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O. FREY

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SURFACE CONDENSER

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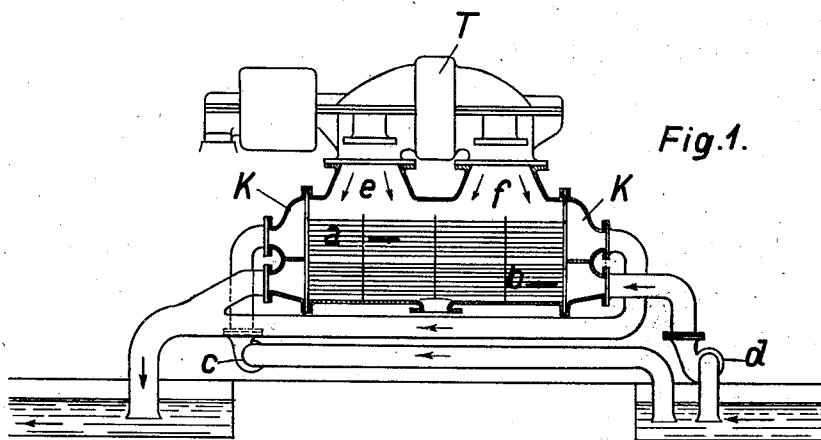


Fig. 1.

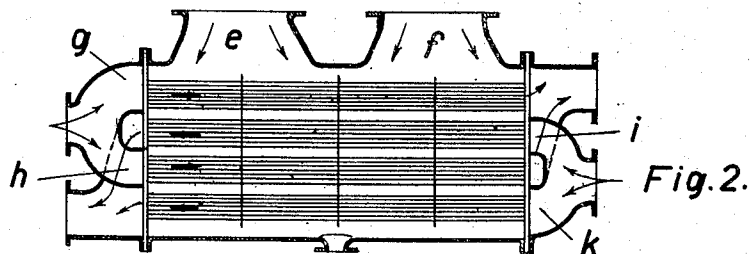


Fig. 2.

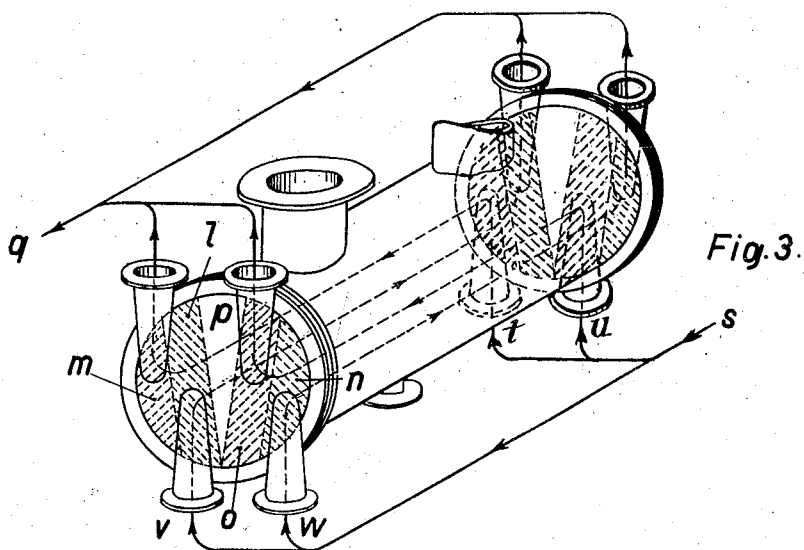


Fig. 3.

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UNITED STATES PATENT OFFICE

OTTO FREY, OF WINDISCH, SWITZERLAND, ASSIGNOR TO AKTIENGESSELLSCHAFT BROWN BOVERI & CIE., OF BADEN, SWITZERLAND, A JOINT-STOCK COMPANY OF SWITZERLAND

SURFACE CONDENSER

Application filed September 24, 1926, Serial No. 137,438, and in Germany June 11, 1926.

This invention relates to steam condensing apparatus of the surface type. Its general object is the provision of steam condensing apparatus in which the highest possible vacuum can be maintained with the least expenditure of cooling water.

A specific object is the provision of surface condensing apparatus in which a uniform rate of condensation throughout the length of the condenser is ensured.

Other and further objects will be indicated or pointed out hereinafter or will be obvious to one skilled in the art upon an understanding of the present disclosure.

In the drawing forming a part of this specification I show one form in which the invention may be embodied and certain modifications, but it is to be understood that these are presented for purpose of illustration only and are not to be construed as limiting the invention claimed short of its true and most comprehensive scope in the art.

In the drawing,

Fig. 1 is a part longitudinal section and part elevation showing a turbine in conjunction with a condenser construction demonstrating the invention,

Fig. 2 is a longitudinal section of a modified form of condenser,

Fig. 3 is a perspective view of a further modification showing the distribution of the different groups of tubes and the water inlets and outlets.

In order that the cooling water may be properly utilized in a condenser it is necessary for each unit of surface to be exposed to a given and uniform flow of water. Consequently in small condensers the water must be passed several times backwards and forwards along the condenser, or in several "flows" as it is termed, since the total tube length required to fulfill the above condition largely exceeds the length of the condenser shell. This arrangement is an advantage in that it gives a more uniform distribution of temperature throughout the length of the condenser than is obtainable with only a single flow. When the length of the shell equals the calculated total tube length to be traversed, the single-

flow type is of course adopted; this occurs only in the larger sizes.

When the cooling water enters the condenser its temperature is a minimum and a correspondingly large quantity of steam is condensed, whereas when leaving the condenser the water is comparatively warm and condenses far less steam. As a consequence the steam does not sweep uniformly over the nest of tubes and irregular flow and inefficiency results. Attempts have been made to equalize the flow by varying the tube pitching between the inlet and outlet ends and also by placing the exhaust branch near the outlet end. Such measures have only attained a partial success.

According to my invention a uniform condensation rate along the whole length of the condenser is ensured by introducing the circulating water at both ends of the condenser simultaneously. The tube surface at each end will then be supplied with water at the same temperature and will be capable of condensing the same weight of steam. This property becomes very important when the condenser is used with large double-flow turbines, since a long condenser with two steam inlet branches could be very conveniently applied to such a turbine were it not for the irregular distribution of the steam. This condition is still further aggravated by the presence of the numerous tube supporting plates necessary in a long condenser. My invention allows such a form of condenser to be used without any of these attendant disadvantages, and a typical arrangement is illustrated in Fig. 1 of the drawing. The reference character T designates a low-pressure double-flow turbine exhausting into a condenser K which is shown in longitudinal section. The circulating water is divided into two flows *a* and *b* which traverse the condenser in opposite directions. Flow *a* passes from left to right and circulation is maintained by a pump *c*. A second pump *d* maintains a flow *b* in the opposite direction to *a*. Thus the mean water temperature in the half *e* of the condenser is the same as it is in *f* and hence the rate of steam condensation is approximately the same for

both halves. The cooling and extraction of the air from these condensers is performed in the customary manner.

The above represents the invention applied in its simplest form which, however, suffers from certain disadvantages. For example, considering the steam entering the right-hand half *f* of the condenser it will be seen that it must first pass through the warm part of flow *a* before reaching the colder tubes beneath. This disadvantage may be removed by dividing each of the main flows into smaller parallel flows which are arranged alternately in such a way that the steam entering at either end of the condenser traverses several cold and warm nests of tubes in succession. An example illustrating this arrangement is given in Fig. 2. The exhaust enters by the two branches *e* and *f* and the flow of circulating water passing from left to right is separated into the two smaller parallel flows *g* and *h*. Similarly the main flow from right to left divides into two flows *i* and *k* and the four flows are arranged alternately. Thus the entering steam traverses in succession the nests of tubes *g*, *i*, *h* and *k*, in which the flow is left to right, right to left, left to right, and right to left respectively.

When the condensers are designed with clear passages between the nests of tubes with the object of allowing the steam to penetrate unimpeded to the bottom of the condenser (the so-called regenerative principle), it is an advantage if the tube nests flanking the steam passage are of opposing flows since this tends to give a more uniform rate of condensation in the passage.

An example embodying this improvement is illustrated in Fig. 3 of the drawing which shows diagrammatically the distribution of the various groups of tubes and the water inlets and outlets.

The shaded portions *l*, *m*, *n* and *o* represent groups of tubes each of which is supplied with water from a separate inlet. The free space *p* lying between the groups *l* and *o* permits the steam to penetrate unimpeded to the lower layers of tubes. Cold circulating water enters the condenser by the lower inlets *t*, *u*, *v* and *w*, that is to say at both ends of the condenser simultaneously. The cold water flows through the group *l* from left to right and through group *o* from right to left, in each case being discharged when it has made one pass through the condenser; similarly with the outer groups of tubes the direction of flow in which can be seen from the drawing. The water is discharged from outlets at the top of the condenser as shown.

What I claim is:

1. A surface condenser comprising, in combination, a shell member, a steam inlet, a water box fitted with both inlet and outlet connections at each end of the shell, groups

of cooling tubes communicating with corresponding compartments in the water boxes, and being spaced to provide a steam passage directed transversely with respect to such groups, and means providing for introduction of cooling water simultaneously at both ends of the condenser and directed in opposite directions through the groups of tubes flanking said passage.

2. In a regenerative surface condenser having a vertical free passage dividing the cooling tubes thereof and reaching from the top to the bottom of the same, a steam inlet, tubes divided into sub-groups on each side of such passage, water inlet and outlet boxes disposed alternately and cooperating with each sub-group, and means providing for introduction of cooling water at both ends of the condenser simultaneously and for passage of said water in opposite directions in the sub-groups flanking such passage.

In testimony whereof I have hereunto subscribed my name at Zurich, Switzerland, on the 8th day of September, A. D. 1926.

OTTO FREY.