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THROUGH TRANSOM DRIVE SHAFT MOUNTING
FOR INBOARD-OUTBOARD DRIVE
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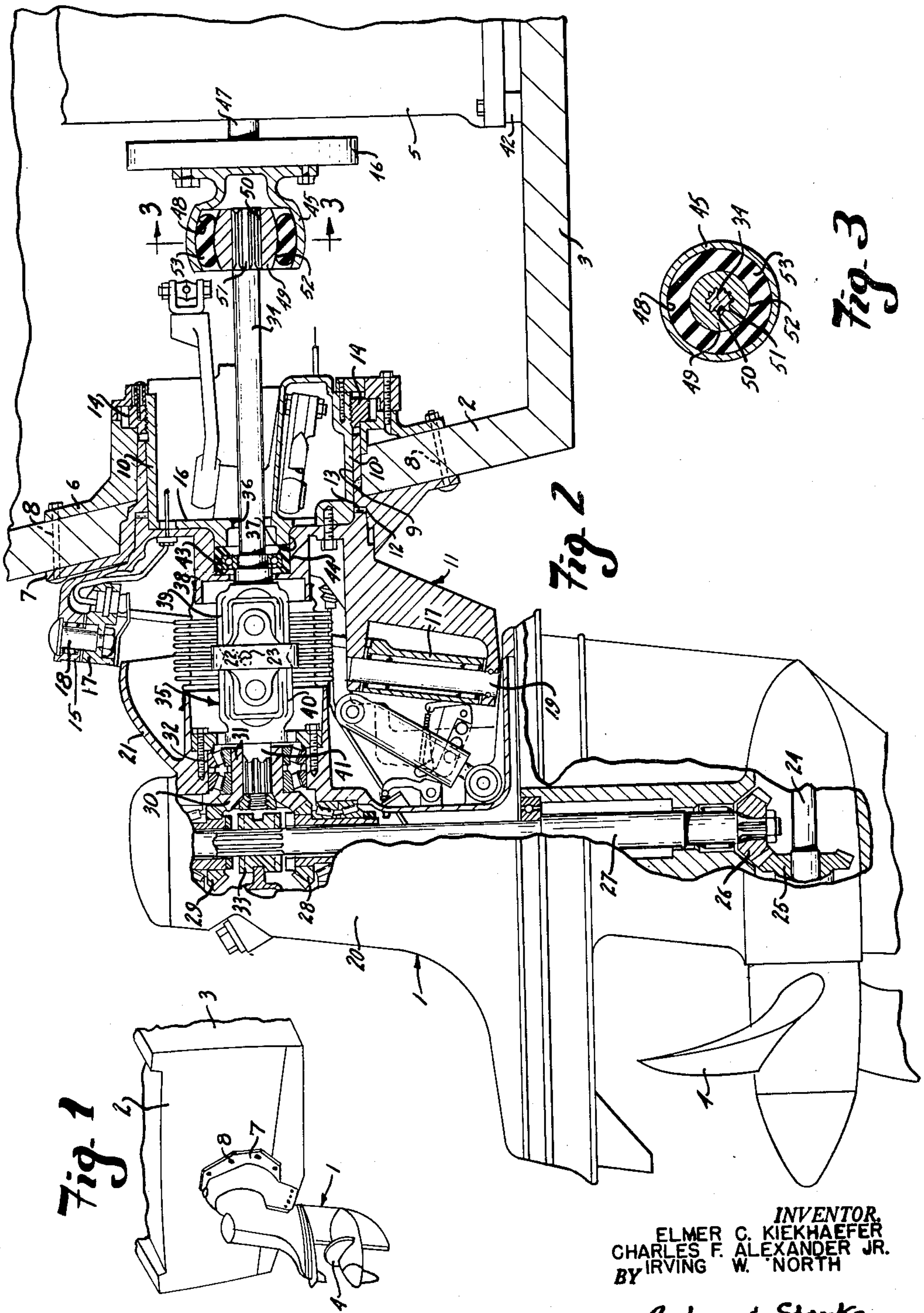

Fig. 2

Fig. 3

Fig. 1

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THROUGH TRANSOM DRIVE SHAFT MOUNTING FOR INBOARD-OUTBOARD DRIVE

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This invention relates to an inboard-outboard drive for watercraft and more particularly to an improved through transom drive shaft mounting.

In inboard-outboard drives, the engines have generally been mounted directly to the floor or on platforms secured solidly with respect to the floor of the watercraft. In such a mounting, engine vibration and shake are imparted to the watercraft and are the cause for considerable discomfort to the occupants. Under these conditions too the watercraft acts as a sounding board for engine noises which further detracts from the pleasure of the occupants. It is generally an object of this invention to eliminate or substantially lessen the noted effects by mounting the engine resiliently with respect to the watercraft and providing a through transom drive connection to the propulsion unit which is capable of accommodating torsional and vibrational movements of an engine so mounted.

According to this invention, the engine unit of an inboard-outboard drive is resiliently mounted within a watercraft and is subject to torsional and vibrational movements on its mounts during its operation. The drive connection between the engine unit and outboard propulsion unit must be adapted to accommodate the engine movements and comprises a generally horizontal drive shaft mounted in suitable bearing intermediate its length to substantially maintain the shaft on center and which is in effect universally connected to both the engine unit and the propulsion unit. Since the engine movements on its resilient mount will cause the distance between the engine unit and the propulsion unit to vary, provision is made for relative movement axially of the drive shaft between the shaft and at least one of said units.

The drawings furnished herewith illustrate the best mode for carrying out the invention as presently contemplated and set forth hereinafter.

In the drawings:

FIGURE 1 is a perspective view of the outboard portion of an inboard-outboard drive shown mounted on the transom of a boat or other watercraft;

FIGURE 2 is an enlarged partial side elevation of an inboard-outboard drive with parts broken away and sectioned to show the drive for the propulsion unit including particularly the through transom mounting of this invention, and

FIGURE 3 is an enlarged sectional view taken generally on line 3—3 of FIG. 2.

Referring to the drawings, the inboard-outboard drive includes a drive or propulsion unit **1** suspended outboard from the transom **2** of a partially shown boat or other watercraft **3**. The propulsion unit **1** includes a propeller **4** which is driven by the engine **5** mounted inboard of the boat to be propelled.

The suspension for the propulsion unit **1** includes inner and outer plates **6** and **7** secured on opposed sides of the transom **2** by means of a plurality of throughbolts **8**. Plates **6** and **7** define a cylindrical transom opening **9** which is adapted to receive the forward cylindrical portion **10** of housing member **11**. Rearwardly the opening **9** is stepped to provide a shoulder **12** which is engageable by a corresponding shoulder **13** on member **11**. The cylindrical portion **10** of member **11** extends through opening **9** and is externally threaded adjacent the forward end thereof and a nut member **14** is threaded thereon to draw the shoulders **12** and **13** together and rigidly secure the housing member to the boat transom. Rearwardly the housing member **11** includes a generally bell-shaped housing portion **15** and a generally vertical partition wall **16** separates housing portion **15** from the forward cylindrical portion **10**.

The propulsion unit **1** is pendantly and dirigibly carried with respect to a generally transverse horizontal tilt axis and a generally vertical swivel axis respectively by the housing member **11**. A gimbal ring member **17** is interposed between the propulsion unit **1** and the housing member **11** and is disposed generally interiorly of the bell-shaped housing portion **15** of member **11**. Ring member **17** is rotatably mounted on a generally vertical swivel axis with respect to housing portion **15** by means of the vertically spaced and aligned shaft elements **18** and **19** to provide for steering control of the propulsion unit. The housing **20** of propulsion unit **1** includes a generally bell-shaped portion **21** which opens forwardly and is adapted to be received within gimbal ring member **17**. Housing portion **21** is pivotably mounted on a generally transverse horizontal axis within the ring member by means of the transversely spaced and aligned shaft elements **22** and **23** to permit the propulsion unit to tilt upwardly in a generally vertical plane as when striking a floating or submerged obstruction. While the generally transverse horizontal tilt axis is disposed in or substantially in the transverse vertical plane through the generally vertical steering axis, it will be noted that the propulsion unit suspension permits the unit to tilt without in any way disturbing the steering geometry for the unit.

The propeller **4** of the propulsion unit is carried by the generally horizontal propeller shaft **24** which is driven through beveled gears **25** and **26** by the generally vertical drive shaft **27** rotatably supported within the propulsion unit housing **20**. A pair of vertically spaced beveled gears **28** and **29**, one of which is a forward gear and the other a reverse gear, are mounted in suitable bearings and are freely rotatable on the upper end of shaft **27**. The drive gear **30** having a hub **31** disposed generally horizontally within the bearing housing **32** projecting forwardly into the bell-shaped portion **21** of housing **20** drivingly engages the beveled gears **28** and **29** and causes the latter gears to rotate in opposed directions. A clutch element **33** disposed between beveled gears **28** and **29** is carried by shaft **27** and is slidable axially thereon to selectively engage gears **28** and **29** to complete the drive connection between the drive gear **30** and vertical shaft **27**.

The drive gear **30** is driven by engine **5** through the generally horizontal drive connection including the shaft **34** and the double universal joint or coupling **35**. The shaft **34** extends from the engine **5** through the central opening **36** in the partition wall **16** of housing member

11 and continues through the cylindrical bore 37 provided in the bearing housing 38 projecting rearwardly from the partition wall and terminates with the end yoke 39 of joint 35. The opposite end yoke 40 of joint 35 is carried by the stub shaft 41 which is fixedly secured within the hub 31 of drive gear 30 and is generally in alignment with shaft 34. The shafts 34 and 41 have their axes disposed generally parallel to and a relatively short distance beneath the horizontal plane through the tilt axis of the propulsion unit and support the coupling 35 interiorly of the ring member 17 with the center of the coupling disposed generally on the swivel axis. In the embodiment shown in the drawings wherein the swivel axis is disposed at a slight forward rake, the vertical centerline of the coupling is disposed to generally intersect the swivel axis in the horizontal plane of the tilt axis. With the geometric center of the coupling 35 disposed at the intersection of the generally transverse vertical plane containing the swivel axis and the generally transverse horizontal plane containing the tilt axis or with the center of the coupling spaced from this intersection within the limits of the coupling, the coupling 35 will accomomdate pivoting movements of the propulsion unit 1 on the tilt and/or swivel axis wihout interruption in the horizontal drive connection.

According to this invention, the engine 5, shown only in part, is placed on resilient mounts 42 to substantially isolate engine vibration and shake from the watercraft 3.

When the engine 5 is so mounted, the horizontal drive shaft 34 must be mounted or supported in a manner to accomodate the engine movements permitted by the resilient mounts.

Intermediate its length shaft 34 is supported substantially on center by the ball bearing unit 43 which is seated within the bore 37 of bearing housing 38 between the end yoke 39 of the universal joint 35 and the partition wall 16 of housing member 11. The bearing unit 43 is mounted within a relatively thin rubber sleeve 44 and so is adapted to pivot with drive shaft 34 while the shaft is held substantially on center. Shaft 34 is movable axially within the bearing unit 43 as may be occasioned when joint end yoke 39 is displaced a slight amount.

At the engine end, shaft 34 is supported within a cup-shaped hub member 45 fixedly secured centrally of the engine flywheel 46 carried on engine shaft 47. Interiorly the hub member 45 is provided with an axially extending arcuate surface 48 and carries an annular inner hub member 49 spaced radially therefrom. The inner hub member 49 is preferably made of bronze and is provided with a plurality of spline projections 50 interiorly thereof. The end of shaft 34 is provided with corresponding spline grooves 51 and is slidably received within hub member 49. Exteriorly the hub member 49 is provided with an arcuate surface 52 generally concentric with the opposed interior surface 48 on the outer hub member 45, and an annular rubber bush 53 is compressed between the opposed surfaces and bonded to the inner hub surface 52 to place the shaft 34 in general alignment with engine shaft 47. The hub structure receiving the engine end of shaft 34 in effect constitutes a universal coupling between the shaft and engine and further provides for relative axial movement therebetween.

During operation of the drive, the engine 5 is subject to considerable movement on its resilient mounts 42 due in large measure to torsional deflection and vibration of the engine. This engine movement is accommodated in the drive connection of this invention between the engine 5 and the propulsion unit 1 by providing for relative movement between the engine 5 and shaft 34 and by the deflection and dampening afforded by rubber bush 53. Rubber bush 53 also serves to protect the engine in that it cushions shocks in the drive connection due to shifting of gears. The provision for relative movement between engine 5 and the through transom shaft 34 is

also utilized when rotating the propulsion unit 1 in a generally transverse vertical plane to an inverted position as described in the copending joint application of E. C. Kiekhaefer, C. F. Alexander and R. A. Boda, Serial No. 180,282 and filed on even date herewith.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

We claim:

1. In an inboard-outboard drive for watercraft having a transom, a propulsion unit mounted on the transom and disposed outboard of the watercraft, a propeller and drive means therefor carried by the propulsion unit, an engine mounted inboard of the watercraft to drive the propeller, said engine being mounted on resilient mounts and being movable on said mounts relative to the watercraft and propulsion unit, a drive shaft extending through the transom and disposed between the engine and propulsion unit, universal coupling means connecting one end of the drive shaft to the propulsion unit propeller drive means, and a second universal coupling means connecting the other end of the drive shaft to the engine, said second universal coupling means providing for relative movement axially between the engine and drive shaft during operation.

2. The invention of claim 1 wherein means are provided intermediate the universal coupling means to rotatably support the through transom drive shaft substantially on center, said support means being pivotable to accomomdate pivotal movements of the drive shaft.

3. The invention of claim 1 wherein the through transom drive shaft extends through a bearing housing intermediate the universal coupling means, bearing means on said shaft in said housing, and an annular resilient sleeve between the housing and said bearing means, said resiliently mounted bearing means supporting said shaft substantially on center and being pivotable within said housing to accommodate pivotal movements of the shaft.

4. The invention of claim 1 wherein the engine end of the through transom drive shaft is keyed within said second universal coupling means providing for a rotary drive connection with relative axial movement therebetween.

5. The invention of claim 1 wherein the second universal coupling means between the engine and the through transom drive shaft comprises inner and outer spaced hub members, said inner hub member being keyed on said drive shaft to drive the shaft and provide for relative axial movement therebetween and said outer hub member being carried by the engine shaft, and an annular resilient bush disposed between the spaced hub members, said bush being deflectable to cushion and damp vibration, shock and certain other movements emanating from the engine and propulsion unit.

6. In an inboard-outboard drive for watercraft having a transom, a propulsion unit mounted on the transom and disposed outboard of the watercraft, a propeller and drive means therefor carried by the propulsion unit, an engine having a flywheel and mounted inboard of the watercraft to drive the propeller, said engine being mounted on resilient mounts and being movable on said mounts relative to the watercraft and propulsion unit, a drive shaft extending through the transom and disposed between the engine and propulsion unit, a double universal joint connecting the through transom drive shaft to the propulsion unit propeller drive means, a bearing housing supported from said transom, bearing means on said drive shaft and disposed in said bearing housing adjacent to said double universal joint, an annular resilient sleeve disposed between the housing and said bearing means, said bearing means supporting said shaft substantially on center and being pivotable with said shaft relative to said housing, inner and outer spaced hub mem-

bers, said inner hub member being keyed on the engine end of said drive shaft to drive the shaft and provide for relative axial movement therebetween, said outer hub member being a cup-like member fixedly secured centrally to the engine flywheel, and an annular resilient bush disposed between the spaced hub members and being deflectable to cushion and damp vibration, shock and certain other movements emanating from the engine and propulsion unit.

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