June 10, 1930. H. F. SCHMIDT 1,762,358

PROPELLER TYPE BLOWER

Filed May 20, 1927 3 Sheets-Sheet 1

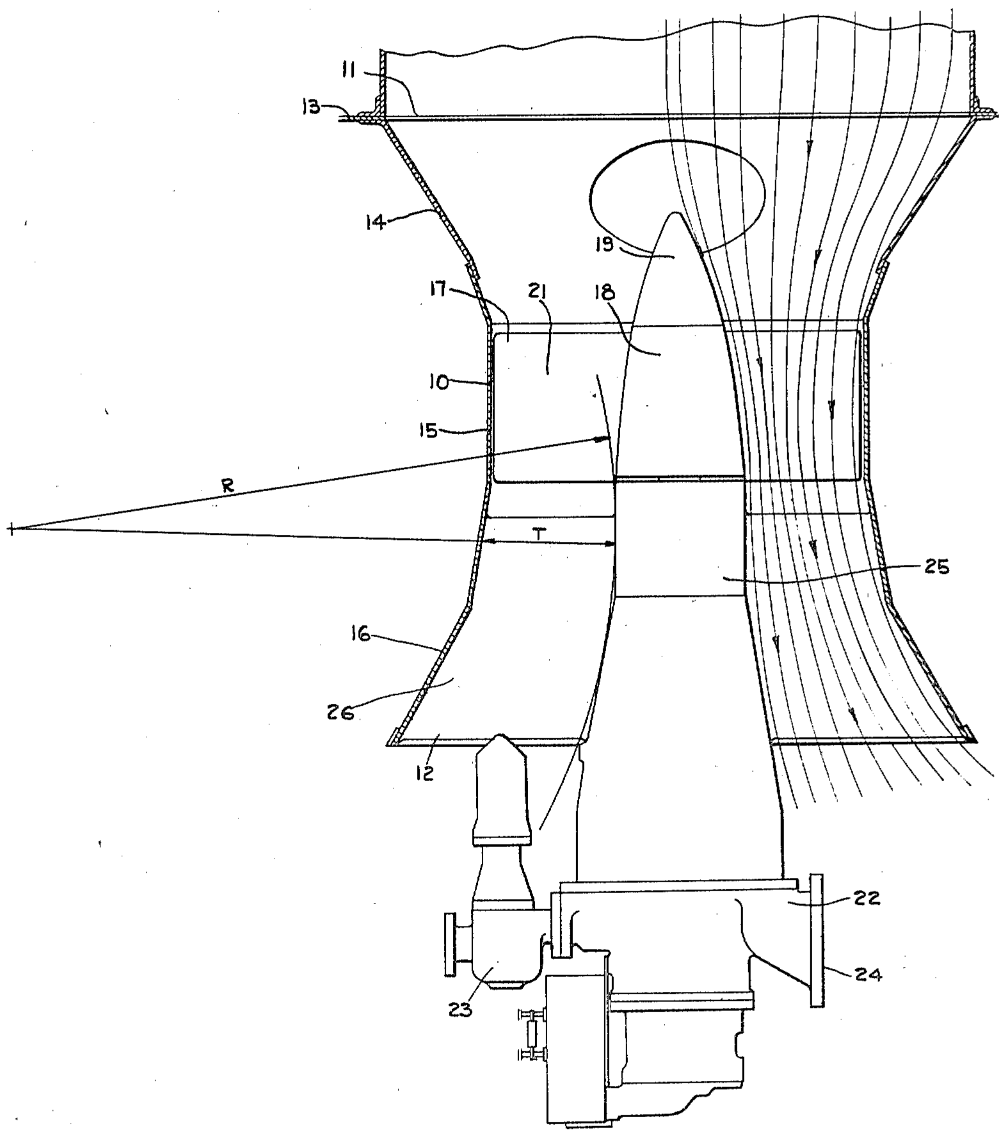

Fig. 1.

WITNESS

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Filed May 20, 1927 3 Sheets-Sheet 2

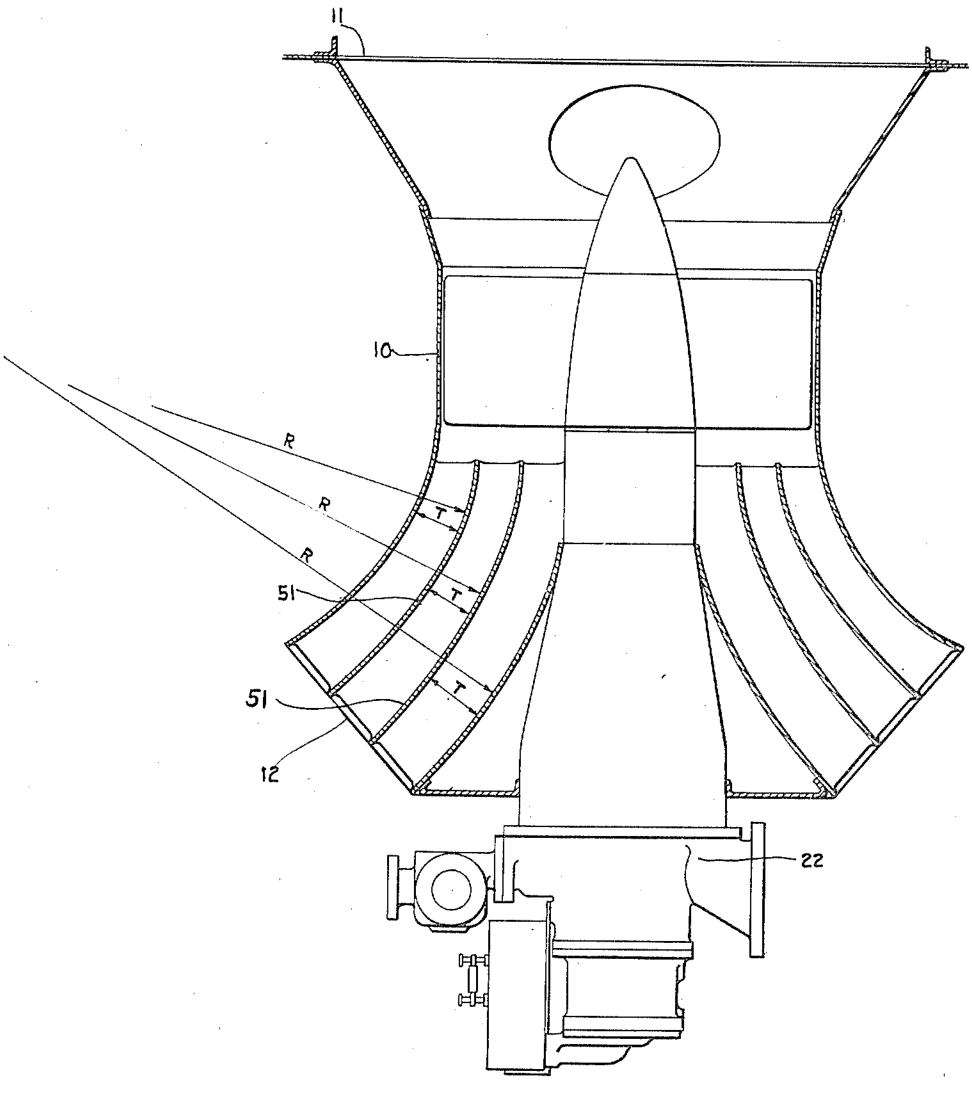

Fig. 2.

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Filed May 20, 1927 3 Sheets-Sheet 3

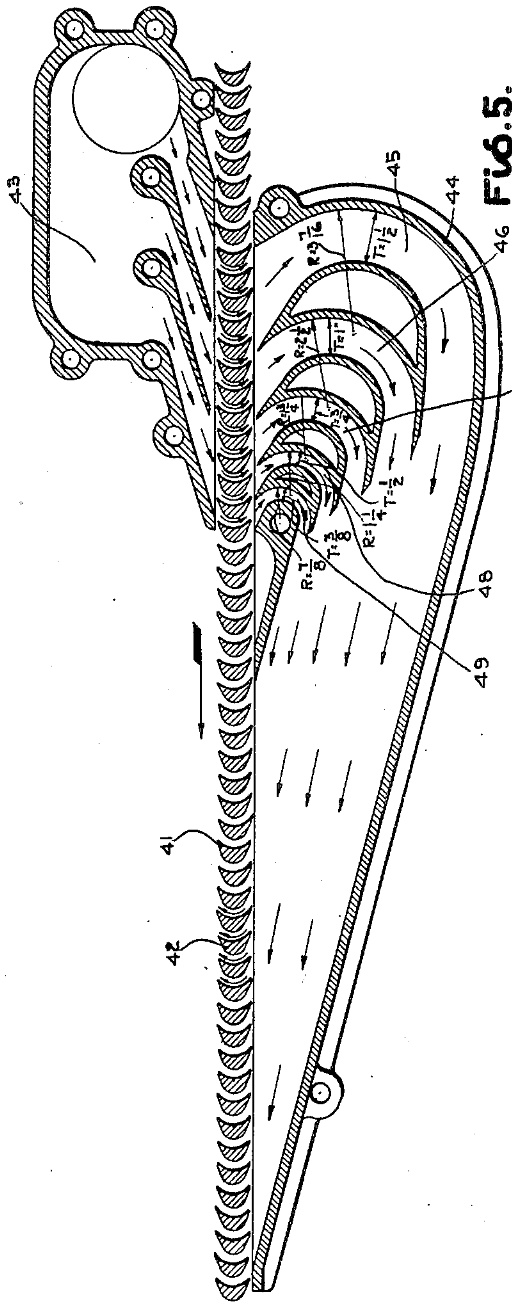

Fig. 5.

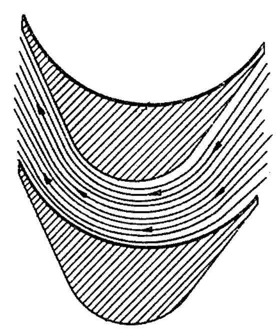

Fig. 3.

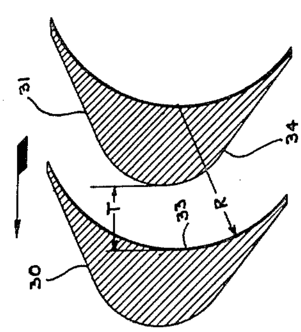

Fig. 4.

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Patented June 10, 1930 1,762,358

UNITED STATES PATENT OFFICE

HENRY F. SCHMIDT, OF LANSDOWNE, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

PROPELLER-TYPE BLOWER

Application filed May 20, 1927. Serial No. 192,951.

My invention relates to blowers, more particularly to that type suitable for marine boiler rooms, and it has for an object to provide a form of blower which shall very effectively and very efficiently convert the velocity energy imparted to the air by the rotating element of the blower into pressure energy.

It has for a further object to provide a blower which shall be so arranged that the air passing therethrough shall not be subjected to shock, in which frictional resistance to flow shall be reduced and in which eddy currents shall be minimized, thus insuring very efficient flow characteristics.

These and other objects, which will be made apparent throughout the further description of my invention, may be attained by the employment of the apparatus hereinafter described and illustrated in the accompanying drawings in which:

Fig. 1 is a view, in sectional elevation, showing one form of blower arranged in accordance with my invention;

Fig. 2 is a view, in sectional elevation, of another form of blower arranged in accordance with my invention;

Fig. 3 is a diagrammatic view illustrating the passage of steam between the blades of a steam turbine;

Fig. 4 is a diagrammatic view which illustrates the method employed in designing the turbine blades shown in Fig. 3; and,

Fig. 5 is a sectional, somewhat diagrammatic, view of a portion of a steam turbine which is equipped with a reversing chamber.

In the design and construction of blowers, and especially those of the forced draft type, it is highly desirable that the air passing through the blower casing travel in a path which is nearly as straight or direct as possible in order that very little of its kinetic energy be absorbed. However, in view of the fact that it is generally necessary to provide a blower casing of such form as to be capable of converting the velocity energy imparted to the air by the propeller of the blower into pressure energy, the casing is usually made of a converging-diverging form. This requires that the air passing through the casing travel in an annular duct which, in radial cross-section, is substantially arcuate in shape. It is, therefore, advisable to make the radius of this arcuate passage as large as possible or as nearly approaching a straight line as possible, in order that friction losses, etc., may be held to a minimum. It is further desirable that the air passing through the annular, arcuate-shaped duct flow in a single, continuous curved path and not in a path having its direction of curvature reversed, as reverse curvature of flow is conducive to frictional resistance.

Referring now to Fig. 1, I show a blower comprising a casing 10 having an inlet portion 11 and a discharge portion 12. The casing 10 is adapted to be suspended from some supporting structure, such as the deck of a ship 13. The casing 10 comprises a converging portion 14, a cylindrical portion 15 and a diverging portion 16. Located within the cylindrical portion 15 is a propeller 17 having a hub portion 18, a fish-tail portion 19 and a plurality of blades 21. The hub portion 18 and the fish-tail portion 19 are preferably stream-lined, as illustrated, in order to offer a minimum amount of resistance to the admission of air to the blower casing.

Disposed below and directly connected to the propeller 17 is a prime mover 22, such as a steam turbine, for driving the same. The prime mover 22 is provided with a motive fluid admission valve 23 and an exhaust connection 24. Interposed between the propeller 17 and the turbine 22 and directly connected to the latter is a central supporting member 25, which is provided with a plurality of fixed guide vanes 26 secured to the casing 10 in order to support the propeller and the turbine. While, in the present example, I have shown the propeller and the turbine as being entirely supported from the casing 10, nevertheless, it is obvious that the propeller and the turbine may be supported by other means entirely independent of the blower casing, as is frequently done in marine practice.

The casing 10 is formed in the manner illustrated in order to effect the required velocity pressure conversion of the air during its passage from the entrance 11 to the discharge 12. The outer contour of the central supporting member 25 is so formed, with respect to the casing 10, as to insure passage of the air through a considerable portion of the duct in a smooth, continuous curve which very nearly approaches a straight line. From inspection of the arrow lines shown in the right-hand portion of Fig. 1, which lines graphically represent the direction of air flow, it will be apparent that, in a blower formed in accordance with the manner illustrated, substantially all of the air passes therethrough in a direct continuous curvature. It is true, that the fishtail portion of the propeller permits some of the air to follow a reverse curvature, and as stated heretofore, this is not desirable, but attention is invited to the fact that the air which travels in a reverse curvature forms only a small percentage of the air stream, as the area of the propeller hub portion is, as a rule, only from 1/9 to 1/6 of the total area of the air stream.

From the foregoing, it will be apparent that it is generally necessary, in order to effect the required velocity pressure conversion, to so form the blower casing that the air travels in a somewhat arcuate path, that is, inwardly toward the longitudinal axis of the blower on the inlet side of the blower and thence outwardly from the axis of the blower on the discharge side of the propeller. I have, therefore, established a formula by which this arcuate air passageway may be so proportioned that the best flow characteristics are assured.

Referring now to prime mover apparatus, such as steam turbines, and particularly to the blading therefor, it will be seen in Fig. 3 that the motive steam traverses the face of the one blade and the back of the adjacent blade in a somewhat arcuate path, much in the manner of the flow of air through the converging-diverging casing of a force draft blower. Referring now to Fig. 4, 30 and 31 represent conventional turbine blades of the impulse type, the steam traversing the space intervening between the working or front face 33 of the blade 30 and the rear or back face 34 of the blade 31, all as indicated by the arrow lines in Fig. 3. The rotor of the turbine is consequently actuated in a direction represented by the arrow. In this figure, R represents the radius of curvature of the face of the blades and T represents the distance intervening between the face of the blade 33 and the back of the blade 34, or, in other words, the width of the flow passage. I originally established the fact that the best flow characteristics for turbine blading were obtainable when T was made to vary from 0.28R to 0.50R. This formula is now generally accepted by all turbine designers, and is fully and comprehensively set forth in Sterling's Marine Engineers Handbook, 1920 edition, pages 615 and 616.

It will, therefore, be apparent from the foregoing, that, in order to pass a fluid through a reversing passage or through a curved passage, best results are obtainable when the value R bears a certain definite relation to the value T. In turbine design, this idea is not solely applied to the blading, but to the design of the reversing chambers as well.

Referring now to Fig. 5, I show a turbine wheel 41 provided with suitable blades 42 and a nozzle block 43 for projecting steam at high velocities against the blades in order to rotate the wheel in the direction indicated by the arrow. In order that velocity energy of the steam may be more thoroughly abstracted, a reversing chamber 44, is frequently provided for receiving the steam after it is discharged from the turbine blades and for projecting it against the blades. In the reversing chamber 44, 45 to 49 inclusive, represent arcuate passageways taken by the steam in order to effect the required reversal of direction. The design of reversing chamber shown in this illustration is a standard reversing chamber for a turbine of approximately 500 kw. capacity which is manufactured by the Westinghouse Elec. & Mfg. Co., the assignee of the present application. In this figure, R represents the radius of curvature of each passage and T the width of the passage in the same manner as the turbine blading previously referred to. From inspection of the dimensions given for this reversing chamber, it will be found that the $\frac{T}{R}$ characteristic of each passage is approximately .4. In other words, a value of $\frac{T}{R}$ approximating .4 has been found, in the design of reversing chambers, to give the most efficient flow characteristics.

I have, therefore, conceived of the idea of applying the foregoing principle of design to blowers in order to reduce the losses involved in the passage of the air through the converging-diverging casing.

Returning now to Fig. 1, R represents the maximum radius of curvature of the air passing through the annulus formed between the central supporting member 25 and the casing 10 while T represents the radial distance or width of air flow passageway intervening between the central supporting structure 25 and the casing 10. In the form of blower illustrated in Fig. 1, the value of $\frac{T}{R}$ =approximately .2 and I have found that in order to give the best flow characteristics in blowers of this type, the value of $\frac{T}{R}$ should not exceed .4. When the valve of $\frac{T}{R}$ is held within this limit, shock losses are minimized, eddy currents are lessened and friction losses are reduced to a minimum so that the fluid passes through the blower casing with very little loss of kinetic energy.

It will be seen that the value of $\frac{T}{R}$, when applied to blower design, is less than that for turbine blading, the principal reason for this being that edge losses seriously affect the latter, while edge loss considerations do not enter into the design of a blower to the same extent. While I have shown a form of blower in which the hub portion of the propeller varies somewhat from the radius R, nevertheless it is apparent that I may so form the blower that both the hub portion of the propeller and the central supporting member cooperate to define a continuous contour line substantially coinciding with the radius R.

Under some conditions of installations, it may be absolutely necessary, as shown in Fig. 2, to discharge the air at a substantial angle with respect to the blower axis, in which case the value of $\frac{T}{R}$ would ordinarily be far in excess of .4. However, in such installations, good flow characteristics may still be had by providing a series of intervening baffle members 51 and thus dividing the air stream passing through the blower casing into several strata, each stratum having a value of $\frac{T}{R}$ less than .4. The blower illustrated in Fig. 2 has been designed in accordance with this idea, the several passageways each having a value of $\frac{T}{R}$ less than .15. In this way, ideal flow characteristics are obtained, even though the requirements are such as to compel rather abrupt changes in direction of the flow of air through the blower casing. Of course, as pointed out heretofore, it is always desirable, where possible, to have the air travel in a direction as nearly straight as possible because then the friction losses are considerably less than that of the blower shown in Fig. 2, and consequently the flow is better.

From the foregoing, it will be apparent that I have established certain basic or fundamental formulae for the design of the air passageway through blowers of the force draft type whereby the air passes through the blower with a minimum loss in kinetic energy. In this way, I materially improve the operating efficiency of apparatus of this character.

While I have shown my invention in two forms, it will be obvious to those skilled in the art, that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art, or as are specifically set forth in the appended claims.

What I claim is:

1. In a blower of the propeller type, the combination of a converging-diverging housing having an intermediate throat portion, a propeller at or in the throat portion, and a supporting structure for the propeller including a central core member which diverges from the propeller end and which defines with the housing a divergent annular passageway having a substantial component of axial direction at the discharge end, and the average thickness of said passage being not greater than .4 of the maximum radius of curvature thereof in axial planes.

2. In a blower, the combination of a casing having an air inlet located in one end and a diverging air outlet located in the other end, a propeller disposed in an intermediate portion of the casing, means for driving the propeller, and deflecting members provided in the diverging outlet portion of the casing for dividing said portion into a plurality of curved passageways each of which has a value of $\frac{T}{R}$ not greater than .4 wherein R is the maximum radius of curvature of the passageway and T is the thickness of the passageway as included in R.

In testimony whereof, I have hereunto subscribed my named this 19th day of May, 1927.

HENRY F. SCHMIDT.