

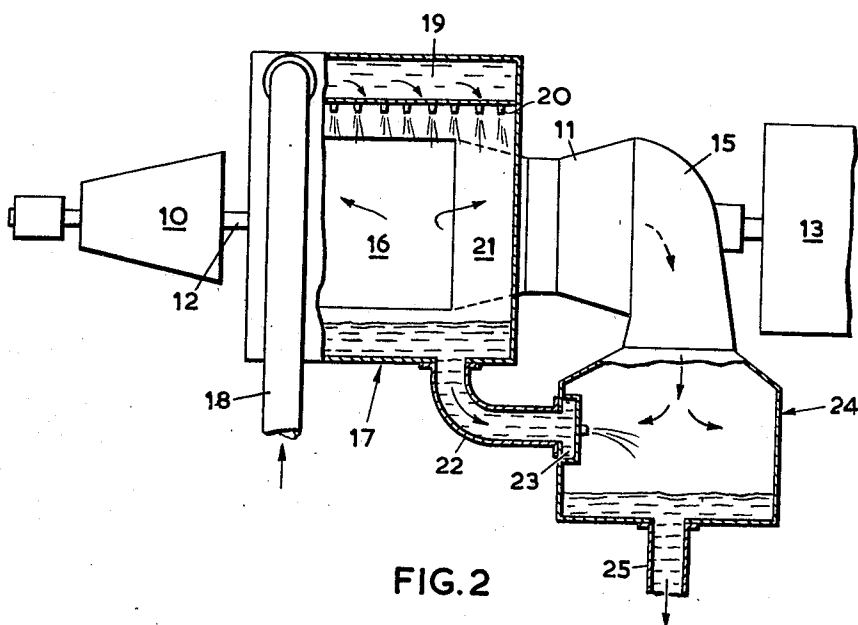
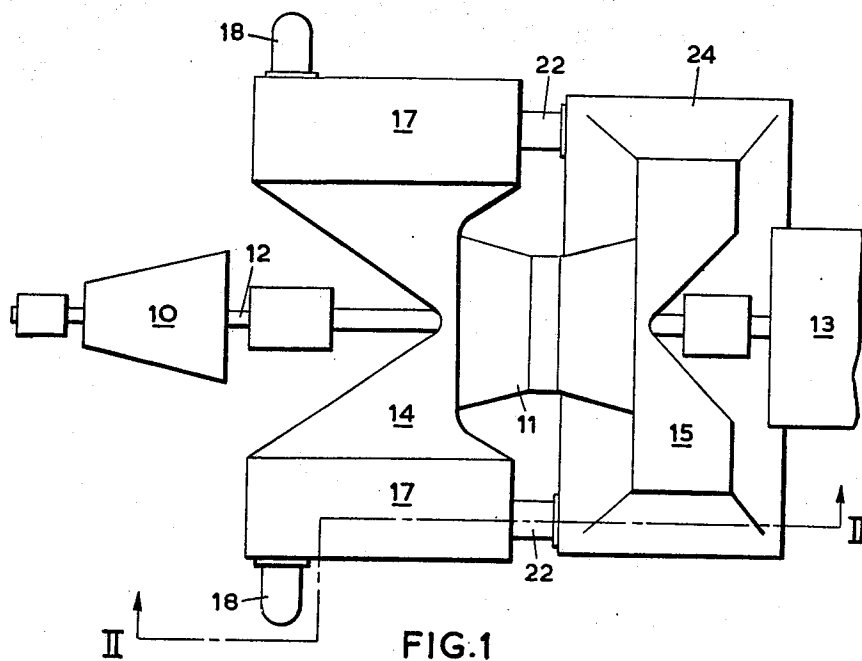
March 3, 1970

J. H. DALTRY
TURBINE PLANT

3,498,062

Filed Aug. 24, 1967

5 Sheets-Sheet 1



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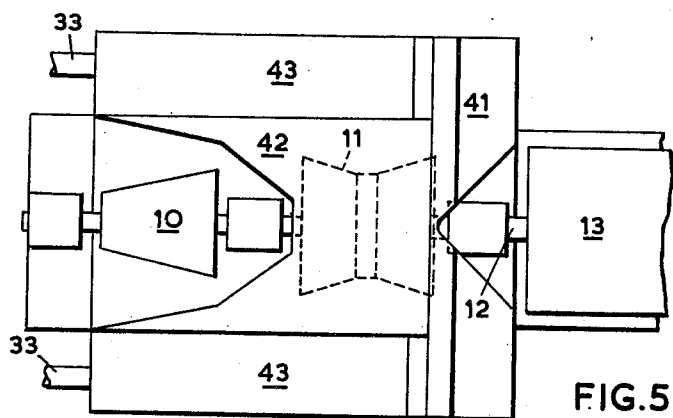
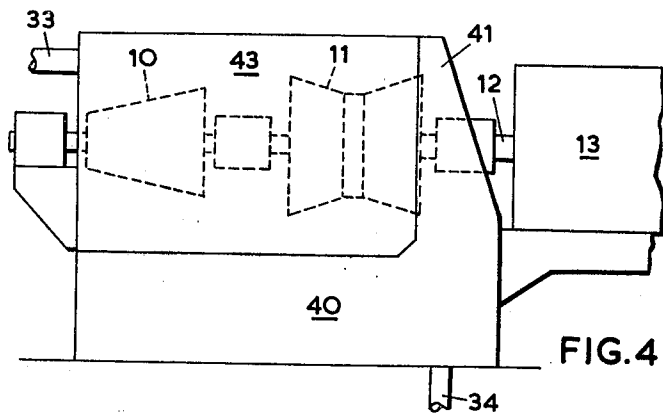
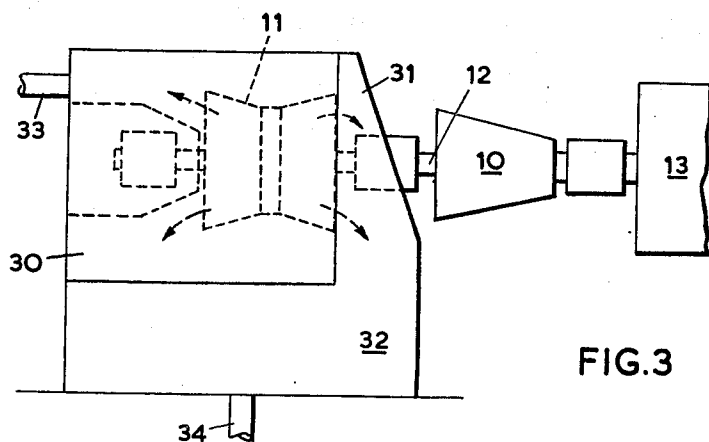
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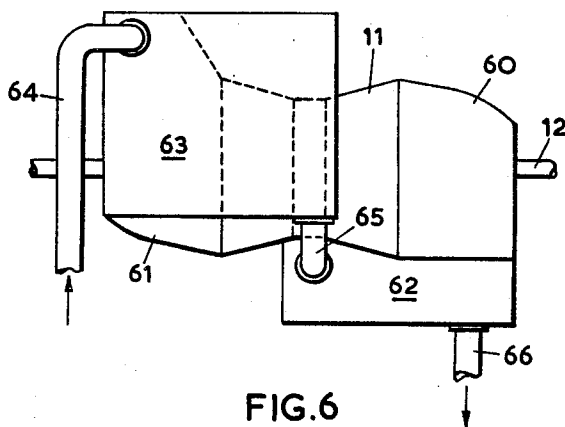


FIG. 6

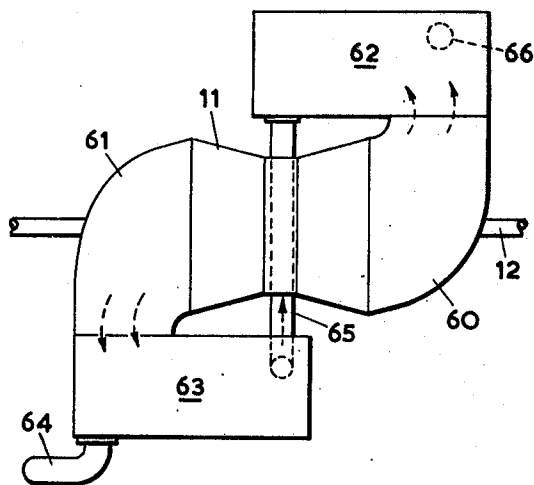


FIG. 7

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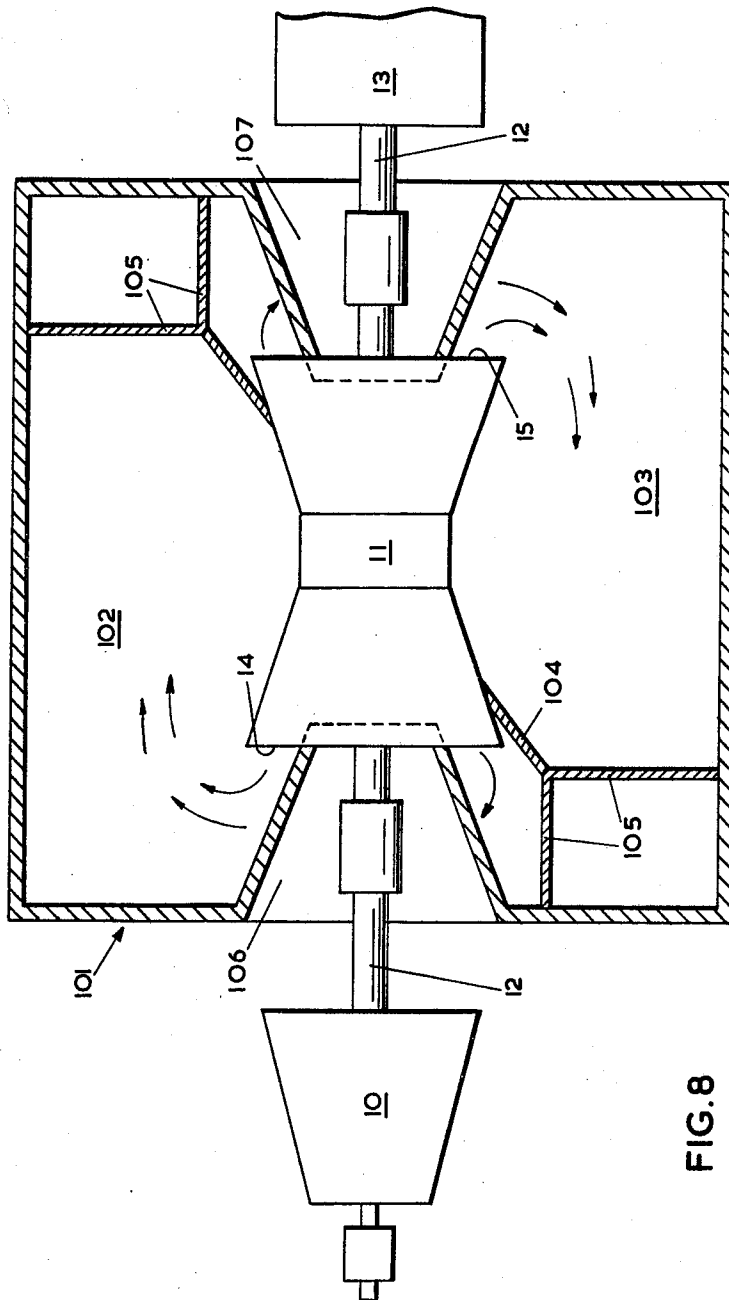


FIG. 8

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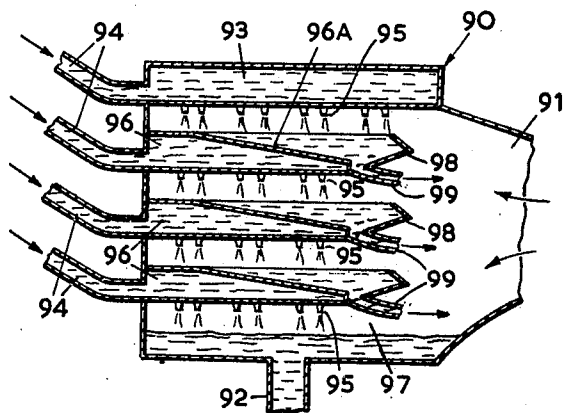
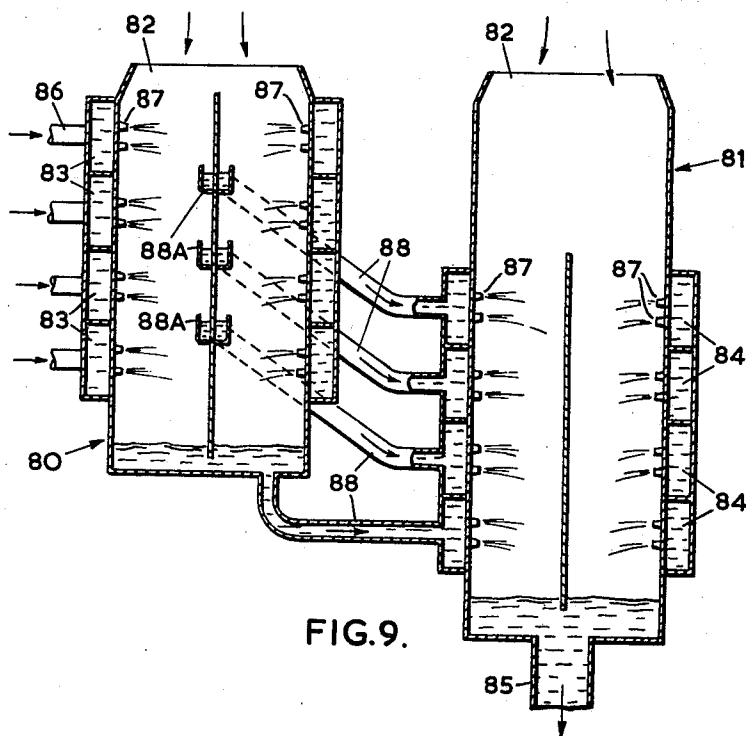
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TURBINE PLANT

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U.S. Cl. 60-64

8 Claims

ABSTRACT OF THE DISCLOSURE

The invention provides improved arrangements of stepped-series condenser system, that is to say a system comprising a number of condensers, each connected to a steam turbine exhaust outlet which are arranged at different levels and connected in series by feeding the condensate from each condenser to the cooling water inlet of the next lower condenser.

The improved arrangements provide a reduction in the basement height normally required for such system.

Thus, one arrangement comprises arranging the uppermost condenser of the system at or above the level of its corresponding turbine exhaust outlet, and another arrangement comprises providing a plurality of cooling water inlets and condensate outlets at different levels over the height of each condenser, thus enabling several series connections to be made between adjacent condensers of the system over the height of said condensers.

The two arrangements may be combined to at least reduce the basement height to a minimum.

This invention relates to condenser systems for condensing steam turbine plant, which plant is of the kind having at least two steam exhaust outlets.

In such plant it is known to provide a direct-contact steam condenser for each exhaust outlet, said condensers being positioned beneath their corresponding exhaust outlets at different levels, to provide a cooling water supply to the uppermost condenser, and to connect the condensate outlet of each condenser, except to the lowest, to the cooling water inlet of the condenser at the next lower level so that the cooling water and condensate collected from the condensers passes in series through all of the condensers to the condenser at the lowest level. Such a condenser system will hereinafter be referred to as a "stepped-series condenser system."

A major disadvantage of the known stepped-series condenser system is that a very deep basement is required beneath the condensing steam turbine plant to house the condensers, and the present invention provides improved arrangements for at least reducing the basement height.

According to one aspect of the basement invention, a stepped-series condenser system for condensing steam plant is characterised in that the uppermost condenser is arranged at least at the level of its corresponding turbine exhaust outlet.

According to another aspect of the present invention, a stepped-series condenser system for condensing steam plant is characterised in that a plurality of condensate outlets are provided for at least each condenser of the series except the lowermost, the condensate outlets of each condenser being positioned at different levels over its height and each outlet of each condenser being connected to a cooling-water inlet of the condenser at the next lower level.

In order that the invention may be readily understood and further features made apparent, various embodiments of stepped-series condenser system constructed in accord-

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ance with the invention, will now be described, by way of example, with reference to the accompanying drawings in which:

FIG. 1 is a plan view of a condensing steam turbine plant in one form incorporating features of the invention;

FIG. 2 is a sectional elevation taken on the line II-II of FIG. 1;

FIGS. 3 and 4 are elevations of two further forms of condensing steam turbine plant incorporating features of the invention;

FIG. 5 is a plan view of the plant shown in FIG. 4;

FIGS. 6 and 7 are respectively an elevation and plan view of another condensing steam turbine plant incorporating features of the invention;

FIG. 8 is a part-sectional elevation of yet another form of condensing steam turbine plant incorporating features of the invention;

FIG. 9 is a sectional elevation of the first embodiment; and

FIG. 10 is a sectional elevation of the second embodiment.

With reference firstly to FIGS. 1 and 2, a steam turbine plant includes a steam turbine having a high-pressure stage 10 and a low-pressure stage 11 on a common shaft 12 with an alternator 13. The low-pressure (L.P.) stage 11 is of the dual-flow type, i.e. steam exhausts therefrom at both ends, through separate exhaust hoods 14, 15. The hood 14 exhaust through steam inlets 16 to the uppermost condenser which in this case is of pannier form and comprises a pair of direct-contact condensers 17 arranged one on each side of the L.P. stage 11. Each condenser 17 has a cooling-water inlet 18 feeding a waterbox 19, which is provided with spray nozzles 20 whereby cooling water is brought into contact with the steam in the condensing space 21 of the condenser.

The cooling water, and the condensate formed thereby, pass together from the condensers 17 by gravity through pipes 22 to the waterboxes 23 of a further direct-contact condenser 24 which is connected in stepped-series relationship with the condensers 17. The latter is arranged below the level of the L.P. stage 11 and is supplied with the exhaust steam passing through the exhaust hood 15. The condenser 24 has an outlet 25 for the used cooling water and condensate.

The arrangements shown in FIGS. 3 to 8 operate on the same principle as that just described, but differ in the relative positions of the condensers. In FIG. 3, the two steam outlets from the dual-flow L.P. cylinder 11 exhaust respectively into an annular direct-contact condenser 30 surrounding the cylinder 11, and into a hood 31 which leads to an underslung direct-contact condenser 32 positioned directly below the condenser 30. The condensers 30 and 32 are formed integrally with each other and with the hood 31, and together completely enclose the L.P. cylinder 11. The lower condenser 32 also provides the foundation of the cylinder 11. Water collecting in the bottom of condenser 30 can enter the water sprays (not shown) of the condenser 32 directly, by gravity. A cooling water inlet 33 is provided for the condenser 30 and a water outlet 34 at the bottom of condenser 32.

In the arrangements shown in FIGS. 4 and 5, the lower condenser 40, into which steam exhausts from one of the two steam outlets of L.P. cylinder 11 via the hood 41, forms also the foundation for the turbine including the high-pressure stage 10. The other steam outlet from the L.P. cylinder 11 exhausts, through an exhaust hood 42 surrounding the cylinder 11, to the uppermost condenser which again is of pannier form comprising two direct-contact condensers 43 mounted on each side of the turbine and mounted directly on the lower condenser 40. Water collecting in the condensers 43 can enter the sprays (not shown) of the condenser 40 directly, by gravity.

FIGS. 6 and 7 show a dual-flow L.P. cylinder 11 the two steam outlets of which exhaust through respective hoods 60, 61 to two condensers 62, 63 mounted on opposite sides of the turbine and at different levels. The upper condenser 63 has a cooling-water inlet 64 and a water outlet pipe 65 leading to the cooling-water inlet of the lower condenser 62. The latter has a water outlet 66.

With reference now to FIG. 8, a dual-flow L.P. cylinder 11 is completely enclosed by a box-like structure 101, which is separated into an upper compartment 102, and a lower compartment 103, by a main dividing wall 104 rigidly connected to, and sealed to the casing of the L.P. stage 11, and further dividing walls 105. The compartments 102, and 103 each form a casing for a direct-contact condenser (not shown), and the condensers are connected in stepped-series relationship.

The walls of the box-like structure adjacent the exhaust ports of the turbine cylinder 11 are each formed to provide a deflector cone 106, 107 for encouraging steam exhausted from the turbine 11 to flow into the compartments 102 and 103.

This embodiment thus provides a compact arrangement for the condensers, and the box-like structure 101 may conveniently provide at least a part of the foundation for the turbine.

With reference now to FIG. 9, a stepped-series condenser system comprises a pair of vertically mounted direct-contact condensers 80, 81, each having an exhaust-steam inlet 82 at its upper end and four encircling waterboxes 83, 84 respectively. The waterboxes 84 and the lower end of the condenser 81 are mounted at lower levels than the corresponding parts of the condenser 80, the water outlet 85 for the system being at the bottom of condenser 81.

Each waterbox 83 of the upper condenser 80 has a separate cooling water-inlet 86 and is provided with spray nozzles 87. Each waterbox 84 of the lower condenser 81, also provided with spray nozzles 87, has a separate cooling water inlet pipe 88 connected into the condenser 80. The pipe 88 associated with the lowest waterbox 84 leads from the bottom of the upper condenser 80: the remaining pipes 88 each extend to an open inlet or trough 88A, facing upwardly inside the condenser 80. The inlets 88A are shown arranged one above the other (though this need not be the case), and each is at a higher level than the corresponding waterbox 84 of condenser 81.

FIG. 10 shows an alternative form of stepped-series condenser system to FIG. 9 in which a direct-contact condenser 90 has a side inlet 91 for steam and a bottom outlet 92 for water. One waterbox 93, having a cooling-water inlet 94 and spray nozzles 95 facing downwards, is mounted at the top of the condenser, and three further waterboxes 96, each with its own cooling-water inlet 94 and downward-facing spray nozzles 95, are arranged one above the other within the condenser and extending laterally into the condensing space 97 thereof. Each of the three waterboxes 96 is formed so as to act as a tray for receiving water. In the example shown, which is only one of many possible arrangements for these trays, the top face 96a of each waterbox 96 is inclined downwardly towards the steam inlet 91, the tray being completed by a collecting portion 98 connected through a pipe 99 (similar to the pipe 88 in FIG. 1) connected to the corresponding waterbox of a condenser at a lower level. It can be seen that with this arrangement, as with that shown in FIG. 9, the condenser at the lower level need not be mounted at such a low level as would be the case if the water was all collected from the bottom of the upper condenser.

The condenser of FIG. 10 serves to collect water as soon as its temperature has reached substantially that of the steam, and to remove it in such a way as not to obstruct the steam flow appreciably. There may be a single outlet from the turbine supplying all the waterboxes 93,

96. Condensers such as shown in FIG. 10 can be used as single-stage condensers, the water leaving the trays then passing (for example) down the back of the condenser to minimise obstruction of the steam flow or of the remaining condensing areas, instead of leaving through the pipes 99.

The condensers shown in FIG. 9, or either of them, may be adapted for entry of steam at the side instead of at the top, the condensers being positioned accordingly relative to the turbine. Suitably adapted, condensers of the general kind typified by the examples shown in FIGS. 9 and 10 may be used in conjunction with the arrangements described hereinbefore with reference to FIGS. 1 to 8.

In arrangements such as those shown in FIGS. 9 and 10, there may be any convenient number of waterboxes, with their associated inlets and spray nozzles arranged at different levels, the four shown being only an example.

The invention is not confined to power plants having turbines with dual-flow L.P. cylinders, or to condensers or condenser systems incorporated in such plants, but may be applied wherever the turbine has more than one outlet for exhaust steam to be condensed. For instance, where the L.P. stage of the turbine comprises a triple or quadruple flow stage, with respectively, one dual-flow and one single-flow cylinder or two dual-flow cylinders, each of the three or four exhaust steam outlets (as the case may be) can have its own condenser means arranged for series flow of the cooling water successively through the various condenser means. The condenser means (some or all of which may comprise pairs of condensers, e.g. the condensers 17 in FIG. 1) will be arranged at successively lower levels.

A variation on the above arrangement, within the scope of the invention, comprises one dual-flow L.P. cylinder in which both steam outlets exhaust into a pair of pannier condensers or into a single annular condenser, and another dual-flow L.P. cylinder in which both steam outlets exhaust into a single condenser mounted underneath the said other cylinder. The condenser or condensers associated with the first-mentioned cylinder will then be arranged for water to drain therefrom to the cooling-water inlet or inlets of the other condenser.

I claim:

1. In combination a steam turbine plant having at least some exhaust outlets, and a stepped-series condenser system comprising a condenser for each said exhaust outlet, the condensers being arranged at different levels whereby condensate is fed from the uppermost condenser serially through the lower condenser(s), characterized in that the condensers are mounted one on top of another, the lowermost condenser provides a foundation for at least a part of said turbine plant, and at least the uppermost said condenser is arranged at least at the level of its corresponding exhaust outlet of said turbine plant.

2. The combination of a steam turbine plant and a stepped-series condenser system according to claim 1, further characterized in that the condensers are formed integrally with one another.

3. The combination of a steam turbine plant and a stepped-series condenser system according to claim 2, further characterized in that the turbine plant includes a dual flow L.P. turbine cylinder which provides two said steam exhaust outlets.

4. A stepped-series condenser system according to claim 3, characterised in that the uppermost condenser comprises an annular condenser which surrounds the L.P. turbine cylinder.

5. A stepped-series condenser system according to claim 3, characterised in that the uppermost condenser is of pannier form comprising a pair of direct-contact condensers positioned one on each side of the L.P. cylinder.

6. The combination of a steam turbine plant and a stepped-series condenser system according to claim 3, further characterized in that a box-like structure is pro-

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vided for the two condensers associated with said two said steam exhaust outlets of the dual flow L.P. turbine cylinder which completely encloses said dual flow turbine cylinder, and dividing walls are provided within the box-like structure for dividing the latter into upper and lower compartments, one said exhaust outlet of the cylinder communicating with the upper compartment and the other said exhaust outlet communicating with the lower compartment, said compartments thereby constituting the casings for upper and lower condensers, respectively, of said stepped-series system.

7. The combination of a steam turbine plant and a stepped-series condenser system according to claim 6, further characterized in that each wall of said box-like structure adjacent a said steam exhaust outlet of the cylinder is formed with a deflector cone for encouraging steam issuing from the exhaust outlets to flow into their respective condensers.

8. The combination of a steam turbine plant and a stepped-series condenser system according to claim 1, further characterized in that a plurality of condensate outlets are provided for at least each condenser of said stepped-series condenser system except the lowermost condenser, the condensate outlets of each condenser being

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positioned at different levels over its height and each said condensate outlets of each condenser being connected to a cooling water inlet of the condenser at the next lower level.

References Cited

UNITED STATES PATENTS

1,721,251	7/1929	Hodgkinson	165—112
1,723,110	8/1929	Wirt	60—64
3,186,176	6/1965	Edminson et al.	60—95
2,026,233	12/7935	Kirgan	165—100
3,194,021	7/1965	Peabe et al.	60—95

FOREIGN PATENTS

865,744	2/1953	Germany.
106,106	5/1917	Great Britain.
714,705	9/1954	Great Britain.

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U.S. Cl. X.R.

60—95; 165—110, 112