March 29, 1927. 1,622,374

J. E. GOODWILLIE

SURFACE CONDENSER

Filed April 11, 1925 2 Sheets-Sheet 1

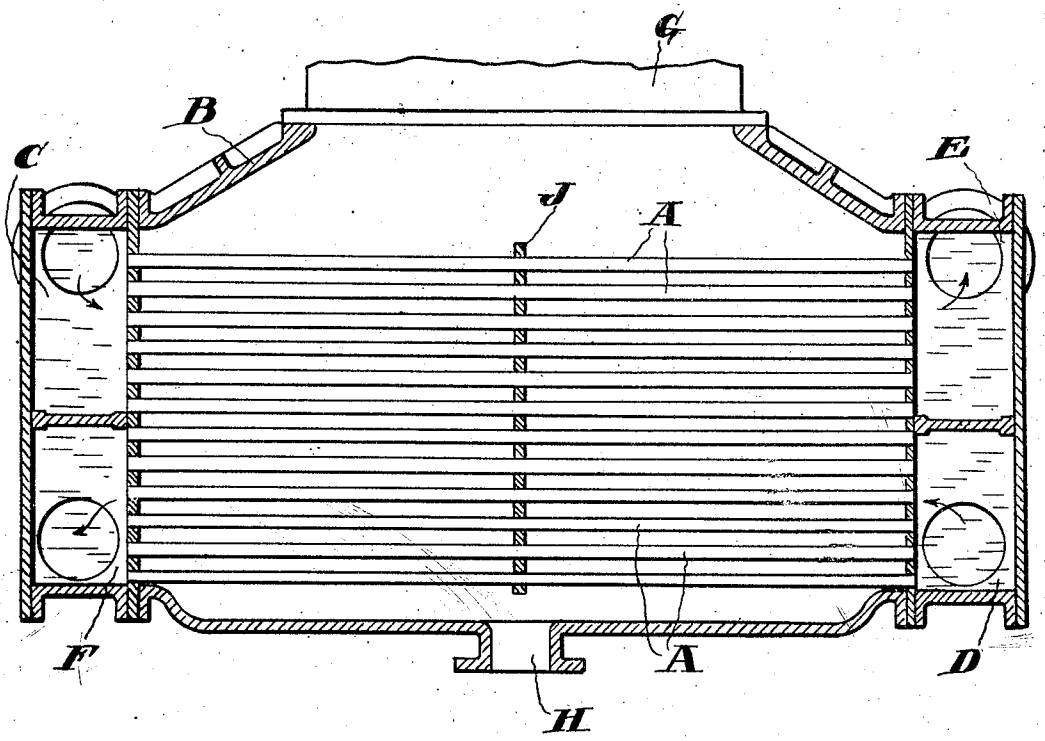

Fig. 1.

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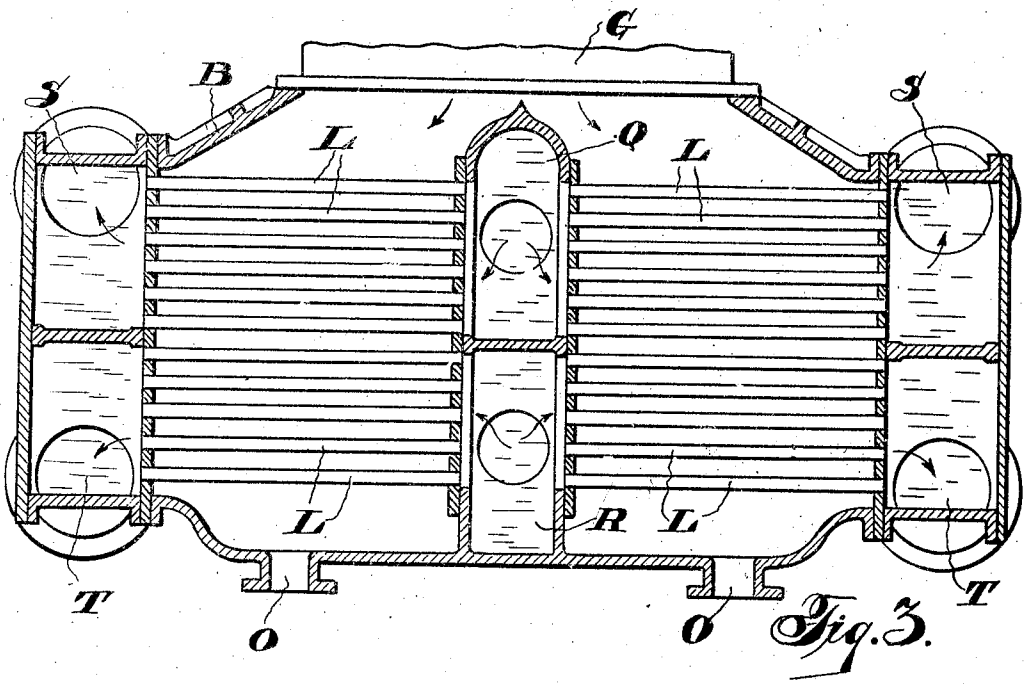

Fig. 3.

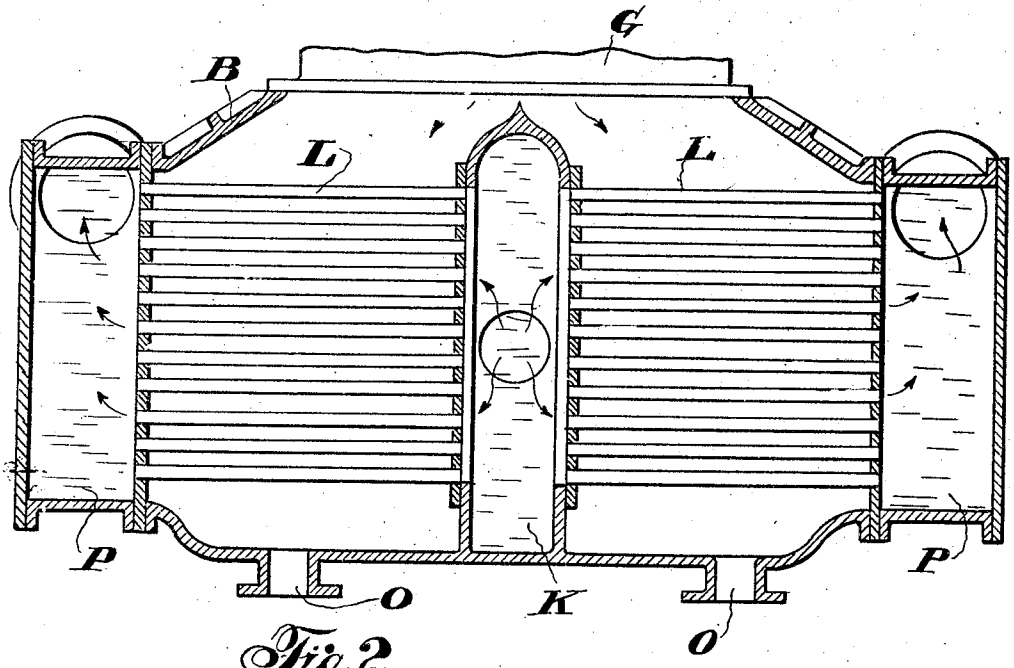

Fig. 2.

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UNITED STATES PATENT OFFICE.

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SURFACE CONDENSER.

Application filed April 11, 1925. Serial No. 22,249.

This invention relates to single pass condensers, but more particularly to that type called surface condensers in which a plurality of water cooled tubes are provided to condense steam or other vapor coming in contact therewith.

In the more common forms of steam condensers of this type, a plurality of water tubes extend longitudinally in the chamber across which the steam to be condensed is passed. The usual practice is to supply water to the tubes from a head at one end of the condenser and to discharge it at the other end of the condenser. In the more common forms of single pass condensers the water flows through all the pipes in the same direction. This usually results in uneven capacity for condensing steam in the opposite ends of the condenser, the cooler end being adapted to condense a greater volume of steam than the warmer end. Likewise, the depth of steam penetration into the condenser varies throughout the length of the condenser since the volume of steam passing through the cooler end is completely condensed upon reaching a less depth than the depth of penetration required for complete condensation at the warmer end, the tubes at the warmer end having less steam condensing capacity on account of their higher temperature than the cooler ends of the tubes at the opposite end of the condenser.

It is an object of this invention to equalize the steam condensing capacity of the two ends of the condenser and also to equalize the depth of penetration of the steam into the banks of tubes so that the entire space provided for condensing the steam may be most efficiently utilized.

Other objects and advantages will be apparent from the following description of certain embodiments of the invention shown in the drawings, in which—

Figure 1 is a longitudinal vertical section of a condenser in which the condensing capacities of the various portions are equalized by passing the water through certain levels of the tubes in opposite directions.

Figure 2 is a modification shown in longitudinal vertical section in which water is supplied to the tubes at their mid section and passes in opposite directions toward the ends of the condenser, and

Figure 3 is a modification shown in longitudinal vertical section in which the banks of tubes are divided into two levels each of which is supplied at the center with water from separate sources.

Since the inequality in the condensing capacity of the usual form of single pass surface condenser is due to the unsymmetrical arrangement of the condensing capacity of the tubes, it is proposed to overcome this condition by balancing the two ends through a symmetrical arrangement of the condensing capacities so that if the condenser be considered to be divided at the center in two sections of equal volume, each such volume will include substantially similar cooling surfaces of corresponding temperatures.

In the embodiment shown in Figure 1 this is accomplished by grouping the tubes into upper and lower levels containing the same length and number of water tubes A which are enclosed within a casing or shell B forming the steam chamber. The cooling water is introduced into the upper level of the water tubes A by means of an upper inlet water head C and to the lower level of tubes A from a lower water inlet head D. The water heads C and D are situated at opposite ends of the casing B and are each supplied with cold water of substantially the same temperature. The upper group of tubes A discharge into an outlet water head E and the lower level of tubes A discharge into an outlet water head F.

The steam enters the casing B through a steam inlet G and passing transversely across the tubes A is condensed into water which is drawn out at the condensate outlet H by means of suitable evacuating apparatus as is well known. As the steam passes across the banks of the tubes A in the direction of the outlet H, its heat of vaporization is absorbed by the tubes and the temperature of the water therein is thereupon raised. The heat is transferred to the tubes in proportion to their heat absorbing power which depends upon the temperature difference between the steam and the cooling area of the tubes. The water in the tubes A absorbs more and more heat in passing from the respective water inlets to the water outlets, so that the water is at a substantially higher temperature at the outlets than at the inlets. The difference in temperature between the inlet and outlet water may be 10° or more, depending upon the velocity of the water. However, with the arrangement of inlets

and outlets for the water as above described, the average temperature of the water in any cross section in the length of the tubes A will be substantially the same and therefore, the condensing capacity at any section along the length of the condenser is also substantially contant. A straight line flow for the steam substantially perpendicular to the tubes A may be assisted by the use of a tube supporting sheet J which partitions the condenser into approximately equal parts and to a great extent prevents a diagonal flow of steam from the upper warm end to the lower warm end.

In Figure 2, symmetry in the condenser is obtained by the use of a central water inlet K which supplies water to the tubes L at all levels. The same number and length of tubes L are provided on either side of the inlet K. Since the steam inlet G is located symmetrically with respect to the water inlet K and similar condensate outlets O connected with each other and with similar evacuating apparatus, substantially the same volume of steam should pass to each section of the condenser. In this embodiment, the water outlet heads P are situated at the ends of the condenser.

The embodiment shown in Figure 3 is one which is designed to produce greater economy in the water supply. Here the tubes L are divided into upper and lower levels, the upper level being provided with a water inlet Q and the lower level being provided with a water inlet R. Corresponding water outlets S and T are provided for the water supply to the tubes L from the inlets Q and R respectively. The same symmetry of cooling surfaces is found in this arrangement as is described in connection with Figure 2. The tubes L in the lower level are designed mainly for cooling the condensate and uncondensible gas before its discharge from the condensate outlets Q and when used for this purpose are not required to absorb as great a quantity of heat as those tubes L in the upper level. Therefore, water is supplied to the water inlet R at much less velocity than at the inlet Q. In the upper levels the greater part of the condensation takes place and therefore, in order to produce less temperature drop in opposite ends of the tubes L the water is supplied through the inlet Q at a relatively high velocity which in addition to supplying a greater quantity of cooling water assists in agitating the water within the tubes L and breaks up the stream line flow of water causing the metal to water heat transfer to be materially increased.

Operating conditions may be considerably improved by the use of separate inlets for upper or lower levels of tubes as above described, for instance, when the inlet water is very cold as in winter, it may be unnecessary to supply any water from the inlet R leaving the entire condensation to be taken care of by the tubes in the upper level without loss of efficiency. In summer when the cooling water is not as cold as in winter, it may be desirable to supply cooling water from both inlets Q and R at their maximum capacity in order to condense the steam.

I claim:

1. A single pass surface condenser, comprising a casing, water tubes extending into said casing transverse to the direction of steam flow, and a central inlet associated with said water tubes for supplying water to said tubes in substantially equal quantities and in opposite directions along said casing.

2. A surface condenser, comprising a casing, water tubes extending into said casing, two inlets centrally disposed in said casing and arranged to group said tubes in upper and lower levels, each of said water inlets being adapted to supply water to said tubes in equal quantities flowing in opposite directions along said casing and to equal numbers of said tubes.

In testimony whereof I have signed this specification.

JOHN E. GOODWILLIE.