

Nov. 17, 1959

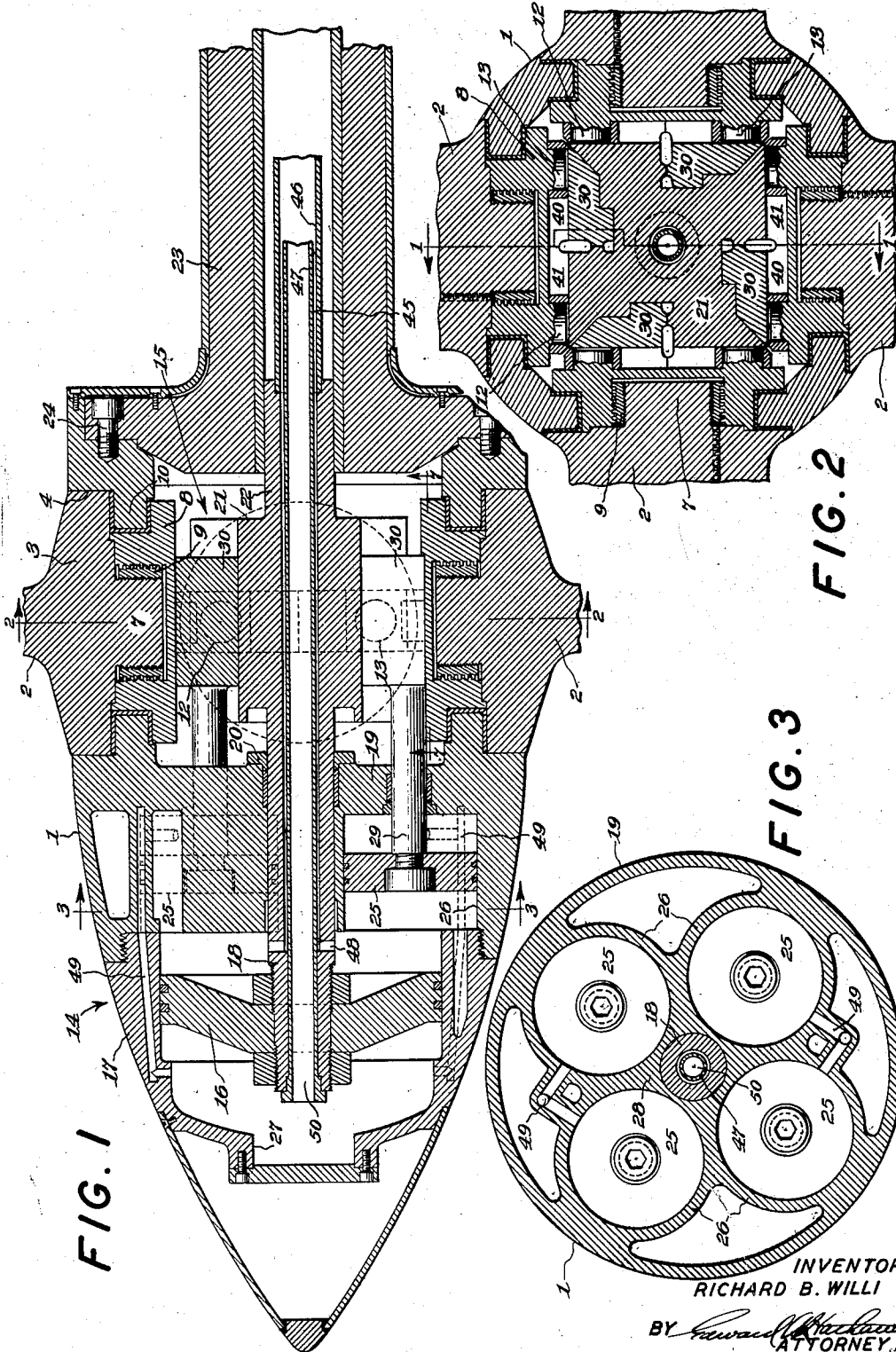
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2,913,057

OPERATING MECHANISM FOR ADJUSTABLE BLADE PROPELLER

Filed June 20, 1955

5 Sheets-Sheet 1



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OPERATING MECHANISM FOR ADJUSTABLE BLADE PROPELLER

Filed June 20, 1955

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FIG. 4

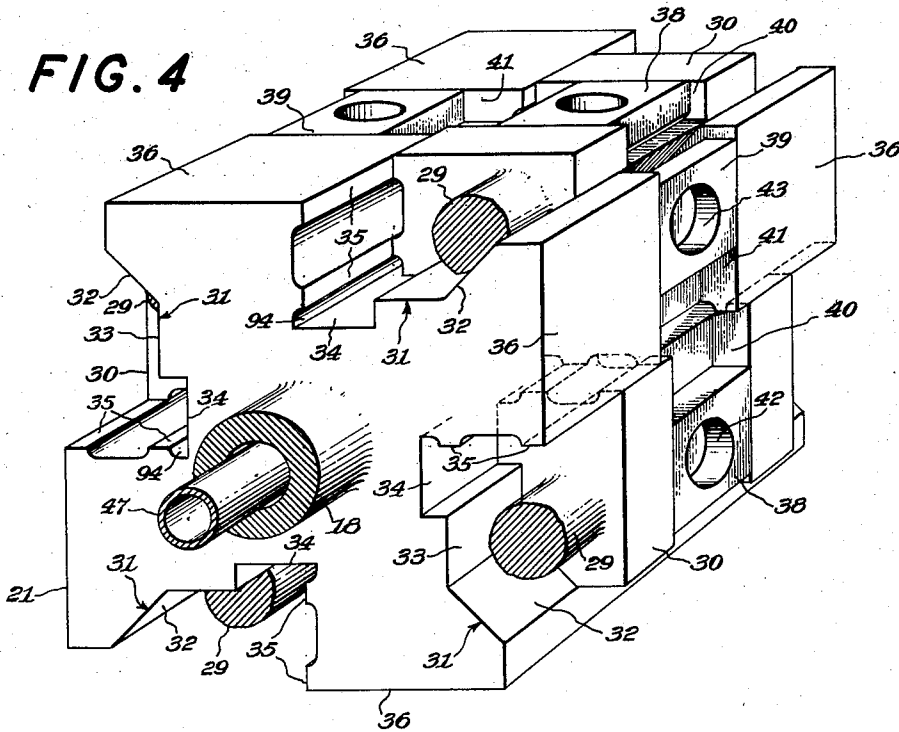
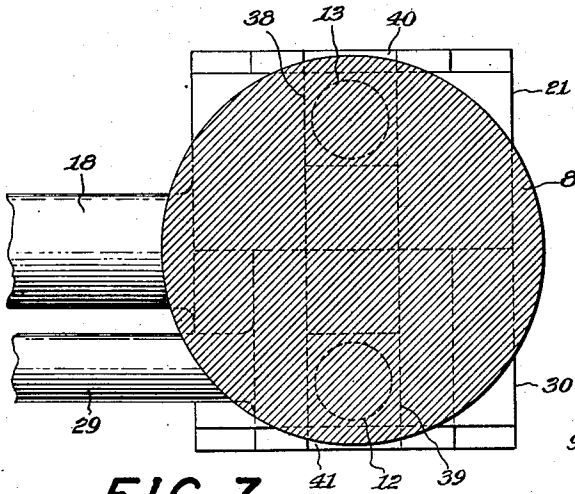


FIG. 7

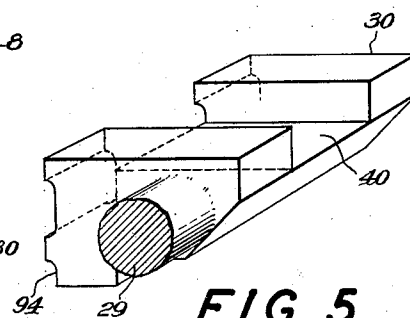
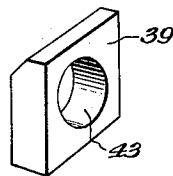


FIG. 5

FIG. 6



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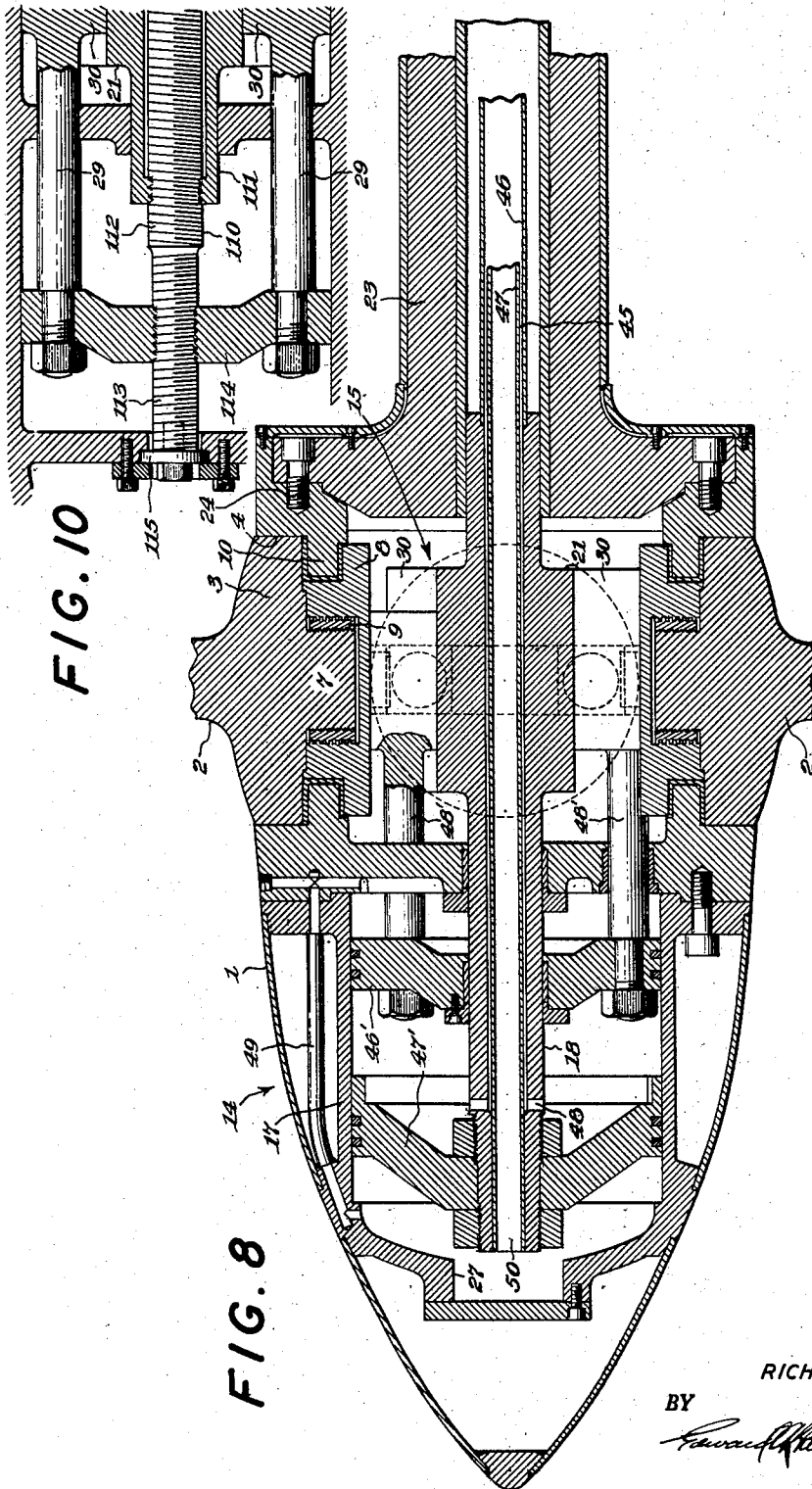
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OPERATING MECHANISM FOR ADJUSTABLE BLADE PROPELLER

Filed June 20, 1955

5 Sheets-Sheet 3



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OPERATING MECHANISM FOR ADJUSTABLE BLADE PROPELLER

Filed June 20, 1955

5 Sheets-Sheet 4

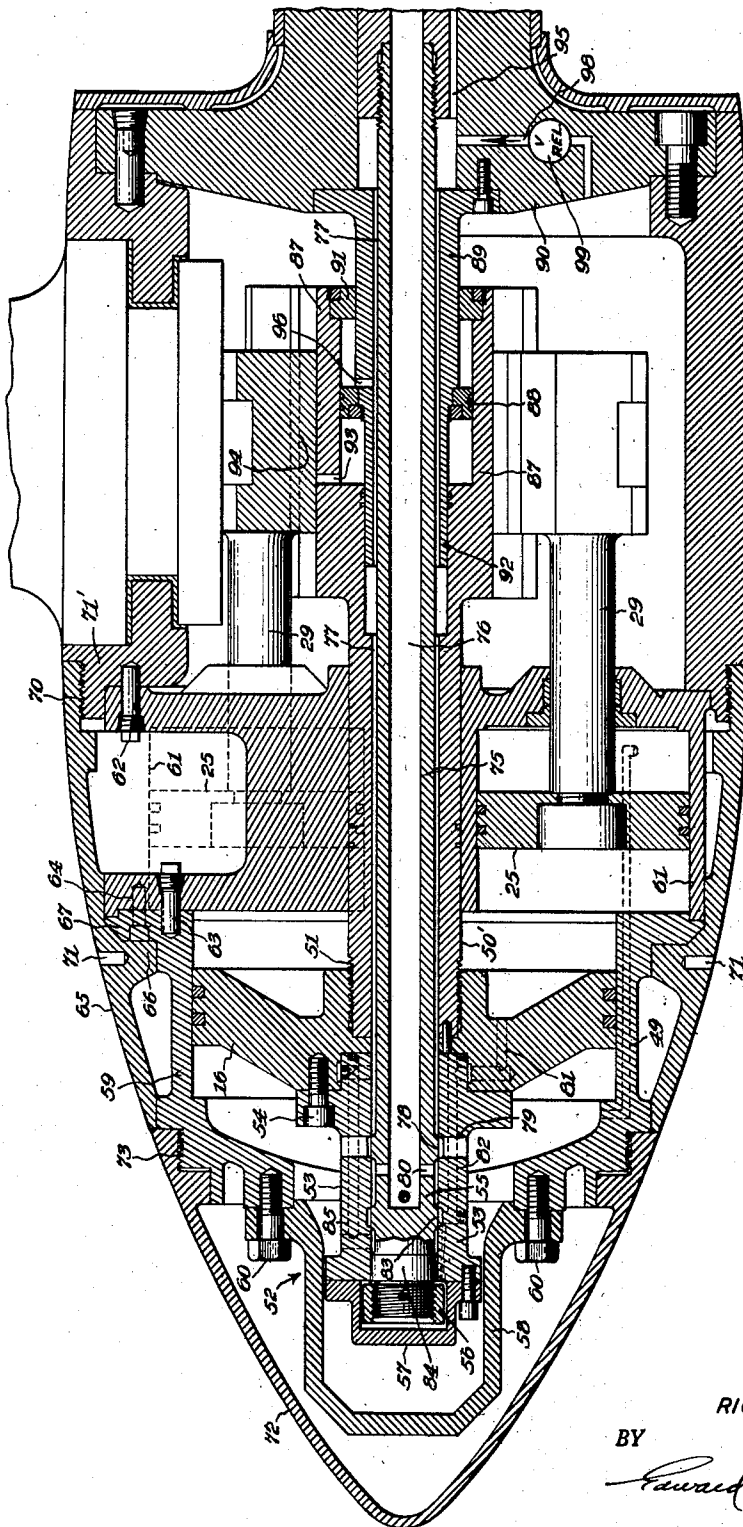


FIG. 9

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OPERATING MECHANISM FOR ADJUSTABLE BLADE PROPELLER

Filed June 20, 1955

5 Sheets-Sheet 5

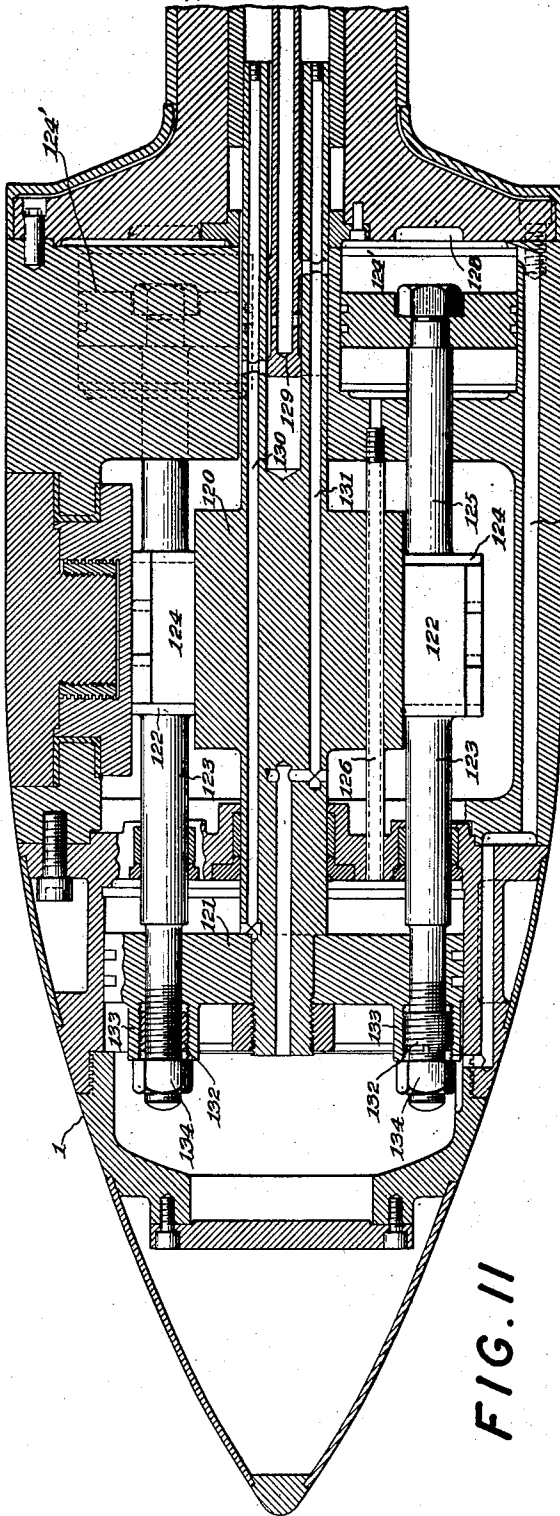


FIG. 11

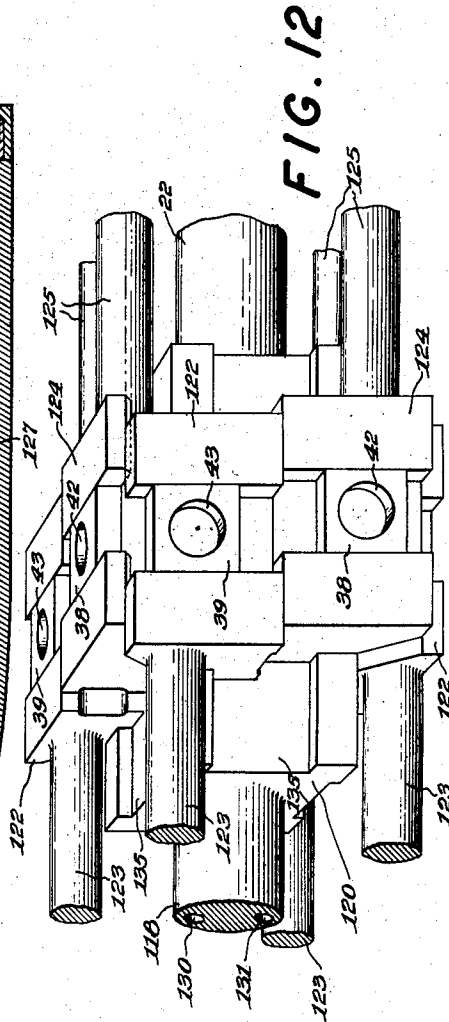


FIG. 12

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OPERATING MECHANISM FOR ADJUSTABLE BLADE PROPELLER

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Application June 20, 1955, Serial No. 516,428

10 Claims. (Cl. 170—160.32)

This invention relates to power operated means for adjusting the blade pitch of adjustable blade propellers such as are used, for example, on ships although the principles hereof may be applicable to adjustable blade propellers in other fields.

The problem in connection with adjustable blade marine propellers is particularly difficult because of the large propeller blade forces involved and the need for producing within a relatively small space the necessary large operating forces to adjust the blades. While various mechanisms have been heretofore proposed and used for effecting such adjustment, yet, they have been deficient structurally, functionally or economically, or have required excessive space for housing the operating mechanism.

It has been proposed in certain prior mechanisms to accomplish compactness by using relatively small operating piston and cylinders actuated by very high operating fluid pressures, whereby the small size piston and cylinders allow sufficient room for the relatively large linkages heretofore used. Such high operating pressures and large linkages have obvious serious disadvantages.

One object of my invention is to provide power operated mechanism, for adjusting variable pitch propeller blades, having a high degree of compactness both as to the power means and the mechanism for transmitting power to the blades to angularly adjust the same.

A further object is to accomplish a high degree of compactness while at the same time using a high capacity power means operated by a relatively low pressure.

A still further object is to provide, in a propeller blade adjusting mechanism of a type employing two crank pins for each of a plurality of blades, means to insure uniform loading on each crank pin of each blade throughout all angular adjustments of the blades regardless of non-uniform wear or fit of any bearings or parts.

Still another object is to provide an improved power operated mechanism, for angularly adjusting propeller blades, that is relatively simple in construction, operation and maintenance, considering the complicated nature of the problem involved, and in which various parts are reasonably accessible for inspection and repair notwithstanding the extreme compactness of my device.

Other objects and advantages will be more apparent to those skilled in the art from the following description of the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view, taken on the line 1—1 of Fig. 2, of an adjustable blade ship propeller embodying one form of my invention in which the blade adjusting servo-motor has a single main piston and a multiplicity of auxiliary pistons all arranged for automatic equalization of operating forces, the blades being only partially shown for simplicity;

Fig. 2 is a transverse section taken on line 2—2 of Fig. 1 in the direction of the arrows showing the relation of main and auxiliary crossheads and crank pin slide blocks to the propeller blades;

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Fig. 3 is a transverse section taken substantially on the line 3—3 of Fig. 1;

Fig. 4 is a perspective of the power transmission assembly of crossheads for converting linear motion into torque for angularly adjusting the blades;

Fig. 5 is a perspective of one of the auxiliary crossheads;

Fig. 6 is a perspective of one of the crank pin slide blocks;

Fig. 7 is a longitudinal section taken substantially on the line 7—7 of Fig. 1;

Fig. 8 is a longitudinal section similar to Fig. 1 but showing a modified arrangement employing a single main piston and a single auxiliary piston arranged for non-automatic equalization of the blade adjusting forces;

Fig. 9 is a longitudinal section similar to Fig. 1 of another modification employing automatic equalization of the blade adjusting forces and means to automatically compensate for a variable fluid volume within the propeller hub, as well as other details of a distributing valve construction;

Fig. 10 diagrammatically illustrates mechanical instead of hydraulic operation of the crossheads;

Fig. 11 is a longitudinal section generally similar to Fig. 1 but showing a modified arrangement whereby the blades may be relatively angularly adjusted to insure a uniform pitch for all blades, this section being taken as though the elements 122 and 124 on the front side of Fig. 12 were removed and the body 120 of the main crosshead sectioned; and

Fig. 12 is a partial diagrammatic perspective showing the main crosshead divided into separate portions for allowing individual pitch settings of the blades and also showing the auxiliary crossheads.

For purposes of illustration, I have shown a ship propeller hub 1 having any suitable number of radially disposed blades 2 shown specifically as four in number and which are broken off for simplicity of illustration. Each blade projects from a circular base 3 which is journaled in a suitable hub recess 4 and secured therein in any desired manner. The form shown herein will constitute the subject matter of another application of mine to be filed and, hence, it will suffice to briefly state here that each blade has a threaded shank 7 and an internally threaded crank pin ring 8 while a sleeve 9 has internal threaded engagement with the shank threads and external threaded engagement with the threads of crank ring 8. These two sets of threads are of different pitch so that relative adjustment thereof permits the blade disk 3 to be properly adjustably seated and held in the recesses 4 against a hub flange 10. The crank ring is then suitably secured in fixed relation to the blade.

To angularly adjust the blades each crank ring 8, Fig. 2, has two inwardly projecting diametrically disposed crank pins 12 and 13. To operate the crank pins there is provided a power operated servo-mechanism preferably of the piston and cylinder type generally indicated at 14, and a reciprocating type power transmitting assembly generally indicated at 15 for connection to the crank pins for converting reciprocating motion into torque. The servomechanism comprises a main piston 16 of relatively large diameter whose cylinder 17 is a screw threaded extension of the propeller hub 1. The main piston has a piston rod 18 extending through a radial hub partition 19 with a suitable packing gland 20 and carries a preferably integrally formed main crosshead 21 which is guided at its other end by a tail rod 22 slidably supported within the propeller shaft 23. This propeller shaft is secured to the power hub by a series of usual cap screws 24. The partition forms a cavity in the end of the hub shaft 23.

The servo-mechanism also includes four auxiliary pis-

tons 25 symmetrically arranged around the propeller hub axis as shown in Fig. 3, the auxiliary cylinders 26 being formed as a part of the partition 19 which serves as the rear cylinder head for the auxiliary pistons. The other end of the cylinders 25 have open communication with the cylinder of main piston 16 whose left end is closed by a cylinder head 27. The main piston rod 18, as shown in Fig. 3, extends axially through the structural area 28 which commonly joins the auxiliary cylinders. Each auxiliary piston has a piston rod 29 extending through suitable packing glands in partition 19 for connection to individual auxiliary crossheads 30. These auxiliary crossheads 30 are respectively slidably supported in four auxiliary crosshead guideways 31 formed in each side of the main crosshead block 21. Each guideway 31 consists of an inclined surface 32, vertical surfaces 33 and 34 and horizontal surfaces 35 and the auxiliary crossheads have complementary mating surfaces. The guideways are offset from the transverse center links of crosshead block 21 so as to provide side surfaces 36 of substantial area on each of the four sides of the crosshead.

Thus far it is seen that the main crosshead 21 is reciprocated by the main piston 16 and the auxiliary crossheads 30 by the auxiliary pistons 25. To convert the reciprocating power of the crossheads to torque applied to the crank pins for angularly adjusting the propeller blades, there is provided for each blade, two crank pin slide blocks 38 and 39 disposed respectively in a recess 40 of auxiliary crosshead 30 and a recess 41 in the side surface portion 36 of the main crosshead. The blocks 38 and 39 slide in recesses 40 and 41 in directions transverse to the axis of reciprocation of the main crosshead. Each slide block 38 and 39 has crank pin openings 42 and 43 to receive the diametrically opposed crank pins 12 and 13 of a given blade. This arrangement of crank pin slide blocks is duplicated on each of the four sides of the main crosshead thereby providing operating connections for the crank pins of each of the four blades.

Operation.—To rotatably adjust the blades fluid pressure from a suitable external source is admitted, for example, to a passage 45, Fig. 1, formed by sleeves 46 and 47 and thence through a port 48 to a common chamber between the right side of main piston 16 and the left of auxiliary pistons 25 while the opposite sides of these pistons are connected by passages 49 and 50 to a suitable exhaust connection thereby moving the pistons away from each other, or in the event that it is desired to move the pistons toward each other the supply and exhaust connections are reversed. As the main and auxiliary pistons move in opposite directions, the main crosshead and auxiliary crossheads are similarly moved to transmit torque to the crank pins through their slide blocks 38 and 39. As the blades rotate the crank pin slide blocks 38 and 39 will move, crosswise of the main crosshead, within guideways 40 and 41 to compensate for the change in angular position of the crank pins during rotation of the propeller blades. When the main piston and auxiliary pistons move they are subjected not only to a common operating pressure which insures equalized piston forces, but also by having each auxiliary piston individually connected to its own blade there is complete equalizing of forces on all of the crank pins even though one crank pin may wear more than another in the course of use or may have a different initial fit or a different length connecting rod. The main crosshead by commonly positively interconnecting all of the blades through slide blocks 39 and one crank pin on each propeller blade insures that the blades will be kept in their proper relative angular positions throughout all blade adjustments. It will be understood that the effective area of the main piston is approximately equal to the effective areas of the auxiliary pistons in either direction of movement.

Thus it is seen that I have provided an extremely compact blade adjusting mechanism that can produce the

necessary degree of operating force with relatively low pressure and at the same time automatically insure complete equalization of forces on the crank pins thereby avoiding excessive strains and wear on the operating parts. This insures long life and minimum maintenance and allows a high degree of known stress distribution throughout the structural parts which permits maximum effective use of a minimum amount of material without any sacrifice in ruggedness or reliability.

Fig. 8.—In this arrangement only a single auxiliary piston 46' is used, disposed coaxially with and opposed to the single main piston 47' and slidably mounted on the main piston rod 18. There are four auxiliary piston rods such as 48' connected to the single piston 46' and respectively to the four auxiliary crossheads 30. While this arrangement does not utilize the equalization of the operating forces between the various propeller blades and their operating element as is the case with the independently operable multiple auxiliary pistons, yet, there is still retained the major desirable advantages and principles of compactness by utilizing the reciprocating main and auxiliary crosshead assembly. The construction and operation of this arrangement is otherwise the same as for Fig. 1.

Fig. 9.—This arrangement is generally the same as that of Fig. 1 except that a fluid distributing valve for the servo-mechanism is built into the latter in a novel manner and means are provided to compensate for volumetric changes occurring within the propeller hub during reciprocation of the main crosshead and of the piston rods moving either inwardly or outwardly of the hub cavity which produces a differential volume therein. This arrangement also has the advantage of permitting left and right hand counter-revolving propellers to be made by using interchangeable parts for either left or right hand rotation. In addition the construction is very economical. Other features will be also apparent from the description.

The main piston and auxiliary pistons are given the same reference numbers as in Fig. 1 inasmuch as their relationship to each other and to the main and auxiliary crossheads is the same as previously described. However, the main piston rod 50' terminates in a threaded connection 51 within the main piston while a distributing valve mechanism generally indicated at 52 is mounted on the other side of the piston. This valve consists of a casing 53 removably connected by cap screws 54 to the main piston 16 and moves axially as a unit therewith. The bore of the valve casing has a reciprocable three-spool valve element 55. A stop collar 56 is threadedly connected to the end of the valve element 55 to limit right hand movement thereof by abutting the end of the casing 53 and left hand movement by abutting a cover 57 for the valve casing. The chamber within the cover is vented by a passage 57' communicating with one side of the main cylinder. The distributing valve mechanism is enclosed within the left hand fluid pressure space of main cylinder 59 by reason of a cylinder head portion 58 projecting axially from and secured to the main cylinder by cap screws 60. To have ease of accessibility to the main and auxiliary cylinders the casting for the main cylinder 59 and the auxiliary cylinders 61 are formed as separate units, held in axial and angular alignment with respect to each other and to the propeller hub by a series of dowel pins 62 and 63 while cap screws 64 also hold the two cylinder units together. However, the two cylinder units are tightly secured to the propeller hub by a frustum of a conical shell 65 which has an inwardly projecting annular flange 66 seated axially against a flange 67 on the main cylinder unit 59. The inner end of this encompassing shell has threaded engagement 70 with the propeller hub. Suitable wrench holes 71 permit rotation of this shell to tightly pull the flange 67 against the auxiliary cylinder casting 61 which in turn is firmly held against the end of the propeller hub 71'. A conical clo-

sure cap 72 has threaded engagement 73 with the end of the main cylinder casting 59 thereby forming a smooth continuation for the entire hub contour.

The movable valve element 55 is formed on the end of an axially shiftable rod 75 which extends through the propeller shaft to be operated externally thereof by a suitable mechanism not shown herein as it does not constitute a part of my present invention. It will suffice to state that the valve rod has an interior operating fluid passage 76 terminating within the distributing valve and is spaced inwardly of the hollow piston rod 50' to provide an exhaust passage 77 connected to usual pump sump.

To provide a left hand propeller, it is only necessary to use a main crosshead 21 with its auxiliary crosshead guideways located to the left of the longitudinal axis instead of to the right as in Fig. 4, looking down on the top of Fig. 4. With this left hand arrangement the main crosshead blocks 39 and auxiliary crosshead blocks 38 will now be connected to the crank pins oppositely to those of Fig. 4. This left and right hand arrangement insures equal angular displacement of the counter-revolving blades for a given displacement in the same direction of the valve elements 55, one for each propeller. In shifting the auxiliary crossheads to the left side of the main crosshead the auxiliary pistons and their rods must be angularly shifted by the same amount. To do this, dowel pins 62 are disposed in other holes provided for this purpose. This angular positioning of the auxiliary cylinders is readily accomplished by reason of the auxiliary cylinder casting being separate from the propeller blade hub and being held thereto by the encompassing threaded shell 65.

Operation, Fig. 9.—To move simultaneously main piston 16 to the right and auxiliary pistons to the left, rod 75 and its valve element 55 are moved to the right whereby the right hand spool 78 of the valve uncovers an annular passage which communicates by radial ports 79 directly with the left end of main cylinder 59. Operating pressure fluid thence flows from passage 76 through ports 80 and 79 to act on the left side of piston 16 and simultaneously this pressure fluid flows from the main cylinder through the passages 49 previously described for Fig. 1 to the right end of the auxiliary pistons. Fluid from the common cylinder chamber between the main and auxiliary pistons is exhausted through passages 81 and 82 past the left side of the middle valve spool 83 and around the annular space between this spool and the last spool 84 to a passage 85 which communicates with exhaust passage 77. Inasmuch as the valve casing is secured to the main piston to move therewith there is a follow-up action between the valve casing and valve element which will cause the valve spools to shut off the fluid flow if the valve rod 75 is held after any given adjustment is made. If the valve stem is continuously moved in the direction in which the main piston is moving then the valve casing will not overrun the valve spools and accordingly the main piston will continue to follow movement of the valve element. Conversely when it is desired to move the main and auxiliary piston away from each other the valve rod 75 is moved to the left.

Volume compensating means, Fig. 9.—The interior of the propeller hub is filled with oil for lubrication of the crossheads and other moving parts but the volume of the hub cavity varies with movement of the auxiliary piston rods 29 inwardly and outwardly of the cavity. To compensate for this variation a compensating cylinder 87 is formed on the main piston rod 50' to move therewith and a stationary piston 88 is formed on sleeve 89 secured to the rear wall 90 of the hub, this sleeve extending through suitable packing 91 and having a reduced guiding sleeve 92 guided in the main piston rod. The cross sectional area of sleeve 89 is not quite equal to that of main piston rod 50' so that as cylinder 87 moves,

say, to the right with the main piston an increasing volumetric effect is produced within the hub cavity and in a direction to partially counteract the increasing displacement caused by the auxiliary piston rods moving out of the hub cavity but the remaining difference is made up by the net cross sectional area of cylinder 87. For instance, as the main piston moves to the right fluid within the compensating cylinder 87 is displaced through a port 93 and thence through a longitudinal space 94 formed within one of the main slide blocks communicating with the hub cavity thereby making up any differential volume that is needed. Simultaneously fluid is supplied to the other end of the compensating cylinder 87 from a usual pump sump (not shown) through passages 95, 77, and port 96. When the main piston moves to the left and the auxiliary pistons to the right the compensating cylinder 87 is enlarged whereby the decreasing volumetric change within the hub forces fluid back into cylinder 87 as it expands and fluid is also forced out of the rear end thereof through passages 77 and 95. If for any reason, during operation, an excess amount of fluid should gain admission to the hub cavity, such as through some of the packing glands, whereby the differential piston rod action would produce an excessive pressure within the hub, this pressure may be relieved through passages 98 connecting the hub cavity with the exhaust or return oil passage 95. A suitable relief valve 99 insures that fluid can be discharged from the hub only if a predetermined pressure is developed thereby insuring that the hub cavity will always be maintained full.

Modification of Fig. 10.—The power mechanism for operating the main and auxiliary crossheads is preferably of the hydraulic piston and cylinder type servo-mechanism but mechanical power means, which broadly constitute a servo-motor mechanism, may be also employed. One form of such mechanism comprises a rotatable shaft 110 disposed within the propeller shaft and extending through a main crosshead rod 111. Left and right hand threads 112 and 113 have engagement respectively with the interior of the main crosshead rod 111 and with a single member 114 which corresponds to the single auxiliary piston 46' of Fig. 8, with its four piston rod connections 29 to the auxiliary crossheads 30. The screw shaft 110 will be suitably rotated in either direction by means located externally of the propeller shaft but not constituting a part of my present invention. The screw shaft is suitably held against axial movement by a thrust bearing generally indicated at 115. Rotation of the screw in either direction moves the main and auxiliary crossheads toward or away from each other to reversely adjust the blades in the same manner as for the other forms heretofore described.

Fig. 11 modification.—In this arrangement the main crosshead is divided into a body portion 120 connected to the single main piston 121 and adjustable portions 122 which are longitudinally slidably supported on each of the four sides of the body 120. Each one of the adjustable portions 122 is connected to one of the crank pins of each blade by the use of slide blocks such as 39 of Fig. 4. For ease of understanding, elements in Fig. 11 corresponding to Figs. 1 and 4 are given the same reference numbers. Each adjustable portion 122 is provided with rods 123 which extend forwardly for connection to the single piston 121, in a manner to be described presently, whereby the adjustable portions 122 are normally held in fixed relation to the main crosshead body 120 so as to operate as an integral unit therewith the same as in Fig. 4. The auxiliary crossheads 124, Fig. 12, are similar in their operation to the auxiliary crossheads 30 of Fig. 4 except that their individual piston and cylinders 124' are disposed at the right end of the hub and connected by rearwardly extending piston rods 125. This rearward location of auxiliary piston and cylinders is necessary because of the space required for rods 123.

Automatic equalization of the operating forces for angularly adjusting the blades is also obtained in this modification by having the right side of main piston 121 communicating through a pipe 126 with one of the auxiliary cylinders which in turn suitably communicates with the other auxiliary cylinders through ports (not shown) which may extend through the common walls of adjacent cylinders such as shown in Fig. 3. The left side of main piston 121 communicates through a passage 127 with the right side of the auxiliary pistons which on this side have common communication with each other through an annular passage 128. A valve 129 controls supply of operating fluid to and exhaust of fluid from the main piston and cylinder 121 and the auxiliary cylinders through passages 130 and 131.

In order to obtain a uniform pitch setting for all of the blades, bushings 132 are threaded on the outer ends of the rods 123 and are also externally threaded in a suitable boss 133 of the main piston 121. The external and internal threads of the bushing are of different pitch so that upon removal of a lock nut 134 the bushing may be rotated whereby the differential thread action causes the rod 123 to be moved longitudinally relative to the main piston 121 and accordingly longitudinally shift its adjustable main crosshead portion 122. The blade which is connected to this adjustable crosshead portion through its crank pin will accordingly be angularly adjusted relative to the other blades. When all of the blades have a uniform pitch setting, through adjustment of their individual crosshead portions 122, the lock nuts 134 for each rod can then be secured in position to hold the pitch setting. Thereafter, the blades will be simultaneously adjusted by operation of the main and auxiliary pistons in the manner previously described for Fig. 1 and others. It will be understood that the auxiliary crossheads 124 and the adjustable main crosshead portions 122 are slidable on suitable guideways generally indicated at 135, Fig. 12.

From the foregoing disclosure of the several modifications it is seen that I have provided an extremely compact yet powerful operating mechanism for adjusting the propeller blades, this compactness being accomplished without sacrificing the effective accessibility to the operating parts for inspection, maintenance, repairs or replacement of parts.

It will, of course, be understood that various changes in details of construction and arrangement of parts may be made by those skilled in the art without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. An adjustable blade propeller having a hub and angularly adjustable blades journaled therein, a pair of crank pins secured to each of said blades for angularly adjusting the blades, a main crosshead connected to one crank pin of each blade, a plurality of auxiliary crossheads connected respectively to the other crank pins of the blades, and power mechanism for simultaneously moving the main and auxiliary crossheads to angularly adjust the blades and the power mechanism having provision for allowing the auxiliary crossheads to have movement relative to each other to equalize the adjusting forces on the crank pins.

2. An adjustable blade propeller having a hub and angularly adjustable blades journaled therein, a pair of crank pins secured to each of said blades for angularly adjusting the blades, a main crosshead connected to one crank pin of each blade, a plurality of auxiliary crossheads connected respectively to the other crank pins of the blades, power mechanism for simultaneously moving the main and auxiliary crossheads to angularly adjust the blades, said power mechanism including a single fluid operated main piston and cylinder connected to the main crosshead for reciprocating the same and a plurality of individual auxiliary piston and cylinder units con-

nected respectively to the auxiliary crossheads, and means for supplying operating fluid under a common pressure to the auxiliary cylinders whereby the auxiliary pistons act individually on the auxiliary crossheads to maintain equalized forces on their crank pins throughout adjustment of the blades.

3. An adjustable blade propeller having a hub and angularly adjustable blades journaled therein, a pair of crank pins secured to each of said blades for angularly adjusting the blades, a main crosshead connected to one crank pin of each blade, a plurality of auxiliary crossheads connected respectively to the other crank pins of the blades, power mechanism for simultaneously moving the main and auxiliary crossheads to angularly adjust the blades, said power mechanism including a single fluid operated main piston and cylinder disposed coaxially of the axis of hub rotation and connected to the main crosshead for reciprocating the same and a plurality of individual auxiliary piston and cylinder units connected respectively to the auxiliary crossheads and being disposed circumferentially about the runner hub axis of rotation laterally therefrom.

4. An adjustable blade propeller having a hub and a plurality of angularly adjustable blades journaled therein, each blade having a pair of crank pins, a hydraulically operated servo-motor mechanism having oppositely movable power elements operatively connected respectively to the crank pins of each blade so that the blades are rotated upon opposite movement of the power elements, the power elements that are movable in one of said directions being free to move relative to each other so as to effect equalization of all operating forces acting on the blades to angularly adjust the same.

5. An adjustable blade propeller having a hub adapted for connection at one end to a shaft and angularly adjustable blades journaled in said hub adjacent to the shaft end thereof, means forming a cavity within said hub adjacent said shaft end thereof and having a transverse partition toward the other end of the hub, a plurality of cylinders and pistons disposed laterally of each other on the side of said partition toward said other end of the hub and having piston rods extending through said partition for connection to the blades to angularly adjust the same upon reciprocation of the pistons, said plurality of cylinders and pistons being disposed with their axes laterally offset from each other, one of said piston rods having an axial bore and being disposed coaxially of the axis of rotation of the runner hub, and a valve for distributing operating fluid to said cylinders including a valve casing connected to one of the pistons to move as a unit therewith, and a valve element disposed within said casing to control the distribution of the operating fluid.

6. An adjustable blade propeller having a hub adapted for connection at one end to a shaft and angularly adjustable blades journaled in said hub adjacent to the shaft end thereof, means forming a cavity within said hub adjacent said shaft end thereof and having a transverse partition toward the other end of the hub, a plurality of cylinders and pistons disposed on the side of said partition toward said other end of the hub and having piston rods extending through said partition for connection to the blades to angularly adjust the same upon reciprocation of the pistons, the movement of certain of the piston rods inwardly and outwardly of the hub cavity producing a variation in the volume of the cavity, and means providing a fluid space whose volume varies inversely to that of said volumetric variation of the cavity so as to maintain a total combined volume of said cavity and space that is substantially constant, said cavity and space being in communication with each other and being completely filled with hydraulic fluid at all times and yet compensated for variations in the volume of the cavity.

7. An adjustable blade propeller having a hub adapted for connection at one end to a shaft and angularly ad-

justable blades journaled in said hub near the shaft end thereof, means forming a cavity within the shaft end of said hub including a transverse partition toward the other end of the hub, said cavity being completely filled at all times with hydraulic fluid, a main piston and cylinder 5 supported by said hub disposed coaxially of the axis runner rotation and having a piston rod extending through said partition into said cavity, a plurality of auxiliary cylinders and pistons having piston rods also extending through said partition into said cavity, means for connecting all of said rods to the blades for rotatably adjusting the same, means for compensating for a variable volume of said cavity by reason of said auxiliary piston rods moving inwardly and outwardly of the hub cavity, 10 said compensating means including piston and cylinder elements one of which is connected to one of the piston rods and the other of which has connection with the hub so that upon movement of the piston rods the volume of the compensating cylinder is enlarged or decreased to cause its volume, taken with the volume of the hub cavity 20 at any given position of the piston rods, to be substantially constant, and means for allowing communication between said compensating cylinder and the hub cavity whereby the hub cavity may be completely filled with fluid at all times.

8. An adjustable blade propeller having a hub adapted for connection at one end to a shaft and angularly adjustable blades journaled in said hub, an auxiliary cylinder unit supported against the other end of said hub and having auxiliary cylinders laterally offset from each other, a main cylinder unit supported against the end of said auxiliary cylinder unit, a shell encompassing said cylinder units and connected to the runner hub to exert an 25

axial force on said cylinder units to hold them in position, and pistons disposed in said cylinders and having piston rods connected to the runner blades for angular adjustment thereof, whereby said pistons and cylinders are accessible by removal of said encompassing shell.

9. The combination set forth in claim 1 further characterized in that the main crosshead comprises two portions normally connected together to move as a unit and to one of which the main crosshead crank pins are connected, and means for relatively moving said portions so that the blades may be individually adjusted to effect a uniform pitch setting for all blades.

10. The combination set forth in claim 1 further characterized in that the main crosshead comprises two portions normally connected together to move as a unit and to one of which the main crosshead crank pins are connected, means for relatively moving said portions so that the blades may be individually adjusted to effect a uniform pitch setting for all blades, and the power mechanism for simultaneously moving the main and auxiliary crossheads to angularly adjust the blades having provision for imparting equalized operating forces to all of the crossheads regardless of the relatively adjusted positions of the two portions of the main crosshead.

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