube **26** which does not rotate and is connected to the outer rotatable housing **17** at its lower end by a bearing **27.** The inner housing tube thereby carries a substantial portion of the thrust load of the propeller when the transmission is in use.

The steering shaft **18** is coaxial with the axis of rotation of the outer rotatable housing **17.** The lower end of the steering shaft is coupled to the rotating housing so that the shaft and housing turn together. The upper end of the steering shaft **18** is supported in the fixed housing by a conventional bearing **24** and extends through the upper face of the fixed housing to the tiller.

A drive tube **28** extends through much of the vertical extent of the power transmission and is coaxial with the steering shaft **18** and the inner housing tube **26.** The drive tube is supported at its upper end by the fixed housing and a bearing **29.** At its lower end the drive tube is supported by a bearing **31** connecting it to the lower end of the inner housing tube **26.** The bearings **29** and **31** permit the drive tube to rotate about a vertical axis independently of position or rotation of the steering shaft or housings.

A bevel gear **32** on the upper end of the drive tube **28** engages a bevel gear **33** on the drive shaft **34** from the motor. It will be apparent that if desired a clutch and gear ratio changing transmission may be included between the power transmission and the motor or if desired can be made integral with the illustrated power transmission. The gear ratios in such a transmission can be any desired value for accommodating the gear ratios established by the gearing hereinafter described in the steerable power transmission so that the propeller can be driven at any desired speed relative to the motor.

A lower driving bevel gear **36** is fixed near the lower end of the drive tube **28.** The driving bevel gear **36** engages a driven bevel gear **37** mounted on a short shaft **38** supported by a bearing **39** in the inner housing tube **26.** At the opposite end of the shaft **38** from the driven gear **37** is a drive train output bevel gear **41** which engages a lower ring gear **42.** The lower ring gear **42** is coaxial with the drive tube and is supported on the inner housing tube **26** by a bearing **43.**

The lower ring gear **42** has two bearing faces, one in engagement with the drive train output gear **41,** and the other in engagement with a bevel gear **44** on the output shaft **46** leading to the boat propeller. The bevel gear **44** on the output shaft is also in engagement with a gear face on an upper ring gear **47.** For the power transmission system to operate properly, the upper ring gear **47** must rotate in a direction opposite to the direction of rotation of the lower ring gear **42.**

A drive train is, therefore, provided between the drive tube **28** and the upper ring gear **47** to cause it to rotate in the opposite direction from the lower ring gear. This upper drive train includes an upper driving gear **48** on the drive tube having its gear face facing in the opposite direction from the gear face on the lower driving gear **36.** The upper driving gear **48** is in engagement with a driven bevel gear **49** mounted on a short shaft **51.** The shaft **51** is supported on the inner housing tube **26** by a bearing **52.** At the opposite end of the shaft from the driven gear **49** is a drive train output gear **53** which is in engagement with a second gear face on the upper ring gear **47.** The gear ratios of the two drive trains between the drive tube and the ring gears are the same so that the upper and lower ring gears are driven in rotation in opposite directions at the same speed.

Since the bevel gear **44** on the output shaft is in engagement with both contra-rotating ring gears the driving torque on it is balanced relative to the shaft axis. If the bevel gear were in engagement with only one ring gear there would be a tendency for the output bevel gear to "run around" the ring gear, carrying the rotatable outer housing **17** with it. This would merely cause the power transmission to spin idly in the water and no useful purpose could be accomplished. The forces on the output shaft are, however, balanced by the contra-rotating ring gears, both of which are driven by the drive tube, and there is therefore no significant torque tending to twist the rotatable housing **17** from the position in which it rests. As a matter of fact with only such an arrangement it would be impossible to rotate the rotatable housing **17** relative to the inner housing tube **26** since that would amount to a phase shift between the two ring gears. This is resisted since both ring gears are linked to the drive tube by the drive trains. A balanced, but fixed, drive would result.

To permit the rotatable housing **17** to be moved and the transmission steered, a conventional over-running clutch **54** is provided between the shaft **38** and the

drive train output gear **41**. Similarly an over-running clutch **56** is provided between the shaft **51** and the drive train output gear **53**. The over-running clutches **54** and **56** are illustrated in a cut away portion of the respective gears as one of the sprags of a conventional sprag type over-running clutch. Either ratchet type or roller and cam type over-running clutches can be used in lieu of the sprag type. In the schematic illustration of FIG. **2** the bearings typically associated with a sprag type over-running clutch are omitted. The over-running clutches **54** and **56** are oriented for carrying a forward driving torque from the drive tube through the respective drive train to the respective ring gear. Any substantial torque in the opposite direction will cause an over-running clutch to slip. It will be noted, therefore, that a reversing mechanism between the motor and the power transmission is undesirable.

The over-running clutches permit one of the ring gears **42** or **47** to run relatively faster than the other ring gear. This is probably easiest to visualize in a static situation when torque is not being transmitted through the power transmission. Assuming that the lower ring gear **42** is fixed in position, if one rotates the outer housing **17** about its vertical axis in the proper direction by turning the steering shaft **18**, the propeller shaft **46** is carried with it. The output bevel gear **44** on the propeller shaft rotates and causes the upper ring gear **47** to advance at twice the rate that the output shaft moves about the housing axis. The upper ring gear is thus running relatively faster than the lower ring gear and the upper over-running clutch **56** slips to permit this to occur without transmitting such motion to the drive tube. If the housing is turned in the opposite direction, the lower over-running clutch slips to accomodate the motion. The same thing occurs when the various parts are moving and torque is being transmitted through the power transmission. Over-running clutches typically require no more than about 3 percent of the transmitted torque in a reverse direction in order to cause slippage. The torque applied through the steering shaft to effect turning of the housing is, therefore, no more than about 3 percent of the transmitted torque.

Although but one embodiment of power transmission constructed according to principles of this invention has been described and illustrated in detail herein, many modifications and variations will be apparent to one skilled in the art. Thus, for example, instead of the output shaft **46** coming out normal to the axis of the outer housing it can be carried through a right angle bevel gear system to come out of the bottom of the housing, which may be desirable for operating a jet pump of the like in lieu of the propeller provided in a preferred embodiment.

The drive trains between the drive tube and the respective ring gears need not be located opposite to each other as in the illustrated embodiment, but can be in any desired positions around the drive axis. Force levels are minimized with the drive trains on opposite sides of the fixed inner housing tube. If a larger bevel gear is used on the output shaft so that the ring gears are further apart, the drive trains can be rearranged so that both are between the ring gears. Similarly, both drive trains can be outside of the space between the ring gears if desired. This latter arrangement permits manufacture of identical upper and lower ring gears with gear faces on opposite sides thereof which cuts fabrication costs. The length of the transmission may be increased if this arrangement is used, but the diameter can be reduced.

The preferred arrangement has a central steering shaft inside the drive tube, however, if desired a drive shaft can be used and the steering torque can be applied to the rotatable housing **17** by a gear engaging the upper portion of the housing somewhere in the vicinity of the bearing **23**. A reduction in housing diameter can result.

It will also be noted that numerous output bevel gears may be provided in engagement with the two ring gears so that plural driven outputs can be rotated. Thus, for example, four output gears may be provided in engagement with the ring gears at orthogonal positions around the axis of the housing and all four of these can be driven at once and rotated about the housing axis at once. Such an embodiment may have utility in driving mechanisms for rotary wing aircraft, for example. If two opposite output shafts are used, both "pusher" and "puller" propellers can be used on a boat.

In the illustrated arrangement the outer housing and output shaft can be rotated a full 360° around the axis of the power transmission in either direction. This is desirable in the embodiment where the power transmission is used in a boat since it permits the propeller to be oriented towards the bow for driving the boat backwards without a reversing mechanism. This is actually quite efficient since marine propellers are most efficient in their forward direction.

Many other modifications and variations will be apparent to one skilled in the art. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A power transmission comprising:
- a rotatable output shaft;
- an output bevel gear on the output shaft;
- a first drive bevel gear having an axis normal to the axis of the output shaft in engagement with the output bevel gear;
- a second drive bevel gear coaxial with the first drive bevel gear and in engagement with the output bevel gear;
- common means for driving the first drive bevel gear and the second drive bevel gear in mutually opposite directions; and
- an over-running clutch between the means for driving and each of the drive bevel gears so that the drive bevel gears can rotate at relatively different rates and the axis of the output shaft can pivot around the axis of the drive bevel gears.

2. A power transmission as defined in claim **1** wherein the means for driving is coaxial with the first and second drive bevel gears for pivoting of the axis of the output shaft around 360°.

3. A power transmission as defined in claim **1** wherein the means for driving comprises a drive member coaxial with the drive bevel gears and first and second drive train means connecting the driving member to the first and second drive bevel gears respectively for driving them in opposite directions.

4. A power transmission as defined in claim **3** wherein each drive train means includes one of the over-running clutches for permitting the respective drive bevel gear to rotate relatively faster than the other drive bevel gear.

5. A power transmission as defined in claim 4 wherein each drive train means comprises;
a first gear in engagement with the drive member;
a second gear in engagement with a portion of the respective drive bevel gear; and
means for supporting the first and second gears for rotation about an axis extending transverse to the drive member axis, and wherein the over-running clutch is between the first and second gears.

6. A steerable power transmission comprising:
a fixed housing;
an outer housing surrounding a portion of the fixed housing;
means for pivoting the outer housing about an axis extending through the fixed housing;
a drive member coaxial with the outer housing;
means for mounting the drive member for rotation relative to the fixed housing and the outer housing;
an output shaft extending through the outer housing;
a driven bevel gear connected to the output shaft and having an axis transverse to the drive member axis;
a first ring gear coaxial with the drive member;
a second ring gear coaxial with the drive member, the first and second ring gears being in engagement with opposite sides of the driven bevel gear;
means for mounting the first ring gear and second ring gear respectively for rotation relative to the fixed housing and the outer housing;
means for connecting the drive member to the first and second ring gears respectively for driving them in mutually opposite directions of rotation; and
a pair of over-running clutches for permitting either of the ring gears to run relatively faster than the other of the ring gears.

7. A steerable power transmission as defined in claim 6 wherein the means for pivoting the outer housing comprises a steering shaft coaxial with and extending through the drive member, and connected to the outer housing.

8. A transmission as defined in claim 6 wherein the means for connecting comprises, for each ring gear:
a driving bevel gear on the drive member;
a driven bevel gear in engagement with the driving gear;
an output drive gear connected to the driving gear and in engagement with one of the ring gears; and
means for mounting the driven gear and output drive gear for rotation about an axis transverse to the axis of the drive member, and wherein the over-running clutch is between the driven gear and the output drive gear.

9. A steerable power transmission comprising:
a fixed housing including an inner housing tube;
an outer housing surrounding the inner housing tube;
means for mounting the outer housing for rotation about an axis extending along the inner housing tube;
a drive tube coaxial with the outer housing;
means for mounting the drive tube for rotation relative to the fixed housing and the outer housing;
a steering shaft coaxial with the drive tube and connected to the outer housing;
an output shaft extending through the outer housing;
a driven bevel gear connected to the output shaft and having an axis transverse to the drive tube axis;
a first ring gear between the fixed inner housing tube and the outer housing and coaxial with the drive tube;
a second ring gear between the fixed inner housing tube and the outer housing and coaxial with the drive tube, the first and second ring gears being in engagement with opposite sides of the driven bevel gear;
means for mounting the first and second ring gears for rotation relative to the inner housing tube and the outer housing;
drive train means for connecting the drive tube to the first ring gear for driving it in a first direction of rotation including an over-running clutch for permitting the first ring gear to run relatively faster than the drive tube; and
drive train means for connecting the drive tube to the second ring gear for driving the second ring gear in a rotational direction opposite to the direction of rotation of the first ring gear and including an over-running clutch for permitting the second ring gear to run relatively faster than the drive tube.

10. A transmission as defined in claim 9 wherein each of the drive train means comprises:
a driving bevel gear on the drive tube;
a driven bevel gear in engagement with the driving gear;
an output drive gear connected to the driving gear and in engagement with one of the ring gears; and
means for mounting the driven gear and output drive gear for rotation about an axis fixed by the inner housing tube and transverse to the axis of the drive tube, and wherein the over-running clutch is between the driven gear and the output drive gear.

11. A boat comprising:
a hull;
a motor mounted in the hull;
a steerable power transmission connected to the motor and including a vertically extending pivotable portion extending below the hull;
a drive propeller on the pivotable portion of the transmission;
an output gear connected to the propeller;
a pair of drive gears engaging the output gear on opposite sides thereof;
common means for rotating the drive gears in mutually opposite directions;
an over-running clutch between the common means for rotating and each of the drive gears for permitting either of the drive gears to rotate relatively faster than the means for rotating; and
means for pivoting the pivotable portion and the axis of the propeller about a vertical axis.

12. A boat as defined in calim 11 wherein the axis of the propeller can pivot through 360° about a vertical axis and wherein:
the output gear comprises a bevel gear connected to the propeller; and
the drive gears each comprise a bevel gear engaging the output bevel gear and rotatable about the vertical axis.

13. A boat as defined in claim 12 wherein the common means for rotating comprises a drive member coaxial with the vertical axis; and further comprising drive train means including one of the over-running clutches between the drive member and each of the drive bevel gears.

14. A boat as defined in claim 13 wherein each drive train means comprises:
a first gear in engagement with the drive member;
a second gear in engagement with a portion of the respective drive bevel gear; and
means for supporting the first and second gears for rotation about an axis extending transverse to the drive member axis, and wherein the over-running clutch is between the first and second gears.

15. A boat as defined in claim 14 wherein the means for pivoting comprises a shaft coaxial with and extending through the drive member, and connected to the pivotable portion adjacent the lower end thereof.

16. A boat comprising:
a hull;
a motor fixed in the hull; and
a steerable power transmission connected to the motor comprising:
a fixed housing connected to the hull and including a vertically extending inner housing tube;
an outer housing surrounding the inner housing tube;
means for mounting the outer housing on the fixed housing for pivoting around a vertical axis;
a drive member coaxial with the outer housing;
means for mounting the drive member for rotation relative to the fixed housing and the outer housing about the vertical axis;
an output shaft extending through the outer housing;
means for propelling the boat connected to the output shaft and having an axis transverse to the vertical axis;
a driven bevel gear connected to the output shaft and having an axis transverse to the vertical axis;
a first bevel gear coaxial with the drive member;
a second bevel gear coaxial with the drive member, the first and second bevel gears each being in engagement with an opposite side of the driven bevel gear;
means for mounting the first bevel gear and the second bevel gear, respectively, for rotation relative to the fixed housing and the outer housing;
means for connecting the drive member to the first and second bevel gears, respectively, for driving them in mutually opposite directions of rotation; and
a pair of over-running clutches for permitting either of the first or second bevel gears to run relatively faster than the second or first bevel gear, respectively.

17. A boat as defined in calim 16 wherein the drive member comprises a tube, and further comprising a steering shaft coaxial with and extending through the drive tube and connected to the outer housing at its lower end.

18. A boat as defined in claim 17 wherein the means for connecting for each bevel gear comprises:
a driving bevel gear on the drive tube;
a driven bevel gear in engagement with the driving gear;
an output drive gear connected to the driving gear and in engagement with one of the first or second bevel gears, respectively; and
means for mounting the driven gear and output drive gear on the inner housing tube for rotation about an axis transverse to the axis of the drive tube, and wherein the over-running clutch is between the driven gear and the output drive gear.

19. A balanced steerable power transmission comprising:
a fixed housing;
a rotatable drive member within the fixed housing;
a steerable housing around the portion of the fixed housing and mounted for pivoting about an axis extending along the fixed housing;
an output shaft fixed in location on the steerable housing and rotatable relative thereto;
an output gear on the output shaft; and
a pair of similar drive trains between the drive member and the output gear, each drive train having:
an input portion coupled to the drive member and fixed in location by the fixed housing;
an output portion in equal driving engagement with the output gear irrespective of the pivotal location of the output shaft around the pivot axis of the steerable housing, including a ring gear between the fixed housing and the steerable housing and means for mounting the respective ring gear for rotation about the pivot axis of the steerable housing, the respective ring gears in the two drive trains being in driving engagement with opposite sides of the output gear on the output shaft and coupled to the drive member for rotation in mutually opposite sense; and
an overruning clutch in each drive train for permitting either of the respective ring gears to rotate relatively faster than the other ring gear.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,750,616 Dated August 7, 1973

Inventor(s) DONALD F. NELSON

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the grant only, cancel sheet 2 of the drawings and substitute the attached new sheet 2.

Signed and sealed this 22nd day of January 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents

PATENTED AUG 7 1973

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SHEET 1 OF 2

FIG. 1

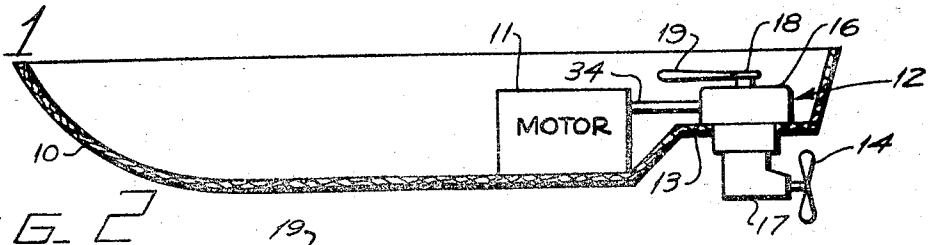
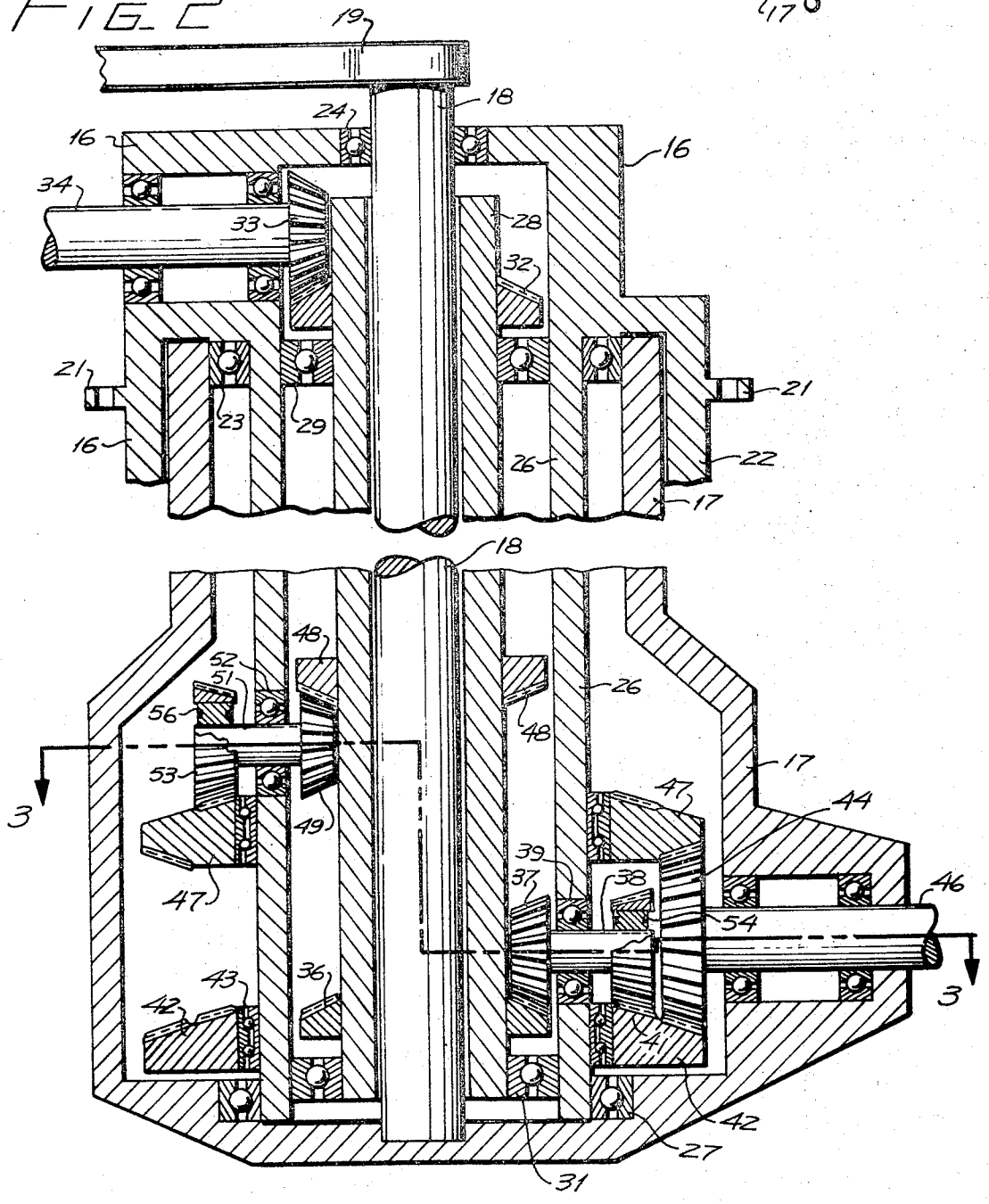


FIG. 2



UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,750,616 Dated August 7, 1973

Inventor(s) Donald F. Nelson

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the grant (only), cancel sheet 2 of the drawings and substitute the attached new sheet 2.

This certificate supersedes Certificate of Correction issued Jan. 22, 1975.

Signed and sealed this 10th day of June 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

PATENTED AUG 7 1973

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SHEET 2 OF 2

FIG. 3

