May 22, 1928. 1,671,083

F. NAGLER

HYDRAULIC APPARATUS

Filed March 27, 1922

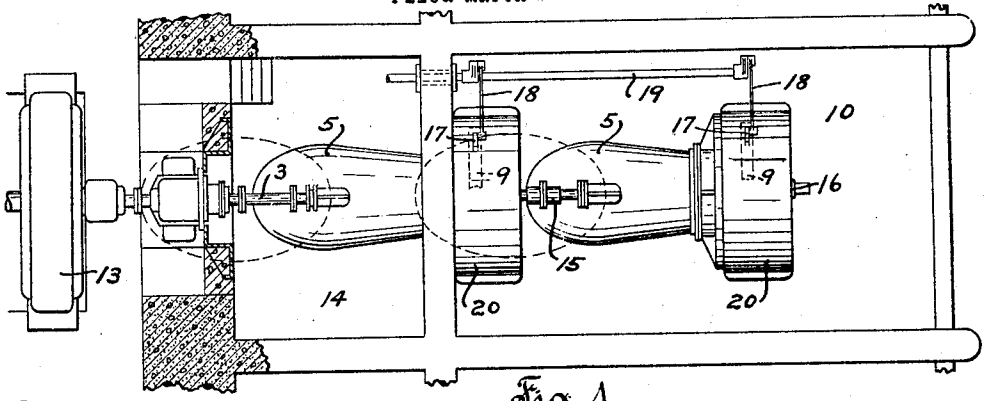


Fig. 1

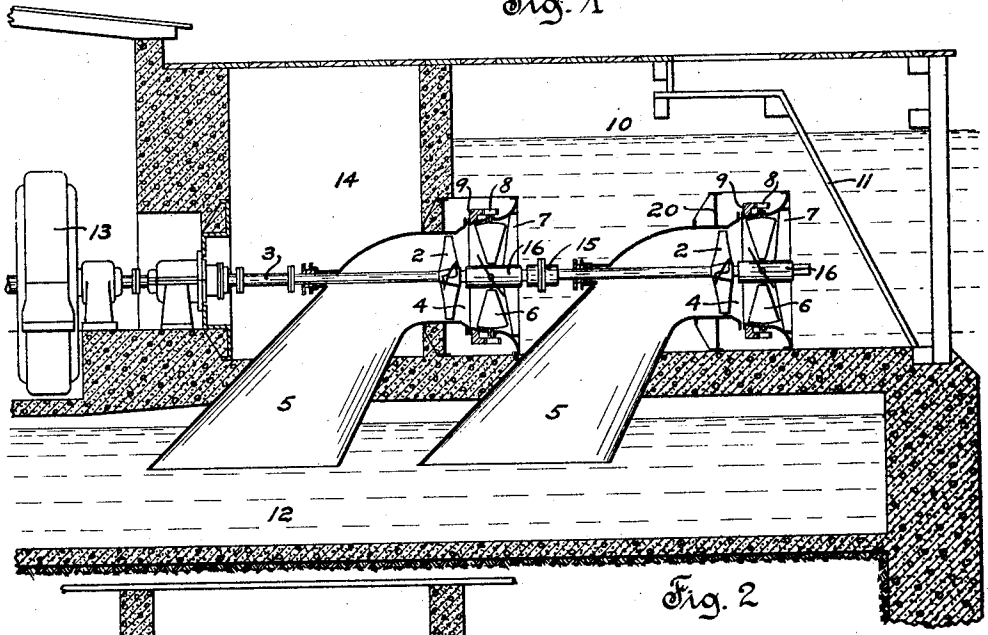


Fig. 2

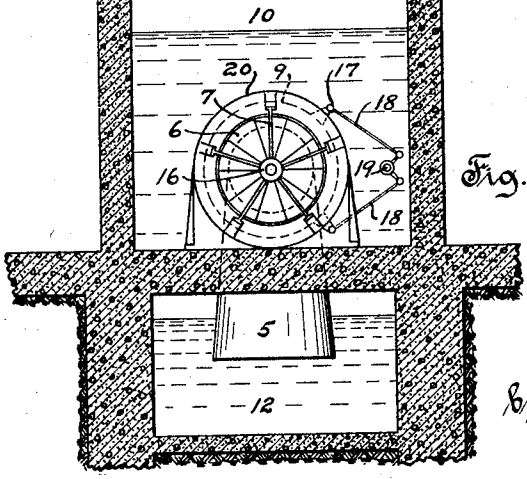


Fig. 3

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UNITED STATES PATENT OFFICE.

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HYDRAULIC APPARATUS.

Application filed March 27, 1922. Serial No. 546,994.

This invention relates in general to improvements in the art of converting hydraulic energy into torque in a rotating shaft, and relates more specifically to improvements in the construction and operation of hydraulic machines such as hydraulic turbines or pumps.

An object of the invention is to provide an improved hydraulic machine which is simple in construction and efficient in operation. Another object of the invention is to provide an improved arrangement of hydraulic machines whereby a plurality of such machines may be efficiently operated from a common source of fluid supply. A further object of the invention is to provide an improved hydraulic power installation in which most efficient hydraulic flow conditions are attained. Another object of the invention is to provide a hydraulic installation having maximum capacity for the space occupied by the unit. Still another object of the invention is to provide a hydraulic turbine unit any desired number of which may be associated to drive a single energy absorber. Another object of the invention is to provide a turbine unit which may be readily substituted for existing units to produce increased efficiency and energy conversion. A further object of the invention is to provide various improvements in the construction and operation of hydraulic turbines having high specific or characteristic speeds. These and other objects and advantages of the present invention will be apparent from the following description.

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

Fig. 1 is a part sectional plan view of an improved hydraulic turbine installation.

Fig. 2 is a longitudinal vertical section through the improved hydraulic turbine installation.

Fig. 3 is a transverse vertical section through the improved hydraulic turbine installation, the section being taken directly in front of one of the turbine units.

The hydraulic installation shown in the drawing, comprises in general a plurality of turbine units cooperating to drive a single energy absorber or dynamo-electric machine 13 through a common horizontal shaft 3. The turbine units receive their operating fluid from a common relatively narrow flume or penstock 10 through a grid 11, and deliver the fluid to a common tailrace 12.

Each of the turbine units comprises a purely axial-flow high-speed impeller 2 mounted upon a section of the horizontal shaft 3 and located within a purely axial-flow portion of the conduit formed by the turbine casing. The admission of fluid to the turbine impeller 2 is effected through a purely axial-flow conduit portion having an annular series of adjustable guide vanes 6 therein and having an axially extending vane free transition space 4 located between the guide vanes 6 and the vanes of the impeller 2. The portion of the turbine shaft 3 which is located directly adjacent to and in advance of each impeller 2, is supported in a bearing 16 which is rigidly associated with the outer turbine casing by means of radial ribs 7 located on the side of the adjustable vanes 6 remote from the impeller 2. The guide vanes 6 are mounted upon radial pivot shafts, the outer extremity of each of which is provided with a vane adjusting gear 8 meshing with an annular gear 9 rotatably supported by the outer turbine casing. The annular vane adjusting gear 9 is provided with ears 17 which are connected to a common regulating shaft 19 by means of connections 18 and intervening levers. The gears 8, 9 are protected from the accumulation of débris, by means of a suitable cover or casing 20. The discharge of each impeller 2 is directed axially adjacent to the impeller and communicates with a draft tube 5 the axis of which preferably extends at an angle less than 60° relatively to the horizontal, in order to avoid abrupt deflection of the discharge flow.

The turbine units are connected to each other by means of a coupling 15 and it will be obvious that with this arrangement any number of units may be associated with a common shaft 3. The regulating shaft 19 may extend into a chamber 14 and may be operated either manually or automatically by means of a governor in the usual manner.

During normal operation of the apparatus,

the guide vanes 6 are set in any convenient manner to admit the desired quantity of fluid in the same axial direction from the common penstock 10 to each of the turbine units. It will be obvious that the guide vanes 6 besides serving to throttle the inlet flow, deliver the fluid into the transition space 4 with an axially advancing whirling motion. The axially advancing stream in passing from the transition space 4 into the adjacent impeller 2 proceeds without shock since the transition space enables the fluid to assume a degree of whirl corresponding to the characteristics of the impeller vanes. In the impeller 2 a considerable portion of the whirl energy of the fluid is transformed into torque in the rotating shaft 3 and the fluid is eventually delivered from the impeller 2 around the gradual bend in the discharge tube and into the draft tube 5 where the remaining whirl and velocity energy is converted into pressure energy. By manipulating the adjusting shaft 19 either manually or automatically, the degree of whirl of the entering fluid and the quantity of fluid admitted, may be readily varied in accordance with the energy demand.

It will be obvious that by arranging the turbine units as illustrated, abrupt changes in the direction of flow are entirely avoided without restricting the quantity of flow to each of the several units. By thus avoiding abrupt changes in the direction of flow, high velocity of flow is attainable with minimum hydraulic energy loss. It will also be noted that any number of the units may be combined in parallel relation to each other to produce any desired amount of energy conversion, the number of units, however, depending upon the available fluid supply. These axial flow units may also be readily substituted for existing radial inlet units, without altering the inlet flumes, to produce relatively greater power, because the axial flow inlet permits attainment of higher inlet velocities. The extreme simplicity of the installation also augments the efficiency attainable due to elimination of obstructions and other structure tending to create eddies and friction losses.

The specific type of impeller herein illustrated forms no part of the present invention being illustrated and claimed in application, Serial No. 197,964, filed Oct. 20, 1917. It will also be obvious that the principles of the present invention are applicable to other types of hydraulic machines and that it is not essential to have the main shaft horizontally disposed. The guide vane adjusting mechanism may also be considerably altered without departing from the present invention.

It should be understood that it is not desired to limit the invention to the exact details of construction and of 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. In combination, a plurality of impellers through which fluid flows in the same axial direction, one of said impellers being located at the inlet side of the other, means forming purely axial flow conduits leading to said impellers, said conduits having independent communication with a common source of fluid supply, adjustable means for producing variable whirling motion of fluid admitted to at least one of said impellers, and a flow decelerator communicating with the discharge of at least one of said impellers.

2. In combination, a plurality of coaxial impellers through which fluid flows in the same axial direction, one of said impellers being located at the inlet side of the other and having its discharge located between said impellers, means forming purely axial flow conduits leading in the same direction toward said impellers, said conduit communicating with a common source of fluid supply, adjustable means for producing variable whirling motion of fluid admitted to at least one of said impellers, and a flow decelerator communicating with the discharge of at least one of said impellers.

3. In combination, a plurality of impellers through which fluid flows in the same axial direction, one of said impellers being located at the inlet side of the other and having its discharge located between said impellers, means forming purely axial flow conduits leading in the same direction toward said impellers, said conduits having independent communication with a common source of fluid supply, means for producing whirling motion of the fluid admitted to each of said impellers, and a flow decelerator communicating with the discharge of each of said impellers.

4. In combination, a plurality of coaxial impellers through which fluid flows in the same axial direction, one of said impellers being located at the inlet side of the other and having its discharge located between said impellers, means forming purely axial flow conduits leading in the same axial direction toward said impellers, said conduits having direct and independent communication with a common source of fluid supply, adjustable means for producing variable whirling motion of the fluid admitted to each of said impellers, and a flow decelerator communicating with the discharge of each of said impellers.

5. In combination, a plurality of impellers through which fluid flows in the same axial direction, means forming purely axial flow conduits leading from a common source of

fluid supply in the same direction directly toward each of said impellers, means for producing whirling motion of fluid admitted to each of said impellers, and a flow decelerator communicating with the discharge of each of said impellers, the decelerator of one of said impellers being located closely adjacent to the inlet of the other.

6. In combination, a plurality of coaxial axial flow impellers through which fluid flows in the same axial direction, a common shaft supporting all of said impellers, means forming purely axial flow conduits communicating with the inlet of each of said impellers, means forming a common source of fluid supply, communicating directly with each of said conduits, adjustable means located in each of said conduits for producing whirling motion of the fluid delivered to said impellers, and a flow decelerator communicating with the discharge of each of said impellers.

7. In combination, a plurality of impellers the discharge of each of which has a substantial component in the direction of impeller axis, a common shaft supporting all of said impellers, means for conducting fluid to said impellers in the same direction in parallel and from a common supply, and a flow decelerating tube communicating with the discharge of each of said impellers, each of said tubes being bent through an angle less than 60° relatively to the axis of said common impeller shaft.

8. In combination, a plurality of identical hydraulic machine associated with a common shaft, each of said machines comprising an impeller through which fluid flows in an axial direction only, means forming a purely axial flow conduit communicating with the inlet of said impeller, means located within said conduit for producing whirling motion of the fluid delivered to said impeller, and a flow decelerator communicating with the discharge of said impeller.

9. In combination, a plurality of identical hydraulic machines associated with a common shaft, means providing a common source of fluid supply communicating directly with the inlet of each of said machines, and means providing a common receiver communicating with the discharge of each of said machines, each of said machines comprising an impeller through which fluid flows in an axial direction only, means forming a purely axial flow conduit communicating with the inlet of said impeller, adjustable means located in said conduit for producing whirling motion of the fluid delivered to said impeller, and a flow decelerator comprising a tube bent through an angle less than 60° relatively to the axis of said shaft and communicating with the discharge of said impeller and with said receiver.

10. In combination, a pair of interconnected high speed turbine impellers through which fluid flows in the same direction, one of said impellers being located at the inlet side of the other, means forming a vane free transition space formed to permit free whirl of the entering fluid directly adjacent to the inlet of each impeller and communicating with a common source of supply, means for producing whirling motion of fluid admitted to at least one of said spaces, and a draft tube communicating with the discharge of at least one of said impellers.

11. In combination, a plurality of interconnected high speed turbine impellers through which fluid flows in the same axial direction, one of said impellers being located at the inlet side of the other, means forming a vane free transition space formed to permit free whirl of the entering fluid directly adjacent to the inlet of each impeller and communicating directly with a common source of supply, adjustable means for producing variable whirling motion of fluid admitted to each of said spaces, and a draft tube communicating with the discharge of each of said impellers.

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

FORREST NAGLER.