United States Patent [19]

Kelp

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[54] **STEAM POWER INSTALLATION HAVING A COOLING TOWER-AIR CONDENSATION APPARATUS**

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Related U.S. Application Data

[63] Continuation of Ser. No. 181,954, Sept. 20, 1971, abandoned.

[30] **Foreign Application Priority Data**

Sept. 22, 1970 Germany 2046605

[52] **U.S. Cl.** **165/111**; 261/DIG. 11

[51] **Int. Cl.²** **F28B 11/00**

[58] **Field of Search** 165/111, 122, 196

[56] **References Cited**

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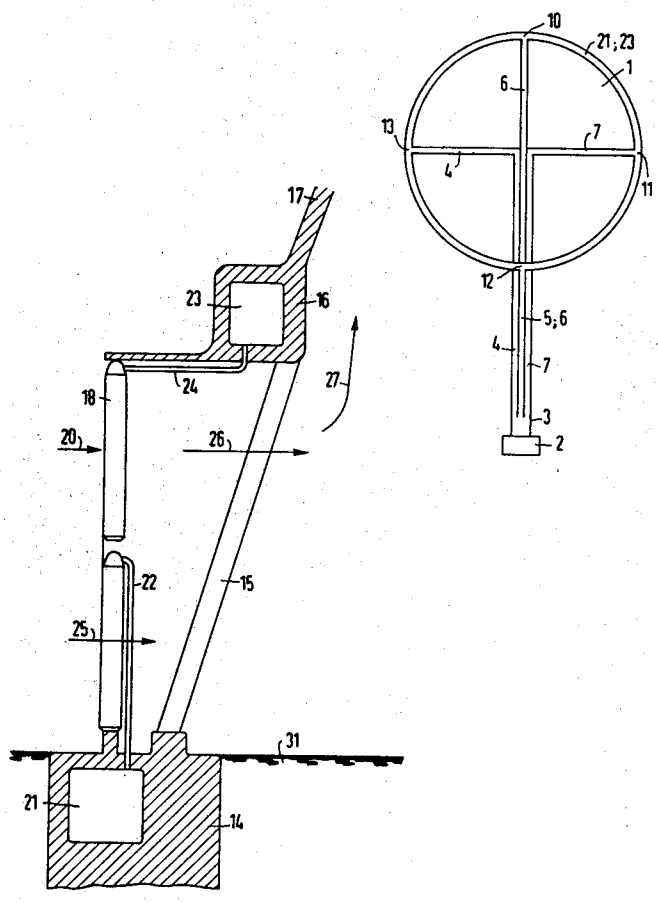
[57] **ABSTRACT**

A steam power installation has a source of heated exhaust vapor and a cooling tower-air condensation apparatus; this apparatus has cooling members having inlets communicating with the source of heated exhaust vapor and disposed in direct heat exchange with a flow of cooling air. Also provided is an exhaust conduit and a manifold conduit connected between the exhaust conduit and the respective inlets of the cooling members for supplying the exhaust vapor in substantially equal quantities to the respective cooling members. The exhaust conduit has a plurality of component conduits of varying lengths and path directions respectively, communicating with the manifold at selected locations thereof, the component conduits having varying cross-sections of given dimension for obtaining in all of the component conduits an equal value of exhaust vapor pressure loss for substantially an equal quantity of the exhaust vapor present in the component conduits.

3 Claims, 3 Drawing Figures



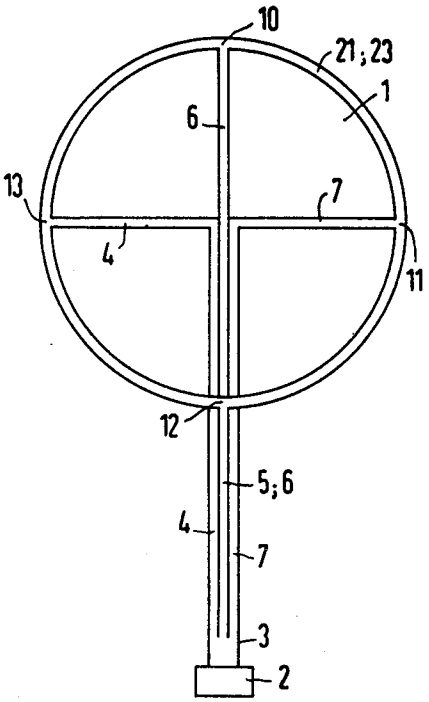


Fig. 1

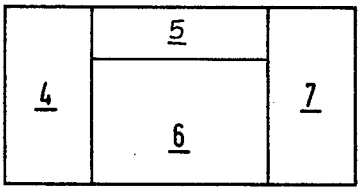


Fig. 2

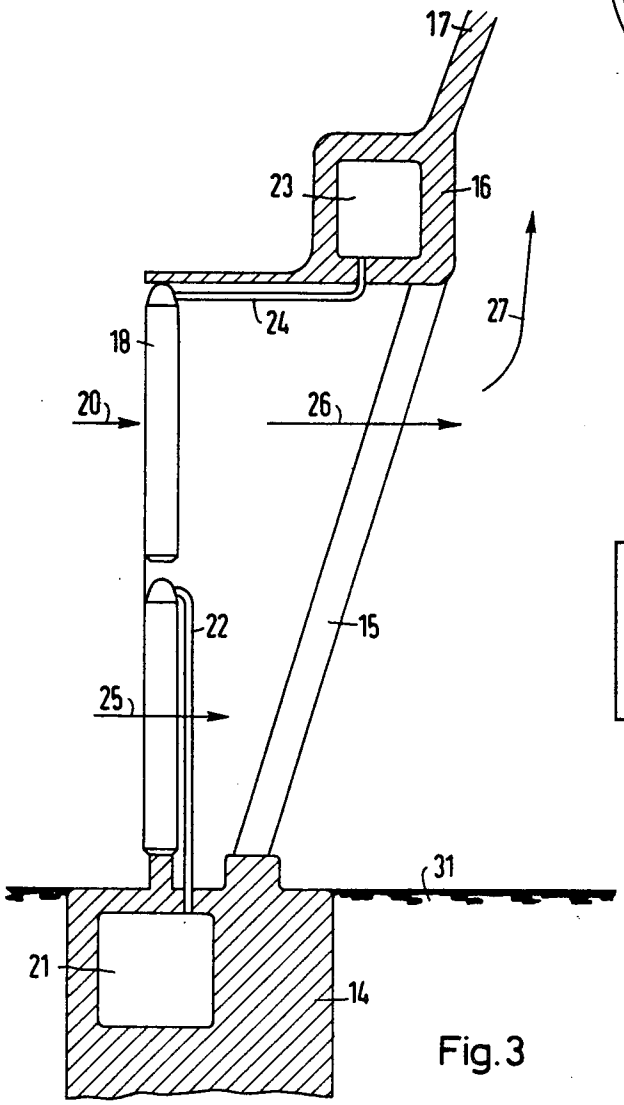


Fig. 3

STEAM POWER INSTALLATION HAVING A COOLING TOWER-AIR CONDENSATION APPARATUS

This is a continuation, of application Ser. No. 181,954, filed Sept. 20, 1971, now abandoned.

My invention relates to a steam power installation having a cooling tower-air condensation apparatus whose cooling members are connected to the exhaust conduit of the power machine or source of exhaust vapor. The cooling members are exposed in direct heat exchange relation to a cooling air stream moved by means of natural draft. A natural draft-cooling tower-air condensation apparatus affords the advantage that no additional energy for moving a cooling medium is required for cooling and condensing the exhaust. Further, utilizing the natural draft causes a minimum of noise so that in contrast to a forced air cooling apparatus, the environment is not affected by any undesired noise.

By means of the direct heat transfer from the cooling tubes to the passing cooling air, the formation of vapor clouds is precluded so that this type of installation poses hardly any annoyance to persons working and living in the immediate vicinity.

In contrast thereto, there is the disadvantage that for voluminous vapor quantities correspondingly large vapor conduits extend over large distances from the outlet of the power machine to the condensation members in the region of the cooling tower. In this connection, consideration must be given to the influences of the wind when the cooling capacity of the individual condensation members is subjected to strong local variations. These conditions are made more difficult if for larger power plant capacities, correspondingly large dimensions of the cooling tower are required. Thus, for example, for larger power plant units, cooling towers are required with a base diameter of more than 100 meters, whereby the center axis of the cooling tower is approximately the same distance from the outlet ports of the steam turbine.

To obtain a uniform vapor loading, one would first direct the exhaust vapor conduit from the outlet ports of the turbine to the center point of the cooling tower and from there undertake a radial distribution with the aid of individual conduits. In this way the steam or vapor can be directed in star formation to the condensation members at various locations. Such a conduit distribution has the disadvantage that large expenditures for construction are required and that in addition a vapor exchange between the various cooled condensation members under the influence of wind is only possible over very long conduit paths; this is in practice hardly realizable.

These disadvantages are precluded by the invention and accordingly, it is an object of my invention to provide a cooling tower-air condensation apparatus which obviates the above delineated difficulties.

It is another object of my invention to provide a substantially even distribution of exhaust vapor to the cooling members of a cooling tower-air condensation apparatus.

According to a feature of my invention the vapor inlets of individual cooling members or groups of cooling members or all cooling members are mutually joined by a manifold conduit which functions as a balancing conduit. And, the exhaust vapor conduit consists of a plurality of parallel extending conduits of different lengths

or paths through which the exhaust vapors pass; these conduits feed into a common manifold or collector conduit at various locations. Further, the cross-sections of the conduits are dimensioned so that with different conduit lengths or conduit paths, the same pressure losses occur for like quantities of vapor.

According to a further feature of the invention, the exhaust conduit can be divided into several parallel component conduits at the region of the power machine or source of exhaust vapor. It is preferable that this division takes place directly at the vapor exhaust of the exhaust vapor source. The manifold conduit which serves as a balancing conduit for the cooling members can be configured as a ring channel, whereby the ring channel can communicate with individual cooling members and groups of cooling members by means of a plurality of connections. The ring channel is given a cross-section of such size that a balance of the exhaust vapor quantities flowing to the cooling members for varying cooling capacities of the individual cooling members is determined for example, by the influence of wind.

Within the scope of the invention, the structural members formed on the cooling tower can be of polygonal form or ring-shaped for mounting the manifold conduit. Also, the structural members for arrangement of the ring-shaped vapor distribution can be considered individually or together within the foundation as well as in the region above where the cooling air enters. Especially in the application of a step-wise condensation, the cooling members can be arranged in the foundation as well as in the reinforcement at higher levels for having separate vapor entrances, since with step-wise condensation, the same quantity of air passes through the cooling members one after the other which are arranged with respect to various exhaust vapor stages of the power machine. In this manner, for example, a lower distribution ring in the cooling tower foundation can be applied for the lower exhaust vapor pressure whereas, the upper distribution ring can be used for the higher one of the two exhaust vapor pressures.

The ring-shaped manifold conduit can be made of steel and can be secured to ring-shaped parts of the cooling tower. Further it is also possible to incorporate these conduits in the construction of the cooling tower, that is, to form them as an integral part of a structural member for example, in the form of a hidden concrete casing. In this connection, by means of integrated building techniques of the ring-shaped structural members of the cooling tower, an application of these structural members to serve at the same time as ring-shaped manifold conduits can be considered, wherewith corresponding protection measures for preventing a heat expansion in the construction must be undertaken as well as a construction to prevent the taking up of foreign particles from the turbine exhaust. In such instances, additional manifold conduits can be obviated.

Other features which are considered as characteristic for the invention are set forth in the appendent claims. Although the invention is illustrated and described herein as a steam power installation having a cooling tower-air condensation apparatus, it is nevertheless not intended to be limited to the details shown, since various modifications may be made therein within the scope and the range of the claims.

The invention, however, together with additional objects and advantages thereof, would best be understood

from the following description in connection with the accompanying drawing in which:

FIG. 1 is a schematic diagram in plan view of a condensation apparatus in which an exhaust conduit is directed from the exhaust ports of a power machine to a cooling tower;

FIG. 2 is a section view of a steam conduit having individual component conduits as required by the invention;

FIG. 3 is a partial section of the lower portion of a cooling tower illustrating cooling members and their supply channels;

FIG. 1 illustrates a plan view of a condensation apparatus in which an exhaust conduit **3** is directed to a cooling tower **1** from the exhaust ports of a power machine or source of heated exhaust vapor **2.** The exhaust conduit **3** is apportioned into four parallel component conduit extrusions **4, 5, 6** and **7** preferably in the region of the machine directly behind the vapor exhaust ports. These component conduits are directed to a cooling tower **1** and serve for supplying the cooling members not illustrated in FIG. **1** and which are located in the regions of sectors **10, 11, 12** and **13.**

Although one would be inclined to direct a single and correspondingly large vapor conduit to the center of the cooling tower **1** and, from there, to supply the manifold conduit **21** in a star-like distribution arrangement for the individual cooling members, the invention, however, teaches that individual conduits are to feed directly into the manifold conduit **21** at four feed locations as shown, whereby the lengths of the individual component conduits vary.

In the illustrated embodiment, the conduit **5** is shorter than the conduits **4, 6, 7** over a large distance which can amount to over 100 meters. The lengths of the conduits **4, 6** and **7** are approximately the same, whereas the conduit **6** extends along a straight line whereas conduits **4** and **7** change direction at an angle of 90°. It is possible to bend the conduits **4** and **7** at a location somewhat before the center of the cooling tower **1** instead of at the center, so that an angle of reduced sharpness is obtained. The bending of these component conduits can occur also at the branching location in the region of the power machine **2.** In this connection, one must take into account that from situation to situation, the conduit lengths and conduit paths for the flow resistance for the vapor quantities are uneven in the individual conduits.

As is apparent from FIG. **2,** according to the invention, the individual parallel component conduits of varying conduit length and conduit path are given the cross-sections of dimensions that vary and that obtain in all of the component conduits an equal value of the exhaust vapor pressure or loss for substantially an equal quantity of the exhaust vapor present in the component conduits.

FIG. **2** shows a sectional view of a vapor conduit having individual component conduits **4, 5, 6** and **7** and are designated by the same reference numerals as in FIG. **1.** For achieving the same pressure loss for the same flow quantities, the component conduit **5** has a smaller section as the component conduit **6,** whereas the conduits **4** and **7** are provided with a larger section because of the change in direction taken by these conduits.

Should this change of direction be undertaken with the correspondingly small angle or the change of direction be provided at the beginning of the conduits **4** and **7,** the conduits **4** and **7** would offer a smaller resistance to flow than conduit **6,** so that smaller cross-sections then would be required for conduits **4** and **7** than for conduit **6,** but a larger cross-section than that required for conduit **5.** The component conduits could have other cross-sections, that is, the sections could deviate from those illustrated in FIG. **2** to incorporate, for example, circular cross-sections.

FIG. **3** illustrates a greatly simplified schematic illustration of the cooling tower taken in the lower region thereof. The foundation ring **14** is embedded within the earth region **31** and carries thereabout a plurality of carrier supports **15** at the region where the air enters. Above the carrier support **15** is located an upper reinforcement ring **16** which carries a cover construction **17.** Cooling members **18** and **19** are arranged in front of the air opening at the region of the carrier support **15.** The flow of cooling air passes members in the direction of the arrows **20** and **25.** The air flow moves in the direction of the arrow **26** through the intermediate space between the carrier support **15** and moves finally in the direction of arrow **27** upwardly into the interior of the cooling tower.

Within the foundation ring **14,** there is a ring channel **21** connected with a row of tubes **22** and which directs the exhaust to be condensed to the cooling members **19.** In a similar manner, the vapor for the cooling member **18** from the ring channel **23** within the reinforcement ring **16** is directed over tubes **24.** In this connection, it is important that the ring conduits **21** and **23** are sufficiently dimensioned in their cross-section in order to balance out changes in the cooling capacity.

By directing the exhaust in subsidiary flows to four locations in the ring channel as in FIG. **1,** a maximum of only one-eighth of the total exhaust vapor quantity flows at any portion of the ring channel. The form of the conduits and channels can be configured as desired, for example, they can be circular in order to obtain the necessary stiffness against the inner under pressure in the simplest possible manner.

I claim:

1. In a steam power installation having a source of heated exhaust vapor, means defining a travel path for a natural draft flow of cooling air, cooling members disposed in direct heat exchange relationship with the flow of cooling air in said travel path, a manifold conduit for supplying said cooling members with heated exhaust vapors, said manifold conduit being in the form of a closed ring defining an endless conduit, said source of heated exhaust vapors being disposed outside of said closed ring defining said manifold conduit, exhaust means leading from said source of heated exhaust vapor to said manifold conduit, said exhaust means including a common first conduit leading from said source of heated exhaust vapor, means dividing said first conduit into a plurality of channels with each channel having a substantially constant cross-sectional area throughout its longitudinal length, at least one of said channels having a cross-sectional area which differs from the cross-sectional area of said other channels, said exhaust means including a plurality of second conduits leading from respective channels and having substantially the same cross-sectional area as the respective channel, at least one of said plurality of second conduits having a length different from the length of other of said plurality of second conduits, at least another of said plurality of second conduits extending

along a path configuration different from the path configuration of the other of said plurality of second conduits, said channels and second conduits having a cross-sectional area related to said differences in length and path configuration of said second conduits such that said exhaust vapor passes through said channels and respective second conduits with the same pressure loss for like quantities of vapor to thereby provide a substantially balanced and even distribution of exhaust vapor to said manifold conduit.

2. In a steam power installation according to claim **1** wherein said cooling members are formed as part of a cooling tower, said manifold conduit being formed as an integral component of said cooling tower.

3. In a steam power installation according to claim **1** wherein said manifold conduit is formed as an endless and open channel.

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