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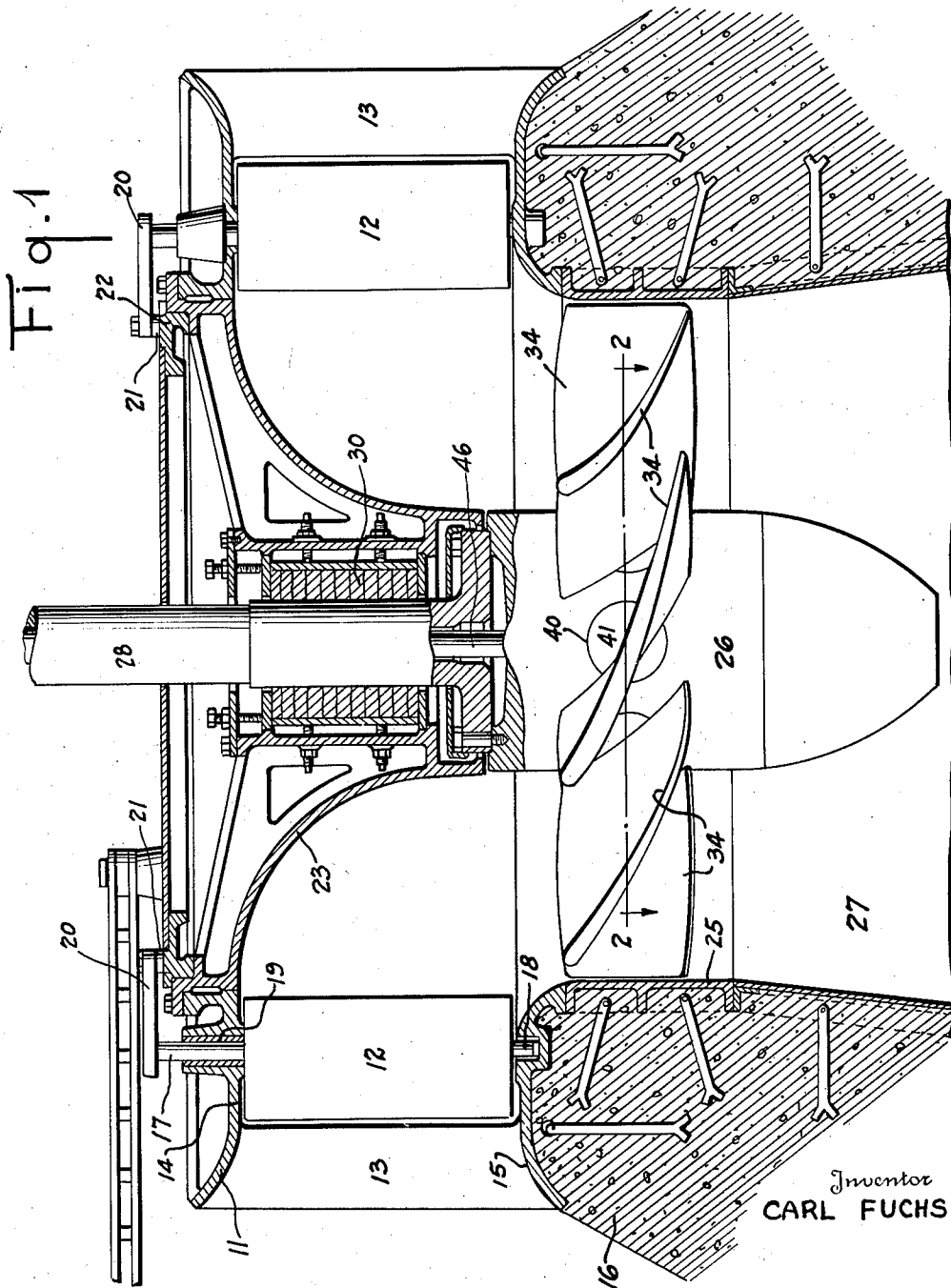
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2,055,196

HYDRAULIC MACHINE

Filed Oct. 15, 1935

3 Sheets-Sheet 1



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## HYDRAULIC MACHINE

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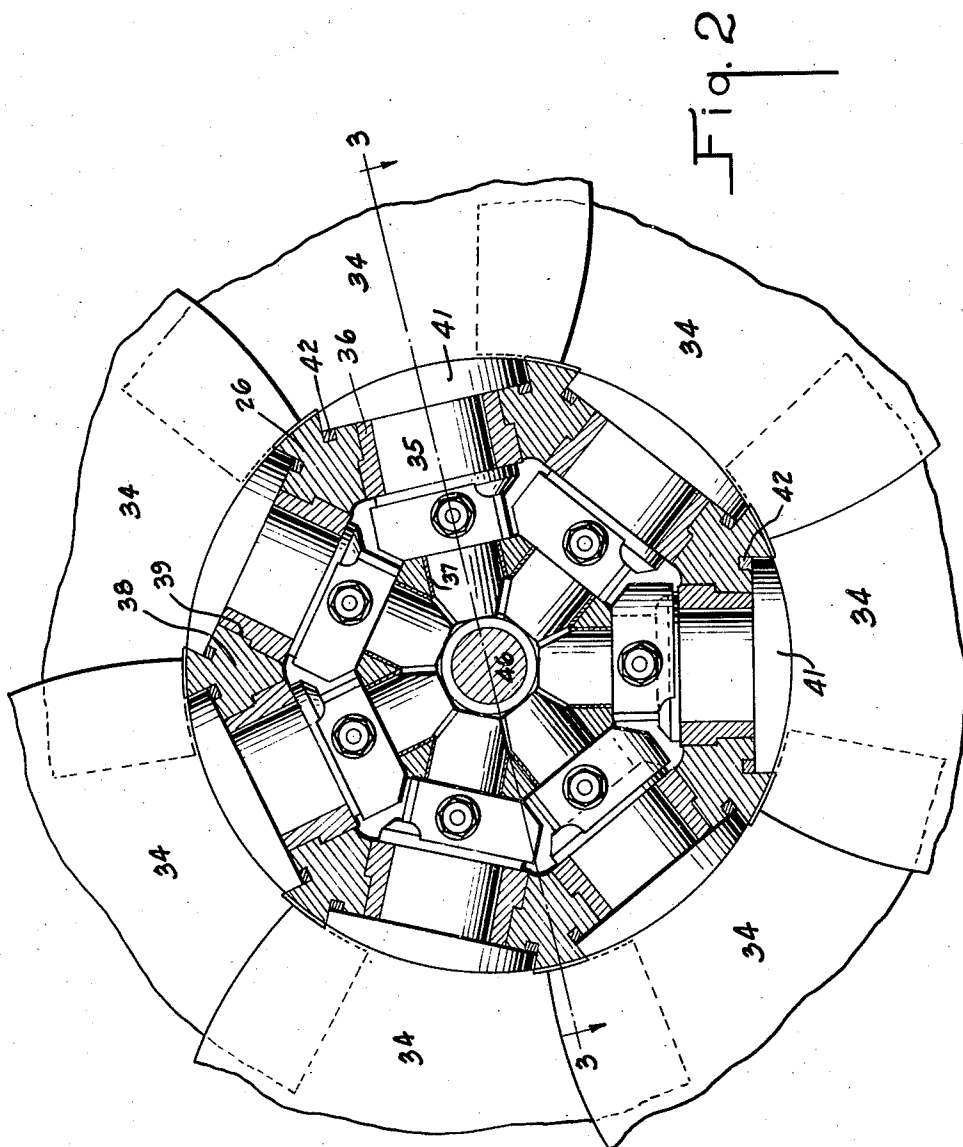


Fig. 2

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Fig. 3

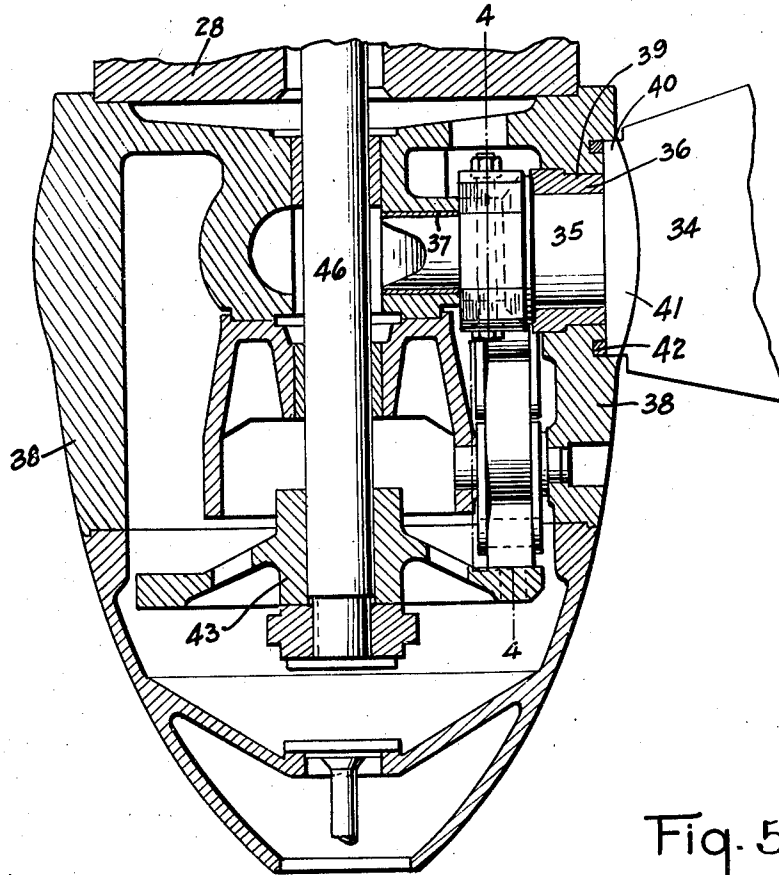


Fig. 4

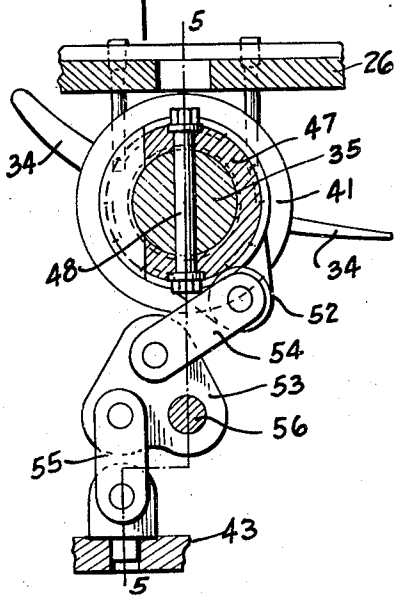
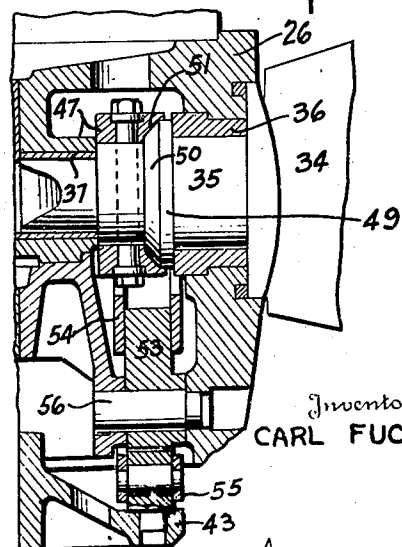


Fig. 5



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## UNITED STATES PATENT OFFICE

2,055,196

## HYDRAULIC MACHINE

Carl Fuchs, Mergelstetten, near Heidenheim-on-the-Brenz, Germany, assignor to J. M. Voith, Heidenheim-on-the-Brenz, Germany, a copartnership composed of Walther Voith, Hermann Voith and Hanns Voith

Application October 15, 1935, Serial No. 45,041

4 Claims. (Cl. 253—148)

This invention relates to improvements in hydraulic machines of the type wherein the blades of the runner of such type of machines are adjustable to vary the angle and the area of the water opening through the runner.

An object of the invention is to provide an improved blade operating mechanism within the hub of the runner of hydraulic machines of the above type.

Another object of the invention is to provide an improved mechanism for adjusting the position of the runner blades, so that a comparatively small hub for the runner can be employed for containing the mechanism when an unusually large number of blades are employed.

Another object of the invention is to provide an improved mechanism for operating the blades of an adjustable blade hydraulic machine in which leverage mechanism of novel construction is employed for actuating the runner blades.

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 side elevation partly in section of a hydraulic turbine having a runner of the adjustable blade type constructed according to the present invention;

Fig. 2 is a horizontal section through the hub of the runner taken on the line 2—2 of Fig. 1;

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 2;

Fig. 4 is a vertical section taken on the line 4—4 of Fig. 3; and

Fig. 5 is a vertical section taken on the line 5—5 of Fig. 4.

Referring to the drawings and especially to Fig. 1, the type of turbine shown in the illustrated embodiment of the invention comprises a speed ring 11, in which are mounted an annular series of wicket gates 12 and guide vanes 13.

The wicket gates 12 are adapted to be rotated simultaneously into different angular positions to control the flow of water into the turbine.

The guide vanes 13 are so disposed relatively to the wicket gates 12 as to intercept the water flowing into the turbine and direct the same towards the openings between the wicket gates.

The speed ring 11 is composed of an upper flange 14 and a lower flange 15, which flanges are rigidly held in spaced relation relatively to each other by the guide vanes 13.

The turbine may be mounted in an open flume with the lower flange 15 of the speed ring 11 set in a concrete setting 16.

Each wicket gate 12 is pivotally mounted in the speed ring 11 by means of a shaft or stem 17 which extends through the wicket gate. The lower end of the shaft 17 is mounted in a bearing 18 formed in the flange 15, and the upper end of said shaft projects upwardly through a bearing or bushing 19 mounted in the flange 14.

The upper end of each shaft 17 is provided with a gate operating arm 20 which is fixed to said shaft. The arms 20 are connected by links 21 to a gate adjusting ring 22. The gate adjusting ring is adapted to be operated in a well known manner so as to simultaneously rotate the wicket gates.

The upper portion of the turbine is closed by an annular crown plate 23 which is disposed within the speed ring 11.

Mounted in the concrete setting 16 and constituting a downward extension of the speed ring 11 is a throat ring 25 which forms an axially directed chamber in which the runner 26 operates.

Beneath the runner 26 is the usual draft tube 27 through which the water which passes through the runner is discharged.

The hub of the runner 26 is fixed to the lower end of a hollow or tubular shaft 28 which is journaled in a suitable bearing 30 mounted in the crown plate 23 of the turbine.

A suitable number of blades 34 are rotatably supported in the hub of the runner 26 and project radially therefrom. In the present instance 7 blades are shown (see Fig. 2).

The inner end of each blade 34 is formed with a trunnion 35 which is journaled in bearings or bushings 36 and 37 supported in the hub. The construction is such that the blades are rotatable into different angular relationships with the axis of the runner.

The hub of the runner 26 is made hollow in order to accommodate the runner blade operated mechanism and said hub has an outer wall 38 formed, at spaced intervals, with openings 39 to receive the bushings 36.

The outer portion of each opening 39 is enlarged as indicated at 40 (Figs. 2 and 3) in order to receive the hub 41 formed on the inner portion of each blade 34, the joint between the hub

of the blade and the hub of the runner being suitably sealed by means of packing 42.

Means are provided for simultaneously rotating all of the blades 34 and for maintaining them in equal angular relationship, such means comprising preferably a leverage mechanism operatively connected to the trunnion of each blade and to a cross head 43 fixed to the lower end of an operating rod 46. The rod 46 extends upwardly through the hollow runner shaft and is adapted to be operated by well known mechanism, such for instance as that disclosed in United States Patent No. 1,937,772 dated December 5, 1933, for Hydraulic turbine, invented by Daniel J. McCormack.

In constructing hydraulic machines of the type herein disclosed, when it is desired to construct a runner of exceedingly large dimensions for use under a high head, in order to utilize a comparatively small hub for the runner, it is necessary to employ compact mechanism within the hub of the runner for operating the runner blades, especially when the runner is provided with more than four blades.

According to the present invention, the trunnion 35 of each blade 34 is formed with a collar 47 which is fixed or otherwise keyed to the trunnion by means of a bolt 48. By utilizing bolt 48 the collar 47 can be readily disassembled from the trunnion of the blade, as will be understood. The bolt 48 only transmits the force necessary for the blade movement and can accordingly be kept small for the sake of reducing the amount of space within the hub to a minimum.

At a point adjacent to the part of the trunnion 35 carrying collar 47, the trunnion is enlarged, as at 49, so as to provide a shoulder adapted to bear against the inner end of bushing 36 and transmit end thrusts to said bushing.

The inner surface of the enlarged portion 39 of each trunnion 35 is made inclined, as indicated at 50, Fig. 5, and the adjacent portion of collar 47 is correspondingly formed inclined as indicated at 51, so that the collar will snugly fit against the enlarged portion 49.

Due to the restricted amount of space between the trunnions 35, especially the portions of said trunnions between bearings 36 and 37, there is insufficient space to accommodate large collars of annular or ring form. Therefore, since the forces are transmitted through the bolts 48 the collars 47 are made substantially C-form and only encircle the trunnions sufficiently to receive the bolts 48, as shown in Fig. 4. By constructing the collars in this manner, when all of the collars are assembled on the trunnions, sufficient clearance space will be had to permit free movement of the parts within the hub as shown in Fig. 2.

In the present instance the trunnion 35 of each blade is operatively connected to the cross head 43 by leverage mechanism including an arm 52 projecting from the collar 47 and connected to an angle or bell crank lever 53 by links 54, the lever 53 in turn being connected to the cross head 43 by links 55. Lever 53 is pivotally mounted in the hub of the runner 26 by a pin 56, as shown in Fig. 5.

The construction and arrangement of the parts of the leverage mechanism is such that very little space is required for the links and levers. This is due to the fact that, by employing an angle or bell crank lever and mounting the same in the hub beneath the trunnion 35 of each blade, as shown in Fig. 4, the lever arm 52 can be so

disposed as to project downwardly beneath the collar 47 and be connected to the adjacent portion of the angle or bell crank lever 53 by comparatively short links 54. Also, the cross head 43 may be connected to the adjacent portion of the angle or bell crank lever 53 by comparatively short links 55, which links are, as shown in Fig. 4, substantially vertically disposed beneath the trunnion on the side thereof opposite to the arm 52.

Heretofore it has been the practice to arrange the lever arms on the trunnions of the blades in a position perpendicular to the axis of rotation of the blades, and to connect said arms to the cross head by links disposed substantially parallel to the vertical axis of the runner.

When the lever arms are disposed perpendicular to the trunnions of the blades, obviously, they occupy considerable space within the runner hub, and hence when a relatively large number of blades are employed, say, five, six or more, it was necessary to substantially increase the diameter of the hub of the runner so as to accommodate the runner blade operating mechanism. Such construction decreased the throat area of the turbine and consequently reduced the area in the turbine through which the water flows a corresponding amount so as to decrease the ability of the turbine to pass the water and thereby unfavorably influence the efficiency and also increase the cost of constructing the turbine.

Furthermore, the perpendicular location of the lever arms caused certain difficulties in design, particularly for turbines under high head, where the regulating forces are great, and to overcome these defects it was necessary to increase the sizes of the parts constituting the runner blade operating mechanism within the hub.

By the present invention, the above difficulties are overcome, because by using a lever arm fastened to the trunnion of the runner blade which is arranged substantially parallel to the axis of rotation of the runner, and by using an angle or bell crank lever between the lever arm and the cross head, the axial movement of the cross head is changed into a movement perpendicular to the runner axis.

Having thus described my invention, what is claimed is:—

1. A runner for hydraulic machines comprising a hub, a plurality of blades having trunnions rotatably mounted in the hub, a lever arm secured to the trunnion of each blade and depending at an angle downwardly therefrom, an angle lever pivotally mounted within the hub beneath the trunnion of each blade, a link connecting said lever arm with said angle lever, a cross head mounted for movement parallel to the axis of rotation of the runner, and a link connecting said angle lever with said cross head.

2. A runner for hydraulic machines comprising a hub, a plurality of blades having trunnions rotatably mounted in the hub, a lever arm secured to the trunnion of each blade and depending at an angle downwardly therefrom, a bell crank lever pivotally mounted within the hub beneath the trunnion of each blade, a link connecting said lever arm with said bell crank lever, a cross head mounted for movement parallel to the axis of rotation of the runner, and a link connecting said bell crank lever with said cross head.

3. A runner for hydraulic machines comprising a hub, a plurality of blades having trunnions rotatably mounted in inner and outer bearings

in the hub, an enlargement formed on each trunnion and bearing against its outer bearing, a C-shaped collar detachably mounted on each trunnion and bearing against said enlargement, 5 a lever arm projecting downwardly from said collar, a lever pivotally mounted in the hub and disposed underneath each trunnion, a link connecting said lever with said lever arm, said link underlying the trunnion, a reciprocating cross 10 head mounted within the hub beneath said trunnions, and a link underlying the trunnion and connecting each lever with said cross head.

4. A runner for hydraulic machines comprising a hub, a plurality of blades having trunnions rotatably mounted in the hub, a cross head reciprocally mounted within the hub, and means 5 operatively connecting said trunnions and said cross head for transmitting movements of said cross head to said blades, including a lever pivotally mounted in said hub and having arms connected respectively to said trunnion and to said cross head.

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