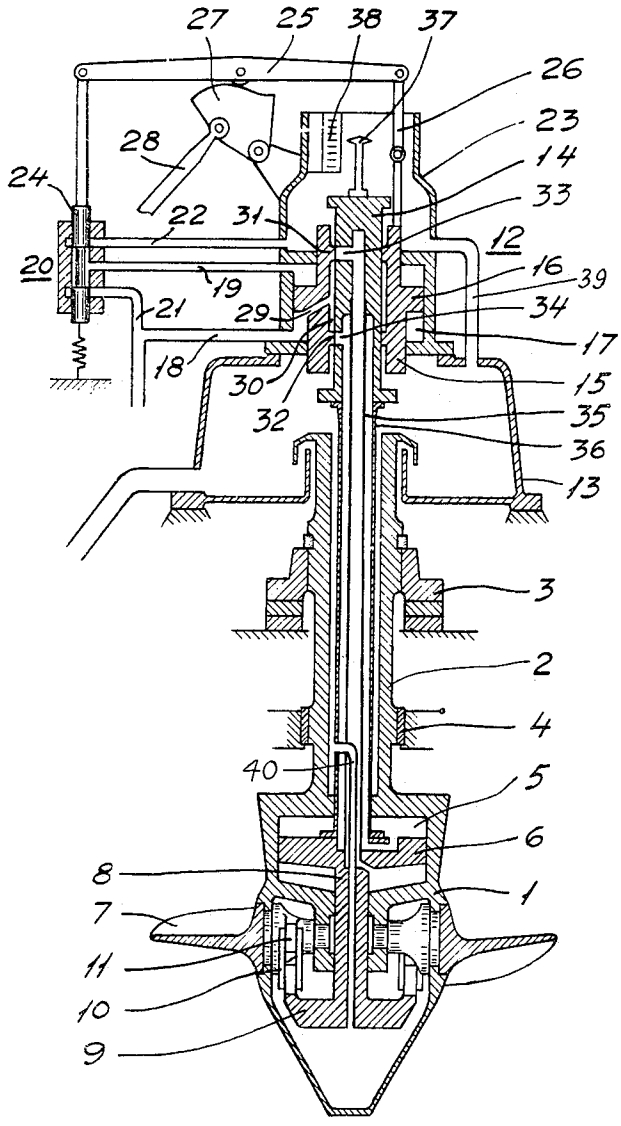
Jan. 18, 1966 O. J. G. HEDBERG 3,229,771

RUNNER-CONTROLLED HYDRAULIC TURBINES, PUMPS AND PROPELLERS

Filed April 23, 1964



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United States Patent Office 3,229,771 Patented Jan. 18, 1966

3,229,771

RUNNER-CONTROLLED HYDRAULIC TURBINES, PUMPS AND PROPELLERS

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Filed Apr. 23, 1964, Ser. No. 361,996
Claims priority, application Sweden, Apr. 29, 1963, 4,651/63
2 Claims. (Cl. 170—160.32)

The present invention relates to runner-controlled hydraulic turbines, pumps and propellers, and particularly to turbines, pumps and propellers having remotely controlled variable pitch or adjustable runner blades.

In known designs of mechanisms for adjusting the runner blades, a hydraulic servomotor is located in the rotating system of the turbine, pump or propeller. This servomotor is operated by means of a control valve which can be located either in the rotating system or outside the rotating system.

Usually the control valve is located in the rotating system, concentric with the axis of rotation and in close proximity to the servomotor. However, with the valve close to the servomotor, it is deep down in the shafting so that access to the control valve and its liner for inspection and overhaul is difficult, and any means for direct mechanical indication of the actual runner blade setting is complicated.

In designs where the control valve is located outside the rotating system, the valve and liner are easily accessible and the means for direct mechanical indication of runner blade position are relatively simple, but these constructions occupy a great deal of space and are expensive as compared with designs in which the control valve is located in the rotating system.

The present invention relates to an improvement in runner-controlled hydraulic turbines, pumps or propellers in which the pitch of the runner blades can be varied by means of a hydraulic servomotor in the runner hub or in the shaft carrying the runner hub, and the control valve is located concentrically in the rotating system in or adjacent to the upper part of the shaft and is mechanically connected to the servomotor in such a manner that direct mechanical indication of runner blade setting is obtained.

For a better understanding of the invention, reference may be had to the accompanying drawing in which the single figure is a schematic vertical section through a hydraulic turbine embodying the invention.

As illustrated in the drawing, the turbine includes a turbine runner or propeller **1** attached to a drive or driven shaft **2**, which is mounted in a thrust bearing **3** and a guide bearing **4**, which may be of the sleeve type, as shown, or of the antifriction ball or roller type. A hydraulic servomotor consisting of a cylinder **5** forming a part of the runner casing and a piston **6** is housed in the runner **1**. The piston **6** is connected to the variable pitch runner blades **7** by means of a piston rod **8**, a crosshead **9** fixed to the piston rod and links **10** pivotally connecting the ends of the crosshead **9** to levers **11** extending substantially radially of the propeller blade hubs to afford a means for rotating the blades around their axes to change their pitch.

The elements for controlling the operation of the servomotor are shown in the upper part of the figure and are referred to hereinafter collectively as a "combinator" **12** which is mounted on the upper wall of an oil pot or reservoir **13**. A control slide valve plug **14** is mounted in a slide valve sleeve **15** having a peripheral piston **16** thereon slidable in a cylinder **17** supported by the oil pot **13**. A lower pipe **18** and an upper pipe **19** communicate with the cylinder **17** on opposite sides of the

piston **16**. Pipe **19** is connected to a regulating slide valve **20**, which is provided with an inlet pipe **21** and an exhaust pipe **22** connected to an oil pan or sump **23**. A slide valve plug **24** in the valve **20** is movably attached to the control valve sleeve **15** by means of a lever **25** and a restoring link **26**. Lever **25** rests by gravity on or is otherwise biased against a cam **27** which can be controlled by means of a connecting rod **28**.

A passage **29** in the sleeve **15** connects the lower part of the cylinder **17** to an annular space **30** between the sleeve **15** and the slide valve plug **14**. Two internal annular collars **31** and **32** in the sleeve **15** are located so that they can close two ports **33** and **34** in the valve plug **14**.

The plug **14** is rigidly attached to the servomotor piston **6** by means of two pipes **35** and **36**. Pipe **35** forms a flow passage between the port **33** and the space below the piston **6** in the cylinder **5**. The space between pipes **35** and **36** forms a passage between the port **34** and the space above the piston **6** in the servomotor cylinder **5**.

A pointer **37** is fixed to the valve plug **14** and is disposed adjacent to a matching scale **38** fixed in the top of the oil pan or sump **23** for indicating the setting of the rod **14** and thereby also the setting of the piston **6** and the pitch of runner blades **7**.

The control system described above operates as follows:

Different height levels of the control valve sleeve **15** correspond to different mutually fixed positions of the parts to which it is mechanically connected, namely the restoring link **26**, the lever **25**, the cam **27** and the valve rod **24** of the regulating valve **20**. If the cam **27** is turned clockwise by means of the connecting rod **28** so that it lifts the lever **25**, valve rod **24** is moved upwardly and communication is established between the pipe **19** and the exhaust pipe **22** allowing oil or other liquid in the system to flow from the cylinder **15** above the piston into the sump **23**. The pressure above the piston **16** will then drop, while the pressure below piston **16** will remain unaltered inasmuch as the space below piston **16** is connected by means of the pipe **18** to a pump (not shown) having its inlet or suction port connected to the reservoir **13** and its discharge port connected to the pipe **18**. Other sources of hydraulic pressure can, of course, be used instead of a pump. The difference in pressure on opposite sides of piston **16** causes the valve sleeve **15** and the restoring link **26** to move upwardly rocking the lever **25** counterclockwise and moving the valve plug **24** downwardly into a position in which it disconnects the pipes **19** and **22**, and thus limits the upward movement of the sleeve **15** to a position corresponding to the position into which cam **27** was turned.

When in the manner described above, the control valve sleeve **15** moves upwardly, the annular collars **31** and **32** will uncover the ports **33** and **34**, allowing oil under pressure supplied by the oil pump to flow through the pipe **18**, passage **29**, space **30**, port **33** and pipe **35** to the space below the piston **6** in the servomotor cylinder **5**, while the space in the cylinder **5** above the piston **6** now communicates with the oil pot or reservoir **13** through the passage between the pipes **36** and **35** and the port **34**. Piston **6** is moved upwardly by the difference in pressure on opposite sides of the piston **6** and also moves control valve plug **14**, to which it is rigidly attached by means of pipes **35** and **36**, upwards until the ports **33** and **34** are again covered and closed by the collars **31** and **32**. With the ports **33** and **34** closed, the oil in the cylinder on both sides of the piston **6** will be trapped and the piston **6** is retained against movement with the blades **7** adjusted to a different pitch.

It will be understood that by turning cam **27** counterclockwise into a position which lowers the lever **25**, the servomotor piston **6** will be moved downwardly with a corresponding change in the adjustment of pitch of the blades.

Inasmuch as the servomotor piston **6** is mechanically connected to the runner blades **7** and rigidly attached to the valve plug **14**, the pointer **37** indicates the pitch of the runner blades **7** directly on the scale **38**.

The control system may include other fluid flow connections than those described above. Thus, an overflow pipe **39** returns oil from the sump **23** to the reservoir or pot **13** and an oil return pipe **40** returns oil leaking from the cylinder **5** to the reservoir **13** or supplies oil to the linkage in the turbine runner, as may be required.

It will be understood that the control system described above can be used with an engine driven propeller, for example, for use for propelling boats, ships and the like, or it may be used in turbines and the like wherein flow of fluid around the runner develops power for driving other mechanisms. Appropriate driving connections will be made to the propeller shaft **2** as may be required.

It will be understood further that the form of the invention described above is illustrative and that other changes in structure and arrangements of parts may be made therein without departing from the invention as set forth in the following claims.

I claim:

1. A control and indicating system for adujsting the blades of turbine, propeller and pump runners and the like comprising a runner having adjustable blades mounted thereon, a tubular drive shaft supporting said runner for rotation, a servomotor in said runner including a cylinder and a first piston movable in said cylinder, means connecting said first piston to said blades for adjusting said blades in response to movement of said piston, a slide valve in axial alignment with and outside of the end of said shaft remote from said runner, said slide valve including a valve plug movable relative to said shaft and a slide valve sleeve slidably receiving said plug and movable relative to said shaft and said plug, conduits extending lengthwise in said tubular shaft and having passages controlled by said plug and sleeve connected to said cylinder at opposite sides of said first piston, said plug and sleeve in one relative position preventing flow of fluid through said passages, and in other positions admitting fluid to said cylinder on one side of said first piston and discharging fluid from the cylinder on the opposite side of said first piston to move said first piston and selectively increase and decrease the pitch of said blades, a second piston connected to said sleeve, a second cylinder receiving said second piston slidably and a second valve operable in one position to prevent flow of fluid to said second cylinder and actuatable for supplying fluid under pressure to said second cylinder to move said sleeve relative to said plug, said conduits fixedly connecting said first piston to said plug for moving said plug relative to said sleeve to said one position to close said passages.

2. A control and indicating system for adjusting the blades of turbine, propeller and pump runners and the like comprising a runner having adjustable blades mounted thereon, a tubular drive shaft supporting said runner for rotation, a servomotor in said runner including a cylinder and a first piston movable in said cylinder, means connecting said first piston to said blades for adjusting said blades in response to movement of said piston, a slide valve in axial alignment with and outside of the end of said shaft remote from said runner, said slide valve including a valve plug movable relative to said shaft and a slide valve sleeve slidably receiving said plug and movable relative to said shaft and said plug, conduits extending lengthwise in said tubular shaft and having passages controlled by said plug and sleeve connected to said cylinder at opposite sides of said first piston, said plug and sleeve in one relative position preventing flow of fluid through said passages, and in other positions admitting fluid to said cylinder on one side of said first piston and discharging fluid from the cylinder on the opposite side of said first piston to move said first piston and selectively increase and decrease the pitch of said blades, a second piston connected to said sleeve, a second cylinder receiving said second piston slidably, a second valve operable in one position to prevent flow of fluid to said second cylinder and actuatable for supplying fluid under pressure to said second cylinder to move said sleeve relative to said plug, lever and link means connecting said second valve and said sleeve, a cam for moving said lever to actuate said second valve to supply fluid to said second cylinder and move said sleeve, and said lever and link means being responsive to movement to said sleeve to restore said second valve to said one position and stop flow of fluid to said second cylinder, said conduits fixedly connecting said first piston to said plug for moving said plug relative to said sleeve to said one position to close said passages.

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