W. M. WHITE.

GOVERNOR.

APPLICATION FILED SEPT. 5, 1918.

1,369,863. Patented Mar. 1, 1921.

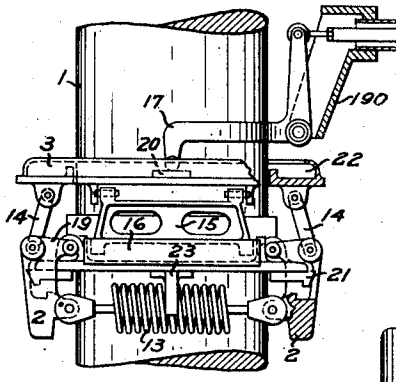


Fig. 2

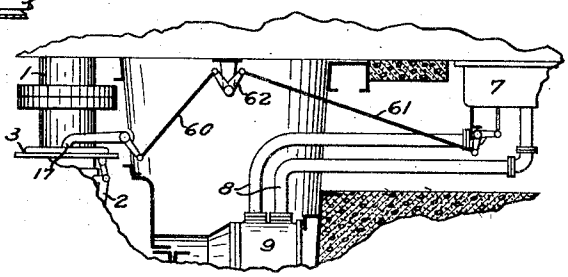


Fig. 3

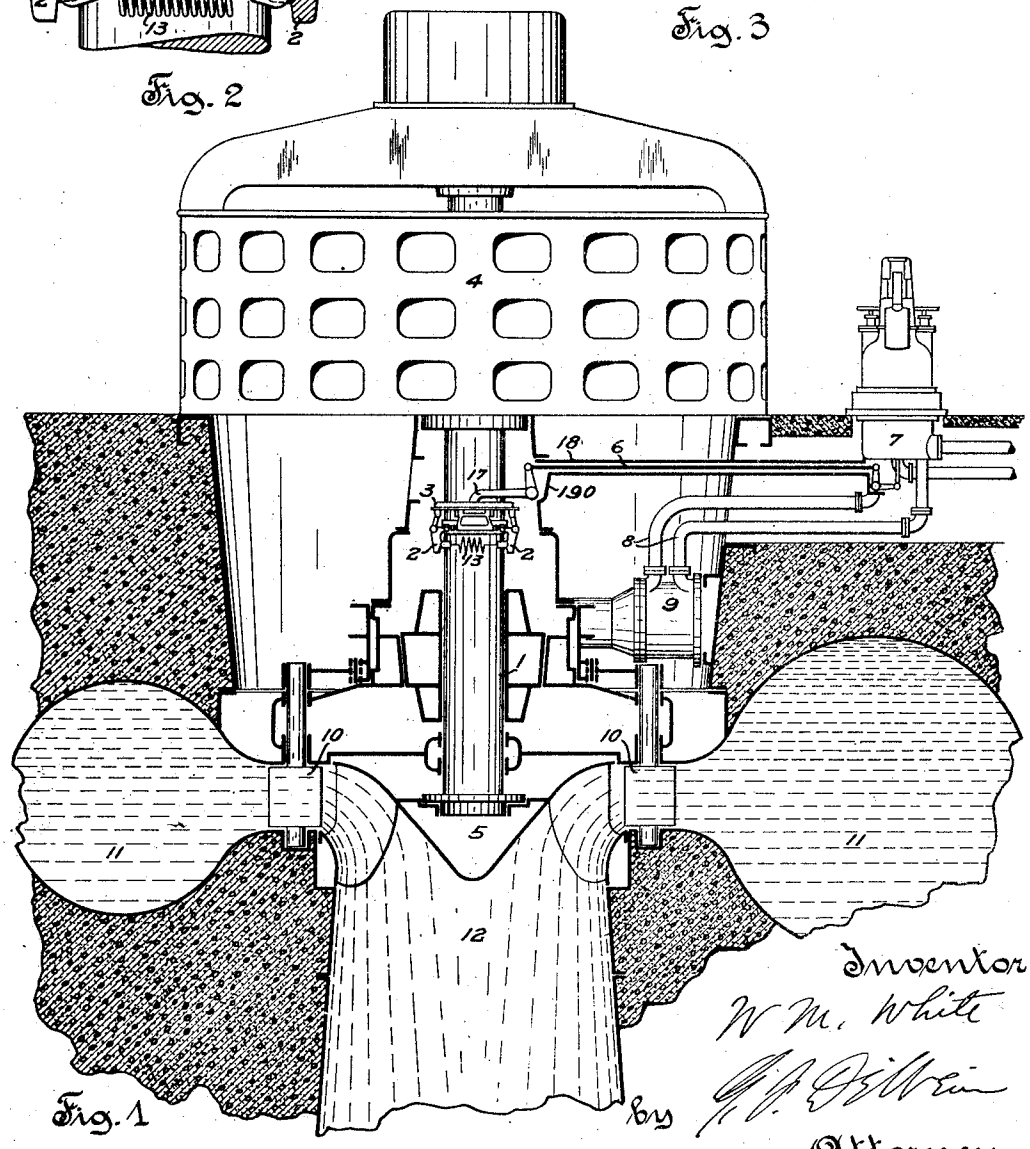


Fig. 1

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GOVERNOR.

1,369,863. Specification of Letters Patent. Patented Mar. 1, 1921.

Original application filed September 15, 1917, Serial No. 191,890. Divided and this application filed September 5, 1918. Serial No. 253,111.

To all whom it may concern:

Be it known that I, WILLIAM MONROE WHITE, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented a certain new and useful Improvement in Governors, of which the following is a specification.

This invention relates to improvements in speed governors for energy-translating machines.

An object of the invention is to provide a speed governor which is simple in construction and efficient in operation.

One of the more specific objects of the invention is to provide simple and efficient means for transmitting motion from the weights or fly balls of a centrifugal governor to the mechanism controlled thereby.

Another specific object of the invention is to provide a speed governor especially adapted for direct connection to the main shaft of an energy translating device. While the governor of the present invention is directly applicable to either horizontally or vertically disposed shafts, its application to the vertical main shafts of direct connected vertical hydro-electric energy-translating machines is especially desirable since such application permits reduction to a minimum of the overall height of the powerhouse. It is customary in the construction of vertical hydro-electric units to mount the generators directly upon the main shafts above the turbines. Traveling cranes located above the generators serve to handle heavy machine parts during installation and in case removal of such parts is necessary. The location of these cranes depend upon the length of shafting between the turbines and the generators, and the height of the building is determined by the location of the crane. It is therefore desirable to make the distance between the generators and the turbines as short as possible, in order to reduce to a minimum the overall height and hence the cost of construction of the building. In existing designs of hydro-electric units, the governors are ordinarily driven by means of horizontal jack shafts which are driven by bevel gearing associated directly with the main shafts of the units. In order to permit inspection of this gearing and to eliminate danger of injury by contact with the revolving jack shafts, it is necessary to allow a considerable space above the floor of the turbine pit and below the horizontal jack shafts. The allowance of this space necessitates lengthening the main shafts and also in most cases necessitates making the supports for the generators considerably larger and heavier than would otherwise be necessary. By utilizing the present invention, the horizontal jack shafts and connecting gearing are eliminated, the governors being mounted directly upon the main shafts, thereby permitting utilization of relatively short main shafts, eliminating danger of injury during inspection and reducing to a minimum the overall height of the units and of the powerhouse.

The present application is a division of application Serial Number 191,890, filed September 15, 1917.

A clear conception of several embodiments of the invention 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 various views.

Figure 1 is a diagrammatic part sectional view of a hydro-electric installation having a governor mounted directly upon the main shaft thereof between the turbine and the generator.

Fig. 2 is an enlarged part sectional front elevation of a governor mounted directly upon the main vertical shaft of an energy-translating device.

Fig. 3 is a fragmentary diagrammatic part sectional view of a hydro-electric installation showing a modified form of governor motion-transmitting mechanism.

The hydro-electric installation to which the governor is disclosed as applied in Fig. 1, comprises an energy-translating device or Francis turbine 5 direct connected to the lower extremity of a vertical main shaft 1, the upper extremity of which has directly connected thereto the rotor of an energy-absorbing device or electric generator 4. The Francis turbine 5 is operated in the usual manner by means of water under pressure admitted from the penstock through the spiral casing 11 past the circular series of adjustable guide vanes 10. The discharge of the turbine 5 communicates with the usual tailrace through a draft tube 12. The guide vanes 10 are adjustable by means of a fluid pressure actuated servo-motor 9

controlled by relay mechanism 7 which controls the flow of actuating fluid through pipes 8 to the servo-motor 9. The mechanism 7 as disclosed in Figs. 1 and 2 is controlled by means of the speed governor through a bifurcated bell crank 17 pivotally mounted upon a stationary casing 190, and a motion-transmitting connection 6 housed within a protecting casing or tube 18. The shaft 1 is provided with a main bearing between the turbine 5 and generator 4, preferably directly below the speed governor.

The speed governor, see Fig. 2, comprises a movable element or collar 3 surrounding but spaced slightly from the main shaft 1, and a pair of diametrically opposite weights 2 pivotally suspended from a collar fixed to the main shaft 1. Each of the weights 2 has an integral projection 19 extending inwardly from the upper end thereof and pivotally connected to the supporting ring on the main shaft 1. The weights 2 are connected with the movable element or collar 3 by means of links 14, which links together with the weight projections 19 constitute diametrically opposite toggle connnections between the shaft 1 and the collar 3. The collar 3 is also connected to the main shaft 1 by means of diametrically opposite toggles consisting of upper links 15 pivoted directly to the collar 3 and lower links 16 pivoted to the fixed shaft collar and pivotally connected to the links 15. The links 14, 15, 16 and the weights 2 are of considerable width measured transversely of the shaft 1, thus positively constraining the toggles to motion in planes perpendicular to their connecting pivots. The governor structure completely surrounds and is supported by the main shaft 1. The shaft 1 is of uniform cross-section at the portion thereof adjacent the governor thus making its strength unimpaired by the attachment of the governor thereto.

The floating collar 3 is provided with an annular recess 22 within which bearing shoes 20 carried by extremities of the bifurcations of the bell-crank 17, are slidable. The recess 22 may be provided with suitable lubricant and the shoes 20 may be provided with antifriction bearing means, in order to reduce the friction to a minimum. The weights 2 are connected to each other by springs 13 located one on each side of the shaft 1, and are prevented from moving inwardly and outwardly beyond predetermined limiting positions, by means of stops 21 which engage abutment surfaces formed on the weights. Excessive outward distortion of the springs 13, due to the action of centrifugal force thereon, is prevented by means of stops 23.

The means for transmitting the governor motion from the bell-crank 17 to the controlling mechanism 7, disclosed in Fig. 3, provides for greater overhead clearance in the turbine pit, than is provided in the arrangement shown in Fig. 1, and by the devices of the prior art. The motion transmitting mechanism of Fig. 3 comprises a pair of connections 60, 61 and an idler bell-crank 62 pivotally mounted upon a bracket secured to the frame of the generator 4. With this arrangement of connections and levers, maximum headroom is provided above the inspection walk of the turbine pit.

During normal operation of the device disclosed in Figs. 1, 2 and 3, the main shaft 1 is rotated by the turbine 5, and the weights 2 of the governor are moved outwardly by centrifugal force, against the tension of the helical springs 13. This outward movement of the weights 2 causes the pivotal connections between the projections 19 of the weights 2 and the links 14 to move upwardly, thereby causing the links 14 to move longitudinally of the shaft 1, and to raise the floating collar 3. During this movement of the weights 2, links 14 and collar 3, the toggles formed by the links 15, 16 are straightened and prevent movement of the collar 3 transversely of the shaft 1. As the speed of the shaft 1 varies, the weights 2 move toward and away from the shaft 1 causing the collar 3 to assume various positions along the shaft. The motion of the collar 3 is transmitted through the shoes 20, bifurcated bell-crank 17 and connections 6, 60, 61 to the controlling mechanism 7, thereby causing variations in the position of the servo-motor and of the guide vanes 10, and regulating the speed of the turbine 5. The bifurcated bell crank 17 converts the movement of the collar 3 longitudinally of the shaft 1 into reciprocating motion of the rod connections 6, 60, 61 in a direction transverse to the shaft 1, thereby permitting location of the relay mechanism 7 above the floor of the power house and at the side of the generator 4. By utilizing reciprocable governor motion-transmitting connections 6, 60, 61 rather than oscillating or rotary connections, the number of bearings for these connections is reduced to a minimum thus reducing to a minimum the frictional resistance to the motion of such connections.

It will be noted that the toggles consisting of the links 15, 16 are movable in a plane at right angles to the plane of movement of the toggles consisting of the links 14 and weight projections 19. The planes of movement of these two sets of toggles intersect at a straight line which substantially coincides with or is parallel to the axis of the shaft 1, thereby always insuring that the collar 3 will remain out of engagement with the shaft 1 and thereby eliminating friction losses. The toggle links 14, 15, 16 constitute the sole means for supporting and guiding the collar 3, thereby reducing the fric-

tion to a minimum and producing a governor of maximum sensitiveness. The toggles, so far as their effect is concerned, may be regarded either as the links 14 constrained at one end by any structure such as the weight projections 19, to move the collar 3 longitudinally of the shaft 1, or they may be considered as comprising the weight projections 19 coacting in any manner with the collar 3 to move the same along the shaft 1. In the construction disclosed, the effects of the two links constituting each toggle, are added. In any case, the toggles whether they be of the single or of the double link type, should constitute the sole means for supporting and guiding the collar 3 in order to reduce to a minimum the friction. While the toggles are disclosed as arranged in diametrically opposite pairs, this arrangement being preferred for the purpose of balancing the elements, it will be apparent that only two toggles movable in different planes are essential in order to produce the desired rectilinear motion.

By mounting the governor directly upon the main turbine shaft, the use of a special governor supporting shaft is avoided and the speed changes are transmitted directly from the main shaft to the governor fly-balls, thereby reducing friction losses to a minimum. By arranging the governor vertically as disclosed, the elements may be readily balanced, thereby also enhancing the sensitiveness of the device. The elimination of rotating motion transmitting mechanism eliminates danger of injury to operators and permits substantial reduction in power house height. The main bearing for the shaft 1 which is located between the turbine 5 and the generator 4 and directly adjacent the speed governor, prevents lateral vibration of the shaft 1 and thereby assuring more sensitive regulation than if vibration of the shaft 1 were unrestrained.

If for any reason it is desired to disconnect the governor and to control the servomotor 9 manually, this may be done by swinging the bell-crank 17 away from the floating collar 3, thereby breaking the connection between the governor and the motion-transmitting mechanism. The guide vanes 10 may then be regulated manually in the usual manner by means of controlling valves such as are ordinarily provided for manual control of the servo-motor 9.

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

It is claimed and desired to secure by Letters Patent:

1. In combination, a vertical shaft, a hydraulic turbine secured to the lower end of said shaft, relay mechanism for controlling the flow of fluid to said hydraulic turbine, an electric generator secured to an upper portion of said shaft, an inspection chamber between said turbine and said generator, a speed governor surrounding and direct-connected to said shaft within said chamber, and a reciprocable governor motion transmitting connection extending from said governor to said relay mechanism transversely of said shaft.

2. In combination, a vertical shaft, a hydraulic turbine secured directly to the lower end of said shaft, a servo-motor for controlling the flow of fluid to said turbine, relay mechanism for controlling said servomotor, an energy translating device secured directly to an upper portion of said shaft, a bearing for said shaft between said turbine and said device, a speed governor surrounding said shaft above said bearing, and a reciprocable governor motion transmitting connection connecting said governor and said relay mechanism and extending transversely of said shaft.

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

WILLIAM MONROE WHITE.