Dec. 16, 1924. 1,519,245

C. J. FECHHEIMER

CENTRIFUGAL FAN

Filed Nov. 10, 1922 2 Sheets-Sheet 1

Fig. 1.

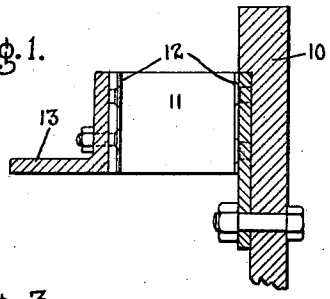


Fig. 2.

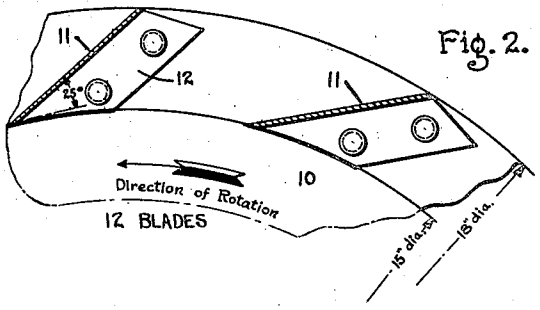


Fig. 3.

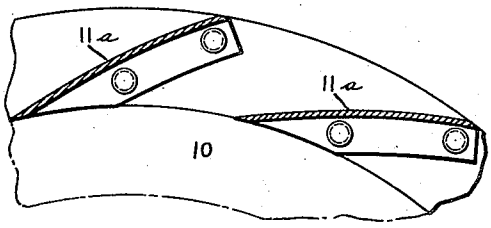


Fig. 4.

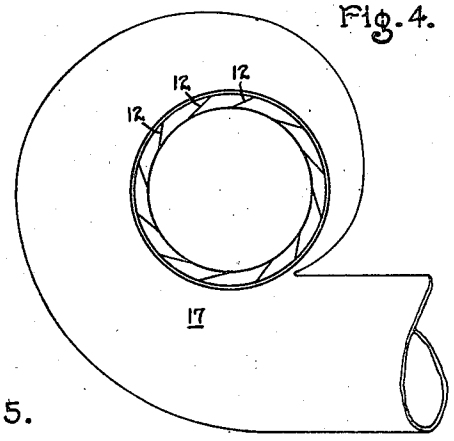
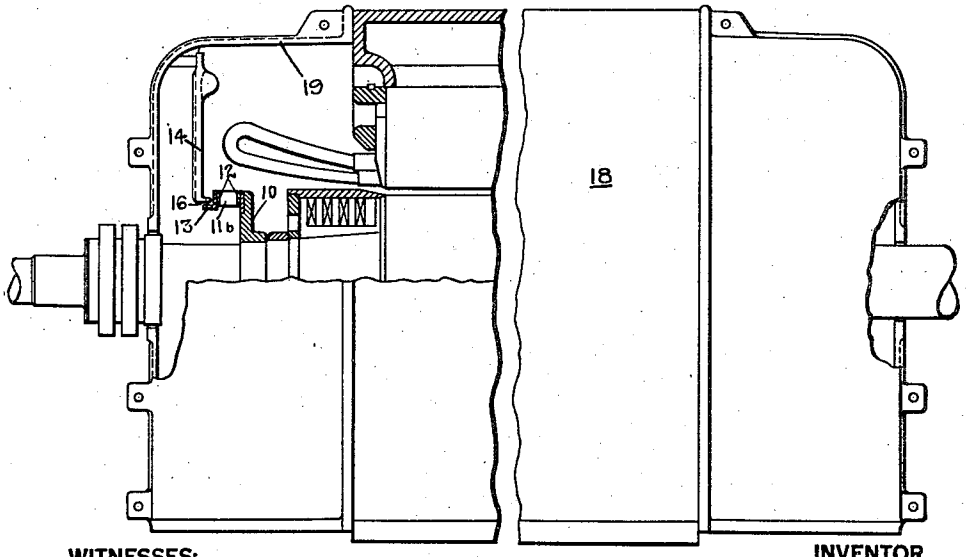


Fig. 5.



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CENTRIFUGAL FAN

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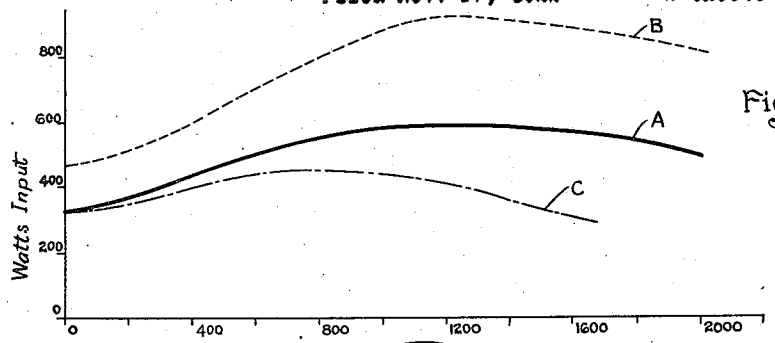


Fig. 6.

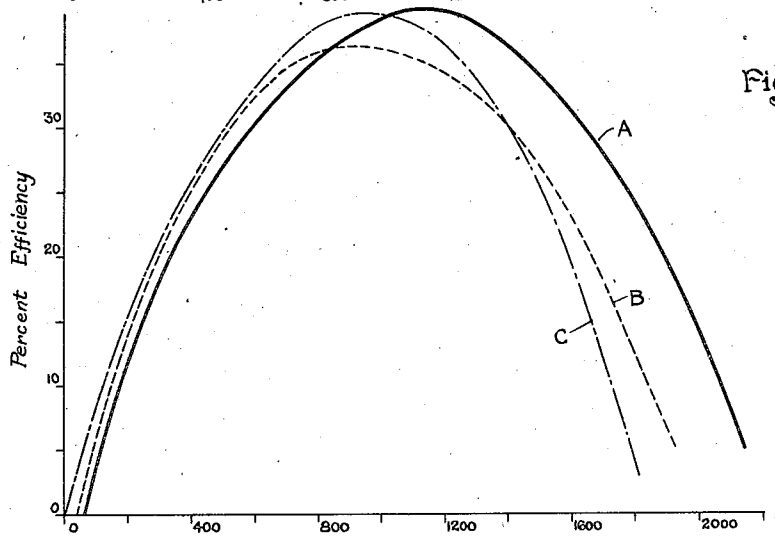


Fig. 7.

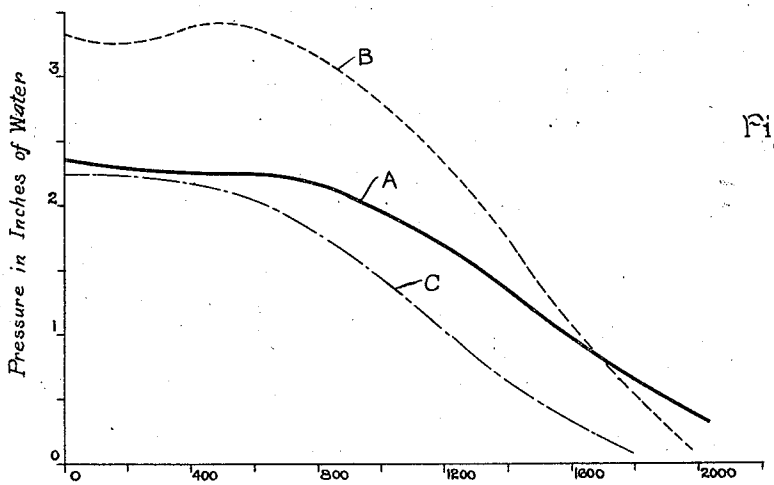


Fig. 8.

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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL FAN.

Application filed November 10, 1922. Serial No. 599,999.

To all whom it may concern:

Be it known that I, CARL J. FECHHEIMER, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Centrifugal Fans, of which the following is a specification.

My invention relates, in general, to centrifugal pumps and fans and has particular relation to the impellers of centrifugal pumps or fans, designed for supplying relatively large volumes of water or air at relatively low pressures while operating at high angular velocities.

In problems of ventilating dynamo-electric machinery, and in many commercial problems of ventilating buildings and the like, it is desirable to force relatively large volumes of air through ducts having rather small resistances, whereby the pressure head of the air will be correspondingly small. When a direct-connected electric motor was used for driving a fan designed along lines with which I was acquainted prior to the conception of my present invention, it was difficult to secure an efficient fan to deliver sufficiently low pressures without reducing the speed of the impeller to such low values as to require a motor of undesirable proportions. A similar statement applies to steam turbine drives and to certain other forms of direct motor drive. In many installations, the fan has been belt-driven by a high-speed motor; in others the fan selected for direct-connection is operated so low on its characteristic pressure-volume curve as to be inefficient and require a large motor and greater power consumption. According to my invention, I have evolved a highly efficient fan wherein the angular velocity is relatively high even for large volumes and low pressures.

In all ventilating problems, moreover, it is extremely difficult to calculate, with even a rough approximation, the resistance to the flow of the air currents, and, hence, the required pressure head for a given rate of flow cannot be accurately predicted prior to the installation of the blower.

In centrifugal fans, such as were used prior to my present invention, the power input at any given speed increased very rapidly as the volume of the air flow increased and, hence, it was very difficult to determine the size of electric motor which would be necessary to drive the blower in actual practice.

According to my invention, I have evolved a design wherein the power input is approximately constant over a relatively wide range.

Moreover, in many centrifugal fans, a large number of curved blades are employed, which make the fans more expensive. One of the advantages of my invention is that the number of blades is small, and, in the preferred form, they are straight instead of curved.

Still another advantage of my invention is the fact that the fan operates with very little noise.

The foregoing and other objects of my invention will be apparent from the following detailed description, when read in connection with the accompanying drawing, wherein—

Figure 1 is a fragmentary longitudinal section of an impeller constructed in accordance with my invention.

Fig. 2 is a fragmentary end view thereof.

Fig. 3 is a fragmentary end view showing a slight modification.

Fig. 4 is a diagrammatic view showing my invention with a volute collecting device.

Fig. 5 is a side elevational view, partly in section, showing my invention applied to a dynamo-electric machine to cool the same, and

Figs. 6, 7 and 8 are curve diagrams illustrating the variation of the watts input, the efficiency and the pressure head, respectively, with respect to the volume of air per minute.

Referring first to Figs. 1 and 2, my fan is shown as comprising a supporting disc 10 adapted to be rotated at a high velocity and carrying a plurality of flat blades 11, each of which is provided with two end flanges 12, one of which is bolted or riveted to the disc 10 and the other of which is bolted or riveted to a flanged ring 13 which serves to support the outer ends of the blades. The flanged ring 13 is adapted to cooperate also with a stationary shroud, as indicated at 14 in Fig. 5, whereby a small clearance 16 is provided for reducing air leakage. As shown in Fig. 1, the rivets used for holding the blades in position are

counter-sunk, in order to minimize the resistance to the flow of the air. The feature just mentioned is not essential but it is very desirable in order to reduce the internal-pressure drop and to improve the efficiency.

As a result of much experimentation and study, it has been found that the angle between the inner ends of the blades 11 and the tangent at that point should be approximately 25°. While some departure from the 25° value may be resorted to without seriously affecting the operation, and while I do not care to be restricted to an exact angle, I have found that if an angle of about 25° is employed, together with other features which will hereinafter be pointed out, the novel features of operation outlined above will be obtained.

I have also found that a shallow-blade construction, having a ratio of inner diameter to outer diameter of about five-sixths, is very desirable for securing large volumes of air at low pressure heads and high peripheral speeds. The desired ratio of diameters is indicated in Fig. 2, wherein the diameters are given as 15″ and 18″, respectively.

While I have found that the straight or flat blade is the more economical to manufacture and the more desirable in some respects, it is also possible to employ blades which may be curved, as indicated at 11*a* in Fig. 3.

The number of blades is also important, as it has been found that, where the blades are so close together that each blade overlaps, or nearly overlaps, the adjacent blade, such that a radius intersecting the outer end of one blade will also intersect the inner end of the next adjacent blade, the operating characteristics of the fan are not nearly so desirable as if a much smaller number of blades is employed. In my tests, I have found that twelve is a very satisfactory number of blades to employ, as indicated in Figs. 2, 3 and 4, and that, if a number of blades is chosen which is on the order of twelve blades, together with the other features of design, such as the 80% ratio of diameters and the 25° entrance angle, a centrifugal fan will be produced having remarkably improved characteristics for the ventilating problems outlined above.

In Figs. 6 to 8 are shown characteristic performance curves taken without a collecting device, such as a volute. In Fig. 6, the heavy curve A shows the power-volume characteristic of a fan having twelve straight blades inclined at a 25° angle and with an 83% ratio of diameters; the dotted curve B represents the similar characteristic curve of a fan employing twelve straight blades inclined at 25° with a 67% ratio of diameters; and the dot-and-dash curve C represents the corresponding characteristic of a fan having 12 curved blades as shown in Fig. 3. The corresponding efficiency and pressure curves are shown in Figs. 7 and 8, from which it will be clear that my invention achieves, in a very remarkable manner, the results outlined hereinabove.

If the fan is provided with a suitable collecting device, such as a volute, the power input is nearly the same, whereas the pressure and volumes are increased, thereby improving the efficiencies, as has been determined by tests on my fan with various forms of collecting devices. Even with such increase in pressure, however, a relatively high angular velocity is still necessary, in order to secure such pressures as are usually required in practice. The efficiencies would also be improved by counter-sinking the rivet heads, the particular tests given having been made on a fan with projecting rivet heads.

In Fig. 4, my invention is shown applied to a blower which is adapted to be driven by an independent electric motor, not shown, and which comprises the impeller member shown in Figs. 1 and 2 mounted in a volute casing 17, as is customary in the art.

In Fig. 5 the invention is shown applied to the rotor member of a dynamo-electric machine 18, wherein the fan blades 11*b* are utilized to force air within the generator end bell 19 in a manner which will be obvious in view of the foregoing explanation. In actual practice, the particular machine illustrated in Fig. 5 is provided with fourteen blades, as such slight departure in the number of blades does not affect the performance appreciably.

While I have illustrated my invention in a number of specific forms which are at present preferred by me, and while I have attempted to explain the same in accordance with my present understanding of the operation thereof, I desire it to be understood that the values stated in the foregoing description are to be taken as illustrative only and that slight modifications may be resorted to, as will be obvious to those skilled in the art, without departing from the essential features of my invention, as outlined in the appended claims.

I claim as my invention:

1. A centrifugal impeller for impelling fluids, embodying a plurality of backwardly directed blades, each being inclined rearwardly at an angle approximately twenty-five degrees to a tangent thereof.

2. A fluid-impelling centrifugal device embodying a plurality of substantially flat blades having entrance angles of approximately twenty-five degrees with respect to the tangent.

3. A centrifugal impeller for impelling fluids, embodying a plurality of backwardly directed blades, each being inclined rearwardly at an angle approximately twenty-

five degrees to a tangent thereof, none of said blades radially overlapping another.

4. A fluid-impelling centrifugal device embodying a plurality of substantially flat blades having entrance angles of approximately twenty-five degrees with respect to the tangent, none of said blades radially overlapping another.

5. A fluid-impelling centrifugal device embodying a plurality of blades having entrance angles of approximately twenty-five degrees with respect to the tangent, said blades having a ratio of internal diameter to external diameter greater than 60%.

6. A fluid-impelling centrifugal device embodying a plurality of substantially flat blades having entrance angles of approximately twenty-five degrees with respect to the tangent, the ratio of the inner diameter to the outer diameter of said blades being upwards of eight-tenths.

7. In a fluid-impelling device, an impeller embodying a relatively small number of relatively shallow, flat blades each inclined rearwardly at an angle of approximately twenty-five degrees to a tangent thereof, whereby a substantially constant power input is required to drive the device over a relatively wide working range.

8. In a fluid-impelling device, an impeller embodying a relatively small number of relatively shallow, flat blades each inclined rearwardly at an angle of approximately twenty-five degrees to a tangent thereof, and means for driving said impeller at a relatively high rate of speed.

9. In a fluid-impelling device, an impeller embodying a relatively small number of relatively shallow, flat blades, each inclined rearwardly at an angle of approximately twenty-five degrees to a tangent thereof.

10. A centrifugal fan for forcing gases and adapted to operate at low heads with high speeds, comprising an impeller having approximately fourteen, substantially flat, rearwardly inclined blades having a ratio of internal diameter to external diameter of approximately eight-tenths.

11. A centrifugal fan for forcing gases and adapted to operate at low heads with high speeds, comprising an impeller having approximately fourteen, substantially flat rearwardly inclined blades having a ratio of internal diameter to external diameter of approximately eight-tenths, said blades having entrance angles of approximately twenty-five degrees with respect to the tangent, whereby a substantially constant power input is obtained over a wide range of volumes of flow.

In testimony whereof, I have hereunto subscribed my name this 24th day of October 1922.

CARL J. FECHHEIMER.