May 26, 1942. J. M. FUNK 2,284,141

SUCTION FAN UNIT

Filed July 25, 1940 2 Sheets-Sheet 1

Fig. 1

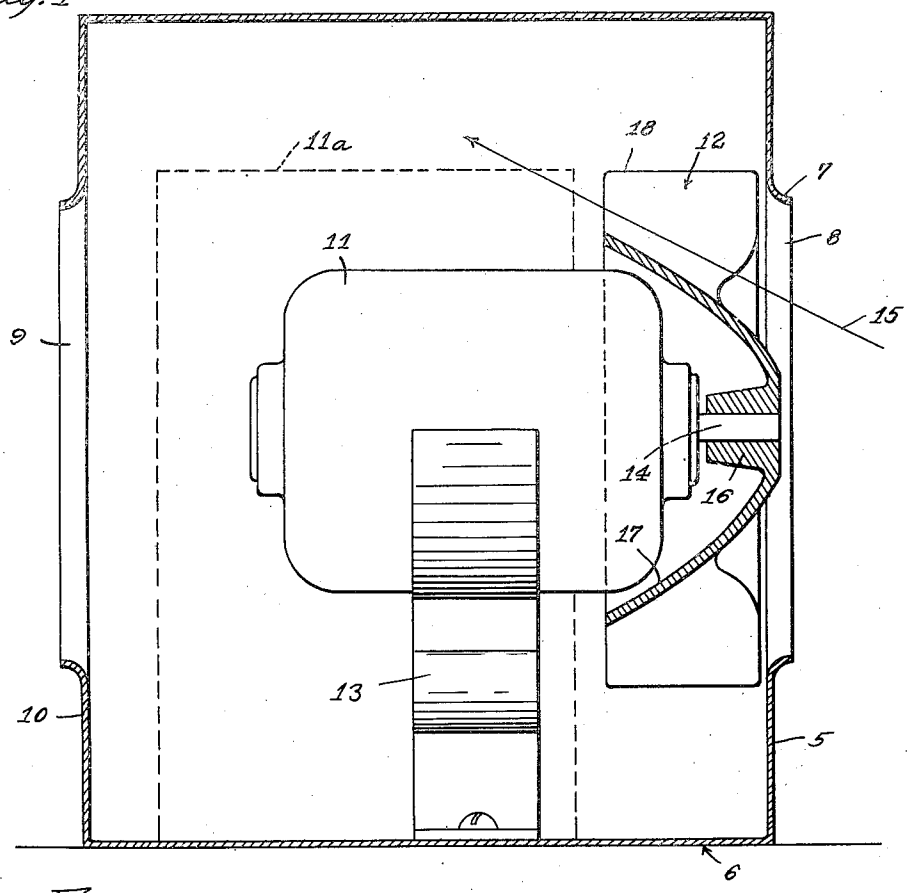

Fig. 2

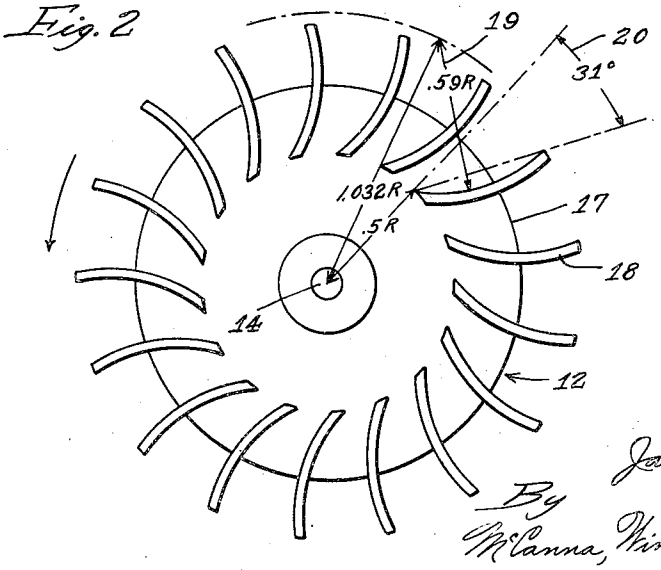

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Fig. 3

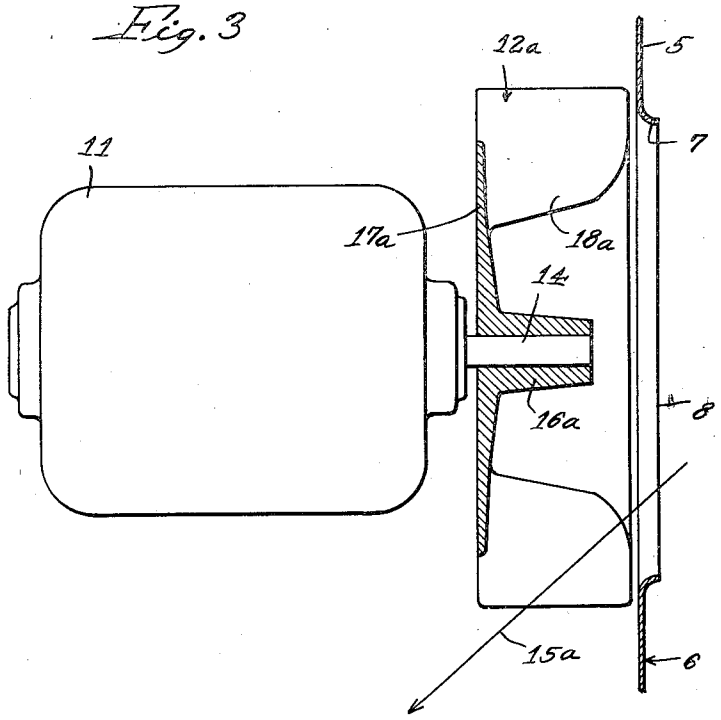
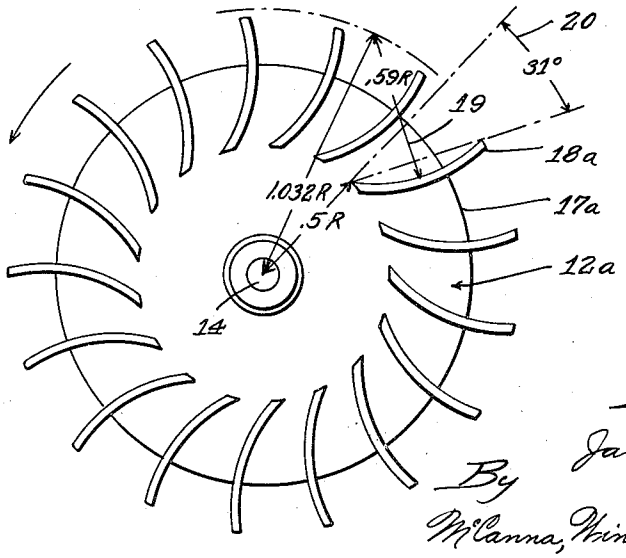


Fig. 4



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Patented May 26, 1942 2,284,141

UNITED STATES PATENT OFFICE

2,284,141

SUCTION FAN UNIT

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Application July 25, 1940, Serial No. 347,373

5 Claims. (Cl. 230—117)

This invention relates to a suction fan unit and is particularly concerned with the provision of a unit in which the fan is so designed that the motor for driving the same can be housed with the fan inside the cabinet for compactness and neat appearance as well as to enable use of the unit in many installations where an exposed motor would be objectionable, if not entirely out of the question.

The suction fan unit of my invention, as will hereinafter appear, provides pressure resisting characteristics of the centrifugal blower type of fan without requiring the scroll housing or auxiliary apparatus for its functioning and, in relation to a blower unit of equal capacity, is less costly, smaller in displacement, and, while no greater in rotational speed, is despite its smaller displacement equal in efficiency, in addition to having better eye appeal and being equally quiet in operation.

The present suction fan, in accordance with my invention, is intended to operate in close confinement with other mechanisms which a given installation may dictate the necessity or desirability of installing within the same cabinet structure, along with the motor for driving the fan.

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

Fig. 1 is a longitudinal section through a suction fan unit made in accordance with my invention showing the motor in side elevation and the fan in cross-section;

Fig. 2 is an intake face view of the fan, and

Figs. 3 and 4 are views similar to Figs. 1 and 2, but showing a modified or alternative construction and showing only a portion of the cabinet in Fig. 3 to conserve space in the drawings.

Similar reference numerals are applied to corresponding parts throughout these views.

Referring first to Figs. 1 and 2, the numeral 5 designates the face plate forming one wall of a cabinet 6 and having an outwardly curved circular flange 7 defining a circular air inlet opening 8. An air outlet opening is indicated at 9 in the back plate 10, but it should be understood that the invention is not limited to this specific arrangement of the inlet and outlet with respect to the electric motor 11 and suction fan 12 driven thereby, although, of course, the specific relationship of the inlet 8 to the fan 12 is important, as well as the arrangement of the motor 11 inside the cabinet 6, as will soon appear. The motor 11 is mounted on a suitable resilient supporting bracket 13 fastened to a wall of the cabinet 6, as shown, but it must be understood that the invention is not limited to an arrangement wherein the motor 11 is supported on the bottom wall of the cabinet. It should also be understood that while there is only the motor 11 shown in the cabinet with the fan 12, the cabinet 6 can be and has been used as a housing for other devices operating in conjunction with the present fan unit, which devices would otherwise have to be exposed in the event a centrifugal blower with the usual scroll housing were used in place of the suction fan unit of my invention. As a matter of fact, in certain types of installations these other devices require the protection of the cabinet 6 where the suction fan unit is used in a high temperature zone. In other words, the air flow through the cabinet keeps the motor 11, as well as the auxiliary device or devices, indicated diagrammatically in dotted lines at 11a, from reaching excessive temperatures. Thus, in one type of installation the housing of the other devices in the cabinet means improved appearance, while in the other installations it enables operation of these other devices as well as the motor 11 in a zone of higher temperatures where these devices and the motor would otherwise be incapable of operating for any length of time without air cooling. The general direction of air flow is indicated by the arrow 15 in Fig. 1, this line indicating the resultant angle of force vectors acting in and upon the air stream when the resistance to the flow of air through the cabinet approximates the usual working pressures in stokers, oil burners, and air conditioning apparatus in general. The resultant direction of flow is changed from axial to radial with an increase in downstream resistance to flow; that is to say, the flow of air will be 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 time all of the energy imparted by the fan 12 to the air is static pressure. The fan 12 is carried by its hub 16 on the shaft 14 and has a convexo-concave or generally conoidal form of back plate 17 preferably cast integral with the hub and carrying impeller blades 18 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, as shown at 15, 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 cabinet 6 and required to overcome resistance to flow through the cabinet. The back plate diameter 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 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 11 in the immediate downstream area of the fan 12 has been found by experiment to be most important to secure the desired performance, there being no air flow directed to the space occupied by the motor so that in the absence of the motor there would be 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. It is evident therefore that the presence of a structure like the motor 11 in the low pressure area filling what would otherwise be a void and forming streamlined surfaces for the air flow past the same results in a fan performance nearer to blower performance. For the same reasons the upstream or outer surface of the back plate 17 is streamlined, and these surfaces are brought as close as practical to the tips of the blades 18, turbulence being thereby avoided and the operating efficiency of the fan increased. The streamlined shape of the back plate 17 aids air flow in an axial direction, and turbulence and shock noises with consequent loss in efficiency of operation are avoided. The diameter of the inlet opening 8 in relation to the diameter of the fan 12, the closeness of the fan 12 to the inside of the face plate 5, the radius of curvature of the inlet flange 7, and having the upstream edge of the inlet smaller in diameter than the diameter of the downstream edge, all in combination and in the relationship shown, have been found to give the best performance in the various units tested under ordinary working conditions. The impeller blades 18 may be classified as "forward curves" but set at a "back angle" in relation to the direction of rotation. As indicated in Fig. 2, the radius 19 of curvature of the blades 18 is equal to approximately .59 of the fan radius, while the angle 20 for the blade setting is approximately 31° back from points at .5 of the radius of the fan, seventeen impeller blades being employed with the blades set parallel with the axis of rotation. However, a change in the number of blades or their axial length it must be understood will change the fan's capacity according to well known fan laws, and such changes are anticipated in order to suit more nearly the exact requirements of each fan installation. Such changes in blade design and angle may be made without departing from the present invention, the present disclosure being merely a specific combination of fan variables which have been found to meet the requirements best for a certain installation.

The unit shown in Fig. 3 has a fan 12*a* driven by an electric motor 11 housed with the fan inside the cabinet 6 with a view to obtaining generally the same advantages as above pointed out regarding the unit of Fig. 1. The fan 12*a*, however, has a flat back plate 17*a* preferably cast integral with the hub 16*a* by means of which the fan is mounted on the armature shaft 14 of the motor. The impeller blades 18*a* in this fan are also preferably cast integral with the back plate and project from the upstream face thereof, reaching radially beyond the periphery of the back plate to approximately the same extent as the impeller blades 18 of the fan 12 in relation to the back plate 17. With this construction, the air flow is substantially in the direction of the arrow 15*a*. While the unit of Fig. 3 will operate satisfactorily, although not with the same high efficiency as the unit of Fig. 1, the principal difference lies in the fact that the flat back plate 17*a* does not permit of such compactness of assembly as the streamlined back plate 17. Here again the motor 11 fills the void in the downstream area behind the back plate so that turbulence and consequent loss in efficiency of operation of the unit is avoided.

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

I claim:

1. In combination, a suction fan comprising a substantially circular back plate having means at the center thereof for driving the same, and impeller blades projecting in an axial direction from the upstream face of said back plate and also in a radial direction beyond the periphery of said back plate, and a cabinet having a circular air inlet and an air outlet, the fan being disposed inside said cabinet in proximity to said inlet with the upstream face toward the inlet and in substantially coaxial relation thereto, the inlet being of a diameter larger than the diameter of the back plate but substantially smaller than the tip diameter of the blades, the air flow induced by the fan from the inlet to the outlet being generally in an axial direction between the impeller blades past the periphery of the back plate.

2. In combination, a suction fan comprising a substantially circular back plate having means at the center thereof for driving the same, and impeller blades projecting in an axial direction from the upstream face of said back plate and also in a radial direction beyond the periphery of said back plate, the blades being forwardly curved and set at a backward angle with respect to radii of said back plate in relation to the direction of rotation, and a cabinet having a circular air inlet and an air outlet, the fan being disposed inside said cabinet in proximity to said inlet with the upstream face toward the inlet and in substantially coaxial relation thereto, the inlet being of a diameter larger than the diameter of the back plate but substantially smaller than the tip diameter of the blades, the air flow induced by the fan from the inlet to the outlet being generally in an axial direction between the impeller blades past the periphery of the back plate.

3. In combination, a suction fan comprising a substantially circular back plate having means at the center thereof for driving the same, the back plate having a concavo-convex form, the convex face being the upstream face, and impeller blades projecting in an axial direction from the upstream face of said back plate and also in a radial direction beyond the periphery of said back plate, and a cabinet having a circular air inlet and an air outlet, the fan being disposed inside said cabinet in proximity to said inlet with the upstream face toward the inlet and in substantially coaxial relation thereto, the inlet being of a diameter larger than the diameter of the back plate but substantially smaller

than the tip diameter of the blades, the air flow induced by the fan from the inlet to the outlet being generally in an axial direction between the impeller blades past the periphery of the back plate.

4. In combination, a suction fan comprising a substantially circular back plate having means at the center thereof for driving the same, the back plate having a concavo-convex form, the convex face being the upstream face, and impeller blades projecting in an axial direction from the upstream face of said back plate and also in a radial direction beyond the periphery of said back plate, the blades being forwardly curved and set at a backward angle with respect to radii of said back plate in relation to the direction of rotation, and a cabinet having a circular air inlet and an air outlet, the fan being disposed inside said cabinet in proximity to said inlet with the upstream face toward the inlet and in substantially coaxial relation thereto, the inlet being of a diameter larger than the diameter of the back plate but substantially smaller than the tip diameter of the blades, the air flow induced by the fan from the inlet to the outlet being generally in an axial direction between the impeller blades past the periphery of the back plate.

5. In combination, a suction fan comprising a substantially circular back plate having means at the center thereof for driving the same, the back plate having a concavo-convex form, the convex face being the upstream face, and impeller blades projecting in an axial direction from the upstream face of said back plate and also in a radial direction beyond the periphery of said back plate, a cabinet having a circular air inlet and an air outlet, the fan being disposed inside said cabinet in proximity to said inlet with the upstream face toward the inlet and in substantially coaxial relation thereto, the inlet being of a diameter larger than the diameter of the back plate but substantially smaller than the tip diameter of the blades, the air flow induced by the fan from the inlet to the outlet being generally in an axial direction between the impeller blades past the periphery of the back plate, and a motor for driving said fan disposed downstream with respect to the back plate in substantially concentric relation thereto and operatively connected therewith, said motor having a substantially cylindrical housing of smaller diameter than the back plate and being disposed with the one end portion thereof projecting into the concave downstream side of said back plate to reduce obstruction to the flow of air passing the periphery of the back plate toward the outlet.

JAMES M. FUNK.