Dec. 1, 1942. J. M. FUNK 2,303,832

AXIAL BLOWER

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Fig. 1

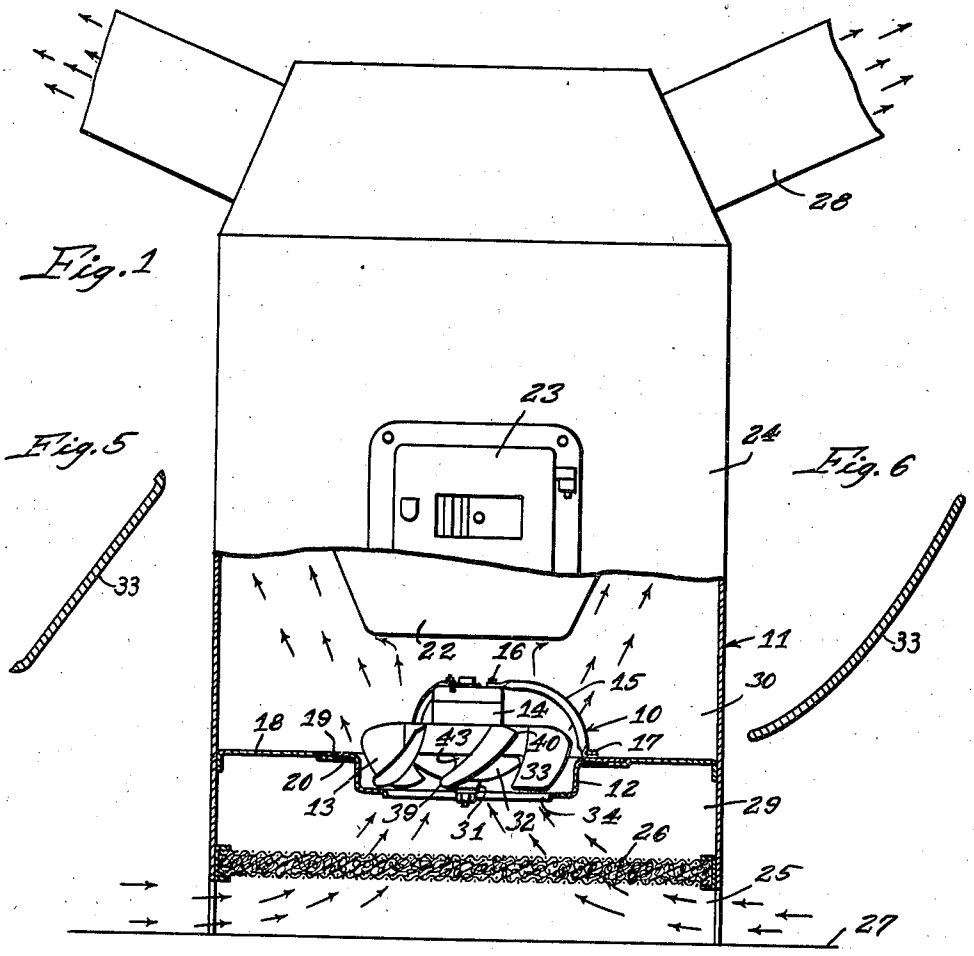


Fig. 5

Fig. 6

Fig. 4

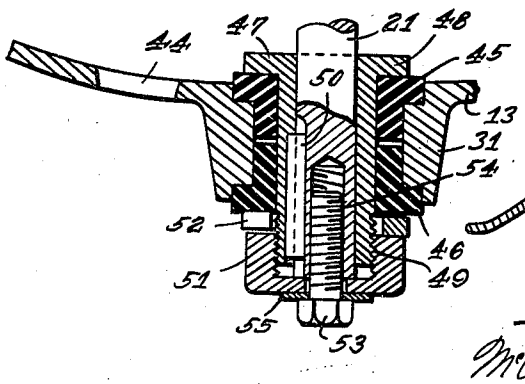


Fig. 7

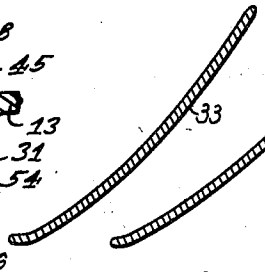
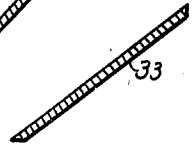


Fig. 8

Fig. 9



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Fig. 2

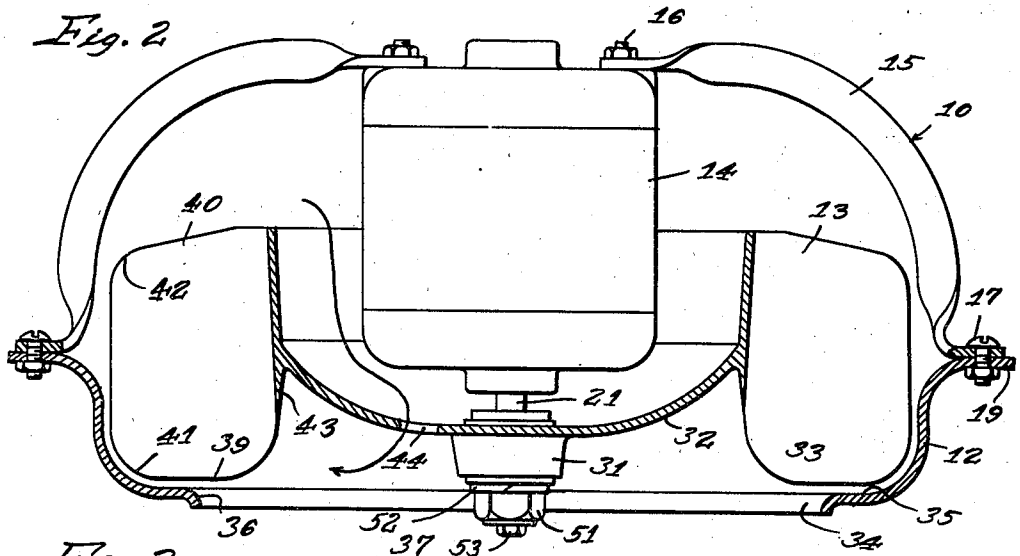
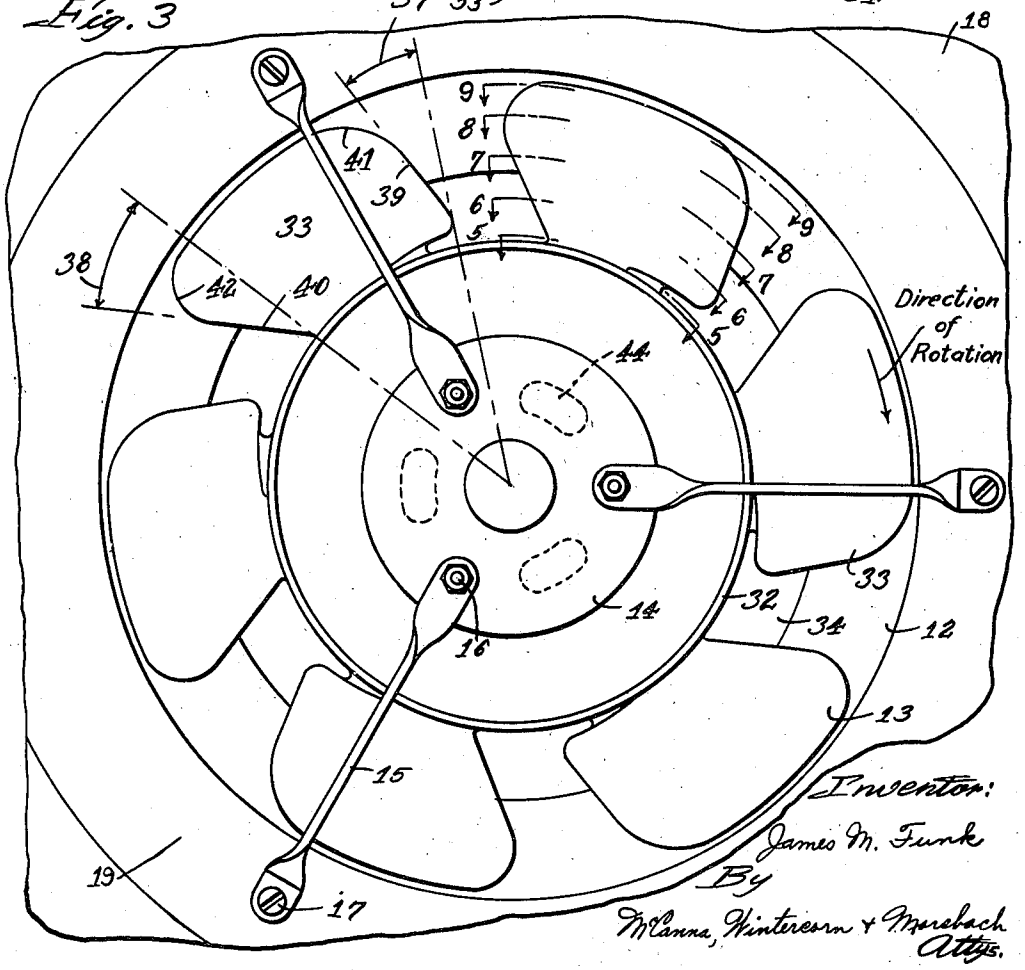


Fig. 3



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AXIAL BLOWER

James M. Funk, Ottawa, Ill.

Application January 17, 1941, Serial No. 374,911

4 Claims. (Cl. 230—120)

This invention relates to a new and improved axial blower.

The principal object of my invention is to provide an axial blower unit providing pressure resisting characteristics obtainable heretofore only with larger diameter centrifugal blower types of fans, the blower of my invention having the further advantage, of particular importance in furnace installations, of operating much more quietly and with smaller power consumption than any centrifugal blower of equivalent capacity with which I am familiar.

More specifically stated, the blower of my invention embodies an improved fan hub, fan inlet, and fan tip shrouding structure which obtains with a smaller diameter fan the results heretofore obtainable only with larger diameter fans.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 is a view partly in vertical section and partly in front elevation of a furnace having a blower unit made in accordance with my invention;

Fig. 2 is a section through the blower unit on a larger scale;

Fig. 3 is a plan view of Fig. 2 looking down on the blower unit from the motor end;

Fig. 4 is a sectional detail of the rubber cushioned fan hub construction, and

Figs. 5 to 9 are blade sections taken at different radii, as indicated by the correspondingly numbered lines in Fig. 3.

The same reference numerals are applied to corresponding parts throughout these views.

Referring first to Fig. 1, the reference numeral 10 designates generally the axial blower unit of my invention and 11 a hot air furnace wherein the same is installed. The blower unit 10 comprises a shroud ring 12, suction fan 13, and electric motor 14 for driving the fan, the motor being mounted on arms 15 secured at their opposite ends to the motor housing and shroud ring, as indicated at 16 and 17. The ring 12 may be formed integral with a horizontal partition wall 18 but is preferably removably mounted by means of its annular flange 19 on the wall 18 in an opening 20 provided in said wall at the center thereof. The unit is disposed with the axis of rotation of the fan 13 and armature shaft 21 of the motor substantially vertical, with the motor 14 uppermost and spaced from the bottom of the combustion chamber 22 of the furnace in which liquid, gaseous, or other fuel is burned. The door, indicated at 23 on the outer casing 24 of the furnace, affords access to the chamber 22. The casing 24 has one or more cold air inlets 25 provided in the bottom thereof under a dust collector or filter 26 disposed horizontally in the lower portion of the casing, below the partition 18 as shown. The cold air inlet may open directly to the basement as shown, 27 indicating the basement floor, or there may be one or more fresh air conduits opening to the outside of the building. At 28 are indicated hot air outlet conduits.

In the operation of the unit 10, the cold air is drawn in through the dust collector 26 and is discharged upwardly so as to scrub the hot walls of the combustion chamber 22 and be heated thereby, the air thus heated being discharged through the hot air conduits 28 to the various rooms to be heated. In other words, 29 is a suction chamber on one side of the partition wall 18 and 30 is a pressure chamber on the other side. The air flow through the furnace keeps the motor 14 as well as the walls of the combustion chamber 22 from reaching excessive temperatures. The motor would otherwise be incapable of operating for any length of time in a zone at such temperatures. The general direction of air flow is indicated by the arrows in Fig. 1, these arrows indicating the resultant angle of force vectors acting in and upon the airstream when the resistance to the flow of air through the furnace approximates the usual working pressures. The resultant direction of flow changes from axial to radial with increase in downstream resistance to flow. That is to say, the flow of air is more in an axial direction as the quantity of air flow is increased and in a radial direction as the flow is decreased to a minimum, at which point all of the energy imparted by the fan to the air is converted to static pressure. Since the downstream resistance to flow in the average furnace installation does not vary appreciably and is usually of a low value, it follows therefore that in the operation of the unit 10 the substantially axial flow of air upwardly will produce an efficient heat exchange and the general heating efficiency of the furnace is proportionately increased.

The fan 13 is carried by its hub 31 on the armature shaft 21 and has a convexo-concave back plate 32 preferably cast integral with the hub and carrying impeller blades 33 on its outer face and projecting beyond the periphery to the extent shown. The purpose in having the diameter of the back plate less than the outside diameter of the blades is to permit air flow in an axial direction past the back plate and to increase the flow

rate and the air handling capacity of the fan. The exact diameter of back plate required in relation to blade tip diameter is governed by the static pressure which it is desired to build up in the furnace or other cabinet in connection with which the blower unit is used to overcome resistance to air flow through the cabinet. The diameter of the back plate 32 is increased for higher static pressure in the cabinet, that is the back plate is extended out to a larger diameter in the circle swept out by the blades 33 until a point is reached where the peripheral velocity converted to pressure, in accordance with well known fan laws, equals the required operating pressure in the cabinet. The location of the motor 14 in the immediate downstream area of the fan 13 has been found to be very important from the standpoint of efficient performance, because there is no air flow directed to the space occupied by the motor and in the absence of the motor there would be many eddy currents at this point and accordingly a marked loss in efficiency by reason of the energy in the stream being partly expended in the void behind the fan. The filling of the void by the motor 14, which provides more or less streamlined surfaces for air flow past the same, results in a fan performance nearer to centrifugal blower performance, and the operation is, moreover, quiet because of the absence of eddy currents and consequent shock noise. The diameter of the inlet opening 34 in the shroud ring 12 in relation to the diameter of the fan 13, and the closeness of the fan 13 to the inside surface 35 of the shroud ring 12, also the radius of curvature of the inlet flange 36, and having the upstream end of the inlet flange 36 of smaller diameter than the downstream end, all in combination and in the relationship shown have been found to give the best performance. The blades 33 are set at a "back angle" in relation to the direction of rotation, as indicated at 37 and 38 in Fig. 3, 37 showing the angularity of the leading edges 39 and 38 showing the angularity of the trailing edges 40. The angles at 37 and 38 are approximately 31°. Experiment has indicated that if the leading edges 39 are given a forward sweep, greater energy is imparted to the air than where a back angle is employed, assuming of course the same R.P.M. However, the back angle or backward sweep has been employed here because it makes for quiet operation while still obtaining the efficiency desired. The tips of the blades, as indicated at 41 and 42, are also rounded to reduce noise. Figs. 5–9 show the cross sections of the blades at different radii as indicated by the lines 5—5 to 9—9 in Fig. 3. Due to the fact that it is desired to have the air move axially, the pitches of the sections are formed as shown in Figs. 5 to 9, the sections being formed on expanding radius lines so as to obtain a desired stream expansion for passage around the combustion chamber 22, as indicated by the arrows in Fig. 1. Six impeller blades 33 are shown, but it must be understood that the number of blades and the axial length thereof are subject to change, depending upon the fan capacity desired, in accordance with well known fan laws.

The shroud ring 12, in accordance with the principal first disclosed in my Patent 1,993,158, issued March 5, 1935, is provided to prevent back flow into the tips of the blades at the trailing edges 40. In the present case the ring is situated to prevent back flow into the tips when the fan is operating in an area of greater than atmospheric pressure. The ring shrouds the tip portion from the leading edges 39 to approximately .4 of the chord, at which point the kinetic energy generated by the blades 33 equals the downstream surrounding pressure. The diameter of the inlet opening 34 in the shroud ring in relation to the fan diameter is also very important, the opening having a radius of approximately .77 of the radius of the fan. A slight variation in the diameter of the inlet opening was found to affect the fan's capacity appreciably, the shroud ring being a very important factor in the performance of this fan unit. At 43 are indicated radial webs joining the inner edges of the blades 33 to the back plate 32 on the working face thereof. These webs also act to prevent back flow of air radially between the blades. Small openings 44 are provided in circumferentially spaced relation in the back plate 32 in close proximity to the hub 31 to allow a small outflow of air to cool the motor 14, the openings 44 being on a small enough radius in relation to the radius of the motor 14 to insure sufficient scrubbing action on the walls of the motor in its outflow to give the desired cooling action, as shown by the arrow (Fig. 2).

The rubber cushioned hub construction shown in section in Fig. 4 makes for smooth and quiet operation, any noises originating in the fan being thereby isolated from the motor so as not to be conducted into the surrounding furnace structure and accordingly magnified. A sleeve of rubber formed by two bushings 45 and 46 serves to insulate the hub 31 of the fan from the metal sleeve 47 on the armature shaft 21. The sleeve 47 has an annular shoulder 48 on its inner end and has the projecting outer end threaded, as indicated at 49. The sleeve 47 is keyed on the shaft 21, as shown at 50. The threads 49 are right handed so that the clockwise rotation of the motor tends to tighten the nut 51 by means of which the fan hub is retained on the sleeve 47. The nut 51 compresses a split spring washer 52 so as to compress the rubber bushings 45 and 46 between the shoulder 48 and the nut 51 and accordingly mount the fan tightly on the motor shaft. A cap screw 53 threads in an axial hole 54 in the end of the shaft 21 to hold the sleeve 47 against endwise movement relative to the shaft 21. A washer 55 is provided under the head of the screw 53.

It is believed the foregoing description conveys a good understanding of the objects and advantages of my invention. The appended claims have been drawn to cover all legitimate modifications and adaptations.

I claim:

1. In combination, a suction fan comprising a substantially circular back plate having a substantially cylindrical blade-carrying rim portion, said back plate having means at the center thereof for driving the same, and impeller blades projecting radially from the cylindrical rim portion and in an axial direction from the upstream face of said back plate, a shroud ring defining a circular air inlet opening, the fan being disposed on the downstream side of said ring in proximity to said opening with the upstream face toward the opening and in substantially coaxial relation thereto, the opening being of a diameter slightly larger than the diameter of the rim portion of said back plate but substantially smaller than the tip diameter of the blades, the air flow induced by the fan through the opening being generally in an axial direction between the impeller blades past the rim portion of the back plate, the shroud ring being of a form extending in closely spaced relation to the tip portions of the

blades on the upstream face thereof and also in close radially spaced relation to the tips of said blades part way to the downstream edges of the blades to prevent back flow of air into the tips of said blades.

2. In combination, a suction fan comprising a substantially circular back plate having a substantially cylindrical blade-carrying rim portion, said back plate having means at the center thereof for driving the same, and impeller blades projecting radially from the cylindrical rim portion and in an axial direction from the upstream face of said back plate, a shroud ring defining a circular air inlet opening, the fan being disposed on the downstream side of said ring in proximity to said opening with the upstream face toward the opening and in substantially coaxial relation thereto, the opening being of a diameter slightly larger than the diameter of the rim portion of said back plate but substantially smaller than the tip diameter of the blades, the air flow induced by the fan through the opening being generally in an axial direction between the impeller blades past the rim portion of the back plate, the radially outermost tips of the blades extending substantially parallel to the periphery of the cylindrical rim portion of the back plate, the shroud ring being of a substantially cylindrical form providing a front wall extending in closely spaced relation to the tip portions of the blades on the upstream face thereof and a cylindrical peripheral wall extending in close radially spaced relation to the radially outermost tips of said blades part way to the downstream edges of the blades to prevent back flow of air into the tips of said blades.

3. A structure as set forth in claim 1, wherein the suction fan includes radial webs joining the radially inner edges of the blades to the back plate on the upstream face thereof to prevent back flow of air radially between the blades.

4. A structure as set forth in claim 2, wherein the suction fan includes radial webs joining the radially inner edges of the blades to the back plate on the upstream face thereof to prevent back flow of air radially between the blades.

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