Sept. 23, 1952 D. D. HERRMAN ET AL 2,611,533

REVERSIBLE FAN AND DELIVERY TUBE

Filed Nov. 8, 1949 2 SHEETS—SHEET 1

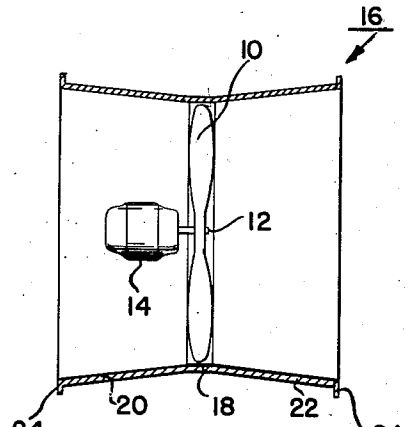


Fig 1

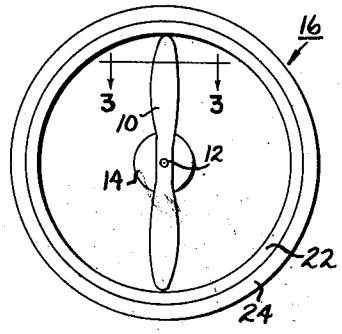


Fig 2

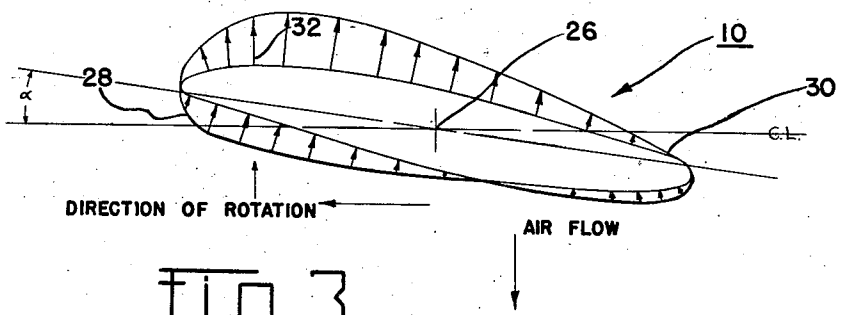


Fig 3

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2 SHEETS—SHEET 2

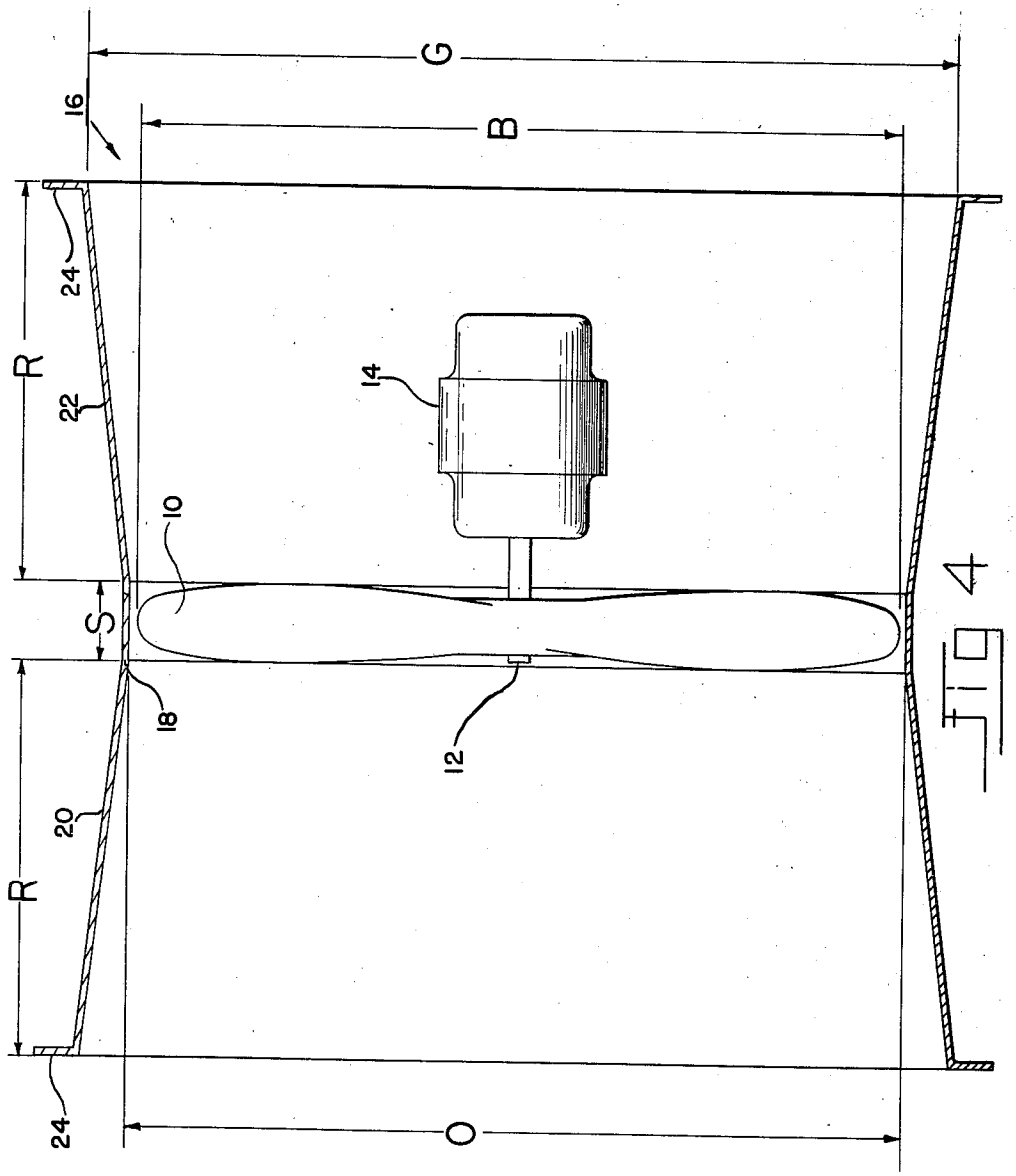


Fig 4

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2,611,533

REVERSIBLE FAN AND DELIVERY TUBE

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Application November 8, 1949, Serial No. 126,163

2 Claims. (Cl. 230—120)

1

This invention relates to fans, especially to fans for reversible flow. More particularly still, this invention relates to a reversible delivery fan having a specially constructed delivery tube for giving efficient operation of the fan in both directions of air flow therethrough, and to a combination of a delivery tube with a reversibly operable propeller.

Reversible fans or propellers of the type with which this invention is concerned are often used in industrial processes, such as in the firing of workpieces in kilns, where it is desirable first to move air in one direction, and then in the other. Heretofore fans for so moving air have been relatively inefficient and expensive, with the result that there was considerable loss of power accompanying the operation of the fan in either one direction or the other, or both.

The particular object of the present invention is the provision of a fan of the type described which is relatively efficient for moving air in both directions, and in combination therewith a delivery tube of a particular design which cooperates with the fan to produce efficient operation of the fan for both directions of air flow.

Another object is the provision of a fan and a delivery tube therefor in which the fan is reversible in its direction of rotation for moving air in opposite directions and which operates efficiently in either direction due to its construction and the nature of the delivery tube.

It is also an object to produce a simple and relatively inexpensive fan and delivery tube therefor which can readily be installed in equipment requiring reversible air flow.

In general, the fan or propeller forming a part of the inventive combination of this application comprises a plurality of blades which are characterized by being symmetrical about a radial axis so as to be a relatively efficient air foil in either direction of movement. The pitch of the blades is fixed, and the direction of air flow is reversed by reversing the direction of the propeller by driving it from a reversing motor, or through a reversing clutch of any of several well known designs.

The actual configuration of the preferred type of propeller is more fully shown in the co-pending application, Serial Number 126,162, filed on November 8, 1949, in the name of Homer K. Monroe, and assigned to the same assignee as the instant application.

In combination with the reversible propeller there is provided a delivery tube which has been arrived at by extensive tests and experimentation, and which is characterized by giving the fan highly efficient operation in both directions of air flow therethrough.

2

The exact nature of the present invention will become more apparent upon reference to the accompanying drawings, in which:

Figure 1 is a side view of a fan and delivery tube combination according to my invention;

Figure 2 is an end view looking in from the right side of Figure 1;

Figure 3 is a transverse section through one of the blades of the propeller, as indicated by line 3—3 on Figure 2. Figure 3 also illustrates the pressure distribution across the faces of the blade for one direction of rotation of the propeller; and

Figure 4 is a view like Figure 1, but drawn at considerably enlarged scale in order better to illustrate the exact nature of the delivery tube of this invention and its physical association with the propeller.

In arriving at the delivery tube design of this invention, the propeller fan was placed in a number of different types of delivery tubes, and the rate of air flow through the tube and the efficiency of operation of the fan was carefully measured. Among the various types of delivery tubes tested were the more or less conventional types having a tapered throat in which the propeller was placed and a discharge duct extending therefrom, a special duct generally convex inwardly about the fan so as to taper in both directions toward the fan, and arrangements having combinations of curved and tapered throats.

It was found by this experimentation and testing that the best arrangement for a delivery tube was one wherein the tube was substantially symmetrical about a transverse plane passing through the plane of the propeller, so that the conditions of discharge for the propeller were the same in both directions of air flow.

The particular delivery tube configuration arrived at is a combination of a straight cylindrical intermediate portion immediately surrounding the propeller and outwardly tapering inlet and discharge portions extending therefrom. In one direction of rotation one of the tapering portions serves as the inlet portion, while the other tapering portion serves as the outlet, and when the propeller is reversed, the function of the said tapering portions is also reversed.

Referring now to the drawings, the propeller is indicated at 10, and it will be seen to be mounted on the shaft 12 of a reversible drive arrangement 14, which may be an electric motor. Pro-

peller 10 is situated centrally in a delivery tube 16 which comprises the central cylindrical part 18 and the outwardly tapering end parts 20 and 22, which latter may advantageously terminate in flanges 24 for connection of the fan arrangement to a duct or to the wall of an enclosure through which air is to be reversibly moved.

Reference to Figure 3 will indicate that the blade of the propeller is substantially symmetrical about a central axis 26, so that in either direction of movement of the blade a substantially efficient air foil is provided. As illustrated, the blade is moving leftwardly, so that the left edge thereof, indicated at 28, is the leading edge, and the other edge thereof, indicated at 30, is the trailing edge. The air flow is toward the bottom of the view, as indicated by the arrow, and the pressure conditions existing across the face of the propeller blade are represented by arrows 32.

It will be evident that the arrows on the rear face of the blade represent a suction force, while those on the face of the blade represent a pressure force, but that both thereof contribute to movement of air through the delivery tube. It will be noted that the pressures vary uniformly across the face of the blade, and that vortices and other evidences of nonstreamlined and inefficient air flow are absent.

It will also be evident that inasmuch as the blade is symmetrical about the central axis 26, the same conditions of air flow and pressure would obtain for the opposite direction of movement of the propeller blade, except that they would be reversed in position and direction.

The particular construction which the delivery tube takes according to this invention for obtaining the above described efficient operation of the propeller is best illustrated in Figure 4. This delivery tube can be manufactured of sheet metal, preferably welded together, so as to provide a smooth interior surface to prevent frictional losses due to the air flowing over the duct surfaces.

The tests and experiments conducted indicate that a high degree of efficiency of operation is obtained for both directions of revolution of the propeller when the porportions set forth in the following table are observed in the construction of the duct. The reference letters in the table represent dimensions which are indicated on Figure 4, and all dimensions are given in percent of the propeller diameter.

	Percent
"B"	100
"O"	101
"G"	112
"R"	50.5
"S"	11.2

It will be appreciated, of course, that the particular nature of the propeller, its speed of rotation, and the quality of the gas being moved thereby will modify to some extent the exact size and shape of the duct. The one illustrated in the drawings, and to which the above table of dimensions pertains, is one that has been designed for a propeller of the type illustrated which is to operate at about 1800 revolutions per minute for moving air.

The propeller, as is more fully illustrated in the co-pending Monroe application referred to above, is preferably formed so that the blades decrease in blade angle from the hub outwardly, taper in thickness from a relatively thick section adjacent the hub to a thinner section at the tip end, and have all of the sections substantially the same shape.

From the foregoing, it will be evident that we have developed a particularly efficient delivery tube and fan combination for reversible flow of air, and that the particular delivery tube arrangement which we have developed has an appreciable effect on the performance efficiency of the combination.

It will be understood that we do not wish to be limited to the exact proportions, ratios, and other factors specifically set forth in the foregoing description and the accompanying drawings, but desire to comprehend such changes thereof as may be further desirable to adapt our invention to different conditions and usages.

We claim:

1. In combination, a propeller adapted for reversible operation for moving gases such as air, and exhibiting substantially equivalent aerodynamic properties in both directions of rotation, and a delivery tube mounted about said propeller, said tube comprising a cylindrical center part in the plane of said propeller and of substantially the same axial length as the width of said blades measured along a plane parallel to the axis of rotation of said propeller, and outwardly tapering frusto-conical end parts of substantially identical configuration connected with said cylindrical center part and forming inlet and discharge ducts for said tube, said center part being connected to said end parts in radially co-extensive relationship so as to provide a delivery tube having a smooth and uninterrupted inside surface from end to end.

2. In combination, a reversible propeller, and a delivery tube surrounding said propeller, said tube comprising a central cylindrical part adjacent said propeller which extends parallel to the rotational axis of said propeller, outwardly tapering frusto-conical end parts on said tube of substantially identical configuration forming inlet and discharge means therefor, and flanged portions on the outer ends of said tapering parts for connection of said delivery tube to a conduit, said central part being connected to said end parts in radially co-extensive abutting relationship so as to provide a delivery tube having a smooth continuous inner surface.

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HOMER K. MONROE.

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