Oct. 1, 1968 H. G. LANGHJELM ET AL 3,403,735

ADJUSTABLE VARIABLE PITCH PROPELLER

Filed March 10, 1967 3 Sheets-Sheet 1

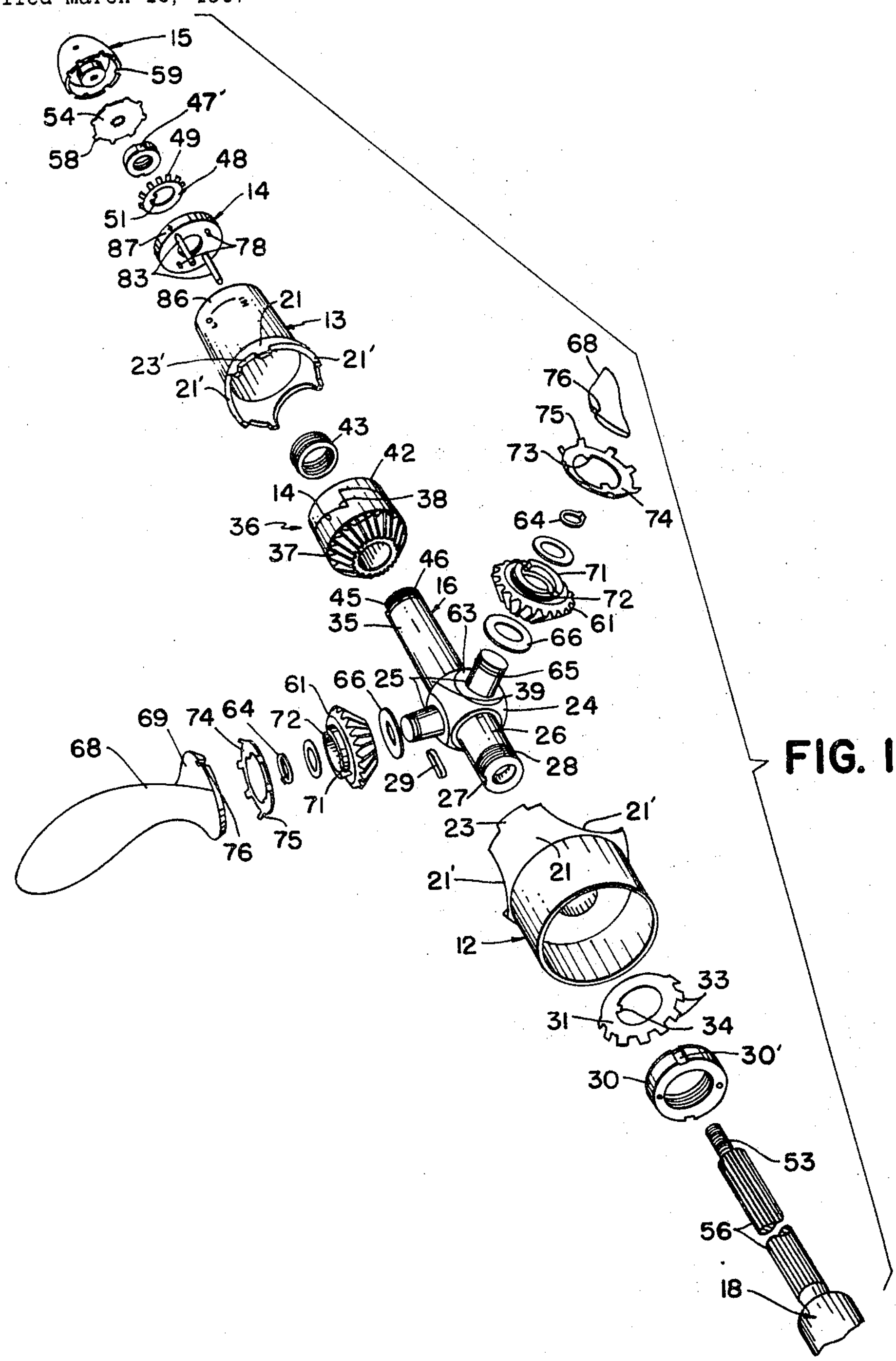

FIG. 1

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FIG.2

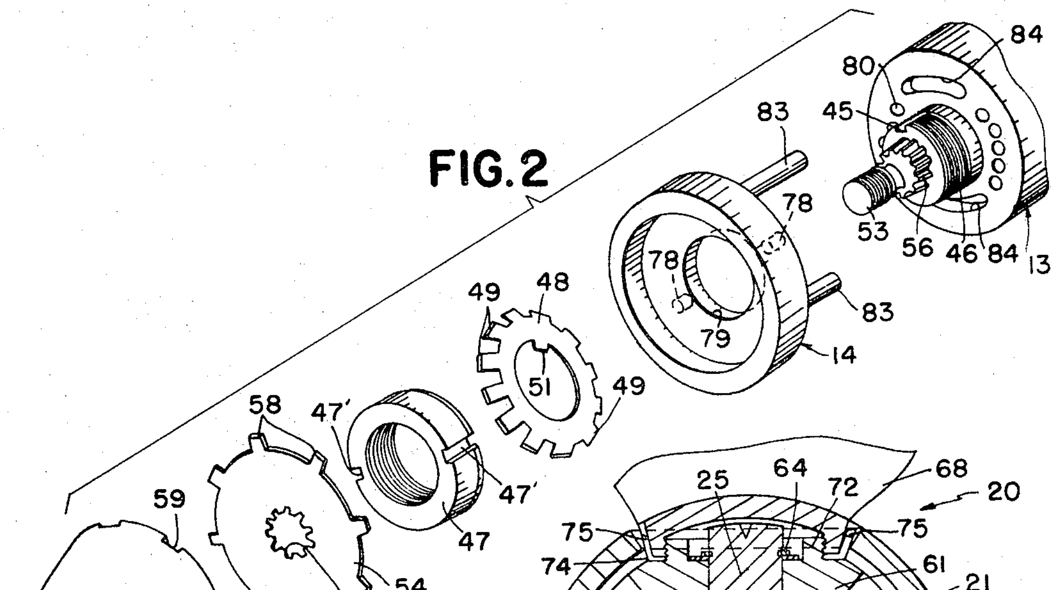

FIG.4

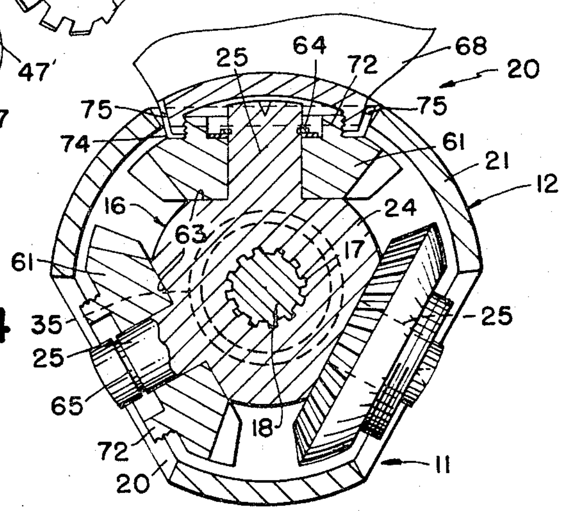

FIG.3

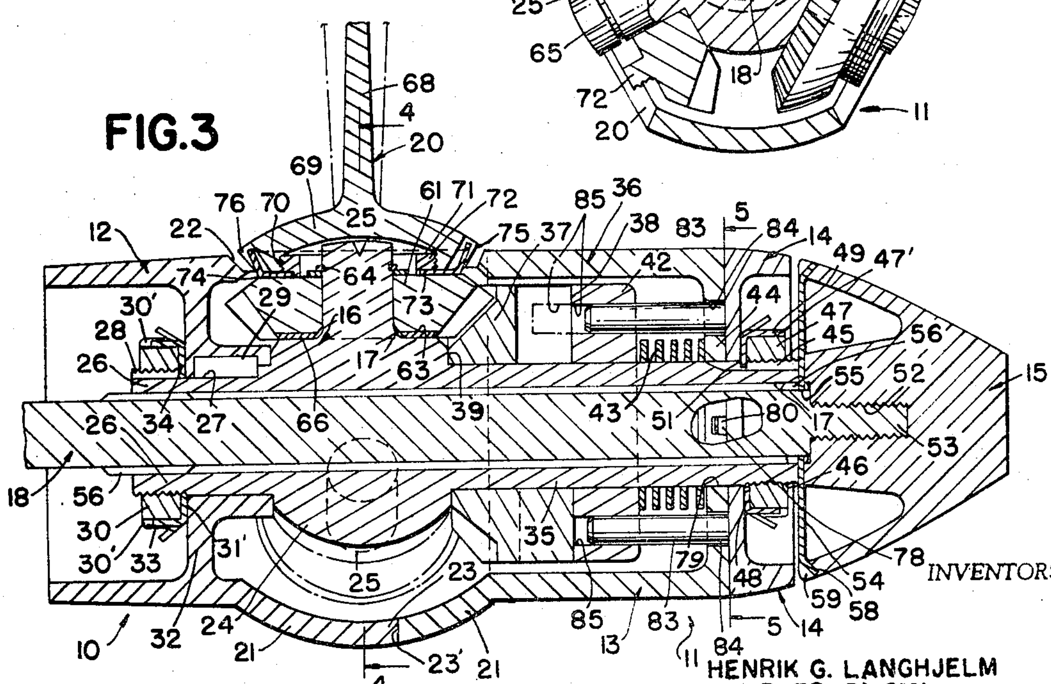

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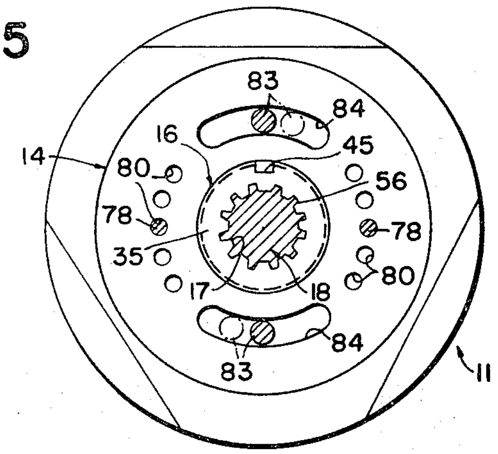
FIG.5



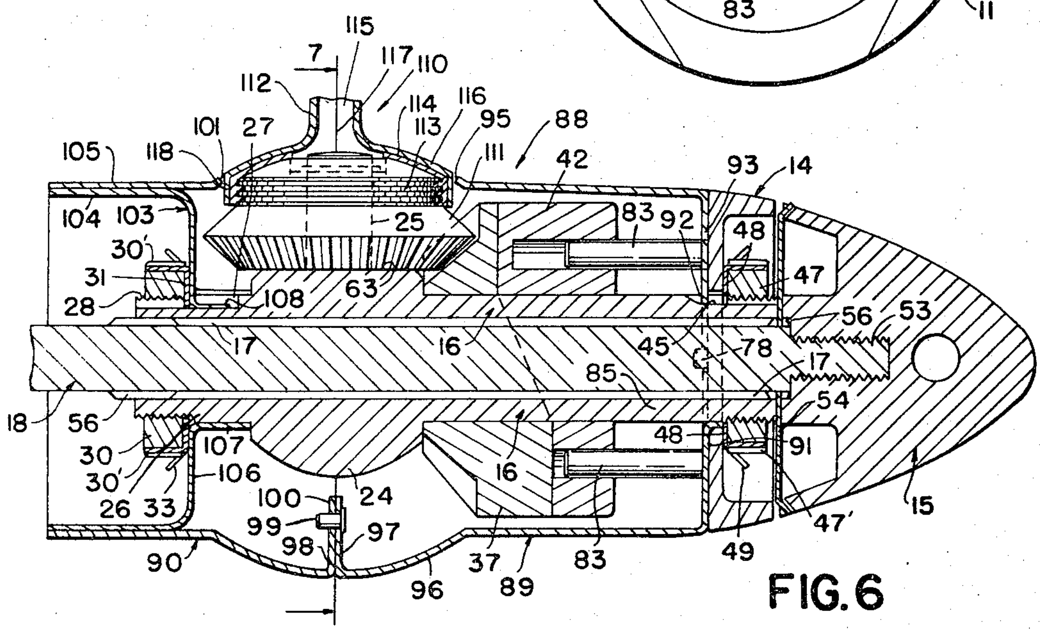


FIG.6

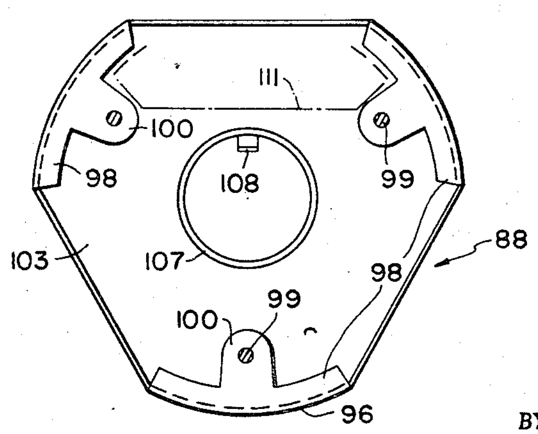


FIG.7

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3,403,735

Patented Oct. 1, 1968

3,403,735

ADJUSTABLE VARIABLE PITCH PROPELLER

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Filed Mar. 10, 1967, Ser. No. 622,214
12 Claims. (Cl. 170—160.51)

ABSTRACT OF THE DISCLOSURE

A variable pitch watercraft or aircraft propeller is provided, in which radially extending propeller blades, variable in pitch angle in a self-sensing way in automatic response to change of speed and/or other condition of operation, are in addition simultaneously adjustable angularly, as a set, when the propeller is not in operation. The individual blade adjustments are in an identical degree to uniformly alter the basic, no-load pitch angle thereof. The blades will then depart and return automatically from and to this altered basic setting in self-sensing response to the varying conditions, in the same way as the blade set would, lacking the improved simultaneous adjustment. The simultaneous adjustment is effected with no disturbance whatsover of certain bevel gear drive means in the variable pitch assembly.

Furthermore, the propeller blades are each mounted directly to an integral portion of an elongated engine shaft-driven sleeve for rotation therewith, as well as being journaled on that portion for the self-sensing and simultaneous adjustments mentioned above. The mount dispenses with bearing and sealing provisions between the blade and the hub, body or housing structure of the propeller; and the powered drive of the blades from the shaft unit is entirely independent of that structure.

CROSS REFERENCES TO RELATED APPLICATIONS

The features of the invention improve on those of the variable pitch propeller designs of the prior art in point of making possible a change of the basic propeller pitch without extensive dismantling of the propeller assembly as a whole, and the attendant possibility of introducing inadvertently a different degree of pitch adjustment of one of the blades than another or other blade or blades. The invention also affords an improved rotative drive of the blades direct from engine driven shaft means, rather than from the propeller hub, body or housing.

BACKGROUND OF THE INVENTION

(1) *Field of the invention.*—The improvement affords a variable pitch propeller for watercraft (inboard or outboard) or aircraft use, as in the case of a co-pending application of common ownership, now Letters Patent No. 3,308,889 to Langhjelm et al. of March 14, 1967. In operation, the two propellers are functionally identical, involving similar assemblies of bevel gear and spring biased cam units or sub-assemblies, through the agency of which the angular attack pitch of the propeller blades is varied in a known manner under differing conditions of operation, primarily speed or load.

The differences between the two propeller structures involve (a) means in the new one to effect a selective angular shift of the blades relative to certain cam surfaces of the bevel gear and cam sub-assembly, and thereby simultaneously effect a desired uniform change from an original or existing, no load angular pitch setting of the propeller blades to a new one; and (b) to permit

the blades to be rotatively power-driven from and through the agency of an engine-powered sleeve, rather than through the agency of the propeller hub or body housing.

(2) *Description of the prior art.*—Over and above the Langhjelm et al. patent, the patent to Kay, No. 1,750,778 of March 18, 1930, discloses a variable pitch aircraft propeller embodying a spring biased cam type of unit, through the partial agency of which pitch variation is accomplished. Seppeler, No. 1,851,784 of March 29, 1932, discloses a variable pitch aircraft propeller embodying a spring urged bevel gear type unit through which pitch variation of the blades is accomplished. French patent to Catelain, 24,707 of June 13, 1922, shows a spring biased bevel gear and cam-type of operation for varying propeller pitch.

However, none of these prior art references shows the bevel gear and cam-controlled, variable pitch features as combined with means whereby an arbitrary and simultaneous adjustment, as to all blades, from or back to a basic or pre-set attack pitch may be effected; nor in an arrangement in which the blades are rotatively power-driven by and on an engine-powered shaft, as distinguished from the propeller body or hub, through the agency of such shaft.

SUMMARY OF THE INVENTION

In a propeller assembly which is generally the same in structure and function as the one we have earlier disclosed, the propeller blades are directly driven about the axis of a main shaft unit, including a tubular drive shaft or sleeve which is spline-connected directly to an engine output shaft therein, instead of being driven by the hub, body or housing structure of the propeller. This sleeve may be a machined casting or forging of considerable axial length.

In addition, the sleeve has integral, radially extending boss formations, three in number, onto or into which the prospective propeller blades are mounted. Such mount thus affords a rotative drive of the blades directly from the engine drive shaft about the propeller axis. The boss formations also journal the blades for their self-sensing pitch variation, and for their simultaneous adjustment as to pitch angle, pursuant to the present invention.

The adjustment is effected when one part of the rotary propeller hub structure, which part is normally connected in the rotative drive of the blades about the axis of the shaft unit, is temporarily disconnected or backed away from its drive connection to another, coaxial part of the hub structure with which it is normally drivingly engaged, as by axially extending pins on one of the parts received selectively in a circumferential series of recesses on the other part.

With the two hub parts thus drivingly disconnected, the simultaneous adjustment of propeller pitch angle may be readily and quickly accomplished. Holding the shaft unit with mild restraint against rotation, as at the backed-off part, one end of the propeller blades may be twisted or turned about its axis of adjusting rotation on a radial boss formation of the shaft unit, the bevel gears of this blade and the other blades then driving the bevel gear of the shaft-mounted gear and cam unit (which last gear rotates integrally with a cam of that unit on the shaft) to alter the angular relationship of a surface of rotative said cam to a meeting surface of another cam restrained by the backed-off part from rotation on the shaft. The same result is of course had by rotating the backed-off part while maintaining its rotation restraining connection to the last named cam. With the desired simultaneous basic blade adjustment thus gained, two hub parts are then drivingly re-engaged, but with the pins on one thereof received in different recesses on the other thereof; and said parts are again locked up on the shaft unit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view in perspective showing all of the hub, shaft, blade and pitch adjusting components of the improved propeller, with one of the three propeller-shaft-driven propeller blade and bevel gear sub-assemblies omitted in the interest of clarity;

FIG. 2 is a similar exploded but fragmentary perspective view from the opposite direction, and in somewhat larger scale than FIG. 1, illustrating primarily the parts of the variable pitch sub-assembly associated with the propeller hub, through the agency of which the improved simultaneous change of basic blade pitch angle is accomplished;

FIG. 3 is a fragmentary view, partially broken away, in cross section in a common plane including the axis of the hub and drive shaft unit and the axis of pitch adjustment of one of the propeller units.

FIG. 4 is a fragmentary view in transverse section along line 4—4 of FIG. 3, showing the relationship of the three blade and bevel gear sub-assemblies to the main shaft unit;

FIG. 5 is a view in transverse section on line 5—5 of FIG. 3, further illustrating provisions for the releasable drive coupling of a pair of propeller hub or housing parts to one another, enabling decoupling thereof for the desired basic adjustment of pitch angle;

FIG. 6 is a fragmentary view in section similar to FIG. 3, showing a modified embodiment of the propeller construction, in which the hub or housing structure is fabricated of metal stampings, as distinguished from relatively massive cast or forged hub components of the embodiment of FIGS. 1–5; and

FIG. 7 is a view along transverse section line 7—7 of FIG. 6, further illustrating the character of the sheet metal hub or housing components, drive shafting being removed for clarity.

DESCRIPTION OF PREFERRED EMBODIMENTS

The improved propeller **10** of the invention, as depicted in axial section and in exploded view in FIGS. 1 and 2, generally has as its basic components, with which the invention primarily deals, a hub or axially elongated housing structure **11** comprised of forgings or castings, including a forward hub part **12**, a first intermediate hub part **13**, a second intermediate hub part **14** directly aft of part **11** and a terminal aft, ogive-shaped part **15**; an axially elongated drive sleeve or tubular drive shaft member **16** which is drivingly coupled by internal splines **17** to the engine drive shaft **18**, and with the latter constitutes a drive shaft unit; and radially projecting propeller blade and bevel gear units or sub-assemblies **20**, shown as being three in number.

As best appears in FIG. 1, the hub parts **12** and **13** are formed on mutually facing, spherically belled axial ends **21** thereof to provide three circumferentially spaced, semi-circular recesses **21'** of substantial radius, so that when these parts are engaged axially against one another, and interlocked against relative angular shift, the respective sets of angularly aligned recesses **21'** constitute radial openings **22** of substantial size (FIG. 3), through which certain components of the respective units or sub-assemblies **20** project radially outwardly. As thus abutted with one another, the forward hub part or casting **12** is interlocked as mentioned with intermediate part **11** by integral rearwardly projecting ears **23** on bell **21** of the former (FIG. 1) and mating recesses **23'** on bell **21** of the latter.

The tubular, internally splined drive shaft or sleeve **16**, which may be a forging, a casting, or be molded of a suitable plastic having good strength and bearing quality, is formed at an intermediate point therealong to provide (as best shown in FIG. 1), a radially protuberant and quasi-spherical boss **24**, from which three integral trunnion portions **25** project radially in equally spaced circumferential relation to one another. These trunnion

members are appropriately turned or finished to provide cylindrical journal surfaces to receive and swivel the respective adjustable blade assemblies **20**, in a manner hereinafter described.

Directly forward of the trunnion-bearing boss **24**, tubular drive shaft **16** presents a reduced diameter sleeve portion **26**, which has an axially extending external key-way **27** and threading **28** at its extremity. Key-way **27** receives a key **29**, which drivingly connects forward housing part **12** to the shaft **16** directly adjacent its quasi-spherical boss.

While the shaft **16** and hub part **12** may well be (and perhaps preferably are) of one piece construction, for example in the form of a stainless steel casting or forging, a molded nylon unit, etc., they are herein shown as being key-connected and separable, as just described. Accordingly, in order to hold members **12** and **16** in assembly for rotative drive as a unit, a lock ring **30** is threaded onto the reduced diameter sleeve portion **26**, with a castellated type of lock washer **31** interposed between it and an integral apertured partition **32** of hub part **12** through which tubular shaft **16** extends. Lock ring **30** has a pair of diametrically opposed outer recesses **30'**, into which a pair diametrically opposed, radial lugs or fingers **33** of washer **31** are bent to lock the parts together securely against separation, once ring **30** has been taken up tightly. An internal lug **34** on washer **31** fits into shaft key-way **27** to effect a positive drive lock-up of hub part **12** to tubular shaft **16**.

The two intermediate hub parts **13** and **14**, as disposed in flush axial abutment with one another (FIG. 3), are held against accidental axial separation from forward hub part **12** by very similar lock ring and washer provisions; and a manipulation of these enters into the operation of simultaneously adjusting basic propeller pitch angle, which is such an important aspect of the invention, as will be described.

Rearwardly of the blade assembly journaling and driving boss **24** of tubular shaft **16**, the latter has an integral reduced diameter aft extension **35** of considerable axial length, which serves for the mounting of a combined bevel gear and cam unit, generally designated **36**, of the present improvement.

That is, the unit **36** comprises a forwardly facing bevel gear member **37** which (in the present instance) has integral inclined ramp-type cam surfaces **38** on its rear, rather than being constituted by separate gear and cam parts pinned for rotation together, as in that application. Bevel gear-cam member **37**, which may be of bronze or molded nylon, is freely rotatable on the tubular shaft extension **35**, directly aft of and in axial abutting engagement with a flat annular bearing surface **39** on a trunnion boss **24**, as shown in FIG. 3; and the cam or ramp surfaces **38** are in flush meeting engagement with similarly inclined cam surfaces **41** (FIG. 1) of a rear cam member **42** of unit or sub-assembly **36**. Member **42** is axially slidable on drive sleeve extension **35**, but is restrained against rotation on the latter by means to be described. A flat section coil compression spring **43** encircles extension **35** behind cam member **42**, this spring acting rearwardly against an integral transverse rear wall **44** of intermediate hub part **13**. This maintains axial engagement of the cam surfaces **38**, **41** of the respective rotatable and axially slidable control components **37** and **42** with one another, thereby completing the structure of the shaft-borne bevel gear and cam unit **36**.

The second intermediate hub or housing part **14** is axially apertured to slidingly fit on the rear of shaft extension **35**, normally abutting the rear wall **44** of hub part **13** (FIG. 3). Extension **35** has a rear key-way **45** and terminal threading **46** to threadedly receive a clamp ring **47**, with a castellated lock washer **48** interposed. This washer, like forward washer **31**, has radial fingers **49**, a pair of which are bendable into diagonally opposite recesses **47'** of ring **47** to lock to the latter; and washer

48 also has an internal lug 51 received in key-way 45 of hub part 14 to complete a driving connection for hub part 14 from the shaft unit.

Finally, the aft-most ogive part 15 of the propeller hub structure 11 is centrally recessed and internally threaded at 52 to screw onto a reduced diameter aft-most extension 53 of engine drive shaft 18; and a still more positive lock-up of part 15 to the drive shaft is effected by means of a castellated coupling plate or washer 54. This is centrally apertured and provided with spline formations at 55 (FIG. 2) which fit the aft end of elongated external splining 56 on engine shaft 18. The coupling plate 54 also has a plurality of radially outwardly projecting lugs or fingers 58 which, with ogive part 15 taken up tightly on drive shaft extension 53, are bent into correspondingly spaced outer and forward recesses 59 on part 15. Thus the latter is positively keyed for drive by the internal engine driven shaft 18, just as the latter drives tubular shaft 16 at the splined connection of these shafts, and just as the housing or hub components 12, 13 and 14 are driven by means including key 29, the angularly matching interfit of hub parts 12, 13 at 23 and 23′, the fore and aft lock ring and washer provisions, and, further, a special releasable driving connection of hub parts 13 and 14. This connection also enters into the adjustment of propeller blade pitch, and will be described following a description of the gear-propeller blade units or sub-assemblies 20, their drive by the shaft units 16, 18 and their mount for pitch adjustment on tubular shaft component 16.

With reference had to FIGS. 1 and 4 in conjunction with FIG. 3, each of the three blade units 20 comprises a bevel gear 61 journalled for rotation on an integral, radially projecting trunnion portion or formation 25 of the enlarged shaft boss 24. Blade gears 61 are each radially inwardly sustained by an annular bearing surface 63 of boss 24, with a washer and split retainer ring 64 received in an annular groove 65 of trunnion 62 to hold the gear against axial separation. A bearing washer 66 also may be interposed between each gear 61 and boss bearing surface 63.

The blade proper, designated 68, of each blade-gear sub-assembly 20 has an inner, radially flared and convex, flange-like formation 69, which is internally threaded at 70 (FIG. 3) to screw tightly onto an integral hub-like extension 71 of bevel gear 61. This extension has diametrically opposed slots 72 in the face thereof, which receive internal lugs 73 of a castellated lock washer 74; and further to lock blade 68 and gear 61 as a unit, the washer 74 has its outer fingers 75 bendable outwardly into said recesses 76 of blade flange 69.

Thus simple means are provided to drivingly connect blade 68 with bevel gear 61 to move as a unit with the latter in the adjustment of pitch of the blade, whether it be the normal self-sensing variation in pitch or the special, simultaneous adjustment of angular pitch of all three blades 68, as contemplated by the invention. If desired, blade 68 may be threaded internally into boss 25 and locked by means similar to those described.

Although pitch adjustment is readily and easily effected without in any way dismantling the blade units or assemblies 20, nor the existing mesh of their gears 61 with the gear members 37 of shaft bevel gear-cam unit 36 (by structure to be described), the blade assemblies 20 are nevertheless readily dismantled individually in the event of damage, or desire for replacement by a different blade design, by simply spreading the washer fingers 75 to free blade 68 for separation from the gear, without disturbing the latter in the slightest in relation to its mount on shaft trunnion portion 26.

It is to be noted that generous radial clearance exists (FIG. 3) between the periphery of blade flange 69 and the blade-accommodating hub recess 22, thereby affording space for the manipulation of washer 74. The exposure of the gearing and other shaft components and the like to water is acceptable inasmuch as it is contemplated that they shall be of non-rusting or corroding material.

Pursuant to the invention, and as best shown in FIGS. 2 and 5, the aft-most part 14 of the two intermediate hub parts is provided with a pair of diametrically opposed, axially projecting and relatively short drive lugs 78, outwardly of its central, shaft receiving opening 79. These project into a pair of correspondingly spaced recesses 80 in the rear transverse wall 44 of the other intermediate hub part 13 when the latter is abutted by hub part 14. There are two circumferentially disposed series or arrays of the recess 80 (FIG. 5), so that the lugs 78 may be inserted in any diametrically opposed pair of the respective arrays. Thus, the hub parts are positively coupled for rotative drive as a unit in any one of several fixed angular relationships to one another, with part 14 tightly taken up flush against part 13 by the means heretofore described.

Furthermore, the aft intermediate hub part 14 carries a pair of axially elongated guide and restraint pins 83, each of which passes with reasonably generous side clearance through an arcuate slot 84 in the rear wall 44 of hub part 13. Pins 83 are forwardly received in diametrically opposed bores 85 in the aft-most cam member 42, the pins thus restraining that cam member from rotation relative to the tubular shaft 35 on which it is slidably mounted, while permitting a considerable degree of such slide as the cam 42 is driven rearwardly by geared cam member 37 under the wedging action at their meeting cam surfaces 38 and 41, as in the case of our co-pending application.

It is to be noted that the relationship of the cam formations is distorted a bit from actuality in FIG. 3 by an intentional angular displacement. Actually, the axially thicker portion of rear cam member 42 will have recesses 85 of sufficient axial extent (as indicated in dot-dash line) to accommodate a maximum axial rearward throw of that member, as when it bottoms out aft-wise on spring 43, fully compressing the same as described in our co-pending application. The matter appears more clearly in FIG. 6 of the drawings.

In operation, in order to produce a basic simultaneous adjustment of the pitch of all three blades 68, as from the soild line position of FIG. 3 to an altered dot-dash line position, it is only necessary to remove or back-off the ogive hub part 15 from drive shaft 18, and remove or back-off lock nut 47 and lock washer 48. This permits hub part 14 to be shifted back from part 13 sufficiently to free its drive lugs 78 from the hub recess 80 in which they happen to be at the time of the adjustment; while still preserving the engagement of pins 83 in the aft cam bores 85. Then, exerting mild restrain on the tubular shaft extension 35 hub part 14 (hence on cam 42) sufficient to prevent its rotation, the adjuster simply twists one of the blades 68 to the desired degree of pitch change. This causes the several bevel gears 61 to rotate the shaft gear 37 pre-determinedly, with the result that the relationship, angular-wise, of the two sets of cam surfaces 38, 41 are altered accordingly.

In the alternative, with the blades held fixed the hub part 14, with its restraint pins 83 still engaging the bores of aft cam 42, may be twisted one way or the other. Markings 86, 87 (FIG. 1) on parts 13 and 14 may be noted to ascertain the sense of the adjustment, direction-wise.

The hub part 14 is then returned against part 13, with the two drive lugs 78 of the former engaged in a different pair of recesses 80 of the latter. This maintains the altered basic cam relationship, consequently the altered basic blade pitch angle setting, after lock ring 47 has been taken up and locked in place by washer 48, and the ogive part 15 taken upon threaded shaft extension 53, then washer-locked against rotation.

The modified embodiment 88 of the improved propeller which is illustrated in FIGS. 6 and 7 of the drawings is one in which the hub or housing structure is in the main fabricated of sheet metal stampings. Inasmuch as certain other components are the same as, or only slightly different from, those illustrated in FIGS. 1–5 and described above, they are designated in FIGS. 6 and 7 by corresponding reference numerals, and further description thereof is dispensed with.

The hub structure comprises, in addition to the aft ogive **14**, the aft and forward sheet metal hub stampings **89** and **90**, respectively, the former having an axial flange formation **91** at its rear which telescopes onto the tubular drive shaft extension **35** and drivingly keys at an internal lug **92** into the key way **45** of the extension. Otherwise, the rear wall or partition **93** of hub part **89** has sets of openings releasably receiving the pair of drive pins **78** projecting forwardly from hub part **14**, and also has arcuate slots receiving the guide and rotation restraining pins **83**, as in the first embodiment of the invention.

Hub part **89** is formed at its forward end to provide three semi-circular recesses **95**, corresponding to the recesses **21'** of the first form; and is outwardly belled at **96** in the zones separating such recesses, terminating in radially inwardly projecting flanges **97**. These abuttingly engage axially corresponding flanges **98** of the forward hub part **90**; and rivet or like fastening elements **99** engage in apertures of aligned radially inner ears **100** in the two flanges to rigidly clamp hub part **89** to part **90**.

The latter is formed to provide three circumferentially spaced, semi-circular recesses **101** between its flanges **98**, these recesses coacting with the recesses **95** of part **89** in providing the radial openings of hub structure **89** which receive the propeller units or sub-assemblies.

To complete the stamped hub structure, a forward cup-shaped and axially apertured end member **103** has its cylindrical flange **104** telescoped within a forward sleeve portion **105** of hub part **90**, preferably without undue tightness such as would make its separation difficult. The aft wall **106** of part **103** has an annular flange **107** fitting on the forward sleeve extension **26** of tubular drive shaft **16**; and a radially inwardly extending lug **108**, struck from wall **106** and flange **107**, is received in the forward key-way **27** of the shaft, thus positively locking part **103** to the shaft unit.

For the rest, the hub parts **90**, **103** and **89** are locked up and drivingly connected to the shaft unit by lock ring and washer provisions indentical to those heretofore described.

A bevel gear and blade assembly of the sheet metal version **88** is generally designated by the reference numeral **110**, the gear bearing reference numeral **111** and the blade bearing reference numeral **112**; and a radially outward hub portion of gear **111** is formed with an Acme thread **113**, which is threadedly engaged by a cup-like inner adapter **114**. Blade **112** is fabricated of two stamped halves **115** each flared or flanged at **116** and, with the blade parts **115** seam or spot welded, or otherwise secured together in abutment, at meeting surfaces **117**. The blade is then spot welded or otherwise rigidly secured to the adapter **114** at telescoped annular flange surfaces **118**, thus completing the blade-gear assembly **110**. It is mounted to a shaft boss trunnion in the manner described in connection with the first embodiment.

What is claimed is:

1. A variable pitch propeller comprising a hub structure, a shaft unit rotatable in said structure, propeller blades projecting radially from the hub structure and drivingly connected to and driven by said shaft unit, and a resiliently biased gear and cam unit in said structure, including a gear member coaxial with the shaft unit and meshing with gear members fixed to the respective propeller blades, to enable automatic self-sensing adjustment of the pitch angle of the blades about radial axes in response to a varying condition of operation of the propeller, said shaft unit having radially disposed portions by which the respective propeller blades and gears therefor are journaled for said self-sensing adjustment, said blades and the gear members thereof having means mounting the same in radially fixed relation to said respective portions of the shaft unit, and quick release means for separating a blade from its gear member without disturbing the mount of the blade on the shaft unit portion.

2. A variable pitch propeller comprising a hub structure, a shaft unit rotatable in said structure, propeller blades projecting radially from the hub structure and drivingly connected to and driven by said shaft unit, and a resiliently biased gear and cam unit in said structure, including a gear member coaxial with the shaft unit and meshing with gear members fixed to the respective propeller blades, to enable automatic self-sensing adjustment of the pitch angle of the blades about radial axes in response to a varying condition of operation of the propeller, said shaft unit having radially disposed portions by which the respective propeller blades and gears therefor are both driven about the axis of the shaft and journaled for said self-sensing adjustment, said blades and the gear members thereof having means mounting the same in radially fixed relation to said respective portions of the shaft unit, and quick release means for separating a blade from its gear member without disturbing the mount of the blade on the shaft unit portion.

3. A variable pitch propeller comprising a hub structure, a shaft unit rotatable in said structure, propeller blades projecting radially from the hub structure and drivingly connected to and driven by said shaft unit, a resiliently biased gear and cam unit in said structure, including a gear meshing with gears fixed to the respective propeller blades, to enable automatic self-sensing adjustment of the pitch angle of the blades about radial axes in response to a varying condition of operation of the propeller, and means to effect a further adjustment of the pitch angle of said blades from one pitch angle setting of each blade to an altered and unchanging setting, while maintaining unaltered the pitch relationships of the blades to one another which existed at said one setting.

4. A variable pitch propeller comprising a hub structure, a shaft unit rotatable in said structure and having integral radially projecting portions, propeller blades projecting radially from the hub structure and drivingly connected to and driven by said shaft unit at said respective portions of the latter, a resiliently biased gear and cam unit in said structure, including a gear meshing with gears fixed to the respective propeller blades, to enable automatic self-sensing adjustment of the pitch angle of the blades about radial axes in response to a varying condition of operation of the propeller, and means to effect a further simultaneous adjustment, as a unit, of the pitch angle of said blades from one pitch angle setting of each blade to an altered and unchanging setting, while maintaining unaltered the pitch relationships of the blades to one another which existed at said one setting, said last named means including means to lock the blades against undesired departure from the altered setting.

5. The propeller of claim **2**, in which said hub structure has radial openings through which said blades project without driving engagement by said structure.

6. The propeller of claim **5**, in which said blade gear members are located radially within said openings.

7. The propeller of claim **3**, in which said simultaneous adjustment means is operatively connected to said shaft and gear-cam units to effect said further adjustment of blade pitch angle without interrupting the mesh of the blade gears with the gear of the gear-cam unit.

8. The propeller of claim **4**, in which said simultaneous adjustment means comprises a part of said hub structure having means to releasably connect it it in fixed relation to another part of the hub structure and in driving engagement with said shaft unit.

9. The propeller of claim **3**, in which said simultaneous adjustment means is operatively connected to said shaft and gear-cam units to effect said further adjustment of blade pitch angle without interrupting the mesh of the blade gears with the gear of the gear-cam unit, said means comprising a part of said hub structure having means to releasably connect it in fixed relation to another part of the hub structure and in driving engagement with said shaft unit.

10. A variable pitch propeller comprising a hub structure, a shaft unit rotatable in said structure, propeller blades projecting radially from the hub structure and drivingly connected to and driven by said shaft unit, a resiliently biased gear and cam unit in said structure, including a gear member coaxial with the shaft unit and meshing with gear members fixed to the respesctive propeller blades, to enable automatic self-sensing adjustment of the pitch angle of the blades about radial axes in response to a varying condition of operation of the propeller, said gear members of the respective shaft unit and blades being in planes normal to the axes thereof, said shaft unit having radially disposed portions by which the respective propeller blades and gears therefor are both driven about the axis of the shaft and journalled for said self-sensing adjustment, said blades and the gears thereof having means mounting the same in radially fixed relation to said respective portions of the shaft unit, and means to effect a further simultaneous adjustment, as a unit, of the pitch angle of said blades from one pitch angle setting of each blade to an altered and unchanging setting, while maintaining unaltered the pitch relationships of the blades to one another which existed at said one setting, said last named means including means to lock the blades against undesired departure from the altered setting.

11. A variable pitch propeller comprising a hub structure, a shaft unit rotatable in said structure, propeller blades projecting radially from the hub structure and drivingly connected to and driven by said shaft unit, means to enable automatic self-sensing adjustment of the pitch angle of the blades about radial axes in response to a varying condition of operation of the propeller, and means to effect a further adjustment of the pitch angle of said blades from one pitch angle setting of each blade to an altered and unchanging setting, while maintaining unaltered the pitch relationships of the blades to one another which existed at said one setting and means to lock the blades against departure from the altered and unchanging setting.

12. The propeller of claim **11**, in which said shaft unit has radially projecting formations on which the respective blades are mounted for said drive by the shaft unit and for said self-sensing adjustment of the blades about radial axes.

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