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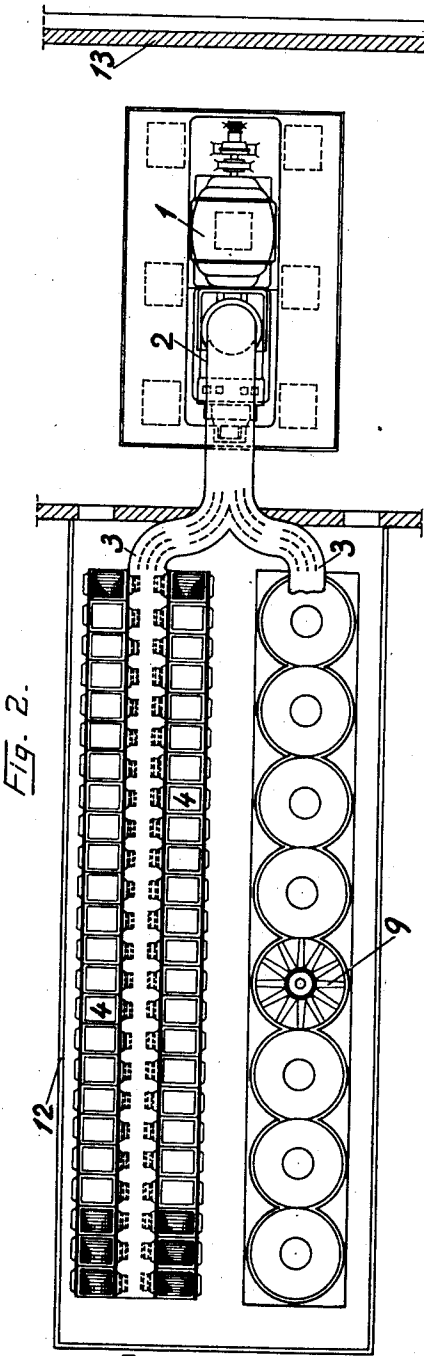
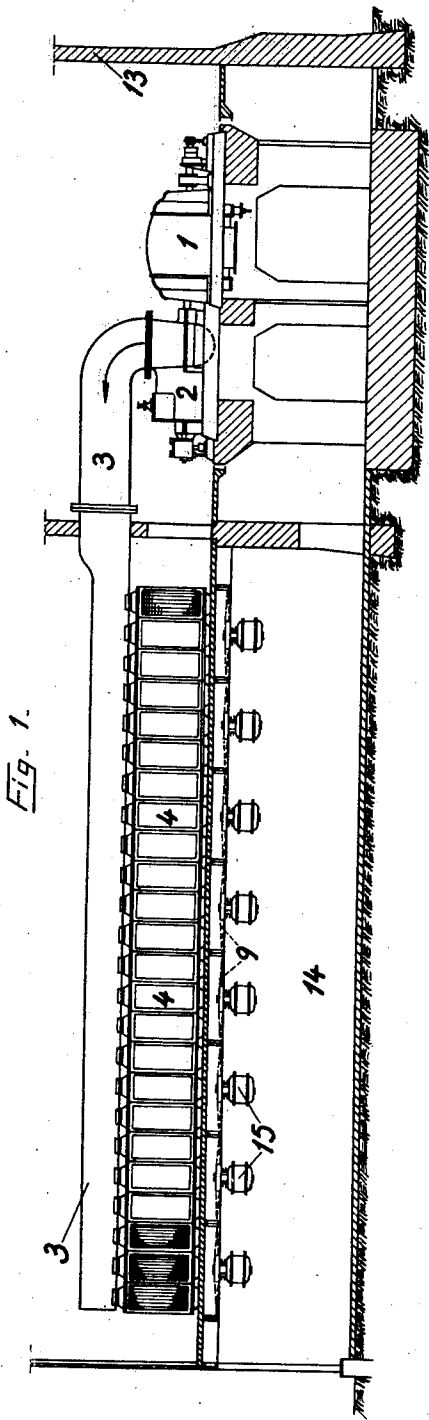
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2,107,478

AIR-COOLED SURFACE CONDENSER

Filed June 22, 1936

3 Sheets-Sheet 1



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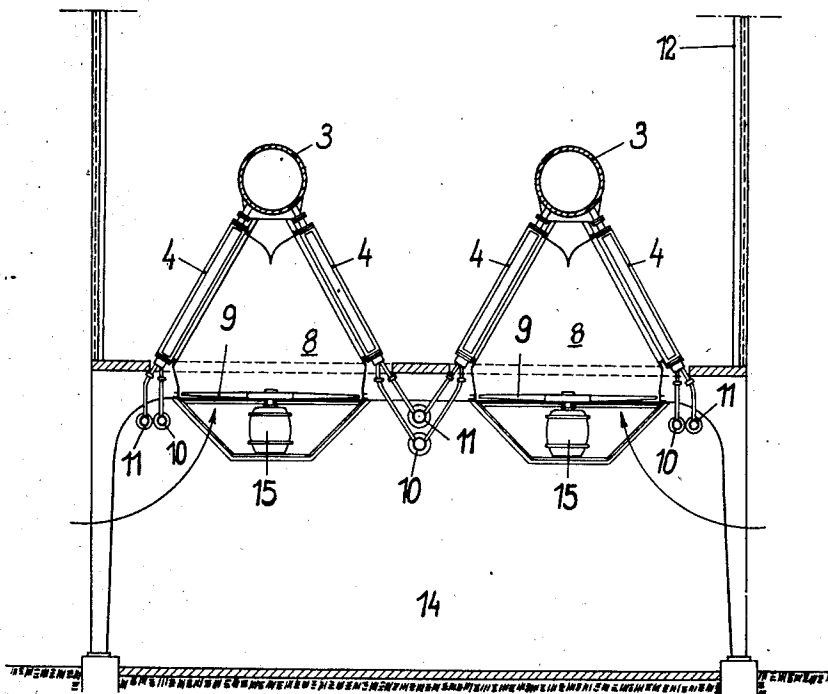
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Fig. 3



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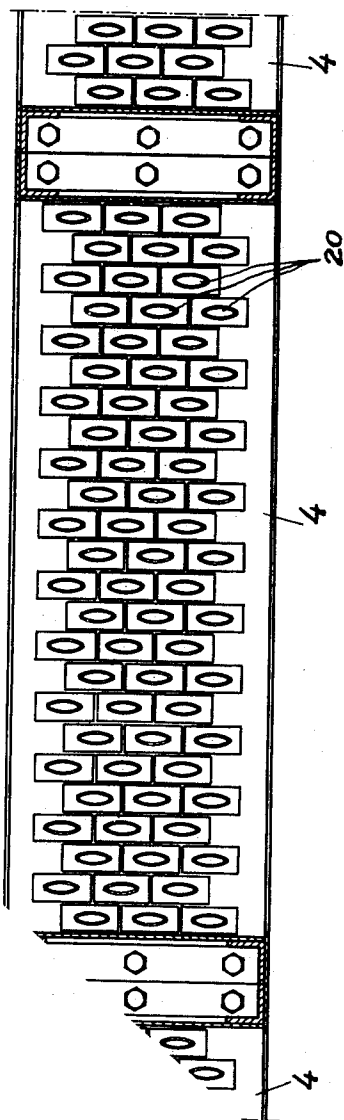
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Fig. 4.



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UNITED STATES PATENT OFFICE

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AIR-COOLED SURFACE CONDENSER

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Application June 22, 1936, Serial No. 86,682

In Germany October 17, 1934

1 Claim. (Cl. 257—36)

The condensation of the exhaust steam of high-powered engines working with a high vacuum, especially steam turbines, has heretofore always been effected by water cooled condensers, the cooling water of which is generally re-cooled by a tower cooler, unless an unlimited supply of water is available. Tower coolers take up more space than the engines themselves, and there is risk of dust from the surroundings getting into the circulating cooling water, so as to settle in the condenser tubes, which necessitates frequent cleaning out of the condenser with consequent temporary closing down of the plant. The deleterious gases in the air also pass into the cooling water and have a detrimental action on the condenser tubes. This results in leakage, which not only affects the vacuum but may also deteriorate the water of condensation used for feeding the boilers.

The main disadvantage of a cooling tower is that a certain amount of fresh water must be added to replace the cooling water evaporated by the ascending current of air, and the supply of this additional water is frequently costly and difficult, as it has to be softened before it can be used.

My invention provides apparatus enabling the exhaust steam of engines to be condensed by means of a blast of dry air, in a surface condenser, thus dispensing with cooling water and with a tower and the auxiliary plant associated therewith.

Surface condensers cooled by a positively propelled current of air are well known, and it has been proposed to provide for instance a small reciprocating steam engine with a condenser of this kind, wherein the blast of air is produced by a fan, in some cases with a vacuum, but such condensers are only suitable for small engines working with a low vacuum. It has also been proposed to use air cooled condensers on locomotives, the condenser elements consisting of narrow elliptical ribbed tubes arranged in rows on both sides of the tender and cooled by a fan, but attempts to produce a vacuum have not been successful in this connection.

Attempts in the past to apply condensers of this kind to engines of high power, especially turbines, working with a high vacuum, have failed, the chief reason being the difficulty of providing the necessary high vacuum. In the summer the temperature of the air used for cooling may be as high as 25° C. so that the mean difference between the temperature of the exhaust steam and that of the cooling air is com-

paratively small, and this has led to the belief in the past that an air-cooled condenser would have to be so large, and the volume of air so great as to render the plant uneconomical.

I have established that this view is not correct and that the difficulties envisaged can be overcome by adopting the construction now to be described. According to the invention the condenser is built up of rows of ribbed tubes of small cross section arranged in parallel, in combination with fans of large diameter designed to blow a large volume of air at a very low pressure, not exceeding about 25 mm. water column, through the system of tubes, said rows of tubes together with the fans being arranged above a large suction chamber open at the sides. The condenser tubes may be small diameter tubes of circular cross section, but are preferably of elliptical cross section, as such tubes combine the most favourable heat exchange properties with a comparatively low resistance to the current of cooling air.

It has been proposed heretofore to use air cooled condensers having elliptical ribbed tubes, for use with locomotives and also for stationary engines, with air and water as the cooling medium, and fans have been used with such locomotive condensers, but the fans were designed to produce an air current of much higher pressure than is contemplated with my invention. The use of low air pressures, which preferably may not exceed about 10 mm. water column, is an essential feature of the invention.

Means are preferably provided for controlling the speed of the fans. This enables the speed to be increased in summer when the temperature is comparatively high, and also at other times when the load is high, and the speed can be reduced in winter when the temperature is lower.

The arrangement of the cooling elements and fans above a large open sided suction chamber results in a reduction of air velocity, so that the air current is fully utilized for cooling purposes, and the fans themselves only have to work against low pressures. As regards the size of the suction chamber, the chamber may for example be approximately 6 meters in height with a 16,000 kw. turbo-generator.

The rows of ribbed tubes are preferably arranged in pairs, the two rows constituting a pair being arranged at right angles or preferably at an acute angle so that they enclose between them a space of the shape of an equilateral triangle, above the apex of which is disposed the steam pipe, and the fans being arranged at the base. Two or

more such groups may be arranged side by side, according to requirements. This results in considerable saving of space as compared with a tower cooling plant and eliminates the other disadvantages associated with known plants for this purpose.

In the above mentioned air cooler condensers for locomotives the condenser tubes are in some cases arranged at an angle to each other so that they enclose a triangular space, the base of which is formed by the fans, the tubes being at an obtuse angle to each other. The acute angular arrangement according to my invention has the advantage that the entrance area for air into the condenser tube is substantially larger than the delivery area of the fans, possibly twice as large, so that the air velocity is reduced before entry among the tubes. Assuming that the air is discharged by the fans at a velocity of 8 to 10 meters per sec., then its velocity on entry into the condensers will have been reduced to approximately 4 to 5 meters per second. As compared with this the reduction of velocity in the case of locomotive condensers is comparatively slight, owing to the obtuse angle formed by the condenser elements.

The acute angle arrangement also has the advantage that the base area is reduced.

The speed of the fans may be controlled in any convenient manner and the fans may be collectively or separately controlled. In the latter case multi-phase current motors may be used to drive the fans, and the speed of these motors may be controlled from a central point, as for example by a frequency transformer, in accordance with the load or the outside temperature. The capacity of the fan motors is such that they are able to sustain a load in excess of normal, so that they are capable of developing the necessary power for the additional volume of air required in the summer when the temperature is higher.

An example of apparatus according to the invention is shown diagrammatically in the accompanying drawings, applied to a turbo-generator of 16,000 kw., and wherein

Fig. 1 is a front elevation,

Fig. 2 a plan, with the condenser structure omitted in the lower half thereof to show the fans,

Fig. 3 a side elevation, and Fig. 4 is a cross sectional view through one of the tube banks of Fig. 3.

The exhaust steam from the turbine 2 which drives the generator 1 passes through the main distributing pipes 3 to the several condenser elements 4.

The elements 4 consisting of one or more rows of tubes 20 are arranged at an acute angle to each other as shown in Fig. 3, so that they enclose a triangular space 3 above the vertex of which is the steam distributing pipe 3, and the base being formed by the fans 9. In the construction shown by way of example the fans are 3 to 4 meters in diameter and running at approximately 300 revolutions per minute which propels the air against a pressure of about 10 mm. water column.

The elements 4 are provided with pipes 10 for the discharge of the condensate, and with air pipes 11. The whole plant is shown installed in an annex 12 to the engine room 13, with the elements at the same level as the turbo-generator, and the suction chamber 14 being below this level. Each fan may have a separate electric motor 15 as shown, the motors being preferably multi-phase. All the motors may be controlled by controlling means common to them all, for example by a frequency transformer controlled in turn by the output of the engine or by the exterior temperature or by the vacuum, so that the fans will run at speeds to suit the existing conditions of operation.

Fig. 4 illustrates by a cross sectional view on a line perpendicular to one of the tube banks 4 in Fig. 3 the tube and fin structure and the relation of adjacent tubes.

I claim:

A high vacuum surface condenser for stationary steam engines and turbines operating under high vacuum, comprising a foundation having a suction chamber, a main distributing pipe in a space above the chamber and through which the exhaust steam passes from the turbine, groups of ribbed tubes of which each tube is of small cross-section connected to and extending in pairs down from the distributing pipe to form an acute angle, and a plurality of fans arranged in a row under the tube elements to draw a large volume of air from the suction chamber up and around the tube elements.

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