July 5, 1966 E. C. KIEKHAEFER 3,259,100

DUAL DRIVE FOR OUTBOARD PROPULSION UNIT

Filed July 22, 1964 2 Sheets-Sheet 1

Fig. 1.

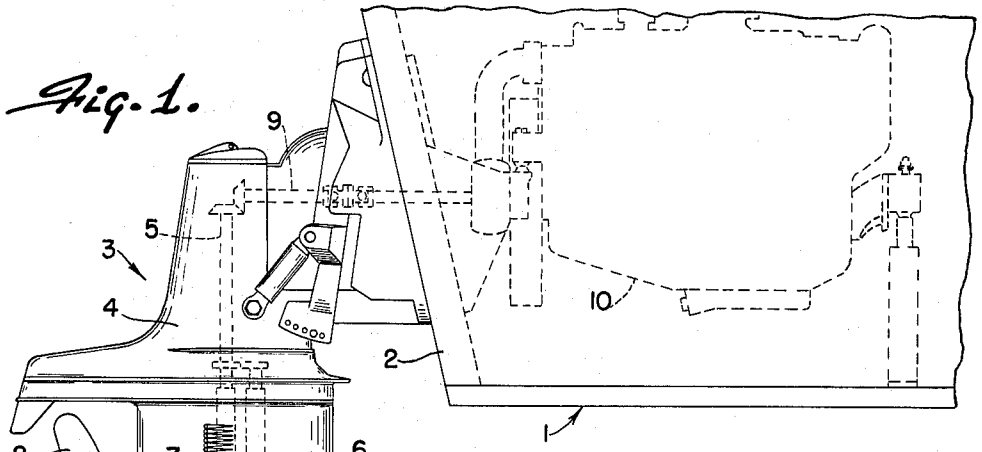
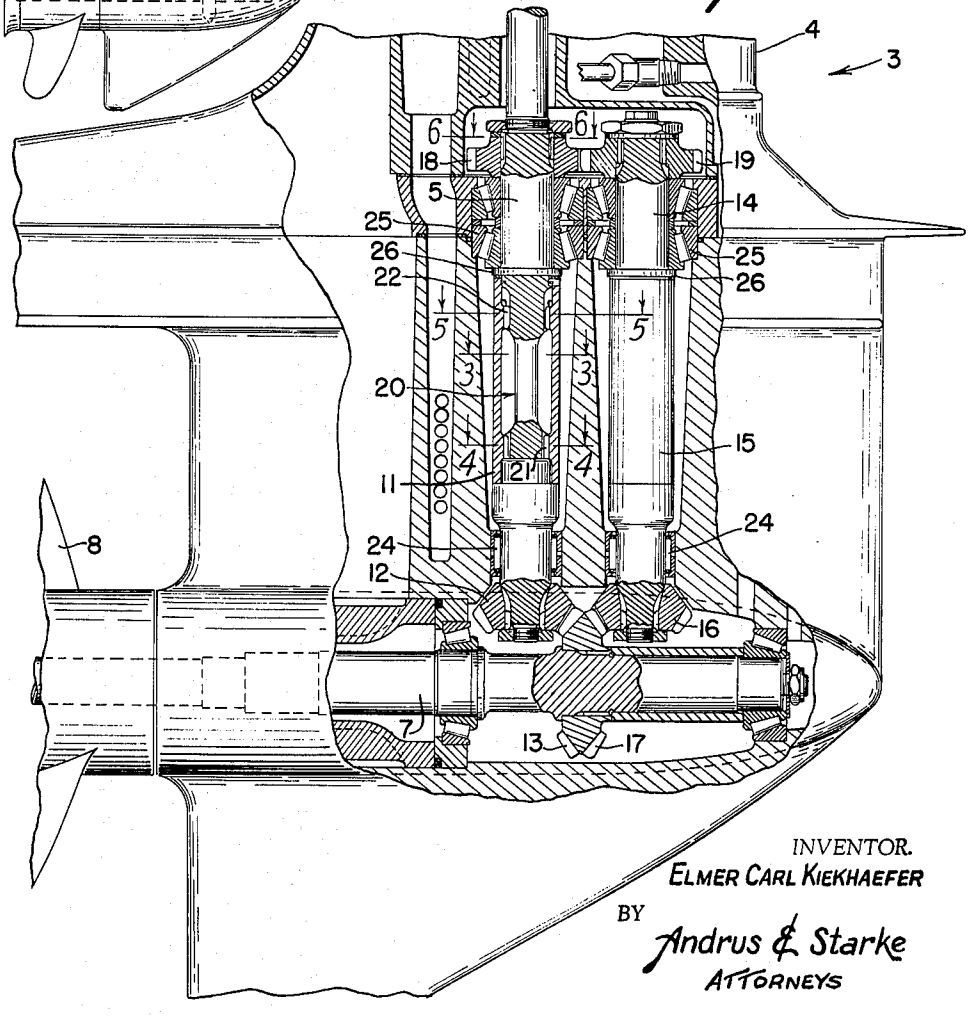


Fig. 2.



INVENTOR.
ELMER CARL KIEKHAEFER
BY
Andrus & Starke
ATTORNEYS

July 5, 1966 E. C. KIEKHAEFER 3,259,100

DUAL DRIVE FOR OUTBOARD PROPULSION UNIT

Filed July 22, 1964 2 Sheets-Sheet 2

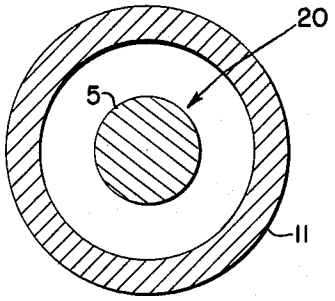


Fig. 3.

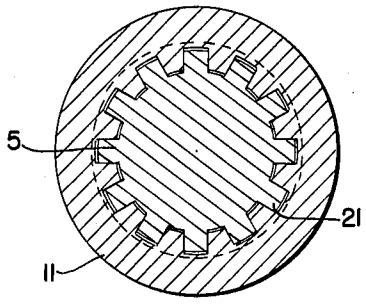


Fig. 4.

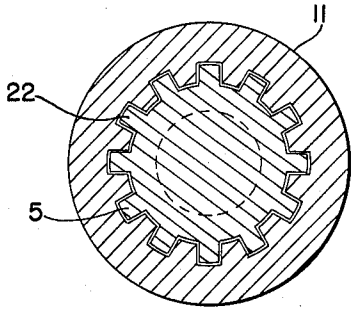


Fig. 5.

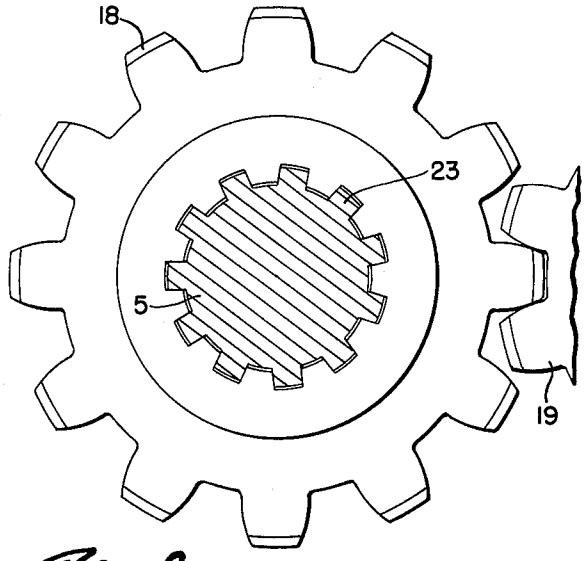


Fig. 6.

INVENTOR.
ELMER CARL KIEKHAEFER
BY
Andrus & Starke
ATTORNEYS

United States Patent Office

3,259,100

Patented July 5, 1966

3,259,100

DUAL DRIVE FOR OUTBOARD PROPULSION UNIT

Elmer Carl Kiekhaefer, Winter Haven, Fla., assignor to Kiekhaefer Corporation, Fond du Lac, Wis., a corporation of Delaware

Filed July 22, 1964, Ser. No. 384,391
6 Claims. (Cl. 115—34)

This invention relates to a dual drive for an outboard propulsion unit for boats.

Propellers for outboard propulsion units are generally mounted upon a propeller shaft which extends horizontally in a fore and aft direction beneath the water and which is driven by means of a downwardly extending drive shaft geared thereto by suitable beveled gears.

Because the gears driving the propeller shaft are necessarily in a gear case beneath the water a problem arises from the drag resulting from the necessary frontal area of the gear case and the fact that as the horsepower is increased the shaft and gear size must be increased thereby increasing the frontal area and the consequent drag so as to partially offset the advantage for the increase in horsepower.

The present invention provides a means for increasing the torque capacity of the drive without increasing the frontal area of the gear case. This is accomplished by dividing the drive into two or more torque transmittal paths, as by utilizing two or more drive shafts, each separately and simultaneously driving the propeller shaft through beveled gears, so that each set of gears takes in effect only a port of the load and can be made substantially smaller than would be a single gear train that transmits the entire load.

Where two drive shafts are employed, each can be made to take approximately one half of the load, and where more shafts are employed a corresponding reduction in load for each is obtained, it being desirable that the drive shafts transmit equal torque to the propeller shaft.

The accompanying drawing illustrates the best mode presently contemplated for carrying out the invention.

In the drawing:

FIGURE 1 is a partial side elevation of a boat with an outboard stern drive generally having the present invention incorporated therein;

FIG. 2 is a central vertical longitudinal section of the drive with the upper end broken away;

FIG. 3 is a horizontal transverse section taken on line 3—3 of FIG. 2;

FIG. 4 is a section taken on line 4—4 of FIG. 2;

FIG. 5 is a section taken on line 5—5 of FIG. 2;

FIG. 6 is a section taken on line 6—6 of FIG. 2.

The invention is illustrated as applied to an outboard stern drive for boats, and is to be understood as similarly applicable to outboard motor drives and to other drives where substantially right angle beveled gears are employed.

The invention has particular advantage in driving underwater propellers since it enables keeping of the gear case small in diameter for high horsepower drives that would otherwise require larger gears with larger gear case diameter. Smaller gear cases are less resistant to forward motion of the unit through the water.

Referring to the drawings, the boat 1 has a rear transom 2 upon which is mounted an outboard stern drive 3.

The drive 3 comprises, in general a vertical drive shaft housing 4 containing the usual upper drive shaft 5, and an underwater unit 6 containing the usual horizontal propeller shaft 7 which extends rearwardly of the unit and carries the propeller 8 thereon.

The drive shaft 5 is driven at its upper end by any suitable means, such as the horizontal shaft 9 driven from an inboard motor 10. In the case of an outboard motor, shaft 5 would be directly connected to the crankshaft of the engine.

In the embodiment of the invention illustrated, the vertical drive shaft 5 is designed to transmit one-half the total driving torque to the propeller shaft 7 through the pinion shaft 11 and bevel gears 12 and 13, and the other half of the driving torque is transmitted through an auxiliary upper drive shaft 14, pinion shaft 15 and bevel gears 16 and 17. It is preferable, although not necessary that the beveled gears 13 and 17 be provided on opposite sides of a common hub secured to shaft 7 as shown in FIG. 2.

The drive shafts 5 and 14 are disposed parallel to each other and are connected by a pair of meshing spur gears 18 and 19 to rotate in opposite directions. Torque exerted by the power source 10 upon drive shaft 5 is divided by the spur gears 18 and 19 and roughly one half of the total torque is then carried by each shaft 5 and 14 through suitable splines to its corresponding pinion shaft 11 or 15. The divided torque is in turn transmitted by pinion shafts 11 and 15 through the corresponding pairs of beveled gears 12–13 and 16–17 to the propeller shaft 7.

In this construction each shaft and each gear tooth carries only a part of the total load. This means that the shafts can be reduced and the gears can be made smaller, thereby providing a smaller frontal area for the unit in the water, than would be necessary if a single vertical shaft and its beveled gears would transmit the entire torque.

With this construction, if it were practical to set up all gears, splines and meshes with no clearances and no tolerance errors, and assume no deflections of any part, each pinion gear 13 and 17 would transmit exactly one half of the total drive torque to shaft 7. However, necessary manufacturing tolerances, clearances and deflections must be taken into account, in order to equalize the torque transmission as closely as possible.

For this purpose several unique innovations are incorporated in the construction illustrated. The spline connections between the upper drive shaft 5 and 14 and their corresponding lower pinion shafts 11 and 15 are constructed to provide a limited resilient transmission of torque by each and which tends to equalize the torque load. In addition, an adjustment is provided that largely compensates for differences in dimensions and in clearances.

In the construction illustrated the resilient cushion for torque transmission is provided as illustrated in FIGS. 2 and 3 by incorporating a torsion section 20 in each of the upper drive shafts 5 and 14, and which is a reduced section purposely designed to yield or deflect torsionally under rotary toroque load. The primary drive between shaft 5 and its pinion shaft 11 and between shaft 14 and its pinion shaft 15 is effected by a driving spline 21 at the lower end of each of the shafts 5 and 14, the pinion shafts being

tubular and concentric to the corresponding drive shafts. The driving splines **21** comprise external splines on the shafts **5** and **14** and mating internal splines in the corresponding shafts **11** and **15** as shown in FIG. 4.

The torsional deflection of each of the sections **20** under torque load will tend to equalize the torque transmission of both shaft assemblies. In order to prevent excessive deflection and possible damage to the shafts **5** and **14**, a loose torsional limiting spline **22** is provided above each section **20** and which is designed to pick up the torque transmission between the upper and lower shafts upon a given deflection of the torsion sections **20**. Here again, the splines **22**, like splines **21**, comprise external splines on the shafts **5** and **14** and mating internal splines in the corresponding shafts **11** and **15**.

Splines **22** are loose as shown in FIG. 5 and normally transmit no load. They function chiefly when the propeller strikes a submerged object which tends to torsionally load the sections **20** beyond the amount for which they are designed, i.e. the maximum permissible deflection.

In order to provide for adjustment of the gears in assembly, spur gears **18** and **19** are mounted upon the corresponding upper drive shafts **5** and **14** by means of mating spline teeth **23** between the hub of the gears and the shafts, as shown in FIG. 6.

The spline teeth **23** between gear **18** and shaft **5** are preferably either one less or one more in number than the teeth **23** between gear **19** and its shaft **14**. Also the number of spline teeth **23** for each gear **18** and **19** should be slightly different from the number of gear teeth for the corresponding gear.

This permits a "differential" action in locating gears **18** and **19** upon their corresponding shafts **5** and **14**, to a fraction of a degree, for compensating any differences in tolerances and clearances for the two drive systems. An even finer adjustment may be provided by using helical type spur gears and shimming one gear axially on its shaft.

In adjusting the assembled gear case, the propeller shaft **7** is held fixed against rotation and a light torque is applied to the upper ends of the drive shafts **5** and **14** to load them lightly in the direction in which they are loaded in actual operation. The angular position of the two spur gears **18** and **19** is then adjusted until a predetermined small clearance appears between the driving faces of the meshing teeth thereon.

In operation, then, at very low power input, the torque flow will be through the upper input drive shaft **5**, through its torsion section **20** and spline **21** to the corresponding lower pinion shaft **11**, and finally through bevel gears **12** and **13** to shaft **7** and propeller **8**. At this time the auxiliary upper drive shaft **14** and its pinion shaft **15** will idle by rotating but not carrying any torque.

As the throttle of the engine is advanced and the input torque increases, the torsion section **20** of drive shaft **5** will deflect torsionally thus taking up the clearance between the meshing teeth of spur gears **18** and **19**. Shaft **14** will then begin to carry a share of the torque.

At higher power input the torque carried by the shaft **14** and its assembly will be generally equal to the torque carried by shaft **5** and its assembly less the small increment of torque initially required to deflect the section **20** of shaft **5** to compensate for the small predetermined clearance between the meshing teeth of gears **18** and **19**. For all practical purposes the torque transmitted by the two shaft assemblies will be substantially equal since the torque deflection required to bring the driving teeth of the spur gears into contact is purposely very small as compared to the total torque deflection under full power. Thus each of the shaft assemblies carries approximately one-half the total torque at the higher power inputs.

The construction and mounting of the upper drive shafts **5** and **14** and the corresponding lower pinion shafts **11** and **15** is such as to provide a maximum of lateral and axial rigidity for the corresponding bevel gears **12** and **16**, so as to maintain accurate meshing between gears **12** and **13** and gears **16** and **17**, thereby providing long life for these gears.

For this purpose the shafts **11** and **15** are mounted in corresponding roller bearings **24** disposed immediately above the corresponding gears **12** and **16**. From there on up the shafts **11** and **15** are tubular to receive the lower ends of the corresponding drive shafts **5** and **14**.

Each drive shaft **5** and **14** is mounted at its upper end in a thrust type roller bearing **25** which secure these shafts both laterally and axially. Below bearings **25** each shaft **5** and **14** has a flange **26** which bears upwardly against the inner rotary race of the corresponding bearing **25**.

The upper end of each hollow shaft **11** and **15** bears against the corresponding flange **26** axially to take the thrust from the lower bevel gears for the respective shaft. In addition the body of each shaft **5** and **14** immediately below flange **26** is of a diameter closely fitting the inside of the corresponding shaft **11** and **15** to provide lateral stability for the latter at the upper end. Thus, a laterally weak torsion section **20** for each shaft **4** and **14** is housed within a laterally and axially rigid outer member of the corresponding shafts **11** and **15**.

Since each bevel gear carries one only-half of the total maximum torque, the size and diameter of the gears can be much less than in former constructions for a given horsepower input.

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.

I claim:

1. In an outboard drive for boats having a streamlined underwater propulsion unit with a substantially horizontal propeller shaft extending longitudinally thereof, and a source of power carried by the boat; a dual pinion drive connecting said power source with said propeller shaft and comprising a substantially vertically disposed main drive shaft between said power source and said propeller shaft, at least one auxiliary drive shaft disposed substantially parallel to said main drive shaft and coupled thereto at its upper end and to said propeller shaft at its lower end, said upper coupling comprising intermeshing spur gears having a minimum free running clearance, and means to take up said clearance and tending to substantially equalize the torque transmittal of said main and auxiliary shafts in driving the propeller under load.

2. The construction of claim **1** in which said last named means comprises a torsionally deflecting section incorporated in each drive shaft and tending to equalize the load transmitted by each between the motor and the propeller shaft.

3. The construction of claim **2** and means to limit the deflection of each of said drive shafts.

4. In a device of the class described, a source of power, a drive shaft connected at one end to said power source to be driven thereby, an output shaft connected to the opposite end of said drive shaft to be driven thereby, an auxiliary drive shaft extending parallel to said first named drive shaft, spur gears connecting said drive shafts remote from said output shaft to effect driving of said auxiliary drive shaft, the opposite end of said auxiliary drive shaft being connected to said output shaft to drive the latter, said gears having a free running clearance when said output shaft is free of load, and a torsionally deflecting section in each of said drive shafts to effect a take up of said clearance and torsional loading of said auxiliary shaft when said output shaft is under heavy load.

5. The construction of claim **4** in which at least one of the spur gears is adjustably mounted upon the corresponding drive shaft to provide the predetermined free running clearance therebetween in the driving direction.

6. The construction of claim **4** in which the connections between the drive shafts and said output shaft are comprised of bevel gears, a bearing support is provided for

each drive shaft immediately adjacent the corresponding connection, and means are provided to prevent lateral deflection of said shafts.

References Cited by the Examiner

UNITED STATES PATENTS

1,903,350	4/1933	Landrum	115—17
3,083,680	4/1963	Willis	115—34
3,148,557	9/1964	Shimanckas	115—18

MILTON BUCHLER, *Primary Examiner.*

FERGUS S. MIDDLETON, *Examiner.*

R. G. BESHA, T. MAJOR, *Assistant Examiners.*