

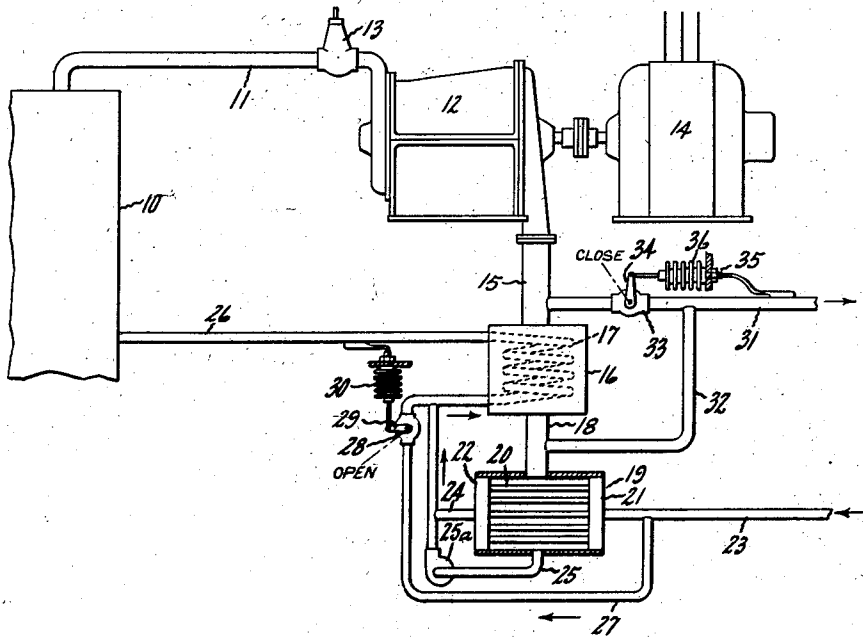
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### EXTRACTION AND NONCONDENSING TURBINE ARRANGEMENT

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## UNITED STATES PATENT OFFICE

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EXTRACTION AND NONCONDENSING  
TURBINE ARRANGEMENTHarold W. Cross, Hinsdale, and Edwin S. Wells,  
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## 1 Claim. (Cl. 60—64)

The present invention relates to extraction and non-condensing turbine arrangements which include a turbine having an intermediate or last stage from which elastic fluid is supplied to a consumer for power generation, heating, processing or like industrial purposes at a predetermined temperature or pressure.

The object of our invention is to provide an improved construction and arrangement of turbine plants whereby better economy and efficiency are attained.

In extraction and non-condensing turbine plants for supplying steam or like elastic fluid from an intermediate or last stage at a certain temperature, it was the practice heretofore to choose an initial elastic fluid condition, that is, a total temperature at the selected inlet pressure that gave the desired temperature at the exhaust or extraction opening of the turbine to suit the low pressure system being served. In most applications made in connection with old, low pressure turbine equipment or in connection with process systems where little or no superheat is desired, the total temperature at the inlet of the turbine is definitely limited. Ordinarily the extraction and non-condensing turbines are arranged to drive an electric generator or generators. The electrical output of such generators depends upon the temperature and pressure drop across the turbine and in case the inlet temperature and the extraction or exhaust temperatures of the turbine are fixed with regard to the temperature required for processing, heating or like purposes, the electrical output of the generator is limited accordingly.

We have found that a considerable gain in electrical output from the high pressure, non-condensing portion of such a cycle can be realized by increasing the total steam temperature at the throttle, that is, at the inlet of the turbine. The electrical output is definitely established by the energy drop between the initial and exhaust conditions and by the quantity of steam flow through the turbine. By increasing the total steam temperature at the throttle for a given steam pressure the available energy between initial and exhaust conditions is increased and with it the electrical output of the generator is increased accordingly. However, the increase in initial temperature causes a corresponding increase of the temperature at the exhaust or extraction stage and results in a temperature that is higher than desired.

According to our invention the temperature at the exhaust or extraction stage is reduced by

the provision of a heat exchanger in the form of a de-superheater.

In some instances of this kind it has been the practice to install a feed water heater supplied with steam or like elastic fluid from the exhaust or extraction stage of the turbine in order to obtain a greater electrical output by utilizing more heat from the exhaust steam, thereby increasing the flow of steam through the high pressure unit. The gain thus obtained is further increased according to our invention by the provision of a combined de-superheater and feed water heater connected in series to the exhaust or extraction stage of the turbine and by increasing the turbine inlet temperature accordingly. In a preferred embodiment the combined de-superheater and feed water heater is arranged in two sections, one section in the form of a surface type heat exchanger designed on the counterflow principle and arranged for free flow of exhaust or extraction steam through it and the other section in the form of a condensation type feed water heater connected in series with the de-superheater. A supply conduit for process steam is connected to receive steam from points ahead and behind the de-superheater.

For a better understanding of what we believe to be novel and our invention, attention is directed to the following description and the claim appended thereto in connection with the accompanying drawing.

The single figure of the drawing illustrates diagrammatically a non-condensing steam turbine arrangement embodying our invention.

The arrangement comprises a boiler 10 having a discharge conduit 11 for supplying steam to a turbine 12 having a throttle valve 13 and being coupled to drive an electric generator 14. The exhaust of the turbine 12 is conducted by a conduit 15 to a surface type de-superheater 16 having a de-superheating coil 17. The de-superheated steam is conducted by a conduit 18 from the de-superheater 16 to a feed water heater 19 which is also of the surface type including cooling tubes 20 connected between headers 21 and 22. Cooling medium, in the present instance feed water, is forced into the feed water heater 19 by means including a conduit 23 connected to the header 21 and discharged from the header 22 through a conduit 24 to the inlet of the de-superheating element 17. During operation part of the steam discharged from the turbine 12 is de-superheated in the de-superheater 16 and thereafter condensed in the feed water heater 19. The condensate is discharged from the latter

through a conduit 25 and a condensate pump 25a connected to the aforementioned conduit 24 and the inlet of the de-superheating element 17. Thus the condensate is mixed with the feed water discharged from the cooling elements of the feed water heater. The outlet of the de-superheating element 17 which constitutes a heating element as regards the feed water supply is connected by a conduit 26 to the inlet of the boiler. In order to permit regulation of the feed water temperature in the conduit 26 a bypass 27 is provided for bypassing some of the feed water with respect to the feed water heater 19. This conduit 27 is connected between the feed water supply conduit 23 and the feed water discharge conduit 24 and includes a valve 28. In the present instance the valve 28 has an arm 29 connected to a temperature-responsive device including a bellows 30 whereby the valve is moved in response to temperature changes in the conduit 26. If the temperature in the conduit 26 increases, the bellows 30 expands, moving the valve 28 towards opening position and bypassing an increased amount of feed water through the conduit 27, resulting in a decrease in temperature in the conduit 26. Thus, the valve 28 is automatically controlled to maintain constant temperature in the boiler inlet conduit 26. As pointed out before, the turbine in accordance with our invention is operated at an inlet temperature which results in an exhaust temperature higher than that desired. In order to obtain the desired temperature some of the steam discharged by the turbine is mixed with steam discharged by the de-superheater. In the present instance a conduit 31 is connected to the turbine discharge conduit 15 for conducting exhaust steam to a consumer for processing, heating or like industrial purpose and this conduit 31 is also connected by a branch conduit 32 to the de-superheater discharge conduit 18 to receive de-superheated steam. The de-superheated steam and the superheated steam received from the turbine discharge conduit 15 mix in the conduit 31 and if properly proportioned will result in the desired temperature. The proportioning is preferably effected automatically by means including a valve in at least one of the conduits 31 and 32. In the present instance the conduit 31 includes a valve 33 which has an arm 34 connected to a temperature-responsive device 35 having a bellows 36 and being responsive to temperature of the steam at a point of the conduit 31 behind its juncture with the branch conduit 32 as regards the direction of flow therethrough. During operation the increase of the temperature in the conduit 31 causes expansion of the bellows 36 whereby the valve 33 is moved towards closing position, thus reducing the

amount of steam flowing from the turbine discharge conduit 15 directly into the conduit 31, resulting in a decrease in temperature. This decrease will continue until the desired temperature is attained. Vice-versa, a drop in temperature in the conduit 31 causes opening movement of the valve 33, resulting in increased flow of superheated steam from the conduit 15 to the conduit 31.

From another viewpoint, the conduit for supplying elastic fluid from an intermediate or last stage of a turbine to a consumer has branches connected ahead and behind the de-superheater 16 respectively. One of the branches, in the present instance the one connected ahead of the de-superheater as regards the direction of flow therethrough, includes a valve for controlling the amount of steam flowing through this branch with regard to that flowing through the other branch 32 in order to obtain the desired steam temperature at a point behind the juncture of the two branches.

Having described the method of operation of our invention, together with the apparatus which we now consider to represent the best embodiment thereof, we desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What we claim as new and desire to secure by Letters Patent of the United States is:

Turbine arrangement including the combination of a turbine having a stage from which fluid is to be supplied for industrial purposes, the turbine being operated at an inlet temperature at which the elastic fluid temperature in said stage is higher than desired for industrial purposes, a de-superheater and a feed water heater connected in series to receive fluid from said stage, means including a conduit having branches connected to the inlet and the outlet respectively of the de-superheater, means for automatically controlling the ratio of flow through said branches in response to temperature changes of the fluid in said conduit, the de-superheater and the feed water heater being of the surface type and having cooling elements connected in series, a conduit for conducting feed water to the feed water heater, a bypass connected between said conduit and the cooling element of the de-superheater for bypassing some of the feed water with respect to the feed water heater, and means including a valve in the bypass for automatically controlling the flow therethrough in response to changes of the temperature of the feed water discharged from the de-superheater.

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