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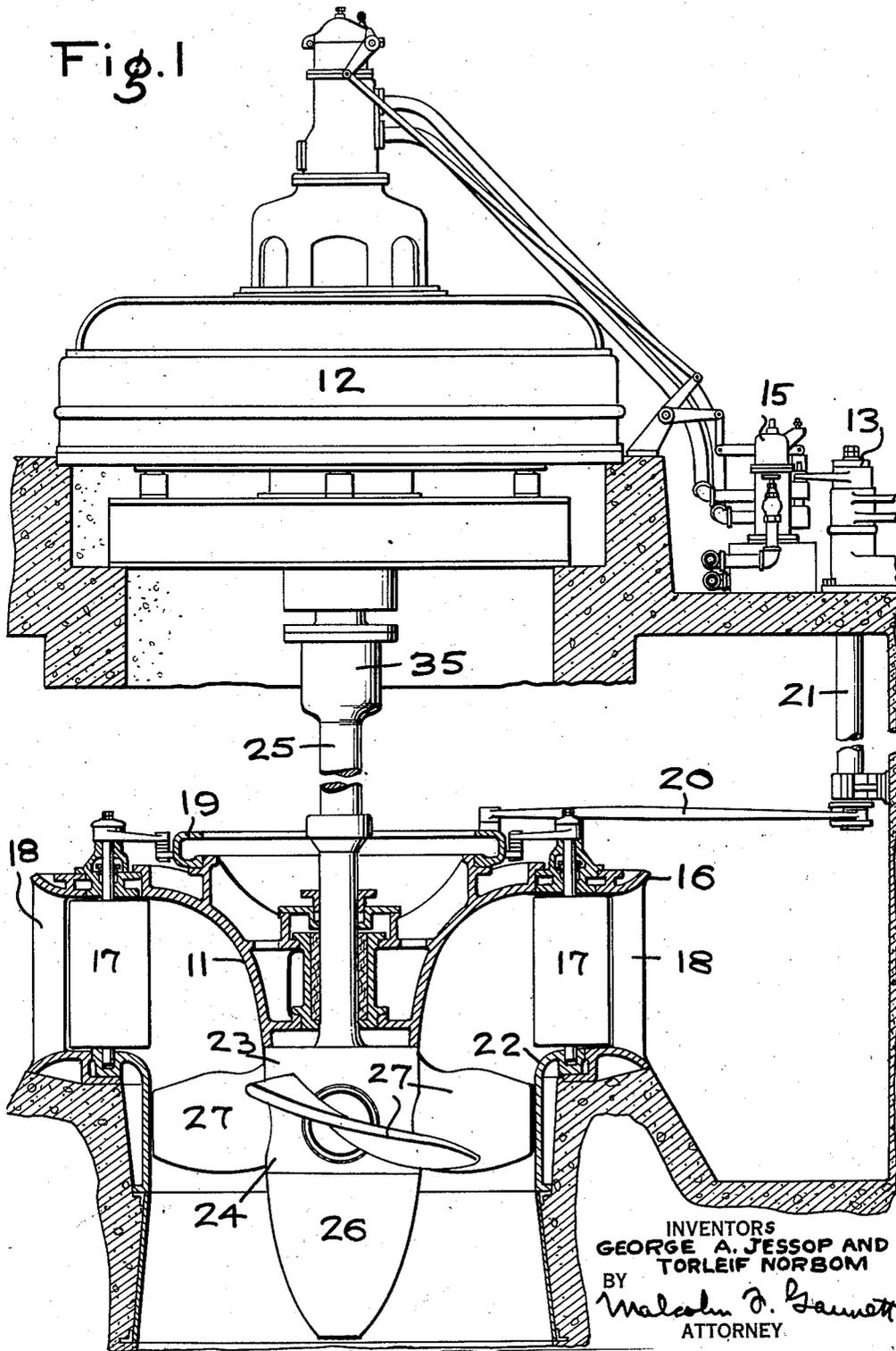
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HYDRAULIC MACHINE

Filed Sept. 17, 1936

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Fig. 1



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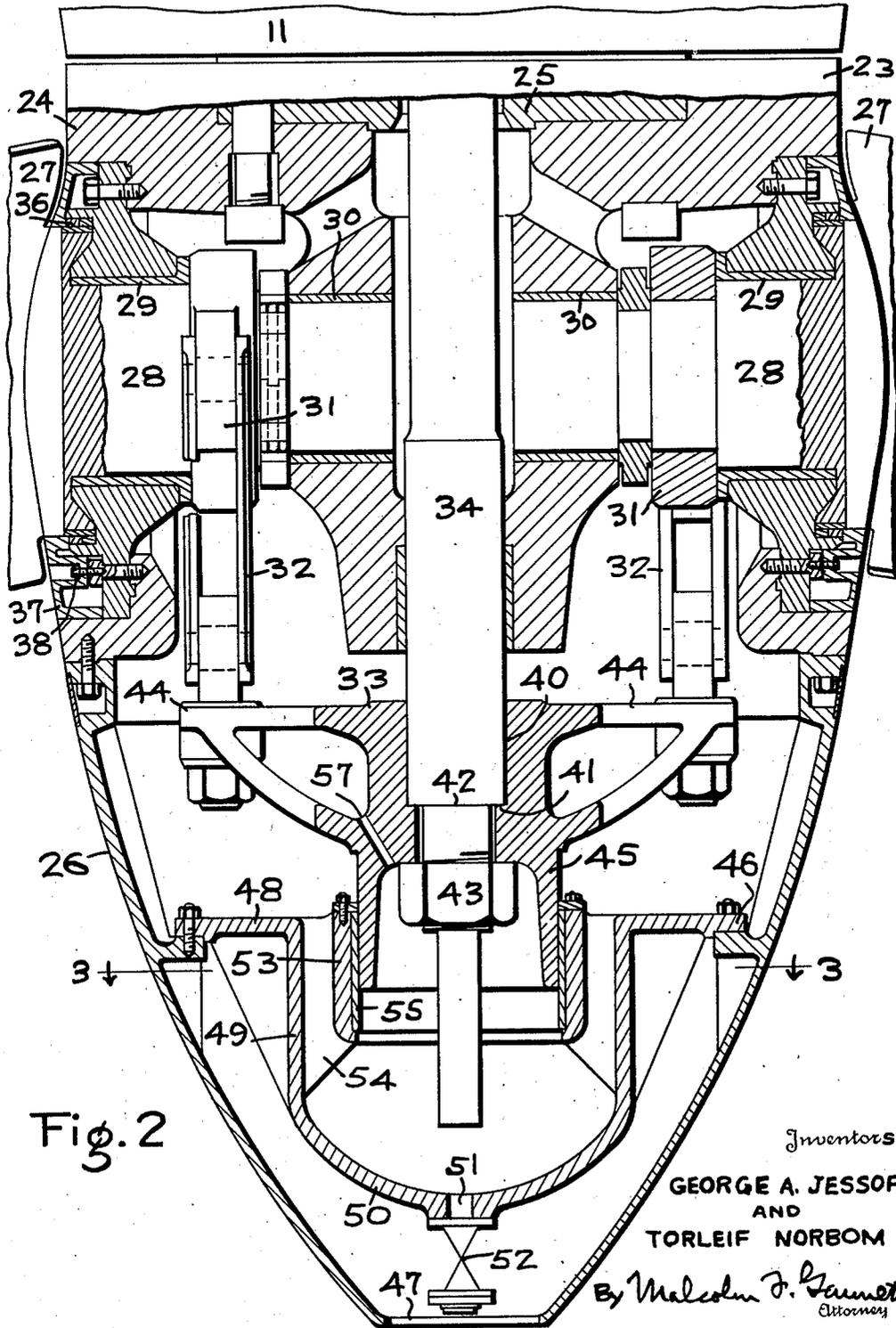


Fig. 2

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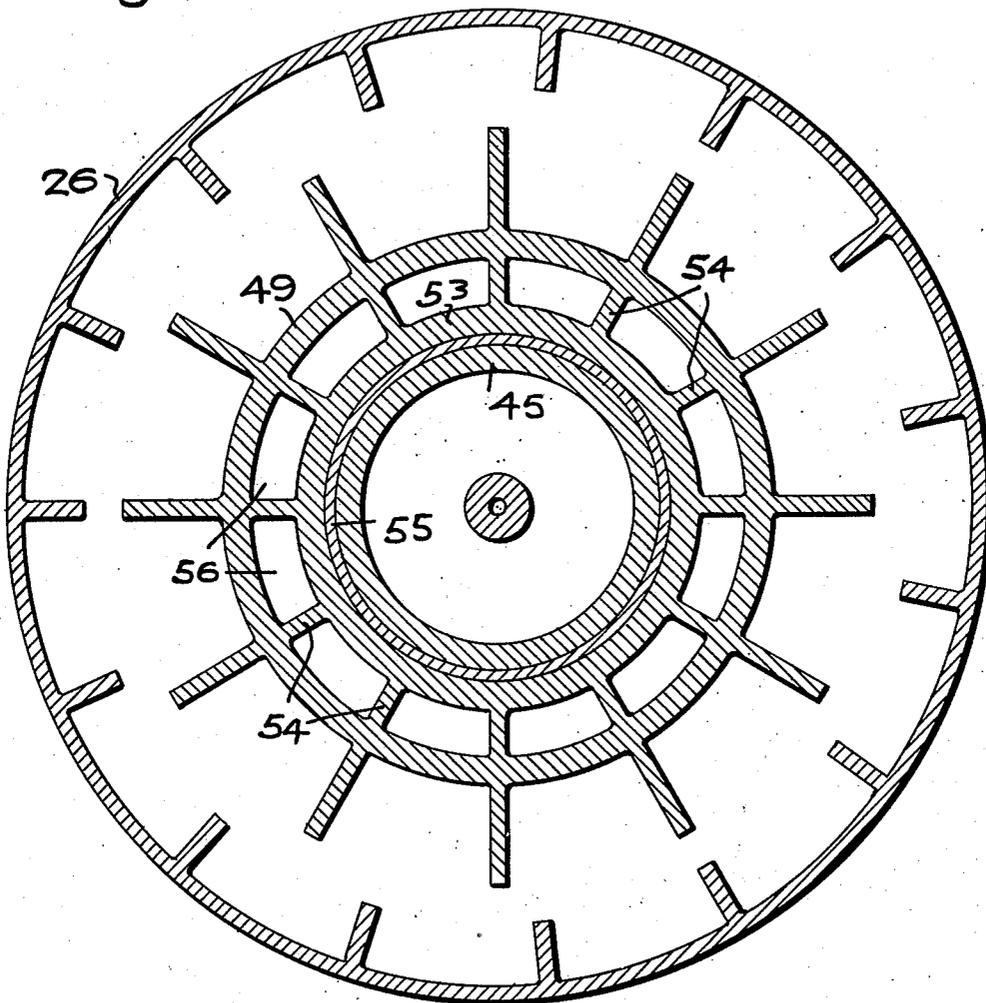
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Fig. 3



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# UNITED STATES PATENT OFFICE

2,087,323

## HYDRAULIC MACHINE

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5 Claims. (Cl. 253—148)

This invention relates to hydraulic machines, such as hydraulic turbines, pumps and the like, and more particularly to the type of hydraulic machines having runners with movable or adjustable blades. The blades of the runners of the above type of hydraulic machines are formed with trunnions which are rotatably mounted within the hub of the runner. Mechanism is provided within the runner hub and operatively connected to the trunnions for simultaneously operating the blades to alter the relative positions thereof. The present invention relates more particularly to improvements in the runner blade operating mechanism whereby breakage of the parts thereof in case the blades become jammed or refuse to turn when their mechanism is operated is reduced to a minimum.

An object of the invention is to provide improved means for guiding the lower end of the operating rod of the mechanism for operating the blades in the runner hub of an adjustable blade hydraulic machine.

Another object of the invention is to provide a sump in the bottom of the runner hub of an adjustable blade hydraulic machine for the water which collects in the hub underneath the lubricating oil therein, and in which the structure of the sump is so formed as to provide a lower guide for the blade operating means.

Another object of the invention is to provide an improved hydraulic machine of the character mentioned, which is simple in construction, and reliable and exact in function under all conditions of service.

The invention also comprises certain new and useful improvements in the construction, arrangement and combination of the several parts of which it is composed, as will be hereinafter more fully described and claimed.

In the accompanying drawings:—

Figure 1 is a view partly in section of an adjustable blade hydraulic turbine embodying the present invention;

Fig. 2 is an enlarged vertical section of the runner hub; and

Fig. 3 is an enlarged cross section taken on the line 3—3 of Fig. 2.

Referring to the drawings, wherein the turbine is shown connected to an electric generator for the purpose of operating the same, the complete generating unit may comprise a hydraulic turbine 11, an electrical generator 12, and a governor mechanism 13.

As is well known in the art, the governor 13 is adapted to automatically control the operation

of the turbine, so that the turbine will operate at a substantially uniform speed, irrespective of the variations of the load.

The turbine 11 has a runner which is made with adjustable blades, the angular positions of which are adapted to be varied according to the load, so that the turbine will operate at its highest efficiency at all times.

In mechanisms falling within the scope of the present invention, the operating fluid is generally oil, means being provided for controlling the oil in such a manner that when the governor 13 operates to adjust the angles of the wicket gates of the turbine, the runner blades will be caused to rotate in a similar direction so as to effect a corresponding adjustment in the angles or positions thereof. In this way the parts of the turbine will be simultaneously adjusted so that all of the parts will at all times retain their correct relationship with each other and the turbine will operate with maximum efficiency and smoothness and with minimum vibration.

For the purpose of controlling the actuation of the runner blade operating mechanism, a control device 15 may be employed. This control device may be operatively connected with the governor 13 and function in the manner shown and described in McCormack Patent No. 1,937,772, granted December 5, 1933, for Hydraulic turbine.

The turbine 11 may comprise a casing 16 which forms a peripheral water inlet in which are mounted an annular series of wicket gates 17 and guide vanes 18.

The wicket gates 17 are rotatably mounted in the casing 16 and said gates are operatively connected to a gate adjusting ring 19 connected by link means 20 to a shaft 21 of the governor mechanism 13, so that the wicket gates 17 will be simultaneously rotated into different angular positions to control the flow of water into the turbine.

The lower portion of the turbine casing forms an axially directed chamber 22 in which the runner 23 operates.

As shown in Fig. 2, the runner 23 has a hub 24 which is connected to the lower end of a hollow or tubular shaft 25. The upper end of shaft 25 is connected to the shaft of the generator 12, as shown in Fig. 1.

The portion of the runner hub designated by reference numeral 24 is preferably made of a single hollow casting, the bottom of which is closed by means of a deflector 26. The construction is such that the parts 24 and 26 constitute the hub of the runner, the upper part 24 being

the main part of the hub and accordingly such part is strongly and heavily constructed.

A suitable number of blades 27 are rotatably supported in the hub of the runner 23 and project radially therefrom.

The inner end of each blade 27 is formed with a trunnion 28 which is journalled in bearings 29 and 30 supported in the hub 24.

Means are provided for simultaneously rotating all of the blades 27 and for maintaining them in equal angular relationship, such means comprising preferably a lever 31 rigidly fixed on the trunnion 28 of each blade and links 32 which connect the levers on the different blades to a cross head 33 fixed to the lower end of an operating rod 34 which extends upwardly through the hollow runner shaft 25.

The upper end of the operating rod 34 is fixed to the piston of a servo motor 35 which is mounted in the runner shaft 25 adjacent to the point where the runner shaft is connected to the shaft of the generator 12 (see Fig. 1).

Operation of the servo motor 43 reciprocates the operating rod 34 downwardly and upwardly and such movements of the operating rod are transmitted by cross head 33 through the links 32 to the levers 31, thereby rotating the runner blades 27 in the manner fully described in the McCormack Patent No. 1,937,772 heretofore referred to.

The mechanism within the hub of the runner 23 requires thorough lubrication. Accordingly, it has been customary to fill the hub of the runner with some suitable lubricating oil.

Since the runner blades 27 are rotatably mounted in the hub of the runner, it is necessary to employ some suitable sealing means around the joints between the runner blades and the hub, so as to prevent escape of the lubricating oil outwardly from the hub, as well as seepage of water into the hub.

Any suitable form of seal can be employed for sealing the joints between the runner blades and the hub. As shown in Fig. 2, the sealing means may comprise suitable packing 36 which surrounds the outer portions of the trunnions 28. The packing 36 is retained in position by means of a sealing ring 37 which is detachably connected to the bearing 29 by tap bolts 38.

During operation of hydraulic turbines of the above described type it sometimes happens that one of the blades becomes jammed so that the same will not move in response to movements imparted to its operating mechanism. Such jamming of a blade may be caused by a timber or other foreign object in the water becoming caught in the space between two of the blades, or the jamming of the blades may occur from some other cause.

When a blade does become jammed or refuses to operate from some cause, all of the power or forces exerted on the operating rod 34 by the servo motor 35 will be delivered to one of the links 32. This puts a tremendous bending moment on the lower end of the operating rod 34, with the result that frequently the cross head 33 is injured and sometimes broken.

Therefore, in order to reinforce the lower end of the operating rod 34 and prevent distortion or bending thereof, according to the present invention, a suitable guide means is provided for the cross head 33 and the operating rod 34.

As shown in Fig. 2, the cross head 33 is formed with a central opening 40 for the reception of the lower end of the operating rod 34.

The opening 40 is formed with two diameters so as to form a shoulder 41, and the lower portion of the operating rod is also formed with two diameters so as to provide a shoulder 42 for engaging the shoulder 41.

Threaded onto the reduced lower portion of the operating rod 34, is a nut 43 which retains the cross head 33 firmly on the operating rod.

The cross head 33 is made of skeleton form, with outwardly projecting arms 44 to which the links 32 are connected as clearly shown in Fig. 2.

The lower portion of the main body of the cross head 33 is formed with a downwardly projecting tubular extension 45, and this portion of the cross head surrounds the nut 43.

Fixed in the lower portion of the deflector 26 heretofore referred to, is a member 46.

As shown in Fig. 2 the bottom of the deflector 26 has an opening 47 formed therein as has been customary in the construction of the runners of hydraulic turbines of the type herein described.

The member 46 comprises an upper horizontal web 48 which extends transversely across the deflector 26.

Depending from the central portion of the web 48 is a cylindrical portion 49, the bottom 50 of which is arcuate in cross section, as shown in Fig. 2. This arcuate bottom 50 of the member 46 provides a sump for the bottom of the hub of the runner, and in this sump collects any water which may seep into the hub of the runner past the packings 36. In order that water can be drained from this sump, an opening 51 is formed therein. The opening 51 is normally closed by means of a suitable valve, diagrammatically indicated at 52.

Within the cylindrical portion 49 of the member 46, there is another cylindrical portion 53 which is supported from the portion 49 by a plurality of webs 54, as shown in Fig. 3.

The cylindrical portion 53 is open at the top and bottom and the interior thereof is fitted with a bushing 55.

The tubular extension 45 of the cross head 33 is disposed within the cylinder 53 and the bushing 55 constitutes a bearing therefor.

The spaces between the webs 54 constitute openings 56 through which the oil in the hub of the runner can readily flow into the sump.

During the operation of the blade operating mechanism the rod 34 and cross head 33 are constantly moving upwardly and downwardly. Since the portion 45 of the cross head 33 is in effect a piston mounted in cylinder 53, the oil in the hub is constantly in motion.

When the cross head 33 moves downwardly the oil in the sump 50 flows upwardly through the openings 56, and in order that no pocket will be formed in the upper portion of the extension 45 of the cross head above the oil in the sump 50, a vent or passage 57 is formed in the cross head as shown in Fig. 2.

The provision of the tubular extension 45 mounted in the cylinder 53 constitutes a guide for rigidly supporting the lower end of the operating rod 34, thereby providing means within the hub of the runner for taking up any bending forces which might be exerted against the operating rod and cross head due to jamming of the runner blades or other causes. In this way bending of the operating rod 34 or breakage of the cross head will be prevented, and the connection between the operating rod and the cross head is considerably strengthened.

By the provision of the sump 50 which is located at a point considerably below the normal position of the cross head 33, a comparatively large chamber is formed in the bottom of the hub of the runner. This chamber will take care of a substantial amount of water before the water level rises to the level of the guide bushing 55. In this way the portion of the cross head which is mounted in the guide bushing 55 will be lubricated entirely with oil and not with a mixture of oil and water, thereby prolonging the life of these parts of the blade operating mechanism.

Having thus described our invention, what we claim is:—

1. In a hydraulic turbine, a runner having a hollow hub, a plurality of blades rotatably mounted in the hub, mechanism within the hub for operating said blades and comprising a cross head and means for reciprocating the same, and a pair of concentrically disposed cylindrical members carried by the lower portion of the hub in spaced relation to the wall thereof, the outer of said cylindrical members having a closed bottom whereby said member constitutes a sump for the lubricating oil in the hub, and the inner cylindrical member being tubular in form and being adapted to receive the lower portion of said cross head and constitute guiding means therefor.

2. In a hydraulic turbine, a runner having a hollow hub, a plurality of blades rotatably mounted in the hub, mechanism within the hub for operating said blades and comprising a cross head and means for reciprocating the same, a depending cylindrical portion formed on the cross head, a pair of concentrically disposed spaced apart cylindrical members carried by the lower portion of the hub, the outer of said cylindrical members having a closed bottom whereby said member constitutes a sump for the lubricating oil in the hub, the inner cylindrical member being tubular in form and being adapted to receive the depending cylindrical portion of said cross head and constitute guiding means therefor.

3. In a hydraulic turbine, a runner having a hollow hub, a plurality of blades rotatably mounted in the hub, mechanism within the hub for operating said blades and comprising a cross head and means for reciprocating the same, a depending cylindrical portion formed on the cross head, a pair of concentrically disposed spaced apart cylindrical members disposed in the lower portion of the hub, the outer of said cylindrical members being supported in the hub in spaced relation to the wall thereof, said outer member having a closed bottom whereby said member constitutes a sump for the lubricating oil in the hub, the inner cylindrical member being tubular for receiving the depending cylindrical portion of said cross head and guiding the same, and a plurality of vertical webs connecting

the inner and outer cylindrical members for supporting the inner member from the outer member.

4. In a hydraulic turbine, a runner having a hollow hub filled with lubricating oil, a plurality of blades rotatably mounted in the hub, mechanism within the hub for operating said blades and comprising a cross head and means for reciprocating the same, and means within the bottom portion of the hub having the combined function of guiding said cross head and for causing the oil to circulate within the hub during actuation of said blade operating mechanism, comprising a pair of concentrically disposed spaced apart cylindrical members, the outer of said members being supported in the hub in spaced relation to the wall thereof, said outer member having a closed bottom whereby the outer member constitutes a sump for the lubricating oil, the inner cylindrical member being tubular for receiving the lower portion of said cross head to guide the same, a plurality of vertical webs connecting the inner and outer cylindrical members for supporting the inner member from the outer member, the spaces between said webs constituting passages through which oil can flow into and out of the sump during the reciprocating movements of the cross head.

5. In a hydraulic turbine, a runner having a hollow hub filled with lubricating oil, a plurality of blades rotatably mounted in the hub, mechanism within the hub for operating said blades and comprising a cross head and means for reciprocating the same, and means within the bottom portion of the hub having the combined function of guiding said cross head and for causing the oil to circulate within the hub during actuation of said blade operating mechanism, comprising a depending cylindrical portion formed on the cross head, a pair of concentrically disposed spaced apart cylindrical members, the outer of said members being supported in the hub in spaced relation to the wall thereof, said outer member having a closed bottom whereby the outer member constitutes a sump for the lubricating oil, the inner cylindrical member being tubular for receiving said depending cylindrical portion of the cross head to guide the same, a plurality of radial vertical webs connecting the inner and outer cylindrical members for supporting the inner member from the outer member, a vent formed in the cross head and connecting the space within the lower cylindrical portion thereof to the interior of said hub above said pair of cylindrical members, said vent and the spaces between said webs constituting passages through which oil can flow into and out of the sump during reciprocation of said cross head.

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