April 12, 1966 NOBUYASU YOKOI 3,245,497

LUBRICATING DEVICE FOR HYDRAULIC MACHINES HAVING AN ADJUSTABLE-BLADE RUNNER

Filed Nov. 6, 1963

Fig. 1

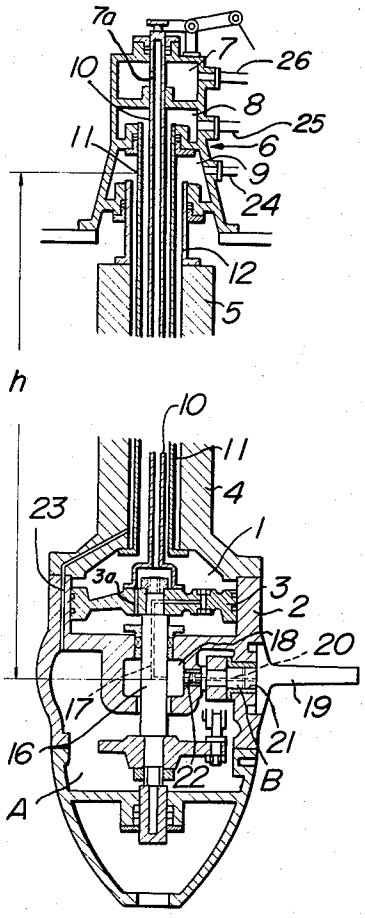
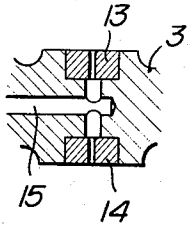


Fig. 2



INVENTOR
NOBUYASU YOKOI
BY Paul M. Craig, Jr.

ATTORNEY

United States Patent Office 3,245,497 Patented Apr. 12, 1966

3,245,497

LUBRICATING DEVICE FOR HYDRAULIC MACHINES HAVING AN ADJUSTABLE-BLADE RUNNER

Nobuyasu Yokoi, Hitachi-shi, Japan, assignor to Hitachi, Ltd., Tokyo, Japan, a corporation of Japan

Filed Nov. 6, 1963, Ser. No. 321,733
Claims priority, application Japan, Nov. 7, 1962, 37/65,983
4 Claims. (Cl. 184—6)

This invention relates to hydraulic machines having an adjustable-blade runner and particularly to lubrication of the interior of the runner hub and prevention of water penetration therein.

Hydraulic machines such as Kaplan turbines having a runner continuously submerged in water generally have the cavity or interior space of the runner hub pressurized with packing means arranged between the runner hub and those relatively movable parts thereon exposed directly to water for the purpose of preventing water penetration into the cavity in the runner hub. One previous method of pressurizing the hub cavity has been to direct the pressure oil into the hub cavtiy from the pressure chamber on one side of the control piston of the servo motor which is arranged in the runner for blade adjustment. An alternative method has been to employ a pressure source separately arranged for introducing an appropriate pressure into the hub cavity. In the former method, however, there has been a danger that some water may penetrate into the runner hub particularly because the oil pressure being introduced therein from only one of the pressure chambers of the servo motor is substantially reduced as the servo motor is operated by a controlling pressure in the other chamber of the servo motor. The latter method abviously involves an additional cost of manufacture for provision of the separate source of pressure.

The primary object of the present invention is to provide an improved lubricating device for a hydraulic machine of the type including an adjustable-blade runner with a servo motor operable to adjust the pitch of the runner blades and having an oil passage for connecting the oil pressure fed to the servo motor with an inner cavity formed in the runner hub portion, the oil passage being formed so as to comunicate with the pressure chambers of the servo motor on both sides of the piston arranged therein.

Another object of the present invention is to provide a lubricating device of the character described which comprises an oil discharge opening formed in the top portion of the runner hub to allow the pressure oil fed through the oil passage into the runner hub to be returned therefrom to an appropriate oil collector tank.

According to the present invention, it will be appreciated that, since the inner cavity of the runner hub is continuously fed with oil pressure from either one of the opposite pressure chambers of a servo motor provided for blade adjustment, there occurs no fluctuation in the pressure in the hub cavity and the bearing portions of the runner blades are effectively lubricated preventing any water penetration into the hub cavity. Also, the inventive device is economical because there is no need for any separate pressure source. On the other hand, the inventive arrangement, further including an oil discharge opening formed in the top of the runner hub for permitting the pressure oil fed into the hub to be returned therefrom to an approprite oil collector tank, is effective to lubricate the shifting mechanism in the runner hub including link, levers, etc. and to maintain the otil pressure in the runner hub at an oil pressure not less than the oil head corresponding to the level of the oil discharge

opening and effective to prevent water penetration into the runner hub. Moreover, the arrangement is advantageous from an economic standpoint since the oil discharged is returned to the oil collector tank for reuse.

The foregoing and other objects and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawing, which illustrates one preferred embodiment of the invention and in which:

FIG. 1 is a fragmentary vertical cross section of one embodiment of the invention as applied to the runner of a Kaplan turbine; and

FIG. 2 is an enlarged fragmentary view of the pressure oil intake section in FIG. 1.

Referring to the drawing, reference numeral **1** designates a servo motor arranged in the top portion of the runner hub **2** and including a piston **3** arranged therein. A pressure oil inlet device **6** is arranged on top of the turbine shaft **4–5** for forcing oil under pressure into the servo motor **1** and includes inlet chambers **7** and **8**. Reference numeral **9** designates an oil reservoir for collecting oil, which has served to lubricate and pressurize the interior of the runner hub **2** and an appropriate oil collecting tank (not shown) is provided to receive oil from the oil reservoir **9** through a conduit **24**. Pressure oil conduits **10** and **11** are arranged in the hollow turbine shaft **4–5** to direct the pressure oil fed into the inlet chambers **7** and **8** to the servo motor **1**.

The pressure oil from the conduit **26** entering the oil pressure inlet chamber **7** is applied through the inlet **7***a* to a pressure oil tube **10**. The pressure oil entering the utbe **10** passes to the lower chamber of the servo motor through a hole **3***a* and is effective to produce a raising of the piston **3**. On the other hand, the pressure oil from a conduit **25** entering the oil-pressure inlet chamber **8** is applied to the pressure oil tube **11**. The pressure oil entering the tube **11** passes to the upper chamber of the servo motor and is effective to drive the piston in a downward direction.

The runner hub **2** defines a major cavity A therein and an oil discharge conduit **12** is formed in the turbine shaft **4–5** and connected with an oil passage **23** extending through the walls of the runner hub **2** and the bottom portion of turbine shaft **4–5** for the purpose of directing the oil fed into the turbine hub for lubrication and pressurization thereof upwardly into the oil reservoir **9**. A pair of pressure oil intake pieces **13** and **14** are fitted in the opposite surfaces of the piston **3** and each have a through aperture having a limited diameter so as to permit passage of fluid while substantially maintaining the pressure differential on the piston **3**. As shown, the through apertures are in communication with an oil passage **15** extending through the piston **3** and in parallel with the opposite surfaces thereof.

An operating rod **16** is mounted in the runner hub **2** for actuating the runner blades **19** and connected at one end with the motor piston **3** and at the other end with a mechanism for operating the runner blades **19**. Formed in the operating rod **16** is a passageway **17** communicating at one end with the oil passage **15** formed in the motor piston and at the other end with an inner or central cavity **18** formed in the runner hub **2**. A passageway **20** is formed through the boss portion B of each of the runner blades **19** to permit the pressure oil from the cavity **18** to flow through said passageway onto the surface of the blade boss portion B for the purpose of lubricating bearing bushings **21** and **22**, which are arranged in the runner hub to support the runner blade.

In operation, the oil pressure from the inlet chambers **7** and **8** is directed through conduits **10** and **11** to enter the servo motor **1** in the runner hub and through the

intake pieces **13** and **14** flows into the oil passage **15**. The oil further flows through passage **17** formed in the blade operating rod **16** to collect in the inner cavity **18** formed in the runner hub **2**. The oil from the inner cavity flows through passageways **20** to enter the oil grooves formed in the surfaces of the blade boss portions B to lubricate the areas of contact between the bushings **21** and **22**, and the blade bosses supported therein. Thereafter, the oil is collected in the major cavity A in the runner hub **2** and together with leakage oil from the inner cavity **18** lubricates the blade-operating mechanism in the major cavity A including links, levers, etc. The lubricating oil then flows upwardly through the oil passage **23** formed in the walls of the runner hub **2** and the bottom portion of the hollow turbine shaft **4** and through the annular space between the oil conduit **11** and shaft **4–5** into the oil reservoir **9** and further through conduit **24** to the oil collector tank not shown.

Having described and shown one preferred embodiment of the present invention, it is to be understood that it is not restricted to the details set forth but changes and modifications may be made without departing from the spirit and scope of the present invention as defined in the appended claims.

What is claimed is:

1. In a hydraulic turbine of the type having runner blades adjustably supported in bearings within a runner hub and a servo motor for adjusting said runner blades including a fluid actuated piston and actuating shaft interconnected with said runner blades so that longitudinal movement of said piston produces coordinate rotation of said blades, the improvement essentially consisting of a lubrication system for said bearings comprising,

fluid passage means in said piston interconnecting the opposing sides of said piston, said fluid passage means being sufficiently restricted to substantially prevent equalization of the pressure on either side of said piston while allowing passage of the actuating fluid, and

further means providing a continuous connection between said fluid passage means and said bearings for conveying the actuating fluid to said bearings,

said further means including reservoir means between said fluid passage means and said bearings for providing continuous pressure to said bearings.

2. In a hydraulic turbine of the type having runner blades adjustably supported in bearings within a runner hub and a servo motor for adjusting said runner blades including a fluid actuated piston and actuating shaft interconnected with said runner blades so that longitudinal movement of said piston produces coordinate rotation of said blades, the improvement essentially consisting of a lubrication system for said bearings comprising,

fluid passage means in said piston interconnecting the opposing sides of said piston, said fluid passage means being sufficiently restricted to substantially prevent equalization of the pressure on either side of said piston while allowing passage of the actuating fluid, and

further means providing a continuous connection between said fluid passage means and said bearings for conveying the actuating fluid to said bearings,

said further means including reservoir means between said fluid passage means and said bearings for providing continuous pressure to said bearings and channel means passing through said actuating shaft between said fluid passage means and said reservoir means.

3. In a hydraulic turbine of the type having runner blades adjustably supported in bearings within a runner hub and a servo motor for adjusting said runner blades including a piston and actuating shaft interconnected with said runner blades so that longitudinal movement of said piston produces coordinate rotation of said blades, the improvement essentially consisting of a lubrication system for said bearings comprising,

fluid passage means in said piston interconnecting the opposing sides of said piston, said fluid passage means being sufficiently restricted to substantially prevent equalization of the pressure on either side of said piston, and

further means providing a continuous connection between said fluid passage means and said bearings,

said further means including reservoir means between said fluid passage means and said bearings for providing continuous pressure to said bearings and channel means passing through said actuating shaft between said fluid passage means and said reservoir means,

said fluid passage means including a pair of intakes on opposing sides of said piston and having restricted apertures therein, said restricted apertures being interconnected by a larger bore.

4. In a hydraulic turbine of the type having runner blades adjustably supported in bearings within a runner hub and a servo motor for adjusting said runner blades including a piston and actuating shaft interconnected with said runner blades so that longitudinal movement of said piston produces coordinate rotation of said blades, the improvement essentially consisting of a lubrication system for said bearings comprising,

fluid passage means in said piston interconnecting the opposing sides of said piston, said fluid passage means being sufficiently restricted to substantially prevent equalization of the pressure on either side of said piston, and

further means providing a continuous connection between said fluid passage means and said bearings,

said further means including reservoir means between said fluid passage means and said bearings for providing continuous pressure to said bearings and channel means passing through said actuating shaft between said fluid passage means and said reservoir means,

said fluid passage means including a pair of intakes on opposing sides of said piston and having restricted apertures therein, said restricted apertures being interconnected by a larger bore,

and return channel means for relieving the pressure within said runner hub by providing a connection to the outside thereof.

References Cited by the Examiner

UNITED STATES PATENTS

1,510,436	9/1924	Englesson	253—148
2,244,479	6/1941	Anderson	253—117
2,283,128	5/1942	Ring	253—117
2,518,925	8/1950	Nussbaum	253—148
3,138,362	6/1964	Allan	253—148

LAVERNE D. GEIGER, *Primary Examiner.*

MILTON KAUFMAN, *Examiner.*