March 19, 1929. W. H. LIEBER 1,706,359

HYDRAULIC MACHINE

Original Filed April 10. 1922

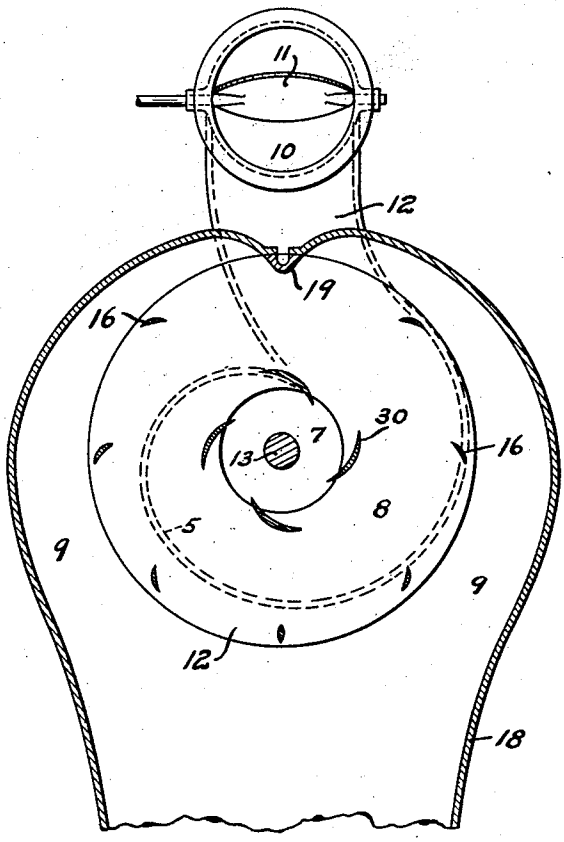


Fig. 2

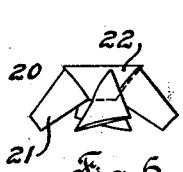


Fig. 6

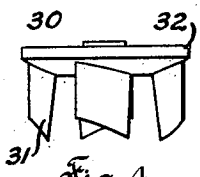


Fig. 4

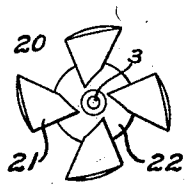


Fig. 7

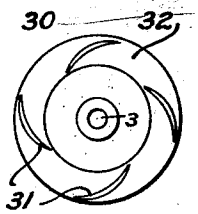


Fig. 5

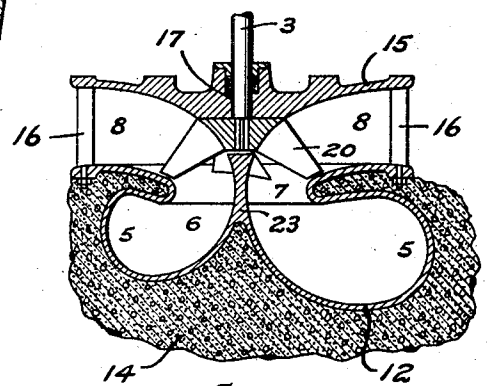


Fig. 3

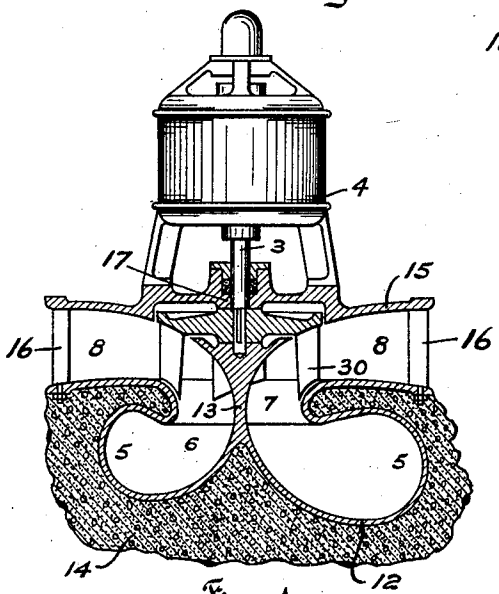


Fig. 1

Inventor

W. H. Lieber

by

Attorney

Patented Mar. 19, 1929. 1,706,359

UNITED STATES PATENT OFFICE.

WILLIAM H. LIEBER, OF WAUWATOSA, WISCONSIN, ASSIGNOR TO ALLIS-CHALMERS MANUFACTURING COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF DELAWARE.

HYDRAULIC MACHINE.

Original application filed April 10, 1922, Serial No. 551,087. Divided and this application filed December 10, 1924. Serial No. 754,915.

This invention relates generally to improvements in hydraulic machines, and relates more specifically to improvements in the construction and operation of hydraulic energy converting apparatus such as hydraulic turbines and pumps.

A general object of the invention is to provide a hydraulic machine which is simple in construction and efficient in operation.

Some of the more specific objects and advantages of the present improvement are as follows:

To provide an exceedingly simple, compact and efficient hydraulic machine of the rotary type.

To provide a hydraulic machine of relatively great capacity which is compact in construction, and in which undesirable obstructions to flow of operating fluid are avoided.

To provide a vertical hydraulic installation in which the thrust induced by the fluid flowing through the rotor is utilized to counter balance the weight of the rotating parts, thereby eliminating necessity of providing costly thrust bearings.

To provide an improved turbine operable under relatively low heads and at relatively high specific speeds, in which the costs of installation and operation are minimized.

To provide a hydraulic energy converting machine comprising a minimum number of elements or parts all of which are conveniently accessible for inspection or removal, and which may be quickly assembled and dismantled.

To provide a hydraulic turbine unit in which retardation of the flow due to the action of centrifugal forces, is substantially eliminated, and in which such action is utilized to the fullest extent in order to augment the flow through the unit.

To provide improved rotor structure for hydraulic machines especially operable at high specific or characteristic speeds.

To provide other improvements in the construction and operation of the hydraulic machines such as rotary pumps and turbines.

The present application is a division of application Serial Number 551,087, filed April 10, 1922, and any novel features of hydraulic machine construction disclosed but not specifically claimed herein form the subject of the parent application.

A clear conception of several embodiments of the invention and of the operation of machines constructed in accordance therewith, may be had by referring to the drawing accompanying and forming part of this specification, in which like reference characters designate the same or similar parts in the various views.

Fig. 1 is a central vertical section through a hydraulic turbine unit embodying a rotor of the purely radial flow type, in which the actuating fluid enters in the form of a vortex advancing axially within and outwardly through the rotor.

Fig. 2 is a horizontal section looking downward into the hydraulic turbine unit illustrated in Fig. 1, the section being taken through the turbine rotor and the discharge passage thereof.

Fig. 3 is a central vertical section through a hydraulic turbine unit embodying a rotor of the mixed flow type, in which the components of flow of the fluid through the rotor are both radial and axial.

Fig. 4 is a side elevation of a radial outward flow rotor formed to produce relatively high specific or characteristic speed.

Fig. 5 is a bottom view of the radial outward flow rotor disclosed in Fig. 4.

Fig. 6 is a side elevation of a mixed flow rotor formed to produce relatively high characteristic or specific speed.

Fig. 7 is a bottom view of the mixed flow rotor disclosed in Fig. 6.

Each of the hydraulic turbine units illustrated in Figs. 1, 2 and 3 comprises generally a lower casing 12 forming a vane free spiral inlet chamber 5, a vane free transition space 6, and an axially upwardly directed vane free conduit portion 7 communicating with the chamber 5; an upper casing portion 15 cooperating with substructure to provide an annular vane free diffuser or flow decelerating passage 8; a turbine rotor 30, 20 located between the communicating conduits 5, 8; a vertical main shaft 3 having its lower end rigidly attached to the turbine rotor; and a dynamo electric machine or generator 4 having a rotary element direct connected to the upper end of the main shaft 3. The spiral inlet conduit 5 which is embedded in the concrete foundation 14, is adapted to receive operating fluid from a source of supply through a vertically disposed inlet pipe 10 having

controlling means such as a butterfly valve 10 therein, and communicating with the inlet chamber 5 in a generally tangential direction as shown in Fig. 2. The spiral inlet chamber 5 communicates inwardly with the symmetrical annular passage or transition space 6 having a central symmetrical conical core 13, 23 therein and providing a vane free guiding and conducting passage for gradually changing the flow of the fluid from inward to axial. The upper casing portion 15 may be spaced and supported from the lower turbine structure by means of annular series of struts 16 located beyond the working passages and formed as guide vanes in order to produce least obstruction to the flow of the fluid delivered from the chamber 8. The upper casing 15 is also formed to provide a guiding surface adjacent to the turbine rotor and the central portion 17 of the casing 15 provides a bearing for the main shaft 3 closely adjacent to the turbine rotor. The periphery of the diffusing chamber 8 communicates with a conducting casing 18 forming a discharge chamber 9 which communicates with a tail-race in the usual manner. One side of the chamber 8 may be provided with a splitter 19 for dividing the flow of the decelerated fluid discharged from the chamber 8 into the chamber 9. By removing the upper casing 15 the turbine rotor 30, 20 is freely vertically removable and all interior portions of the several casings are readily accessible.

Referring specifically to the improved form of rotor disclosed in Figs. 4 and 5, the rotor 30 is of the purely radial outward flow type and comprises an annular series of axially extending parallel vanes 31 secured to a disk-like hub 32, the vanes 31 illustrated having free lower extremities as shown. The vanes 31 may be so spaced that the adjacent edges of successive vanes do not overlap when the rotor is viewed in a direction transversely of its axis. The angularity of the vanes is such that the working surfaces are disposed transversely of the direction of advancement of the individual stream lines of the operating fluid passing through the rotor. The rotor 30 is adapted to deliver its discharge into the adjacent diffusing chamber 8 in planes substantially perpendicular to the turbine axis. With the fluid thus delivered, centrifugal force induced by the whirling mass assists in the delivery of the fluid to the diffusing chamber 8, thus augmenting to a maximum the quantity of fluid passing through the machine.

Referring specifically to the turbine rotor disclosed in Figs. 6 and 7, the rotor 20 is of the mixed flow type and comprises an annular series of dove-tail shaped vanes 21 secured to a conoidal hub 22 and extending laterally and outwardly away from the hub, the vanes 21 having free outer ends as shown. The vanes 21 are so spaced that the adjacent edges of successive vanes do not overlap when such vanes are projected upon a plane perpendicular to the rotor axis. The angularity of the vanes 21 is such that the working surfaces are disposed transversely of the direction of advancement of the individual stream lines of the vortex of operating fluid produced by the chamber 5. The rotor 20 is adapted to deliver its discharge in the adjoining diffusing chamber 8 at an angle of approximately 45° relatively to the turbine axis. By thus delivering the fluid, centrifugal force induced in the whirling mass of liquid, assists in the delivery thereof to the diffusing chamber 8 thus augmenting the quantity of fluid passing through the machine.

During normal operation of a hydraulic turbine constructed in accordance with the present invention, operating fluid under pressure is admitted through the pipe 10 to the chamber 5, transition space 6, and axially extending conduit 7, and from thence outwardly through the rotor to the diffusing and decelerating chamber 8. The quantity of fluid thus admitted through the pipe 10 is controllable either automatically by means of a speed governor, or manually by manipulation of the butterfly valve 11, and the flow of fluid may be cut off entirely by closing the valve 11. In passing through the spiral inlet chamber 5 the entering fluid is caused to whirl due to the spiral formation of the lower casing 12, the direction of whirl being the same as the direction of rotation of the rotor. The fluid is delivered inwardly from the chamber 5 toward the rotor axis and into the transition space 6 wherein the direction of flow of the whirling fluid is changed from inward to axial by the conical core. The axially advancing whirling vortex of liquid then passes through the conduit 7 to the rotor wherein the velocity energy of the fluid is transformed into torque in the rotating shaft 3 and produces rotation at relatively high specific or characteristic speed. The fluid is delivered from the rotor with considerable residual whirl, directly into the outwardly extending diffusing chamber 8. In the chamber 8 the remaining velocity and whirl energy is substantially converted into pressure energy and the fluid is eventually discharged to the chamber 9 with practically no whirl energy left therein and with only sufficient velocity energy to produce a flow to the tail-race.

While passing through the rotor 20, 30 the centrifugal force induced in the whirling mass of fluid, assists in delivery thereof from the rotor. By providing rotors 20, 30 having non-overlapping properly shaped vanes, friction and other energy losses are reduced to a minimum. While the invention has been illustrated herein as applied to vertical hydraulic turbine installations only, it will be obvious that the features thereof are more generally applicable to hydraulic machines

of various types regardless of their disposition.

It should be understood that it is not desired to limit the invention to the exact details of construction and operation herein shown and described, for various modifications within the scope of the claims may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. A high speed hydraulic rotor comprising, a hub, and an annular series of vanes extending away from said hub and along and spirally with respect to the hub axis, the inlet and discharge edges of the successive vanes of said series being spaced apart circumferentially and said vanes being formed for outward delivery of liquid through said spaces when the rotor is operating as a turbine.

2. A high speed hydraulic rotor comprising, a hub, and an annular series of parallel vanes extending away from said hub and parallel to and spirally with respect to the hub axis, the inlet and discharge edges of the successive vanes of said series being substantially parallel to each other and being spaced apart circumferentially with respect to said axis, said vanes being formed for outward delivery of liquid through said spaces when the rotor is operating as a turbine.

In testimony whereof, the signature of the inventor is affixed hereto.

WILLIAM H. LIEBER.