Feb. 7, 1967 P. F. BRIMBLE ETAL 3,302,725

VARIABLE PITCH MARINE PROPELLER

Original Filed Aug. 3, 1961 2 Sheets-Sheet 1

Fig. 1

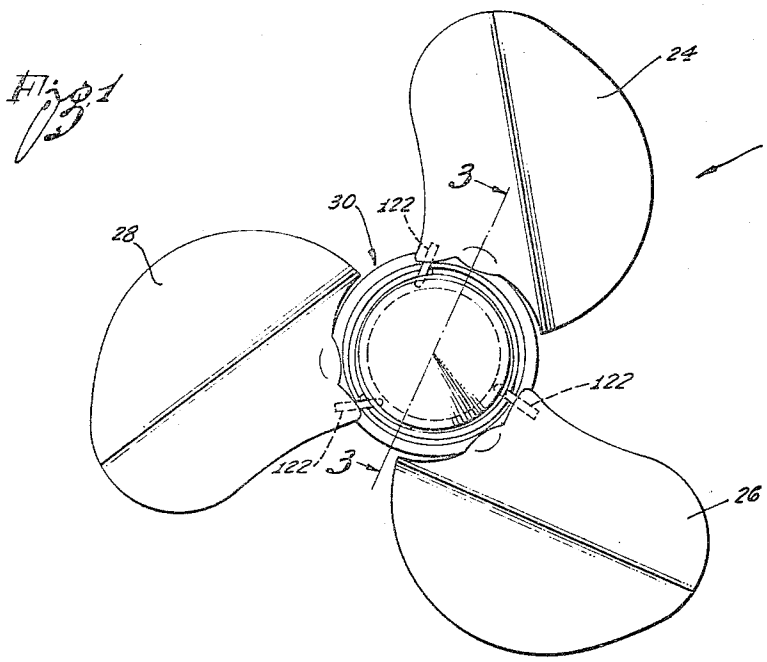


Fig. 2

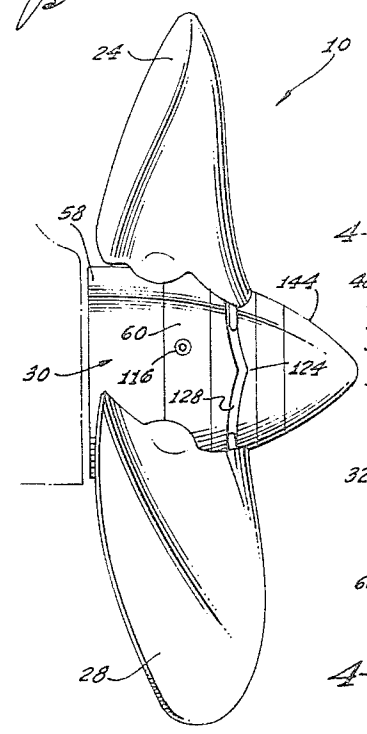
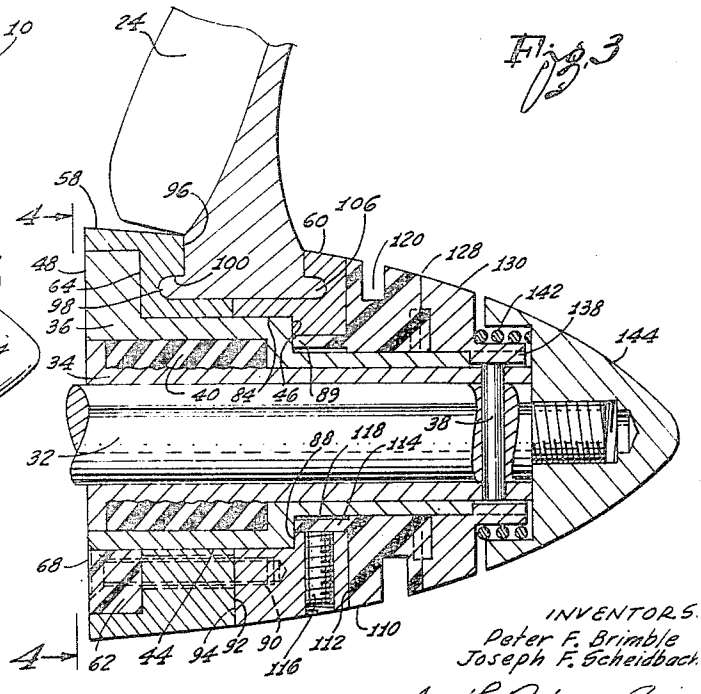


Fig. 3



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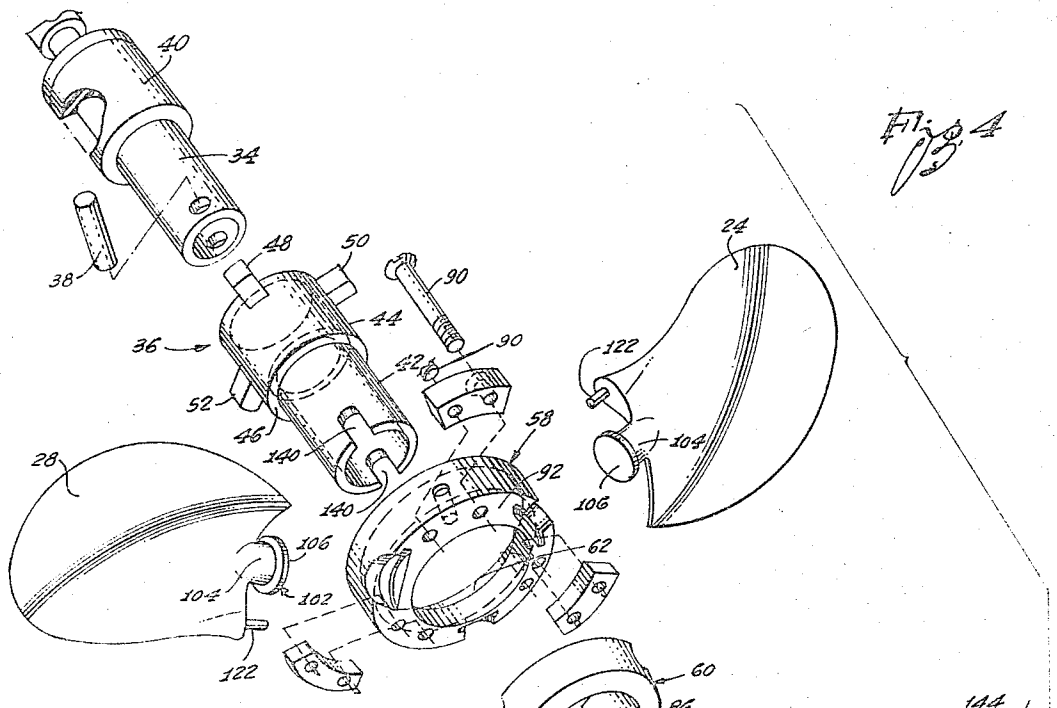


Fig. 4

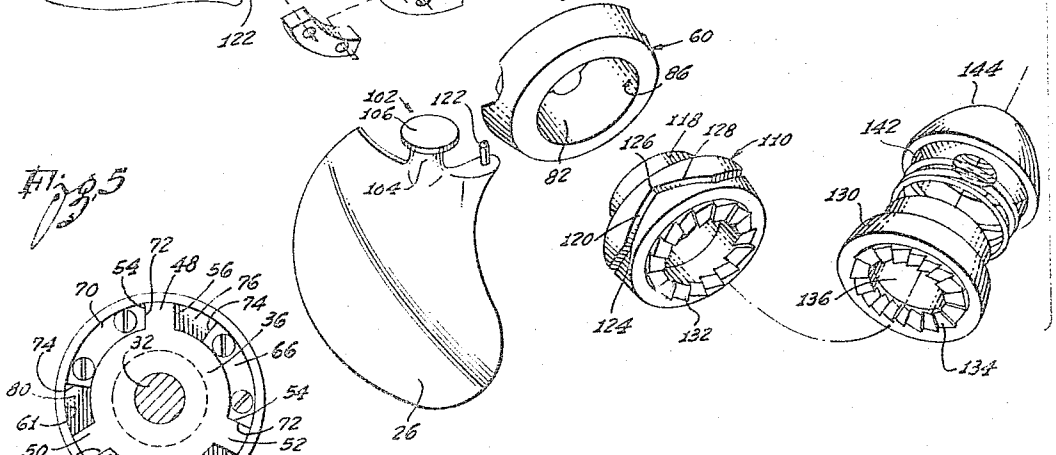


Fig. 5

Fig. 6

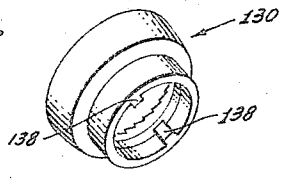
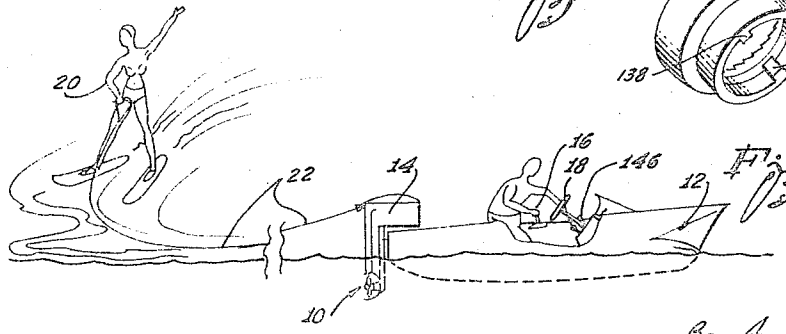


Fig. 7



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3,302,725

VARIABLE PITCH MARINE PROPELLER

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Continuation of application Ser. No. 385,086, July 24, 1964, which is a continuation of application Ser. No. 129,147, Aug. 3, 1961. This application Oct. 22, 1965, Ser. No. 513,611

15 Claims. (Cl. 170—160.13)

This application constitutes a continuation of our application Ser. No. 385,086, filed July 24, 1964, for a Variable Pitch Marine Propeller, which, in turn, is a continuation of our application Ser. No. 129,147, filed Aug. 3, 1961, for a Variable Pitch Marine Propeller, now abandoned.

The present invention relates to propellers and more particularly to marine propellers and means for varying the pitch thereof.

When a boat is propelled by means of a propeller immersed in water and driven by a motor, it is very desirable to obtain maximum efficiency and/or maximum speed. In order to accomplish such an objective it is necessary among other things, for the motor to run at an optimum revolutions per minute and for the propeller to have a pitch that will permit the engine to operate at the desired speed and also provide an efficient drive in the water. The foregoing are in turn dependent upon the operating characteristics of the boat i.e., the load in the boat, the speed of the boat, the condition of the seas etc. Since such factors constantly vary, it is necessary to endeavor to reach a compromise combination of motor and propeller that will produce acceptable performance over a wide range of operating conditions.

In small light weight pleasure boats that are subjected to a wide range of operating conditions it has been very difficult if not impossible to reach a compromise that is satisfactory. In a light weight planing type of runabout driven by an outboard motor, the weight of the load inside of the boat frequently varies over a very wide range and the boat may be employed for towing one or more water skiers. As a result, the requirements for propelling the boat vary over such an extremely wide range that one propeller will not provide proper operation. More particularly, when initially starting out in a heavily loaded boat, the boat travels through the water very slowly and requires a large amount of thrust. As a result during such periods it is highly desirable to employ a propeller having a small pitch. Such a propeller will permit the motor to run at a high speed and develop large amounts of power as well as permit the propeller to operate efficiently in the water. This will permit the boat to rapidly accelerate to a speed that will cause the boat to plane on the surface of the water. This is particularly true where the boat is towing a skier. Once the boat has acquired a planing attitude, if a low pitch propeller is employed the motor must be run at maximum speed and yet the boat and any skiers therebehind will be traveling at less than the maximum speed obtainable with a higher pitch propeller.

In the event the higher pitch propeller is employed when the boat is initially starting out and traveling slow, the propeller will be very inefficient. In addition, the speed of the motor will be held down to such a low amount the motor will not develop maximum power. This in turn results in very poor acceleration that makes it very difficult if not actually impossible for the boat and any skiers therebehind to rise up onto the surface of the water and plane thereacross.

In order to overcome such difficulties numerous attempts have been made to provide a variable pitch propeller wherein the pitch of the blades may be set to the optimum amount for the particular operating conditions. In one form of variable pitch propellers, such as disclosed in U.S. Patent No. 2,953,208 entitled Variable Pitch Marine Propeller and filed in the name of Charles A. O'Conner, the propeller must be stopped and removed from the water while extensive adjustments are manually made thereto. As a result to vary the pitch of the propeller it is not only difficult and inconvenient to do so but in addition such propellers are not well suited for use wherein drastic changes occur in the propeller requirements during operation of the boat. More particularly, if a low pitch is required to cause the boat and any skiers therebehind to attain a planing speed and a higher pitch is desirable for maintaining the required planing attitude, the pitch of such a propeller can not be increased without causing the boat and skier to stop.

In another form of variable pitch propellers means are provided whereby the pitch of the propeller may be altered while the motor is running. However, heretofore such means have been extremely complex and cumbersome and as a result they have not only been expensive and difficult to operate but have also required frequent servicing and have been subject to frequent mechanical difficulties. As a result such propellers have found very limited use on pleasure craft.

It is now proposed to provide a variable pitch propeller that overcomes the foregoing difficulties. More particularly, it is proposed to provide a reliable and inexpensive propeller wherein the pitch of the blades thereon may be varied while the motor is running. According to one form of the invention the propeller employs a plurality of blades that are pivotally mounted on two separate mounting portions of a hub means so that the relative positions of the two portions will be effective to determine the pitch of the blades. One of the mounting portions may be operatively connected to the drive shaft by means of a lost motion connection whereby during normal operation of the motor, the propeller and the blades thereon will be driven in a normal manner. The other mounting portion may be operatively interconnected with the drive shaft by a drive means that will cause the two portions to change their relative positions as a result of the propeller tending to overrun the drive shaft. Thus whenever it is desired to change the pitch of the blades, the speed of the motor may be momentarily reduced abruptly enough to produce an overrunning tendency of the propeller and then the speed of the motor may be again increased. As a result during this interval the two mounting portions will change their relative positions and therefore the pitch of the blades. As a consequence the motor will resume driving the propeller but with a new pitch. Since the interval of time required for the foregoing operation to occur is very short the pitch may be changed without producing a perceptible slowing down of the boat. It may thus be seen that in the event the operating conditions of a boat change sufficiently during the operation thereof to justify the changing of the pitch of the propeller, the pitch may be changed while the boat is running without materially interfering with the operation of the boat by merely decreasing the speed of the motor for a very short interval.

These and other features and advantages of the present invention will become readily apparent from the following detailed description of one form of the present invention, particularly when taken in connection with the accompanying drawings wherein like numerals refer to like parts and wherein:

FIGURE 1 is an end view of a propeller embodying one form of the present invention;

FIGURE 2 is a side view of the propeller of FIGURE 1;

FIGURE 3 is a transverse cross section view, on an enlarged scale, taken substantially along the plane of line 3—3 in FIGURE 1;

FIGURE 4 is an exploded perspective view of the propeller of FIGURE 1;

FIGURE 5 is a fragmentary view of the propeller of FIGURE 1;

FIGURE 6 is a perspective view of one of the elements in the propeller; and

FIGURE 7 is a side view of a boat and skier being propelled by a motor equipped with the propeller of FIGURE 1.

Referring to the drawings in more detail, the present invention is embodied in a propeller **10** adapted for propelling a light weight planing boat **12** across the surface of the water. Although the boat **12** may be of any desired variety, in the present instance it employs an outboard motor **14** that is mounted on the boat transom. The motor **14** may be remotely controlled from the front of the boat **12** by means of a set of manual controls that includes a suitable throttle lever **16** and an ignition switch **18**. The ignition switch **18** may be effective to open the ignition system or short it to ground to thereby prevent the cylinders in the motor firing. If desired, one or more water skiers **20** may be towed behind the boat **12** by means of a rope **22** secured to the motor or transom.

In a light weight planing boat **12** of the present variety the operating characteristics thereof as well as the requirements of the motor **14** and the propeller **10** will vary over a considerable range depending upon how heavy a load is disposed inside the boat **12**, whether the boat **12** is traveling through the water at a slow rate or is planing on top thereof at a high rate of speed and last but by no means least whether or not one or more skiers **20** is being towed behind the boat **12** and whether or not the skier is planing on the surface of the water. Heretofore in such a boat and motor combination it has been customary to utilize a high power motor together with a propeller that was a compromise giving reasonable performance during the various operating conditions.

In the present instance the propeller **10** has a pitch which may be adjusted over a wide range to satisfy the requirements during various operating conditions. Although the propeller **10** may have a diameter and number of blades suitable for the particular motor and boat with which it is to be employed, in the present instance for purposes of illustration, the propeller **10** has three blades **24**, **26** and **28**. The blades **24**, **26** and **28** are mounted on a hub **30** at circumferentially equally spaced intervals therearound so as to project radially outwardly therefrom so as to react with the water as the propeller **10** rotates therein. The hub **30** may be secured to the propeller or drive shaft **32** of the motor **14** for normally rotating in a clockwise direction (as seen in FIGURE 1) and producing a thrust that will tend to drive the propeller **10** forwardly (to the left as seen in FIGURES 2 and 3).

The hub **30** may be connected to the drive shaft **32** by any suitable means. In the present instance a pair of sleeves **34** and **36** are provided that are concentric with each other. The inner sleeve **34** includes a cylindrical passage that is adapted to receive the drive shaft **32**. This sleeve may be secured to the drive shaft by means of a shear pin **38** that extends through registering openings in the drive shaft **32** and the sleeve **34**. The shear pin **38** preferably has a limited strength that is adequate to transmit normal operating torque from the shaft **32** to the sleeve **34** but is inadequate to transmit a large torque such as would occur when one of the blades **24**, **26** or **28** strikes an obstruction.

The outer sleeve **36** fits over the exterior of the inner sleeve **34** and is connected thereto by means of a slipping clutch. The present clutch comprises a rubber bushing **40** that is compressed between the two sleeves. The rubber bushing **40** is effective to provide a friction drive that will transmit normal operating torque. However, the rubber bushing **40** will be effective to limit the torque that may be transmitted to the propeller blades **24**, **26** and **28** and thereby provide additional protection against damage to the blades **24**, **26** and **28** in a manner similar to the shear pin **38**.

The exterior of the sleeve **36** includes a first portion **42** of reduced diameter and a second portion **44** of greater diameter that is separated from the first portion by a radial shoulder **46**. Each of these portions **42** and **44** form substantially cylindrical surfaces that are concentric with the axis of the shaft **32**. The forward end of the sleeve **36** may include a plurality of arms **48**, **50** and **52** that project radially outwardly therefrom. In the present instance there are three arms, each of which has a square cross section with a plane forward face **54** and a reverse face **56**.

In addition a pair of retaining rings **58** and **60** may be provided on the exterior of the sleeve **36**. The first ring **58** includes a cylindrical passage that forms a snug fit on the enlarged portion **44** of the sleeve **36** so as to permit the ring **58** to rotate thereon. The front end of the ring **58** includes an annular recess **62** that extends therearound substantially concentric with the axis of the shaft **32**. The depth and width of this recess **62** are just large enough to permit the arms **48**, **50** and **52** to be disposed therein. The radially outer ends of the arms **48**, **50** and **52** terminate adjacent the outside **61** of the recess **62** while the front side of the arms is substantially flush with the front surface of the ring **58**. The bottom **64** of the recess **62** forms a radial face that slides against the rear side of the arms so as to limit the axial movement of the ring **58**.

A plurality of arcuate blocks **66**, **68** and **70** may be disposed in the recess **62** adjacent the outside arm **61** thereof. These blocks **66**, **68** and **70** which correspond in number to the number of arms **48**, **50** and **52** are secured against the bottom **64** at circumferentially equally spaced points. The ends of the blocks form forward stops **72** and reverse stops **74**. The stops **72** and **74** are separated from each other by circumferentially extending pockets **76**, **78** and **80**. Each of the pockets **76**, **78** and **80** is adapted to receive one of the arms **48**, **50** and **52** whereby the arms may move through the pockets. At one extreme of movement the forward faces **54** will engage the forward stops **72** while at the other extreme the reverse faces **56** will engage the reverse stops **74**. It may thus be seen that the engagement of the arms **48**, **50** and **52** and the blocks **66**, **68** and **70** will thereby limit the amount of relative rotary movement between the sleeves **34** and **36** and the retaining ring **58** as well as permit torque to be transmitted between the sleeves and ring **58**.

The second retaining ring **60** includes a passage **82** that extends axially therethrough for receiving the sleeve **36**. The passage **82** includes a first cylindrical section **84** that forms a snug fit on the exterior of the enlarged portion **44** suitable for permitting the ring **60** to rotate upon the exterior of the sleeve **36**. A second section **86** of the passage **82** has a smaller diameter and is separated from the first section **82** by means of a radial shoulder **88**. This shoulder **88** engages the shoulder **46** and thereby limits the forward axial movement of the ring **60**. The inside diameter of the second section **86** is preferably larger than the diameter of the small portion **42** of the sleeve **36** so as to provide an annular clearance **89** space therebetween.

A plurality of bolts **90** may extend through the blocks **66**, **68** and **70** and first ring **58** and on into the second ring **60**. These bolts **90** will thus not only secure the blocks **66**, **68** and **70** in position in the recess **62** but will also interconnect the rings **58** and **60** with each other and compress the faces **92** and **94** of rings together. The mating faces **92** and **94** on the rings **58** and **60** may be

provided with a plurality of recesses that are circumferentially spaced therearound and correspond in number to the number of blades **24**, **26** and **28**, three in the present instance. The recesses in the two faces **92** and **94** are positioned to register with a complementary recess in the other face to thereby form a plurality of pockets. Each pocket includes a cylindrical entrance passage **96** with an enlarged annular chamber **98** at the radially inner end thereof. This chamber **98** is separated from the passage **96** by means of a radial shoulder **100**. Each of the blades **24**, **26** and **28** includes a pivot shaft **102** on the inner end thereof that fits into the pockets. Each shaft **102** includes a cylindrical portion **104** that fits the passage **96** and an enlarged head **106** that fits into the chamber **98** whereby the head will bear against the shoulder **100**.

It may thus be seen that if the shafts **102** are placed in the recesses on one face **92** or **94** and then the two retainer rings **58** and **60** are secured together, the shafts **102** will be locked in the pockets so as to secure the blades **24**, **26** and **28** in position. Since the shafts **102** and the pockets have circular cross sections, the shafts **102** can rotate in the pockets. Thus although the blades **24**, **26** and **28** are secured in position on the hub they may be rotated so as to vary the pitch thereof.

In order to fix the pitch of the blades **24**, **26** and **28**, a control ring **110** may be provided. The present control ring **110** includes a passage that extends axially therethrough and is adapted to rotatably fit into the reduced portion **42** of the sleeve **36**. The front of the control ring **110** includes a radial surface **112** that slideably engages the rear surface of the retainer ring **60** and a projection **114** that extends forwardly therefrom into the clearance space **89** formed inside of the retainer ring **60**. A set screw **116** may be provided that extends radially inwardly through the retainer ring **60** to bear against the outside of the projection **114**. By adjusting the force the screw **116** exerts on the projection it will be possible to preset the amount of friction opposing movement between the retaining rings **58** and **60** and the control ring **110**. It has been found that by providing a small clearance space **118** between the exterior of the sleeve **36** and the interior of the projection **114** the force of the screw **116** will tend to deflect the projection **114** and thereby permit a more accurate setting of the frictional drag.

The exterior of control ring **110** includes a groove **120** that extends radially inwardly into the control ring **110**. The present groove **120** is substantially rectangular in cross section and extends continuously around the control ring to form at least one cam surface. The cam surface undulates in an axial direction of the control ring as it extends circumferentially around the ring **110**. In the present instance the pattern of the cam surface repeats itself three times or the same number as the blades **24**, **26** and **28**.

Each of the blades **24**, **26** and **28** includes a pin **122** that extends into the groove **120** so as to engage the cam surface and be positioned thereby. Since the cam surface undulates in an axial direction the axial positions of the pins **122** will be determined by the angular positions of the control ring **110**. Since the groove **120** repeats itself for each blade **24**, **26** and **28**, all of the blades **24**, **26** and **28** will have the same pitch. More particularly, if the pins **122** are located at an apex **124** that is disposed at a maximum rearward direction, the blades will have a maximum pitch. If the pins **122** are at an apex **126** having a minimum rearward direction, the blades will have a minimum pitch. If the pins **122** are disposed in an intermediate portion **128** of the cam surface, the blades **24**, **26** and **28** will have some intermediate pitch.

In order to rotate the control ring **110** about the sleeve **36**, a one way drive **128A** may be provided. This one way drive **128A** will be effective to cause the ring **110** to be free to rotate in one direction about the shaft **32** while at the same time preventing the ring **110** rotating in the reverse direction. In the present instance the one way drive **128A** comprises a so-called ratchet that includes complementary teeth **132** and **134** on the rear of the control ring **110** and the front of a drive ring **130**. The drive ring **130** includes a passage **136** that fits onto the exterior of the shaft **32**. A detent **138** may be provided on the inside of the drive ring **130** so as to extend into a slot **140** or key way in the end of the sleeve **36**. The detent **138** will thus prevent the ring **130** rotating on the sleeve **36** while at the same time permitting the ring **130** to move axially thereon. A spring **142** may bear against the end of the drive ring **130** so as to resiliently bias the teeth **134** on the ring **130** against the teeth **132** on the other control ring **110**. The opposite end of the spring **142** may bear against a spinner nut **144**. The spinner nut **144** is threaded onto the end of the drive shaft **32** so as to secure the entire assembly thereto. It may thus be seen that when the control ring **110** tends to rotate in one direction relative to the drive ring **130** the teeth **132** and **134** will mesh and thereby prevent the rings **110** and **130** from rotating. However, if the control ring **110** rotates in the reverse direction the teeth will slide up on each other and force the ring **130** axially against the spring **142** until the teeth have moved relative to each other by an amount corresponding to the pitch of the teeth. At this point the next succeeding teeth will engage.

In order to employ the present invention, the propeller **10** may be first assembled in the following manner. The projection **114** on the forward end of the control ring **110** may first be inserted into the interior of the retainer ring **60** and the set screw **116** tightened enough to secure the two rings **60** and **110** together. The blades **24**, **26** and **28** may next be mounted in position by placing the shafts **102** in the recesses in the face **94** and the pins **122** in the groove **120**. The retaining ring **58** is then put in position and the blocks **66**, **68** and **70** bolted thereto. This will thus form a sub-assembly having the blades **24**, **26** and **28** mounted thereon.

The sleeves **34** and **36** may now be placed concentrically on the shaft **32** and attached thereto by means of the shear pin **38**. Next the sub-assembly may be positioned thereon so that the arms **48**, **50** and **52** are disposed in the pockets **76**, **78** and **80** and bear against the bottom **64**. Following this the drive ring **130** and spring **142** may be placed on the end of the sleeve **36** and the spinner nut **144** tightened so as to compress all of the rings **58**, **60**, **110** and **130** forwardly toward the arms **48**, **50** and **52** to thereby secure the entire propeller **10** in position on the shaft **32**.

After the propeller **10** has been assembled on the drive shaft **32**, it may be placed in the water and the motor **14** started. If the motor **14** is in forward gear the drive shaft **32** will rotate and carry the two sleeves **34** and **36** therewith. If the shaft **32** is rotating in the forward direction the arms **48**, **50** and **52** will rotate inside of the recess **62** until the forward faces **54** of the arms **48**, **50** and **52** engage the forward stops **72**. The two retaining rings **58** and **60** will then move with the sleeves **34** and **36** and the entire propeller **10** will be driven thereby. The blades **24**, **26** and **28** will then react with the water to produce a thrust for driving the boat **12** and any skiers **20** therebehind across the water. The pitch of the blades **24**, **26** and **28** is preferably set at the correct amount for this type of operation. That is, if the boat **12** is just starting to move and it is not yet planing, the propeller **10** may preferably have a low pitch. This is especially true if there is a water skier **20** at rest in the water and holding onto the end of the rope **22** ready to be towed. The pins **122** will thus be located at the apexes **126**. By employing a low pitch the propeller will operate more effectively and also will permit the motor to run at a sufficiently high rate of speed to develop a large amount of power. This in turn will permit the boat and any skiers therebehind

to rapidly accelerate to a sufficient speed to cause the boat **12** and any skier **20** to rise up and plane across the surface of the water.

Once the boat and/or skier has been accelerated to a high speed and has attained a planing attitude on the surface of the water, the amount of power required to drive the boat and skiers at a given speed will be greatly decreased. In addition, if the propeller **10** has a low pitch the motor **14** will not be capable of turning over at a sufficiently high speed to cause the boat to travel at top speed. Accordingly once the boat **12** and skier **20** are planing it may be desirable to increase the pitch of the blades **24, 26** and **28** without in any way slowing the boat **12.**

In order to increase the pitch, the operator may merely cause the motor **10** to abruptly slow down for a very short interval. This may be accomplished by quickly moving the throttle lever **16** toward the closed position or actuating the ignition switch **18.** However, it has been found advisable to employ a shift control button **146.** This button **146** is effective to actuate a time delay circuit which will cause the ignition system to become inactivated for some predetermined interval of time such as one second or less. The instant the motor **14** starts to slow down, the propeller **10** will tend to overrun the propeller shaft **32.**

When this overrunning occurs the two retainer rings **58** and **60** and the blades thereon will rotate about the exterior of the sleeve **36.** The arms **48, 50** and **52** will then move through the pockets **76, 78** and **80** toward the reverse stops **74.** Since the teeth **132** and **134** are meshed with each other, the teeth **132** will slide across the faces of the teeth **134** and force the drive ring **130** to move axially along the shaft **32** toward the spinner nut **144.** The amount of overrunning force, i.e. how abruptly the motor must be slowed down, that is required to produce this motion will be determined by the ramp angle of the teeth **132** and **134** and the force from the spring **142.** If the overrunning is of sufficient magnitude, the teeth **132** and **134** will slide relative to each other until they have moved by an amount at least equal to the pitch thereof. When this amount of motion has occured, each of the teeth will have dropped into engagement with the next succeeding teeth and will lock the rings **110** and **130** together but will be displaced by an amount equal to the pitch of the teeth. This motion will normally occur in a small fraction of a second and will place the propeller in a "cocked" position for changing the pitch.

If the motor **14** is again accelerated the arms **48, 50** and **52** will move forwardly through the pockets **76, 78** and **80** until the faces **54** again engage the stops **72.** At the same time, since the teeth **132** and **134** have been locked in engagement with each other the control ring **110** will be locked to the drive ring **130** which is keyed to the sleeve **36.** As a result, as the shaft **32** rotates together with the sleeves **34** and **36,** the frictional connection provided by set screw **116** will allow relative motion to occur between rings **60** and **110.** As the two rings **60** and **110** move relatively, the pins **122** will move along the groove to thereby vary the pitch of the blades **24, 26** and **28.** The rings **58** and **60** together with the blades **24, 26** and **28** will then be driven in the normal manner. The amount of the change of pitch will be determined by the spacing of the teeth **132** and **134** and the slope of the groove **120.** This, of course, may be chosen to provide a suitable amount of control for the installation being employed.

It is therefore apparent that the pitch of the blades **24, 26** and **28** may be varied by merely abruptly slowing the motor **14** for a very short interval. Thus the pitch may be varied while there is no load on the propeller even though the boat **12** is travelling through the water and the motor **14** is running. Since the interruption required in the drive of the motor **14** is very short, there will not be any perceptible change in the speed of the motor.

It may thus be seen that a propeller **10** has been provided that is not only simple and reliable in operation but also will permit the pitch of the blades **24, 26** and **28** to be varied while the motor **14** is running. Although only one embodiment of the invention has been disclosed, it will be readily apparent to those skilled in the art that numerous changes and modifications may be made thereto without departing from the spirit of the invention. Accordingly the foregoing description and drawings are for illustrative purposes only and are not intended to limit the invention which is defined only by the claims which follow.

What is claimed is:

1. A variable pitch propeller for being mounted on a drive shaft and driven thereby, said propeller comprising the combination of:

hub means having a passage extending therethrough for receiving said shaft, said hub means including a first annular member and a second annular member concentric with said passage, said first member being movable about said shaft between two extreme positions relative to the second member,

drive means connecting the drive shaft to said hub means for driving said hub means in a forward direction and in a reverse direction,

pitch means disposed concentrically about said drive shaft and mounted to rotate about said drive shaft relative to said hub means between a plurality of stations,

a cam surface on the pitch means,

a lost motion connection in said drive means connecting the first annular member with said shaft to provide angular movement of the first annular member between said extreme positions relative to the second annular member,

means frictionally interconnecting the first annular member with the pitch means, said friction means being effective to transfer a sufficient amount of torque between the first annular member and the pitch means to move said pitch means and said first annular member together in a first direction and to provide for relative movement between said first annular member and said pitch means when the torque between the first annular member and the pitch means is greater than said sufficient amount,

a one-way drive interconnecting the said pitch means with said shaft to permit the pitch means to rotate about said shaft in said first direction but to prevent the pitch means rotating about said shaft in the opposite direction,

at least one of said annular members having a sufficient angular moment of inertia to produce a torque between said annular members when said hub means tends to overrun said drive shaft in said first direction and to simultaneously move the first annular member from one of the extreme positions to the other extreme position and the pitch means from one station to the next station when said hub means overruns said shaft, said one-way drive being effective to retain said pitch means in said next station when said hub means is not overrunning said shaft, said friction means being effective to provide for the first annular member returning to said other extreme position when said hub means is being driven in a forward direction by said shaft, and

at least one blade pivotally mounted on at least one of said annular members and having a cam follower that engages said cam surface and positions said blade with a pitch determined by the relative angular position of said members and said pitch means.

2. A variable pitch propeller for being mounted on a drive shaft and rotatably driven by the shaft in a forward direction and a reverse direction, said propeller comprising the combination of:

hub means having a passage extending therethrough, said hub means including a first portion and a sec-

ond portion that are concentric with said passage, said second portion being movable relative to the first portion between a first extreme position and a second extreme position.

drive means connecting said first portion to said shaft to drive said first portion in both of said directions,

a lost motion connection connecting the second portion to said shaft, said lost motion connection providing for movement of the second portion between the first extreme position and the second extreme position,

pitch means disposed on said shaft and interconnected with said second portion to move in a first direction between a plurality of stations,

means continuously frictionally connected to the second portion and the pitch means to provide for movement of the second portion and the pitch means in the first direction relative to said shaft during intervals when said propeller is overrunning said shaft and during intervals when said propeller is driven in the reverse direction,

a one-way drive connecting the pitch means with said shaft to provide for the pitch means rotating about said shaft in said first direction and to prevent said pitch means rotating about the shaft in the opposite direction,

a cam surface on said pitch means,

at least one blade pivotally mounted on at least one of said portions, and

a cam follower on said blade and engaging said cam surface, said blade having a pitch determined by the angular position of the pitch means relative to said portions.

3. A variable pitch propeller for being mounted on a drive shaft and rotatably driven by the shaft forwardly and reversely, said propeller including the combination of:

hub means including a first portion and a second portion that are mountable concentrically upon said shaft, said second portion being movable relative to the first portion between a first extreme position and a second extreme position,

means connecting said first portion to said shaft to drive said first portion,

lost motion means connecting the second portion to said shaft, said lost motion means providing for the second portion rotating about said shaft between the first extreme position and the second extreme position,

said lost motion means being effective to retain said second portion in one of the extreme positions when said propeller is being driven forwardly, said lost motion means being effective to provide for said second portion moving into the other of said extreme positions during intervals when said propeller tends to forwardly overrun said shaft and during intervals when said propeller is driven reversely,

pitch means disposed on said shaft and interconnected with said second portion to move in a first direction when said second portion moves in the first direction from the first extreme position to the second extreme position,

a one-way drive connecting said pitch means with said shaft to provide for the pitch means moving in the first direction with the second portion when said second portion rotates in the first direction between said extreme positions, said one-way drive being effective to retain said pitch means in a fixed position when said shaft is driving said propeller forwardly and the second portion moves in the opposite direction from the second extreme position to the first extreme position, and

at least one propeller blade mounted on the pitch means and on at least one of said portions, said propeller blade having a pitch determined by the relative angular positions of that portion and the pitch means.

4. A variable pitch propeller for being mounted on a drive shaft for being rotatably driven forwardly and reversely, said propeller including the combination of:

hub means having a passage extending therethrough for receiving said shaft, said hub means including a first portion and a second portion, the second portion being movable about said shaft relative to the first portion and between two extreme positions,

drive means on said hub means connecting said hub means to said drive shaft for driving said hub means,

pitch means disposed concentrically about said drive shaft,

friction means connecting the second portion with said pitch means, said friction means being effective to insure the second portion and pitch means rotating in unison when the torque between said portions is less than a predetermined amount, said friction means being effective to provide for relative movement between the first portion and pitch means when said torque is greater than said amount,

a cam surface on said pitch means,

at least one blade pivotally mounted on said first portion and having a cam follower engaging said cam surface, said cam surface having a profile that will vary the pitch of said blade as a function of the relative angular positions of said first portion and said pitch means,

means responsive to the angular inertia of said hub means and having a mass that is sufficient to move the pitch means and second portion from the first extreme position to the second extreme position when said hub means tends to forwardly overrun said shaft to thereby move said cam surface to a new position relative to said follower, and

means for maintaining the cam surface in the new position, said last means being effective to overcome the torque of said friction means when said shaft is driving said propeller in the forward direction.

5. A variable pitch propeller mountable on a drive shaft to be driven thereby, including the combination of:

hub means having a passage extending therethrough for receiving said shaft, said hub means including at least one portion movable about said shaft between first and second extreme positions,

drive means interconnecting said drive shaft with said hub means for driving said hub means in a first direction,

a lost motion connection in said drive means interconnecting the portion with said shaft to provide for the portion rotating about the shaft through a predetermined arc between the two extreme positions, said lost motion connection being effective to provide for the portion remaining in the first of said extreme positions when said shaft is driving said hub means in the first direction, said hub means carrying a sufficiently large mass to move the portion to the other of said extreme positions during intervals when said hub means is overrunning said shaft in the first direction,

pitch means disposed concentrically on said drive shaft and mounted to rotate about said drive shaft,

at least one propeller blade,

mounting means pivotally securing said blade on the hub means and the pitch means, said blade having a pitch determined by the relative angular position of the pitch means,

means interconnecting the pitch means with the portion for moving said pitch means into a new position each time the portion moves from the first extreme position to the second extreme position, and

means for maintaining a change in the relative position of the pitch means each time the portion moves from the second extreme position to the first extreme position.

6. A variable pitch propeller for being mounted on a drive shaft to be driven thereby in a forward direction and in a reverse direction, said propeller including the combination of:

hub means having a passage extending therethrough for receiving said shaft, said hub means including a first portion and a second portion movable between first and second extreme positions relative to the first portion,

drive means drivingly connecting said hub means with said shaft for rotatably driving said portions, said drive means being effective to retain said second portion in one of the extreme positions when the hub means is being driven by said shaft in the forward direction, said drive means being effective to provide for movement of the second portion to the other of said extreme positions when said hub means overruns said drive shaft in a forward direction and when said hub means is driven in a reverse direction, said hub means carrying a sufficient inertia to move the second portion to said other extreme position when that portion is overrunning said shaft,

pitch means on one of said portions for rotating about said drive shaft with that portion between a series of stations,

means interconnecting said portions with each other for moving said pitch means from one station to the next station when said second portion moves from the first extreme position to the second extreme position,

a one-way drive connected to at least one of said portions and being effective to provide for said pitch means rotating about said shaft in one direction when the second portion moves from the first extreme position to the second extreme position and preventing said pitch means from rotating about said shaft in the opposite direction when the second portion moves from the second extreme position to the first extreme position, and

at least one blade pivotally mounted on at least one of said portions and said pitch means, said blade having a pitch that is determined by the relative angular positions of said portion and said pitch means.

7. A variable pitch propeller for being mounted on a rotatable drive shaft and driven thereby in a forward direction and in a reverse direction, said propeller including the combination of:

hub means having a passage extending therethrough for receiving said drive shaft, said hub means including at least one portion movable circumferentially about said shaft between a first extreme position and a second extreme position,

drive means connecting the hub means to said shaft for rotatably driving said hub means in the forward direction and in the reverse direction,

lost motion means connecting the portion to said shaft, said lost motion means being effective to provide for said portion moving relative to the hub and between said two extreme positions,

said drive means being effective to maintain the portion in the first extreme position when the drive shaft is driving said hub means in a forward direction,

said lost motion means being responsive to the angular moment of inertia carried by said portion for allowing the portion to move into the second extreme position during intervals when said hub means overruns the drive shaft in a forward direction,

pitch means disposed on said shaft and movable between a plurality of stations, said pitch means being responsive to the movement of the portion from one of the extreme positions to the other of the extreme positions to change the position of the pitch means from one of the stations to a new station each time the portion moves from said one extreme position to said other extreme position,

means interconnected with said pitch means for retaining said pitch means in the new station each time the portion moves said pitch means to the new station, and

at least one propeller blade mounted on said hub means and said pitch means, said propeller blade being effective to rotate with the hub means about the shaft and to have a pitch determined by the position of the pitch means.

8. A variable pitch propeller for being mounted on a rotatable drive shaft, said propeller including the combination of:

hub means having a passage extending therethrough for receiving said drive shaft and being rotatably driven by said shaft,

at least one propeller blade means,

mounting means on said hub means effective to secure said blade on said hub means and to provide for movement of said blade relative to said hub about a line normal to said shaft to thereby change the pitch of said blade,

at least one of said means including a portion having a mass movable concentrically about said shaft between a first extreme position and a second extreme position,

means on said hub means effective to normally retain said portion in the first extreme position and provide for movement of said portion circumferentially of said hub means from the first extreme position to the second extreme position independently of the angular velocity of said hub means only during intervals when the angular acceleration of said mass in one direction exceeds a predetermined amount, and

means interconnecting said portion with said propeller blade and being responsive to the movement of said portion from one of said extreme positions to the other of said extreme positions, said last means being effective to move said blade on said mounting means and vary the pitch of the blade when said portion moves circumferentially on said hub means from said one extreme position to said other extreme position.

9. A variable pitch propeller for being mounted on a rotating drive shaft, said propeller including the combination of:

hub means having a passage extending therethrough for receiving said drive shaft, said hub means including:

first and second members positioned to be disposed concentric about the drive shaft and being movable relative to each other,

mounting means on said hub means,

at least one propeller rotatably positioned on said mounting means for rotating about a line normal to the axis of said shaft to vary the pitch of said blade,

pitch means interconnected with at least one of said members and movable between a plurality of stations when that member moves, said pitch means being interconnected with the propeller blade to vary the pitch of the blade in response to the position of the pitch means, and

means constructed and arranged to move one of said members when the hub means overruns the drive shaft.

10. A variable pitch propeller for being mounted on a rotating drive shaft, said propeller including the combination of:

hub means having a passage extending therethrough for receiving said drive shaft,

first and second members disposed on the hub means to be concentric about the drive shaft, at least one of said members being rotatable about said shaft relative to the other member,

mounting means on said hub means,

at least one propeller rotatably positioned on said

mounting means for rotating about a line normal to said shaft to vary the pitch of said blade,

pitch means on one of said members and movable therewith, said pitch means being interconnected with said propeller blade to vary the pitch of said propeller blade as said one member rotates, and

means constructed and arranged to rotate one of said members when the hub means overruns the shaft.

11. A variable pitch propeller for being mounted on a rotating drive shaft, said propeller including the combination of:

hub means having a passage extending therethrough for receiving said drive shaft,

first and second members disposed on the hub means to be positioned concentric about the drive shaft, each of said members being rotatable about said shaft relative to each other,

drive means connecting the hub means to said drive shaft to drive the hub means and to permit the first and second members rotating relative to each other,

mounting means on said hub means,

at least one propeller rotatably carried by said mounting means for rotating about a line normal to said shaft to vary the pitch of said blade,

pitch means on the first of said members and movable therewith between a plurality of different stations, said pitch means being interconnected with said propeller blade and effective to set the pitch in accordance with the station that the pitch means is in,

means effective to rotate the second member in a first direction when the drive means is driving the hub means and effective to rotate the second member in the opposite direction when the hub means is overrunning the drive shaft, and

means interconnecting the first member to the second member to move said first member and the pitch means thereon from one station to the next station each time said second member rotates in one of said directions.

12. A variable pitch propeller for being mounted on a drive shaft and driven thereby, said propeller comprising the combination of:

hub means having a passage extending therethrough for receiving said shaft, said hub means including a first annular member and a second annular member concentric with said passage, said members being rotatable about said shaft relative to the hub means,

drive means connecting the drive shaft to said hub means for driving said hub means in a forward direction and a reverse direction,

a cam surface on the first annular member,

at least one propeller blade pivotally mounted on said hub means and having a cam follower that engages the cam surface, said blade having a pitch determined by the angular position of the cam surface relative to the hub means,

means effective to move at least the second annular member in a first direction when said hub means overruns the drive shaft in the forward direction and to move the second annular member in the opposite direction when the hub means is driven in the forward direction by the drive means, and

means interconnecting the first member with the second member so as to move the first member and the surface thereon whenever the second member moves in one of said directions.

13. A variable pitch propeller for being mounted on a drive shaft and driven thereby, said propeller comprising the combination of:

hub means having a passage extending therethrough for receiving said shaft, a first annular member on said hub means, a second annular member on said hub means, said members being concentric with said passage rotatable thereabout relative to each other and to the hub means,

drive means connecting the drive shaft to said hub means for driving said hub means in a forward direction and in a reverse direction,

a cam surface on the first member and rotatable therewith, said cam surface including a plurality of stations,

at least one propeller blade pivotally mounted on said hub means and having a cam follower, said cam follower being positioned to engage the cam surface and rotate said blade into preselected pitches when the follower engages the successive stations,

means effective to rotate the first annular member in a first direction relative to the hub means when said hub means overruns the drive shaft and to move the first annular member in a second direction relative to the hub means when the hub means is driven by the drive means,

means interconnecting the first and second members together whenever the second member moves in one of said directions, and

means to retain the first member in a position with the cam follower engaging one of said stations when the second member moves in the opposite direction.

14. A variable pitch propeller for being mounted on a drive shaft to be driven thereby in a forward direction and in a reverse direction, said propeller including the combination of:

hub means having a passage extending therethrough for receiving said shaft, said hub means including a first member and a second member movable between said first and second extreme positions relative to the first member,

drive means drivingly connecting said hub means with said shaft for rotatably driving said hub means, said drive means being effective to retain said second member in one of the extreme positions when the hub means is being driven by said shaft in the forward direction, said drive means being effective to provide for movement of the second member to the other of said extreme positions when said hub means overruns said drive shaft in a forward direction and when said hub means is driven in a reverse direction,

means effective to move the second member to said other extreme position when the hub means is overrunning said shaft,

pitch means rotatably mounted on said first member for rotating about said drive shaft between a plurality of stations,

means interconnecting said first member to the second member for moving said pitch means from one station to the next station when said second member moves from the first extreme position to the second extreme position,

a one-way drive connected to said first member, said one-way drive being effective to provide for said first member and pitch means rotating about said shaft in one direction when the second member moves from the first extreme position to the second extreme position,

a propeller blade mounted on said hub means to rotate about an axis normal to said shaft, and

means on said propeller blade positioned to engage said pitch means and set the pitch of said blade in accordance with the angular position of the pitch means.

15. In combination for varying the pitch or a propeller to control the movements of an object upon an acceleration of the object to a particular speed,

a shaft for driving the propeller,

hub means mounted on the shaft and operatively coupled to the propeller for obtaining a controlled movement of the propeller with the shaft,

first means mounted on the shaft and cooperative with

the propeller for varying the pitch of the propeller between first and second values,

said first means including a ring slotted to engage the propeller,

said slotting in said ring being provided with a configuration to vary the pitch of the propeller in accordance with the position of engagement between the propeller and the slot, and

said first means being constructed to vary the position of engagement between the propeller and the slot upon an initial deceleration of the shaft and a subsequent acceleration of the shaft,

second means mounted on the shaft and responsive to an initial deceleration of the shaft relative to the propeller for preventing the pitch-varying means from changing the pitch of the propeller, and

third means mounted on the shaft and responsive to a subsequent acceleration of the shaft relative to the propeller for obtaining an operation of the pitch-varying means to provide a change in the pitch of the propeller from the first value to the second value.

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