

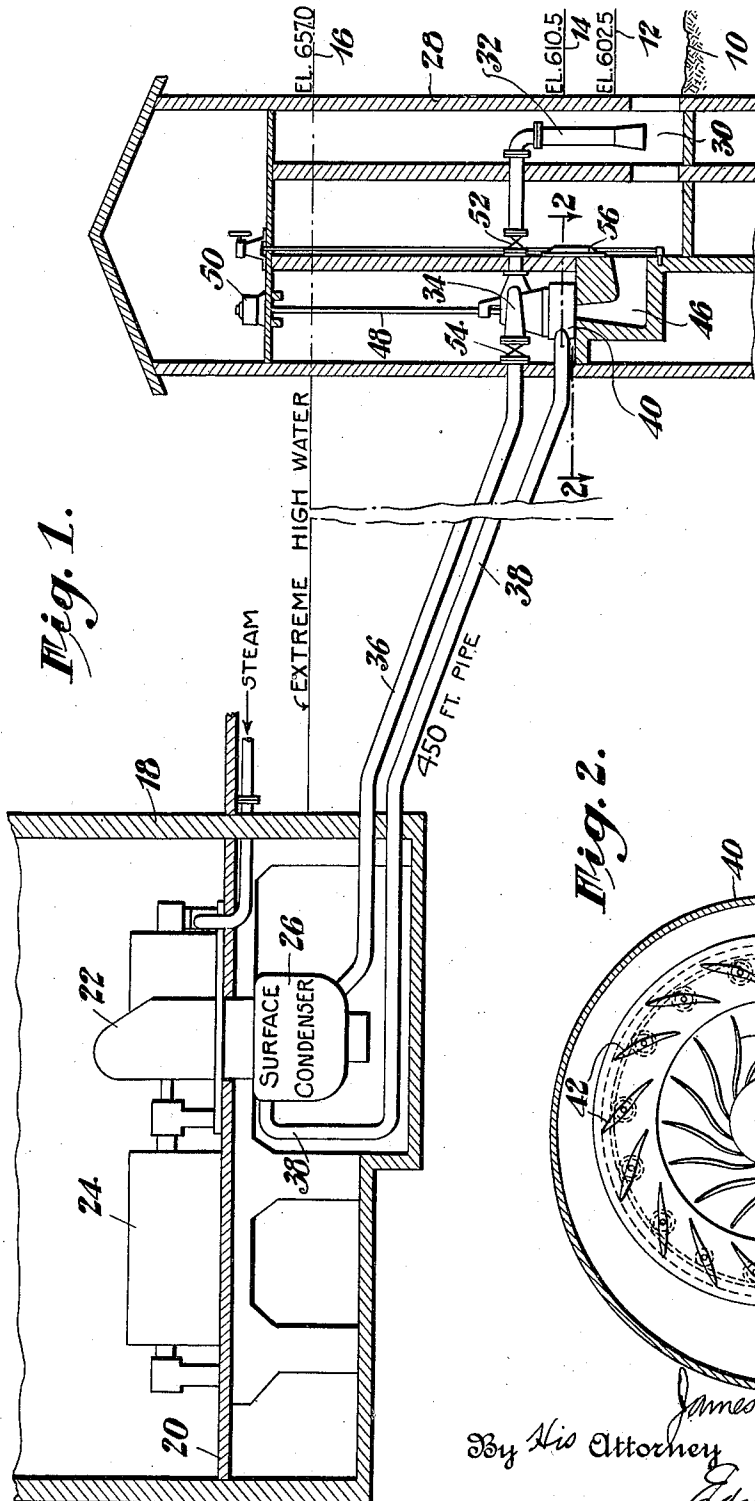
July 1, 1930.

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1,769,671

CONDENSER ARRANGEMENT

Filed April 14, 1928



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CONDENSER ARRANGEMENT

Application filed April 14, 1928. Serial No. 269,943.

It is well-known that the efficient generation of power in steam plants requires very large quantities of condensing water. Steam plants of considerable rating, such as the modern turbo electric steam generating stations, are always located on a stream or body of water affording large quantities of cooling water throughout the year. In certain sections, however, the available sources of condensing water are subject to wide variations in level. For instance, the Ohio River not infrequently rises more than 45 feet from extreme low water to high water with a difference between low water level and the normal water level of about eight feet. In order to avoid the high pumping expenses incidental to pumping of large quantities of condensing water to a considerable height and at the same time to maintain the desired even flow and uniform conditions of pressure in the condenser, all the steam electric generating plants heretofore erected on the Ohio River have either been placed on the bottoms or flat land subject to overflow or the condenser pit has been sunk to a low level. This location, however, has been the cause of great expense. Not only must the building be constructed to resist the flood waters to the extent of keeping them away from the machinery, but the building must be anchored so as to resist the tremendous lifting effects of the water when at flood level. The buildings for the steam electric generating stations along the Ohio River have therefore been very costly.

It is the object of the present invention to provide arrangements of condensing apparatus for use in a steam electric generating station which shall permit the building to be placed at a considerable elevation above the normal level of the water from which the condensing water is taken, and which shall not involve difficulties of operation of the condenser or excessive pumping costs.

In the accompanying drawing is illustrated somewhat diagrammatically an arrangement of turbine, turbine house and condensing apparatus according to the present invention. In said drawing, Fig. 1 is an elevation, parts being shown in section, of a

steam turbo generator and condensing apparatus therefor, the generator and turbine being contained in a building set on a high bank so as to bring the turbine above the high water level of a variable level stream.

Fig. 2 is a half section of a water turbine taken on the line 2—2 of Fig. 1.

Referring to the drawing more in detail, 10 indicates the bed of a stream from which condensing water is to be obtained and which is assumed to have a low water level at the line 12 and at an elevation of 602.5 feet. The normal level of said stream is indicated by the line 14 and is assumed to be at an elevation of 610.5 feet. The extreme high water level of the stream in question reached in time of flood is indicated by the line 16 and is assumed to be at an elevation of 657 feet. The steam power plant according to the present invention is illustrated as including a building 18, set upon ground at an elevation such that the floor 20 on which the steam turbine 22 and generator 24 are placed shall be above the highest level of the river or other body of water from which the condensing water is to be taken. The condenser for turbine 22 is preferably placed below the floor 20 and, in the arrangement illustrated, is indicated at 26. Condensing water for condenser 26 is preferably obtained from a well in a building 28 separate from the generator building and which contains a well 30 open to said stream from which condensing water is to be obtained. A pipe 32 dips into the well 30 and extends below the level 12 which is the lowest water level anticipated to occur. The pipe 32 connects with the pump 34, preferably of the centrifugal type, whereby condensing water is elevated through the pipe 36 to the condenser 26. Preferably pipe 36 is connected into the lower portion of the casing of condenser 26. The condenser 26 is illustrated as being of the surface condenser type and it will be understood that this has been done for the reason that surface condensers are used almost exclusively in turbo electric steam generating plants at present, but the present invention is not limited to surface condensers. The cooling or condensing

water which has been delivered to condenser 26 through pipe 36 and which has passed through the condenser is discharged therefrom, preferably near the top of the condenser, through a pipe 38. Pipe 38 runs to and discharges into a casing 40 of a water turbine having its runner on the same shaft as that of pump 34, whereby the energy in the water descending from the condenser is recovered.

As stated above, the turbine 40 has a shaft 48 in common with the runner of the pump 34. The shaft 48 is extended upwardly through the well house 28 to a point above the high water level where it is connected with an electric motor 50. The motor 50 therefore supplies the hydraulic losses in the circuit including pipe 32, pump 34, pipe 36, condenser 26, pipe 38, turbine 40, tube 46. Power for driving motor 50 may be derived from the generator 24 or from any other suitable source. It is preferred that motor 50 be of the constant speed type.

Turbine 40 may be of any desired type, but it is highly desirable that it have adjustable wickets 42 for controlling the rate of flow of water to the vanes 44 of the turbine runner. The draft tube of the turbine is indicated at 46. Tube 46 discharges below the water level 12. The hydraulic circuit including the pipe 32, pump 34, pipe 36, condenser 26, pipe 38, turbine 40 and tube 46 is therefore a closed circuit, both ends being below level 12 and the amount of power required to put a given amount of water per minute through this circuit is therefore substantially constant irrespective of the level of the water. It has been found that, by setting the wickets or gates 42 of the turbine 40 at a certain position, the average flow of cooling water through the condenser circuit above mentioned may be predetermined and that a given setting of the wickets 42 also predetermines the amount of suction or siphon head on the condenser. It is undesirable to have too high a siphon head in any part of the circuit of the cooling water for the reason that the siphon head is apt to induce air leakage into the cooling water circuit. The difficulties in operation due to air leakage and to other results of the suction head in the surface condenser can be more or less prevented, but their prevention involves additional operating expense. From the standpoint of reliable operation of the surface condenser 26, it would be advisable to set the wicket 46 so as to have a low siphon head on the condenser. On the other hand it has been found that a greater amount of power must be supplied to the pump 34 over that obtained from the water turbine 40 when the siphon head on the condenser 26 is lower. It will be seen that the height

of condenser 26 above the low water level 12 is considerably greater than the height of a water column which can be sustained by the pressure of the atmosphere, and theoretically the siphon head might be made equal to the atmospheric head, but a break in water column in the cooling circuit might entail serious results and it is not desired to set the wickets 42 so that the siphon head on the condenser shall be more than about 20 feet of water at extreme low water in the river. Suitable valves and gates 52, 54 and 56 are provided in the pipes 32 and 36 and at the mouth of the tube 46, respectively, to shut off the water from the turbine and the pump when desired.

In addition to the advantages mentioned above the arrangement and method according to the present invention involves much less hazard from flood during construction.

The present invention has been employed in the design of a power plant, on the Ohio River and the elevations indicated on the drawings for the extreme high water level, normal water level and extreme low water level are those assumed for the Ohio River in the design of said plant.

Engineering estimates made for the installation of a power plant on the Ohio River capable of containing three turbo generator units of 50,000 kilowatts each, showed material savings in applicant's arrangement as compared to the ordinary one when all factors of construction and operation were taken into account.

A specific apparatus and method of operation have been disclosed above and illustrated in the accompanying drawing, but it will be understood that the previous disclosure herein is by way of example only and that the present invention is defined and limited solely by the appended claims.

Having thus described my invention I claim:

1. The combination of a steam operated prime mover and a condenser therefor, a closed circuit for condensing water for said condenser, a pump in said circuit acting to force water toward said condenser, a turbine in said circuit driven by water flowing away from said condenser, the moving element of said pump being mechanically connected to the runners of said turbine and a motor connected to said pump and turbine for supplying the hydraulic losses in said circuit.

2. The combination as set forth in claim 1 and in which said turbine is provided with wickets set to predetermine the rate of flow through said circuit.

3. The combination as set forth in claim 1, and in which said surface condenser is set at a greater height above the normal water level of the source of condensing water than the height of the column of water which can be supported by the atmosphere.

4. A closed hydraulic circuit containing a pump and a hydraulic turbine having a shaft in common, said turbine having adjustable wickets and said pump and circuit being so arranged that the setting of said wickets predetermines the flow of water through the circuit.

5. A closed hydraulic circuit containing a condenser, a pump and a hydraulic turbine, said pump and turbine having a shaft in common, and said turbine having adjustable wickets, said pump and circuit being so constructed and arranged that the setting of said wickets predetermines the flow of water through the circuit.

In testimony whereof I affix my signature.

JAMES A. BJERREGAARD.

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