

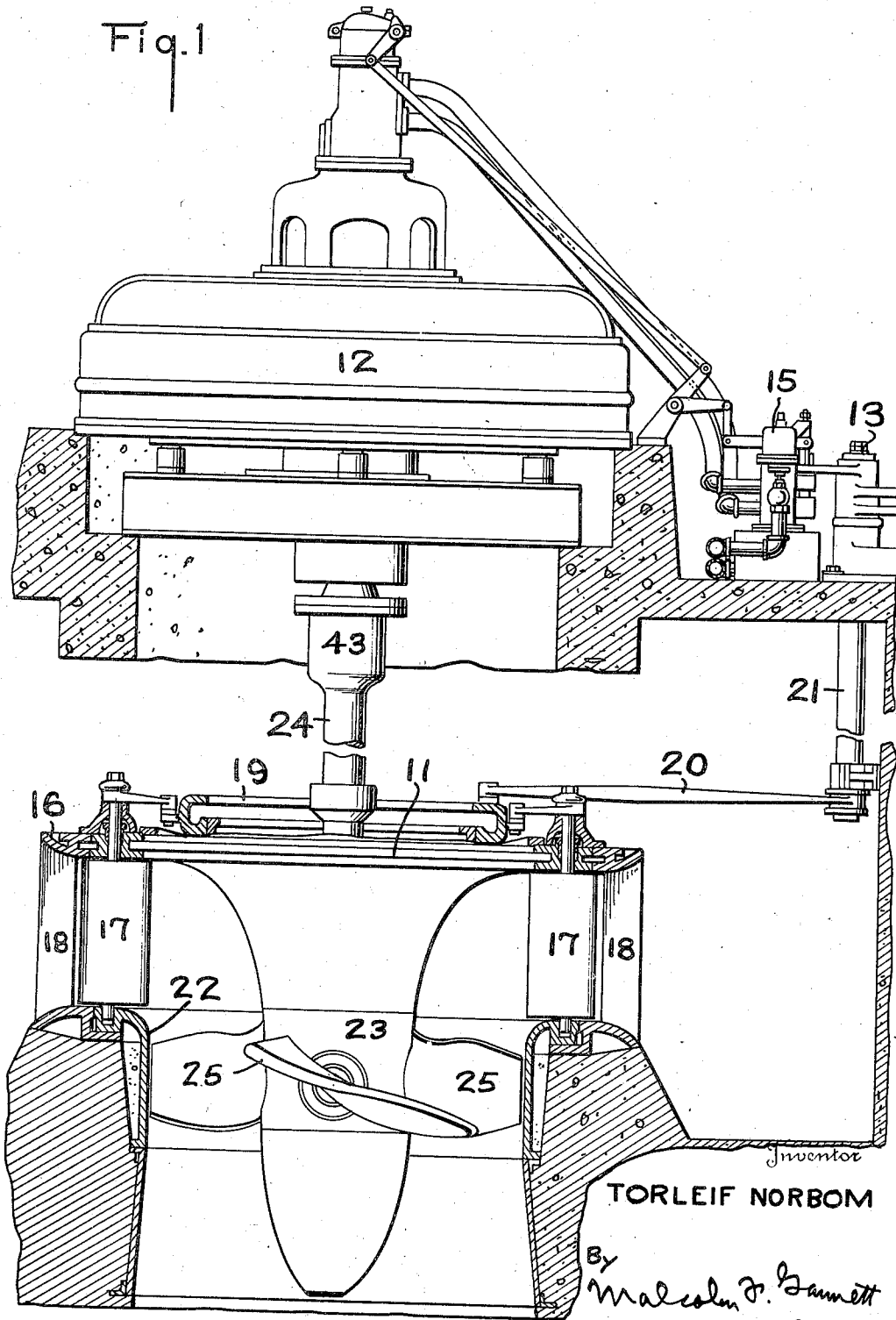
July 13, 1937.

T. NORBOM
HYDRAULIC TURBINE
Filed Sept. 17, 1936

2,086,633

4 Sheets-Sheet 1

Fig. 1



Inventor
TORLEIF NORBOM
By *Malcolm F. Gannett*
Attorney

July 13, 1937.

T. NORBOM

2,086,633

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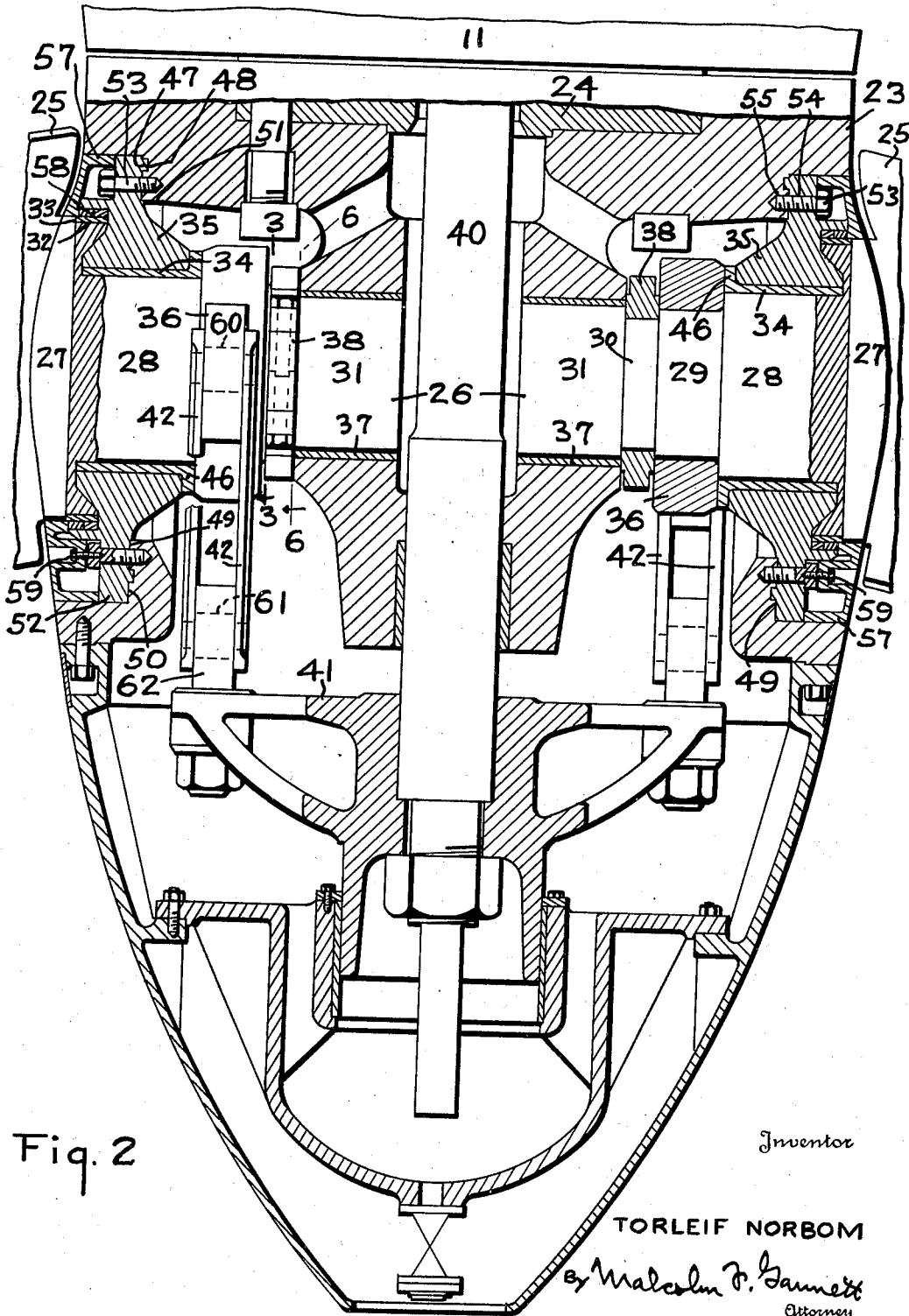


Fig. 2

Inventor

TORLEIF NORBOM

by Malcolm P. Gannett
Attorney

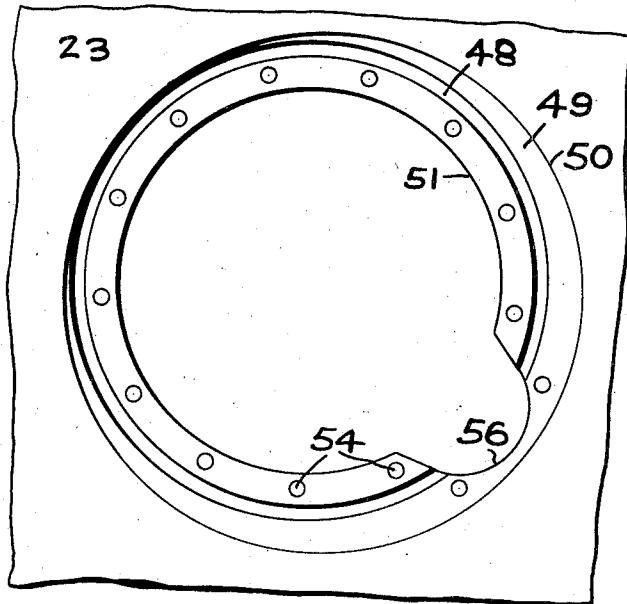
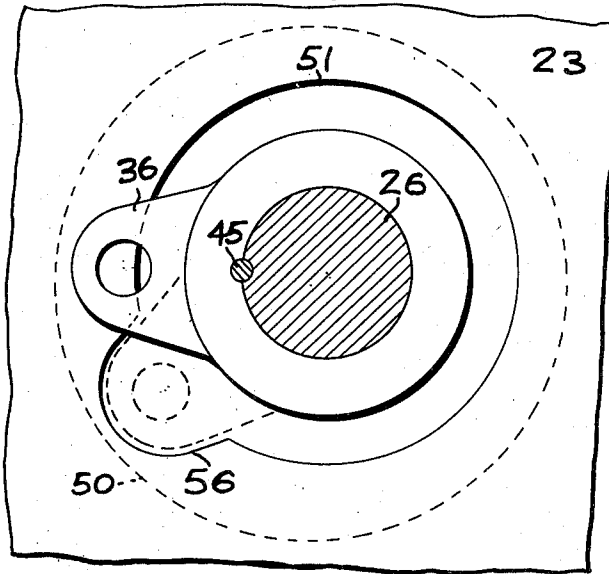
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Fig. 3



Inventor

Fig. 4

TORLEIF NORBOM

By *Malcolm F. Gannett*
Attorney

July 13, 1937.

T. NORBOM

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Fig. 5

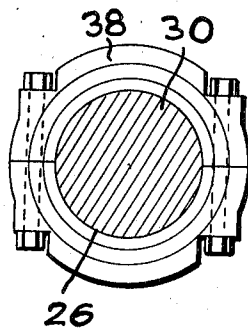
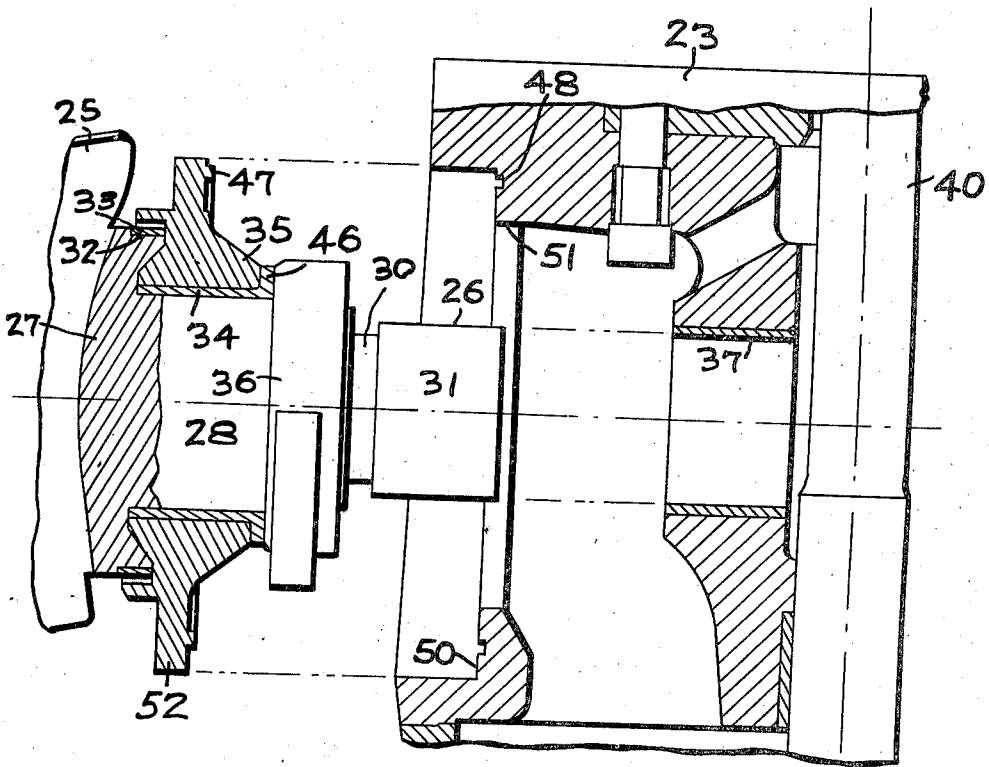


Fig. 6

Inventor
TORLEIF NORBOM

By *Malcolm D. Sammett*
Attorney

UNITED STATES PATENT OFFICE

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HYDRAULIC TURBINE

Torleif Norbom, York, Pa., assignor to S. Morgan Smith Company, York, Pa., a corporation of Pennsylvania

Application September 17, 1936, Serial No. 101,327

3 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 the specific manner of mounting the blades in the runner hub.

15 An object of the invention is to provide improved means for journaling the blades in the runner hub of an adjustable blade hydraulic machine so that the blades can be easily and quickly assembled and disassembled.

20 Another object of the invention is to provide detachable main bearings for the runner blades of an adjustable blade hydraulic machine.

25 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.

30 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:—

35 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;

40 3—3 of Fig. 2;

45 Fig. 4 is an elevation of the outer wall of the runner hub showing one of the openings for a blade, the blade and parts associated with the trunnion thereof being omitted;

Fig. 5 is a section of a portion of the hub shown in Fig. 2, showing the manner of assembling or disassembling one of the runner blades; and

50 Fig. 6 is a transverse section taken on the line 6—6 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 hub of the runner 23 is fixed to the lower end of a hollow or tubular shaft 24. The upper end of shaft 24 is connected to the generator shaft, as shown in Fig. 1.

A suitable number of blades 25 are rotatably supported in the hub of the runner 23 and project radially therefrom.

The inner end of each blade 25 is formed with a trunnion 26, composed of an outer portion 27, intermediate portions 28, 29, and 30, and an inner portion 31.

5 The outer trunnion portion 27 is formed with an annular recess or groove 32 for the reception of a band 33, the purpose of which will be hereinafter more fully described.

10 The trunnion portion 28 is mounted in a bushing 34 carried by a removable bearing 35 to be hereinafter more fully described.

Mounted on the trunnion portion 29 is an arm or lever 36 of the blade operating mechanism.

15 The inner end portion 31 of the trunnion is mounted in a bearing 37 carried by the hub of the runner 23, and encircling the portion 30 of the trunnion is a thrust collar 38.

Means are provided for simultaneously rotating all of the blades 25 and for maintaining them in equal angular relationship, such means comprising an operating rod 40 mounted within the hollow shaft 24 of the turbine and extending downwardly of the hub of the runner 23.

20 Fixed to the lower end of the rod 40 is a cross head 41, which is connected by links 42 to the arms or levers 36 heretofore referred to.

25 The upper end of the operating rod 40 is fixed to the piston of a servomotor 43 which is mounted in the runner shaft 24 adjacent to the point where the runner shaft is connected to the shaft of the generator 12 (see Fig. 1).

30 Operation of the servomotor 43 reciprocates the operating rod 40 downwardly and upwardly and such movements of the operating rod are transmitted by cross head 41 through the links 42 to the levers 36, thereby rotating the runner blades 25 in the manner fully described in the McCormack Patent No. 1,937,772 heretofore referred to.

35 In some instances it is desirable to mount the runner blades 25 in the hub of the runner 23 so that the blades can be readily disassembled without the necessity of removing the arms or levers 36 therefrom. In some prior installations 40 the arms or levers 36 have been made in sections. That is to say, the hubs of the arms or levers 36 which encircle the trunnions 26 of the runner blades have been split, so that after 45 the blades have been mounted in the hub, the levers 36 could be assembled on to the trunnions of the blades. Where the head is very high the split lever is not strong enough and a solid or one piece lever must be used.

50 According to the present invention, when the parts of each blade are being assembled, the portions 27 and 28 of the trunnion 26 have mounted thereon the bushing 34 and the bearing 35, respectively, while the blade is disassembled from the hub of the runner 23.

55 The arm or lever 36 is next mounted on the portion 29 of the trunnion 26, said lever being rigidly connected to the trunnion by means of a key 45, as shown in Fig. 3.

60 The thrust collar 38 is next mounted on the portion 30 of the trunnion 26. Since the internal diameter of collar 38 is less than the diameters of the portions 29 and 31 of the trunnion, said collar may be formed of two semicircular sections, as shown in Fig. 6, which sections are 65 bolted together.

70 The bearing 35 is formed of an annular casting having a main or central portion made comparatively thick in cross section, as shown in Figs. 2 and 5, for the reception of the bushing 34.

The bushing 34 is coextensive with the thick central portion of the bearing 35, and the inner end of said bushing is formed with an outwardly extending flange 46 which is disposed between the inner wall of the bearing 35 and the front wall of the lever 36.

5 During the operation of the machine, rotation of the runner 23 causes considerable end thrusts to be imparted to the trunnions of the blades 25. These end thrusts are taken up by the collars 38 and the flanged portions 46 of the bushings 34.

10 Since the hub of the runner 23 is hollow and is filled with a suitable lubricating oil, friction will be reduced to a minimum between the outer walls of the levers 36 and the flanges 46, so that the levers 36 will operate freely.

15 The inner face of the outer portion of the bearing 35 is formed with an annular rib or bead 47 which is mounted in a correspondingly formed groove 48 formed in the inner vertical wall 49 of an annular recess or depression 50 on the exterior of the runner hub. The recess 50 surrounds an opening 51 in the hub for each trunnion 26.

20 As shown in Fig. 4, the rib or bead 47, groove 48 and opening 51 are formed concentrically with respect to the axis of the trunnion 26, while the wall 49 is eccentrically disposed therewith.

25 The outer periphery 52 of the bearing 35, around the rib or bead 47, is also made eccentric with the axis of the trunnion 26, as shown in Fig. 2, so that the bearing 35 will fit snugly within the recess 50.

30 The bearing 35 is detachably fixed in the runner hub by means of a plurality of tap bolts 53 which are mounted in alined openings 54 and 55, formed respectively in said bearing and said hub (see Figs. 2 and 4).

35 As shown in Fig. 3, lever 36 projects outwardly from the trunnion 26 a distance greater than the diameter of the opening 51. Therefore, in order to permit the insertion or removal of the trunnion 26 with the lever 36 thereon through the opening 51, a notch or slot 56 is formed in the edge of the opening 51.

40 The notch or slot 56 is disposed at an angle from a horizontal plane through the center line of the trunnion 26. In the present instance, slot 56 is shown as being disposed below the normal intermediate or horizontal position of the lever 36 (see Fig. 3).

45 In order that the slot 56 will be covered by the bearing 35 when the parts are assembled, the eccentrically disposed recess 50 heretofore referred to is formed so as to enclose the slot 56 so that when the bearing 35 is mounted in the hub the outer peripheral portion thereof will overlie the slot 56 (see Figs. 3 and 4).

50 Enclosing the outer portion of the periphery of the bearing 35, that is to say, that portion of said bearing which extends beyond the portion 27 of the trunnion 26, is a sealing ring 57.

55 A suitable packing 58 is interposed between the sealing ring 57 and the band 33, so as to prevent leakage of oil outwardly from the hub of the runner 23, as well as seepage of water into the hub, through the joint between the trunnion 26 and the hub.

60 The sealing ring 57 is detachably connected to the bearing 35 by means of tap bolts 59, as shown in Fig. 2.

65 From the foregoing description it will be noted that the blades 25 can be readily assembled or 70

disassembled with the arms or levers 36 mounted on the trunnions 26. In prior constructions where the levers were first placed within the hub and then mounted on the trunnions, it was necessary to heat the levers and then insert the trunnions and let the levers cool in place. In the event it was necessary to dismantle the blades from the runner, it was necessary to split the levers so as to remove the same from the trunnions before the blades could be dismounted. With the runners constructed with the removable bearings 35, the blades can be easily dismounted with the levers attached thereto.

As shown in Fig. 3, the normal intermediate position of the levers 36 is in a substantially horizontal plane with respect to the axis of rotation of the blades.

When it is desired to either insert or withdraw the trunnions 26 through the openings 51, the blades 25 are turned to the position in which the arm of lever 36 registers with the slot 56 (see dotted lines Fig. 3).

In the case when a blade is being mounted in the hub after the trunnion with the bearing 35 and lever 36 thereon has been inserted through the opening 51, the blade is turned to move the lever 36 upwardly to a substantially horizontal position, (see Fig. 3). After which the lever 36 can be connected to the upper ends of the links 42, by pin 60. The other ends of the links 42 are connected by a pin 61 to an eye bolt 62 carried by the cross head 41.

Due to the pivotal connection between the lower ends of the links 42 and the bolt 62 afforded by pin 61, when it is desired to remove a blade 25, the upper ends of the links 42 can be detached from the lever 36 by removing pin 60, and then the blade will be free to swing so that the lever 36 can be positioned to pass freely through the slot 56 when the trunnion 26 is withdrawn through opening 51.

In this way the runner blades can be quickly and easily assembled or disassembled with the lever 36 mounted thereon, and a sturdy construction is provided by the large removable bearing 35.

Having thus described my invention, what I claim is:—

1. A hydraulic machine comprising a runner having a hollow hub, a plurality of rotatable blades, each of said blades having a trunnion extending into the hub; means for simultaneously operating the blades comprising a rod and means for reciprocating the same, a cross head connected to said rod, a lever mounted on

an intermediate portion of the trunnion of each blade and projecting laterally therefrom, and a link connecting the lever of each blade with said cross head; an opening formed in the outer wall of said hub through which the trunnion of each blade extends, said lever projecting outwardly from said trunnion a distance greater than the diameter of said opening, a slot formed in said opening to permit the insertion or withdrawal of the trunnion through said opening when said lever is mounted on the trunnion, a bearing mounted on a portion of said trunnion outwardly with respect to said lever, a recess formed in the outer wall of the hub around the trunnion opening therein, said bearing having an outer peripheral portion mounted in said recess and enclosing said slot, means for detachably connecting said bearing with the hub of the runner, and a packing encircling the bearing for sealing the joint between said bearing and the hub.

2. A hydraulic machine comprising a runner having a hollow hub, a plurality of rotatable blades, each of said blades having a trunnion extending into the hub, means within the hub for simultaneously operating the blades and including a lever fixed to the trunnion of each blade and projecting laterally therefrom, an opening formed in the outer wall of the runner hub through which each blade trunnion with a lever mounted thereon can be inserted and withdrawn, a bearing also mounted on the outer portion of the trunnion between the lever and the blade proper, a recess formed in the outer wall of the hub for said bearing, and means for detachably connecting said bearing with the hub of the runner.

3. A hydraulic machine comprising a runner having a hollow hub, a plurality of rotatable blades, each of said blades having a trunnion extending into the hub through an opening formed in the outer wall of the hub, mechanisms within the hub for simultaneously operating the blades, said mechanism including a lever fixed to the intermediate portion of the trunnion of each blade, a bearing mounted on the portion of the trunnion between the lever and the blade proper, means for preventing movement of the bearing longitudinally of the trunnion, and means for detachably connecting the bearing with the hub of the runner, so that a blade can be assembled or disassembled with a bearing and lever mounted on its trunnion.

TORLEIF NORBOM. 55