Oct. 1, 1957 L. FORGÓ 2,808,197

FAN ASSEMBLY

Filed Dec. 27, 1955 2 Sheets-Sheet 1

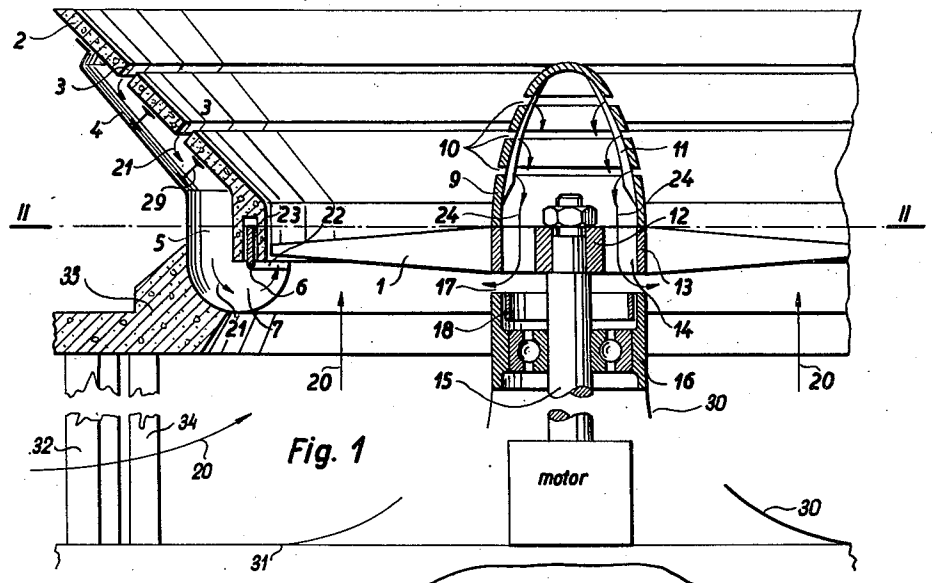


Fig. 1

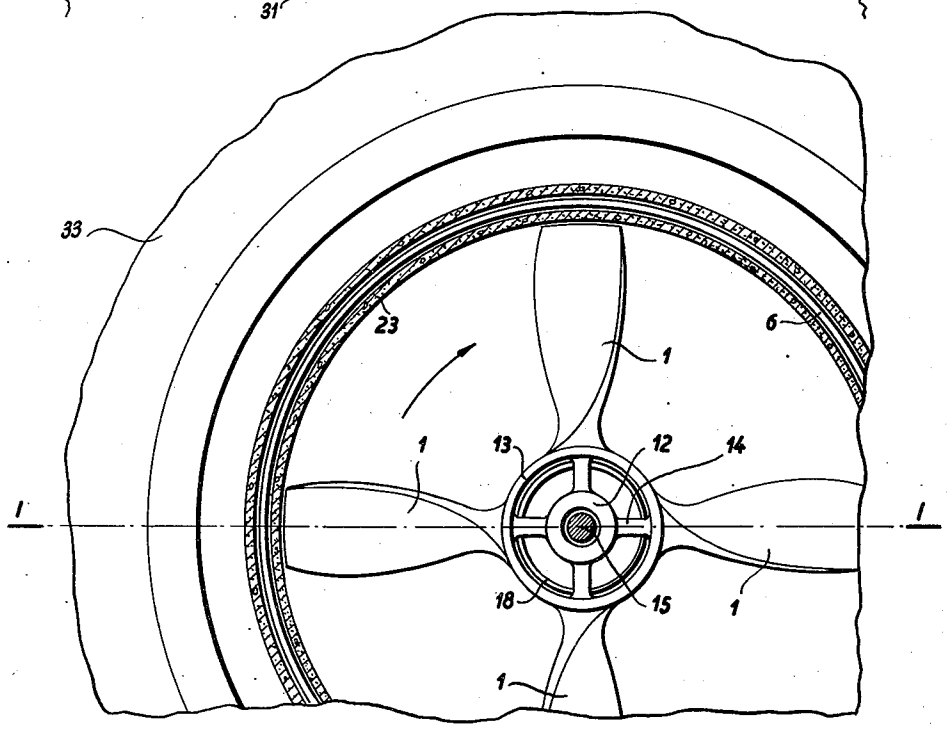


Fig. 2

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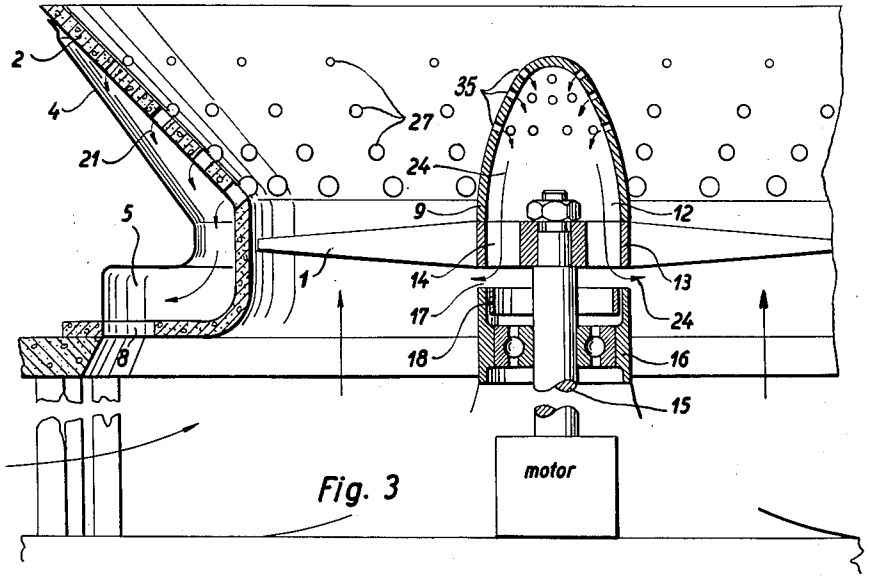


Fig. 3

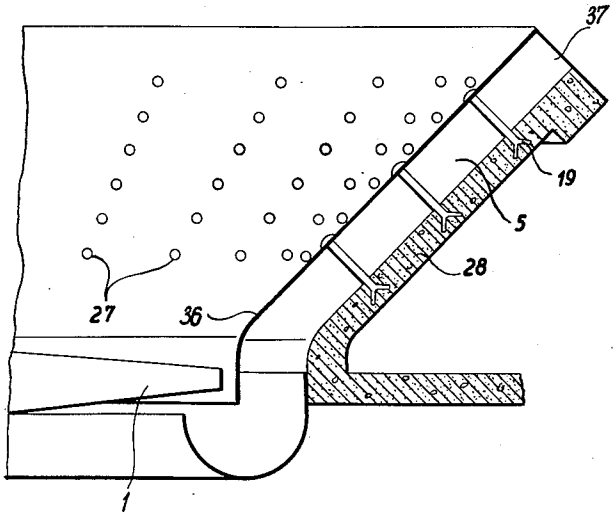


Fig. 4

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FAN ASSEMBLY

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Application December 27, 1955, Serial No. 555,681

5 Claims. (Cl. 230—120)

This invention relates to a fan assembly, particularly to such a device as is adapted to air cooled condensers of steam power plants. In plants of this kind the condensate is moved from an injection condenser through a cooling system comprising at least one pump and heat exchange devices, back to said injection condenser wherein the cooled condensate, i. e. water, serves to condense the dead steam supplied from the turbines or like prime movers of a power plant. As external cooling medium air compelled over the cooling surfaces of the heat exchanger is used. In order to maintain a continuous airflow through the cooling system the air is moved by means of a fan. At the discharge side of said fan there is provided a casing or shell formed, on the one hand, by a cylindrical casing portion arranged coaxially with said fan and, on the other hand, by a divergent outlet portion, called diffuser in this specification and in the appended claims, adjacent to said cylindrical portion and opening, at its free end, into the atmosphere. To obtain good efficiency, the angle of aperture of the diffuser should not exceed 8 to 12 degrees, otherwise the boundary layer of air formed near the walls of the diffuser would become detached therefrom whereby the diffuser action would be impaired. Such small aperture angles may result in very great lengths of the diffuser. Where this is unfeasible or too expensive, the cross-section of the outlet ought to be diminished or, with the drawbacks referred to above, the aperture angle of the diffuser increased.

An object of the invention is to provide an improved diffuser of the above mentioned kind in which means are provided adapted to draw off the boundary layer formed on the inner surface of the diffuser, without employing a separate fan or ventilator for this purpose.

According to the invention the diffuser is double walled along the whole length of its divergent part, openings are provided in the inner wall of the diffuser connecting the discharge side of a fan arranged at the entrance of the diffuser with its intake side by means of a by-way, this by-way being formed by the inner space of the double wall of the diffuser.

Since in steam-plants with high capacity great quantities of cooling air are to be moved through the heat exchangers forming conduits for the condensate, the fan assembly according to this invention will be of great dimensions, the largest diameter of the frusto-conical diffuser measuring up to 20–25 meters. In order to maintain a high efficiency of the fan compelling the air over the cooling surfaces of the heat exchange device, a hollow cap of streamline form should be arranged over the hub of said fan on the discharge side of the fan. To avoid the forming of a stationary boundary layer around this cap and to cause further the air delivered by the fan to fill in the diffuser also in the vicinity of said cap, according to the invention openings are provided in the wall of said cap forming passages between the interior of the diffuser and the space inside the hollow cap this space communicating with the intake side of the fan.

By these means the boundary layers which would form

on the inner surface of the diffuser and on the outer surface of the cap arranged on the hub of the fan, will be drawn off by the fan itself without employing separate devices such as a separate ventilator for this purpose.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings:

Figure 1 is a vertical sectional view taken on line I—I of Figure 2 of one embodiment of the fan assembly according to the invention,

Figure 2 is a cross section taken on line II—II of Figure 1,

Figure 3 is a vertical sectional view of a second embodiment of the invention,

Figure 4 is a vertical sectional view of a third embodiment of the diffuser according to the invention.

In the various figures the same reference characters denote the same parts.

Referring to Figures 1 and 2 the reference number 1 designates the blades of a fan blowing air in the direction of the arrows 20. The blades 1 of the fan are arranged on a spider keyed to the shaft 15 driven by a motor. The spider consists of a hub 12 and a rim 13 connected together by means of spokes 14. Integral with the rim there is provided a hollow cap 9 the wall of this cap being subdivided by slots 10 parallel with one another. The detached parts of the cap 9 are connected to one another by means of ribs 11 provided inside the hollow cap 9. The shaft 15 is carried in a ball bearing arranged in a cylindrical bracket 16, this bracket mounted upon a central hollow support 30 built up of concrete or the like and resting upon an appropriate foundation 31. On this foundation 31 there are erected posts 32 supporting a frame 33, forming the base of a diffuser surrounding the discharge side of the fan described above. Cooling air is drawn between the cooling surfaces of heat exchangers 34 of the kind described in my copending applications Ser. No. 555,682 filed December 27, 1955, and Ser. No. 555,683, December 27, 1955 and is discharged in the diffuser.

The diffuser forms part of a casing or shell having a converging entrance portion, a short cylindrical portion and a diverging outlet portion all these portions being coaxial with the shaft 15 of the fan described above. The diverging portion of the casing, forming the diffuser proper, is a double-walled body, consisting of an inner wall 2 made of concrete and an outer wall 4 made of sheet metal and connected to the inner wall by means of struts 29 disposed in the space 5 between the two walls 2 and 4. The upper edge of the outer wall 4 is flanged all around and tightly connected to the inner wall 2 by any suitable means so as to prevent leakage at this junction of the two walls.

The outer wall 4 is a plain one completely separating the space 5 from the atmosphere. The inner wall 2 is subdivided by means of slots 3 disposed along parallel circles and forming openings through which the space inside the diffuser communicates with the space 5 inside the double-wall 2, 4. Since the space 5 opens at the intake side of the fan through a ring-shaped gap 22, the space 5 forms a by-way connecting the slots 3 with the intake side of the fan. Thus the air which would form a boundary layer on the inner surface of wall 2, is drawn off by the fan itself.

Preferably the cross section, i. e. the width of the slots 3 decreases proportionally to their distance from said fan that is proportionally to the increasing of the pressure inside the diffuser.

In order to control the quantity of the air drawn off in the direction of the arrows 21 through the slots 3 from the inner surface of the wall 2, adjusting means may be

provided in the diffuser adapted to control the cross section of the space **5** near the opening **22** connecting this spcae with the intake side of the fan. For this purpose in the embodiment shown in Figure 1 there is provided a ring-shaped slidable member **6** in the enlarged lower end **23** of the wall **2** which may be lowered into the channel **7** or lifted therefrom, thereby reducing or increasing the sectional area of flow.

In fan assemblies of great dimensions eddies forming behind the fan may cause considerable eddy current losses. In order to avoid these losses I prefer to arrange the hollow cap **9** of stream line form described above. Although the cap **9** is adapted to inhibit the forming of said eddies separate means are to be provided in order to prevent the forming of a stationary boundary layer all around the cap. For this purpose there are provided the slots **10** mentioned above and a ring-shaped gap **17** between the spider of the fan and the bracket **16**. Through the slots **10** in the hollow cap **9**, the space inside the cap and between the spikes **14**, the air that would form a boundary layer around the cap is drawn off and is delivered to the intake side of the fan through the gap **17**. This air flows in the direction of the arrows **24**. The quantity of the air drawn off from the outer surface of the cap **9** may be controlled by a ring-shaped member **18** located near the slot **17** inside the bracket **16**. By lowering and lifting the slidably mounted ring **18** the width of the slot **17** will be increased or reduced.

The embodiment of the fan assembly according to the invention shown in Figure 3 differs from that of Figures 1 and 2 only in that the openings in the inner wall **2** of the diffuser are holes **27** instead of slots, the holes **27** being disposed along circles parallel to one another and coaxial with the shaft **15** of the fan. Similar holes **35** are provided in the wall of the cap **9** over the hub of the fan.

Preferably the total cross section of the holes **27** disposed along each of the coaxial rows decreases proportionally to the distance of the rows from the fan, i. e. proportionally to the increasing of the pressure of the air inside the diffuser. Since this pressure increases proportionally to the distance from the fan, the difference between the pressure of the air in the diffuser and the pressure of the air on the intake side of the fan increases proportionally to the distance of the holes **27** from the fan. To maintain, however, a constant value of the quantity of the air drawn off through subsequent rows of openings, the cross section of the openings is to be diminished proportionally to said distance and increase of air pressure inside the diffuser. For this purpose, in the embodiment of Figs. 1 and 2 the width of the slots **3** is to be varied and in the embodiment of Fig. 3 either the diameter of the holes **27** or their number in the various rows is to be likewise varied. In the embodiment according to Figure 3 the space **5** between the two walls **2** and **4** communicates through openings **8** with the intake side of the fan.

In the two embodiments of the invention shown in Figures 1–3 the double walled diffuser has an inner wall **2** made of concrete and an outer wall **4** made of sheet metal. In the embodiment shown in Figure 4 the inner wall **36** is made of a perforated sheet metal and is supported by means of bolts **19** on the plain outer wall **28** made of concrete. The upper end of the space **5** between the two walls **36** and **28** is closed by the bordered edge **37** of the metallic inner wall **36**. In both cases the solid

frame of the diffuser is formed by the wall made of concrete.

The invention makes it possible to build up cooling structures, such as cooling towers for steam plants of great capacity wherein the cooling air is moved by a fan or ventilator through a diffuser having an aperture of more than the usual 8–12°, even up to 90°–180° and though operating with good efficiency and having a short length. Therefore it is especially adapted for fan assemblies having very great dimensions as are the dimensions of air-cooled steam condensers.

Since the hollow cap **9** is integral with the rim **13** of the spider forming the hub of the fan, so it rotates together with the rotor of the fan and no special supporting mountings are needed as applied in fan assemblies having a stationary or fixed cowling in front of the hub of the rotor.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I therefore wish not to be restricted to the precise constructions herein disclosed.

Having thus described and shown various embodiments of my invention, what I claim is:

1. In a fan assembly of the kind described, in combination a rotor having fan blades, a diffuser arranged on the discharge side of said fan, said diffuser having a plain outer wall and an inner wall provided with openings disposed along circles parallel to one another, the cross-section of said openings decreasing proportionally to their distance from the fan, said openings forming passages between the interior of the diffuser and the inner space between its outer wall and inner wall, said inner space being connected with the intake side of the fan.

2. A fan assembly as claimed in claim 1, in which said openings provided in the inner wall consist of coaxial ring-shaped slots forming circles parallel to one another.

3. A fan assembly as claimed in claim 1, in which the openings in the inner wall are disposed along circles parallel to one another and coaxial with the shaft of the fan.

4. A fan assembly as claimed in claim 1, in which at least one of the inner and outer walls is made of concrete and forms the solid frame of the diffuser.

5. A fan assembly as claimed in claim 1, in which a hollow cap is arranged on the discharge side of the fan and permanently attached to the hub of said fan and openings are provided in the wall of said hollow cap in order to form passages between the interior of the diffuser and the inner space of the hollow cap, said inner space being connected with the intake side of the fan.

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