March 9, 1937. W. L. VOORDUIN 2,072,930

POWER HOUSE STRUCTURE

Filed Feb. 3, 1936

Fig. 1.

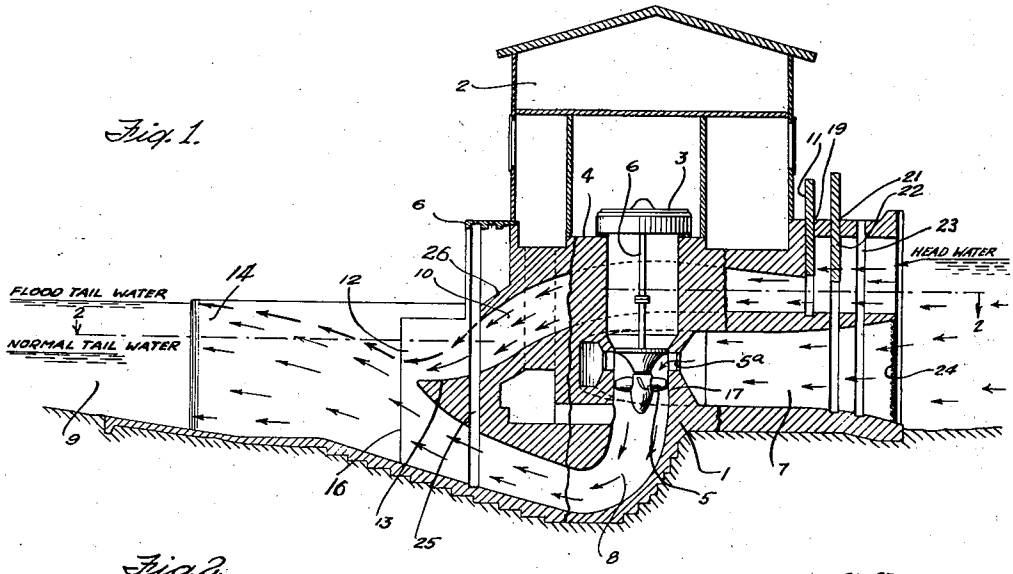


Fig. 2.

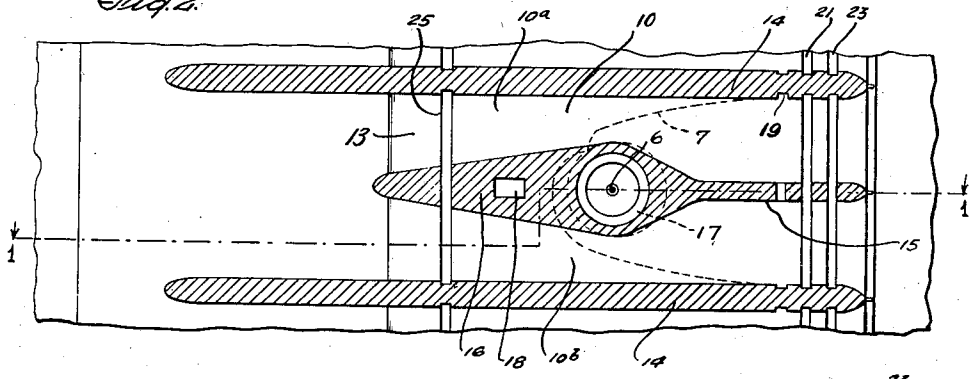
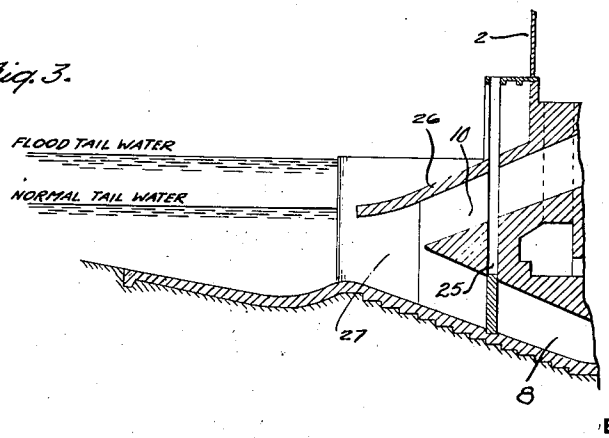


Fig. 3.



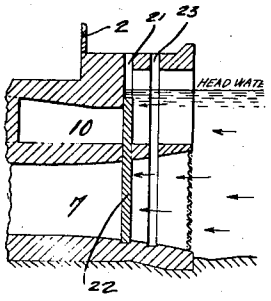


Fig. 4.

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POWER HOUSE STRUCTURE

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12 Claims. (Cl. 61—19)

This invention relates to a combined method of disposing of floodwater and utilizing it to increase the head on the hydraulic turbines of a power house, and to an improved structure for carrying out these ends.

In the ordinary power house construction water providing the power is fed to an hydraulic turbine through a penstock or scroll case and exhausted into the tail-race through a draft tube. During flood periods difficulty is encountered in many hydraulic power installations due to the fact that floodwater backs up in the tail-race of the power house, thus raising the level of the tail-water and decreasing the head on the hydraulic turbines of the power house and thereby decreasing the amount of power which can be developed.

The dam with which the power house is associated is provided with a spillway which may also have large gates for use during exceptional floods and smaller regulating gates for moderate floods. These require special operating equipment and involve additional expense in the construction of the dam, and for their upkeep.

By my invention I provide a method for simultaneously disposing of floodwater and utilizing it to decrease the back pressure on the draft tubes which is otherwise present during flood periods and causes the reduction of head on the hydraulic turbines.

In carrying out my invention I provide a novel but simple structure in which floodwater is passed directly through a power house, its normal rate of flow increased, and is discharged adjacent the lower end of the draft tube.

The structure comprising my invention has the advantage that its initial cost, and its upkeep, are materially less than is required by any other means heretofore suggested for assuring an equivalent amount of power when the head on the turbines is reduced for any reason such as floodwater conditions.

The proportions and arrangement of the parts of my structure are subject to a wide degree of variation to meet the particular requirements of a specific installation without departing from the scope of my invention.

The term "power house spillway" is used herein to denote a conduit for floodwater extending through the power house.

The invention will best be understood if the following description is read in connection with the accompanying drawing, in which

Figure 1 is a vertical cross-section on the line 1—1 of Figure 2.

Figure 2 is a plan view taken on the line 2—2 of Figure 1.

Figure 3 shows a modification of the discharge end of the spillway and draft tubes, and

Figure 4 is a detail view of a control gate structure.

In the drawing the numeral (1) refers to a section of a dam, which serves also to support a housing, or "power house" (2), in which one or more hydroelectric units may be housed. Within the structure illustrated herein are the generator (3) located upon the floor (4), the hydraulic turbine (5), the shaft (6), connecting the turbine to the generator, the scroll case (7) through which water is delivered to the hydraulic turbine (5) and the draft tube (8) through which the water discharged from the turbine (5) passes into the tail-race (9). Beneath the top of the scroll case (7) the structure may be the same as in a conventional structure of this kind. Above the top of the scroll case I provide a conduit or power house spillway (10) extending from the crest gate (11) to a point (12) adjacent the discharge end of the draft tube (8). Through this conduit or power house spillway, (10), water will flow from the forebay to the tail-race when the crest gate (11) is open. As shown in Figure 1 the lower end of the spillway (10) is provided with an apron (13) over which water passing through the spillway flows at a high rate of speed causing the creation of an hydraulic jump in the tail-race, and decreasing the level of the tailwater in a manner well understood by those skilled in the art.

As illustrated in Figure 1 the power house spillway (10), is divided throughout at least a portion of its length into two conduits each of which are restricted in cross-sectional area intermediate their ends to accommodate a hollow pier containing a wheel pit. As will be seen by reference to Figure 2 the spillway (10) extends between the end piers (14), which may serve as dividing walls between separate bays if more than one hydroelectric unit is included in the installation. Between the end piers 14 an intermediate pier 16 is provided having a hollow chamber comprising the wheel pit 17 intercommunicating between the generator room and the turbine. This intermediate pier may be described as somewhat diamond shaped, but is tapered more sharply at the front end than at the rear end. As illustrated herein a forward extension 15 is provided.

The shaft 6 interconnecting the turbine 5 and the generator 3 extends vertically through the wheel pit 17 in pier 16. Ready access to the tur-

bine is thus possible at all times without regard to the operation of the spillway. Pier 16 may also contain one or more staircases or elevator shafts, giving access to operating chambers or inspection galleries and to the scroll case. An entrance 18 to the interior of pier 16 is illustrated in Figure 2. If desired pier 16 may also contain pipe galleries, air ducts, cooling ducts or any other duct or passageway.

In the specific structure illustrated herein pier 16 supports the weight of the generator 3 and turbine 5 and transports these forces through the speed ring 5a of the turbine to the foundation of the dam.

The hollow pier 16 divides the power house spillway 10 into a plurality of channels 10a and 10b, which are restricted in width intermediate their ends due to the more or less diamond shape of the pier. The pier 16 thus cooperates with the floor and roof of the spillway in increasing the rate of flow of water through the spillway.

The end piers (14) are provided with slots to receive control gates for both the power house spillway (10) and the scroll case (7). In Figure 1 a crest gate slot (19) is shown having therein the crest gate (11), referred to above, controlling the entrance to the spillway (10). The head gate slot (21) (Figures 1 and 2) is also provided containing the head gate (22) by which the entrance to the scroll case (7) is controlled, or which, if desired, may be used (Figure 4) as a head gate both for the spillway (10) and the scroll case (7). The slot (23) is adapted to receive a stop log means for either or both the spillway and the scroll case, and the numeral (24) (Figure 1) indicates trash racks to prevent the entrance into the scroll case of drift wood or other matter likely to damage the turbine. At the downstream end of the structure, extending through the power house spillway (10) and the draft tube (8), a control gate slot (25) is provided in which a stop log gate may be positioned, if necessary, to aid in unwatering the portion of the draft tube upstream therefrom to facilitate inspection or repairs to the turbine. In the operation of the spillway conduit negative pressure is built up therein intermediate the ends of the spillway and particularly in the downstream half of the spillway. Under some conditions it is desirable to introduce atmospheric pressure into the spillway conduit to decrease or eliminate the negative pressure therein. For example, when the headwater falls below the top of the entrance to the spillway, air is admitted which is drawn into the conduit and sets up a disturbance therein resulting in undesirable vibration. When atmospheric pressure is introduced into the conduit intermediate its ends this condition is not only overcome but the negative pressure is decreased or entirely eliminated, thereby slowing up the flow of water through the conduit. With less water flowing through the conduit the headwater is withdrawn from the forebay more slowly with the result that the headwater tends to rise and cover the entire entrance to the conduit. The control gate slot (25) in the downstream roof (26) of the spillway as illustrated in Figure 3 provides a means for introducing atmospheric pressure into the conduit intermediate its ends. This slot can be opened by manipulating the stop log gate therein, and if desired a separate cover for the slot may be provided.

It will be appreciated that when floodwater is admitted past the gate (11) into the power house spillway (10) it will pass downwardly over the apron (13) and discharge into the tail-race, creating there an hydraulic jump, thereby reducing the level of the tailwater. Since the discharge end of the spillway is positioned adjacent the discharge end of the draft tube (8) the result is to reduce the tailwater level at the discharge end of the draft tube, thereby reducing the back pressure on the draft tube and increasing the effective head on the turbine (5). In some cases it will be more advantageous to utilize the principle of an ejector rather than an hydraulic jump at the discharge end of the power house spillway. In Figure 3 I have shown a somewhat modified form of structure in which the roof (26) of the spillway (10) is extended rearwardly so that the draft tube (8) and the spillway (10) both discharge into the tail-race through a common passage (27). The water flowing through the power house spillway (10) will be discharged into the common passage at a much greater velocity than the water from the draft tube and because of the relative positions of the ends of the spillway and the draft tube, the water in the power house spillway will serve to create a suction at the discharge end of the draft tube, thereby increasing the rate of flow of water in the draft tube.

In addition to its use in increasing the head on the turbines during flood periods the power house spillway also serves to reduce the length or the capacity of the main spillway required for passing floodwater and in many cases will eliminate entirely the necessity of a main spillway. Where large gates are required to meet occasional large-flood conditions the power house spillway may be operated in lieu of the main spillway regulating gates to dispose of excess water under moderate flood conditions. The operation of the power house spillway gate to dispose of floodwater is more convenient than the operation of a similar gate positioned elsewhere in the dam, and results in an economy in initial cost and operation as pointed out above.

The power house spillway may also be used as a trash flume. Trash or debris accumulating against the trash racks (24) at the entrance to the scroll case may be raked onto the power house spillway crest and washed down the face of the power house spillway by opening the gate (11). A special flume or structure for trash disposal is thus eliminated.

While in the preferred embodiment of my invention described herein I have illustrated the floodwater conduit or power house spillway in the form of a Venturi tube it may in some cases be desirable to modify the form of said conduit, as for example by extending the roof of said conduit on the same horizontal plane, and this may be done without departing from the scope of the invention.

What I claim is:

1. A power house structure comprising a turbine intermediate a scroll case and draft tube extending from the forebay to the tailrace, and a flood water conduit positioned above said scroll case, turbine and draft tube, end piers forming the side walls of said conduit, and a substantially diamond shaped pier positioned between said end piers separating the conduit into a plurality of channels, each varying progressively in width from a point intermediate the ends of said channels to the exit and entrance respectively of said channels.

2. An improved power house construction comprising a turbine intermediate a scroll case and

draft tube leading from the forebay to the tail-race, and a conduit extending above said scroll case, turbine and draft tube and discharging into the tailrace adjacent the discharge end of the draft tube, said conduit having a restricted portion intermediate its ends whereby a negative pressure is built up within the down stream half of said conduit, the said down stream half of said conduit having means for admitting atmospheric pressure to offset the said negative pressure.

3. A power house structure comprising a section of a dam, a power house supported thereby, a turbine intermediate a scroll case and a draft tube leading from the forebay to the tail race and a conduit extending from the forebay to the tailrace above the scroll case, turbine, and draft tube, the entrance to said conduit being positioned below the surface of the drop down curve level of the headwater, and means for admitting atmospheric pressure to said conduit intermediate its ends to limit the rate of flow of water through the conduit and aid in preventing the level of the headwater from falling below the top of the conduit at its entrance.

4. A power house structure comprising a section of a dam, a power house supported thereby, a turbine intermediate a scroll case and draft tube leading from the forebay to the tail-race, and a conduit extending from the forebay to the tailrace above the scroll case, turbine, and draft tube, said conduit having intermediate its ends an air intake communicating with atmospheric pressure, said intake serving when open to decrease the effective length of said conduit.

5. In combination, a dam section, a power house supported thereby, a turbine intermediate a scroll case and a draft tube leading from the forebay to the tailrace, and a spillway extending through said power house above said turbine, scroll case and draft tube, said spillway comprising a closed conduit having cross sections of progressively lesser width on the upstream side of a point intermediate the ends of the spillway, and cross sections of progressively greater width in the portion of the conduit downstream from said point.

6. A power house structure comprising a turbine intermediate a scroll case and a draft tube, a floodwater spillway positioned above said turbine, scroll case, and draft tube, a generator room above said spillway, and an enclosed space extending upwardly from the turbine to the generator room, dividing the said spillway into two channels and giving access at all times to the turbine, and turbine shaft without stopping the flow of water through said conduit.

7. A power house structure comprising a turbine intermediate a scroll case and a draft tube, a floodwater spillway positioned above said turbine, scroll case, and draft tube, and a hollow pier having a chamber extending vertically from said scroll case through the said spillway thereby giving access to the interior of the scroll case and to the shaft joining the turbine to the generator while said conduit is in use, said pier being provided with tapered ends so that it divides the said spillway into two Venturi flumes.

8. A power house structure comprising a turbine intermediate a scroll case and a draft tube, a floodwater spillway positioned above said turbine, scroll case, and draft tube, and a hollow pier having a chamber extending vertically from said scroll case through the said spillway giving access to the interior of the scroll case and to the shaft joining the turbine to the generator, said pier being provided with tapered ends so that it divides the said spillway into two venturi flumes, and a roof enclosing said flumes thereby forming a closed conduit, said conduit having means in its downstream half for admitting atmospheric pressure to said conduit intermediate its ends.

9. A power house structure comprising a turbine intermediate a scroll case and a draft tube which together form a conduit leading from the forebay to the downstream side of the structure, a second conduit extending through the power house above the scroll case, turbine, and draft tube, and an enclosed passage communicating at its inlet end with both said first and second conduits and discharging into the tailrace.

10. In a power house structure the method of reducing the back pressure on the draft tube and thus increasing the effective head on a turbine in said structure, which comprises passing water through the power house in a closed conduit above the scroll case, turbine, and draft tube, admitting air to said conduit intermediate its ends to control the rate of flow of the water therethrough, and discharging the water into the tail-race adjacent the discharge end of the draft tube.

11. In the operation of an hydraulic power development the method of disposing of floodwater which comprises passing it through a conduit extending through the power house above the scroll case, hydraulic turbine, and draft tube, wherein a negative pressure is created, and breaking the negative pressure by admitting air into the conduit intermediate its ends.

12. In the operation of an hydraulic power development the method of disposing of floodwater which comprises passing it through a conduit extending through the power house above the scroll case, hydraulic turbine, and draft tube, wherein a negative pressure is created, and modifying the effective length of said conduit by means of an air valve positioned intermediate the ends of said conduit.

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