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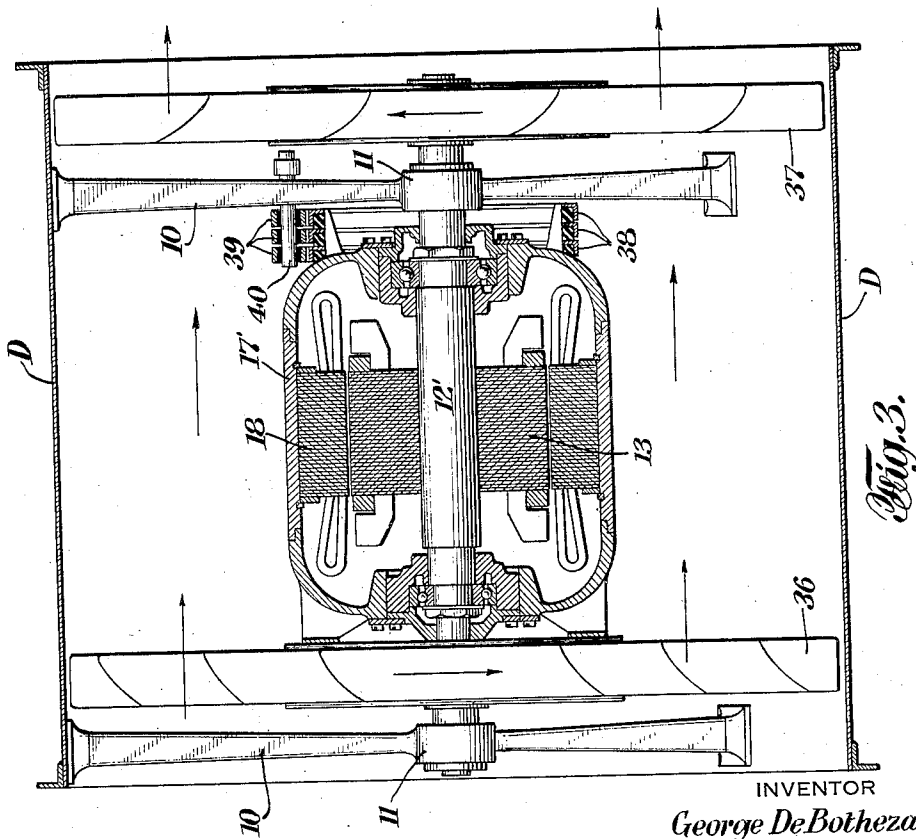
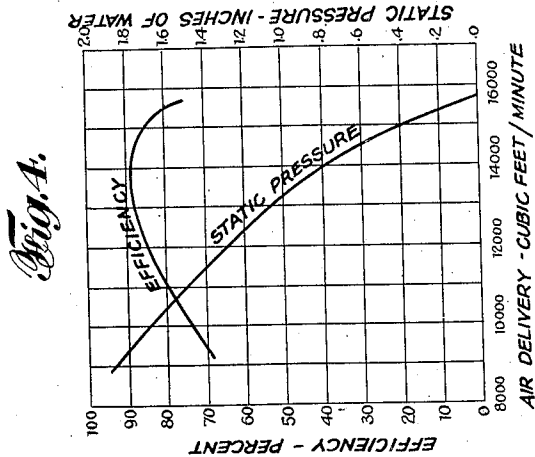
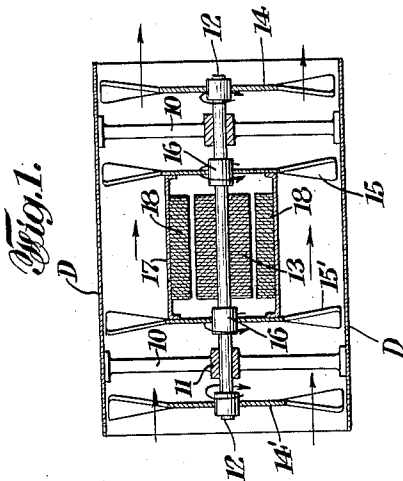
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2,121,073

DISK FAN

Original Filed June 8, 1935

4 Sheets-Sheet 1



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DISK FAN

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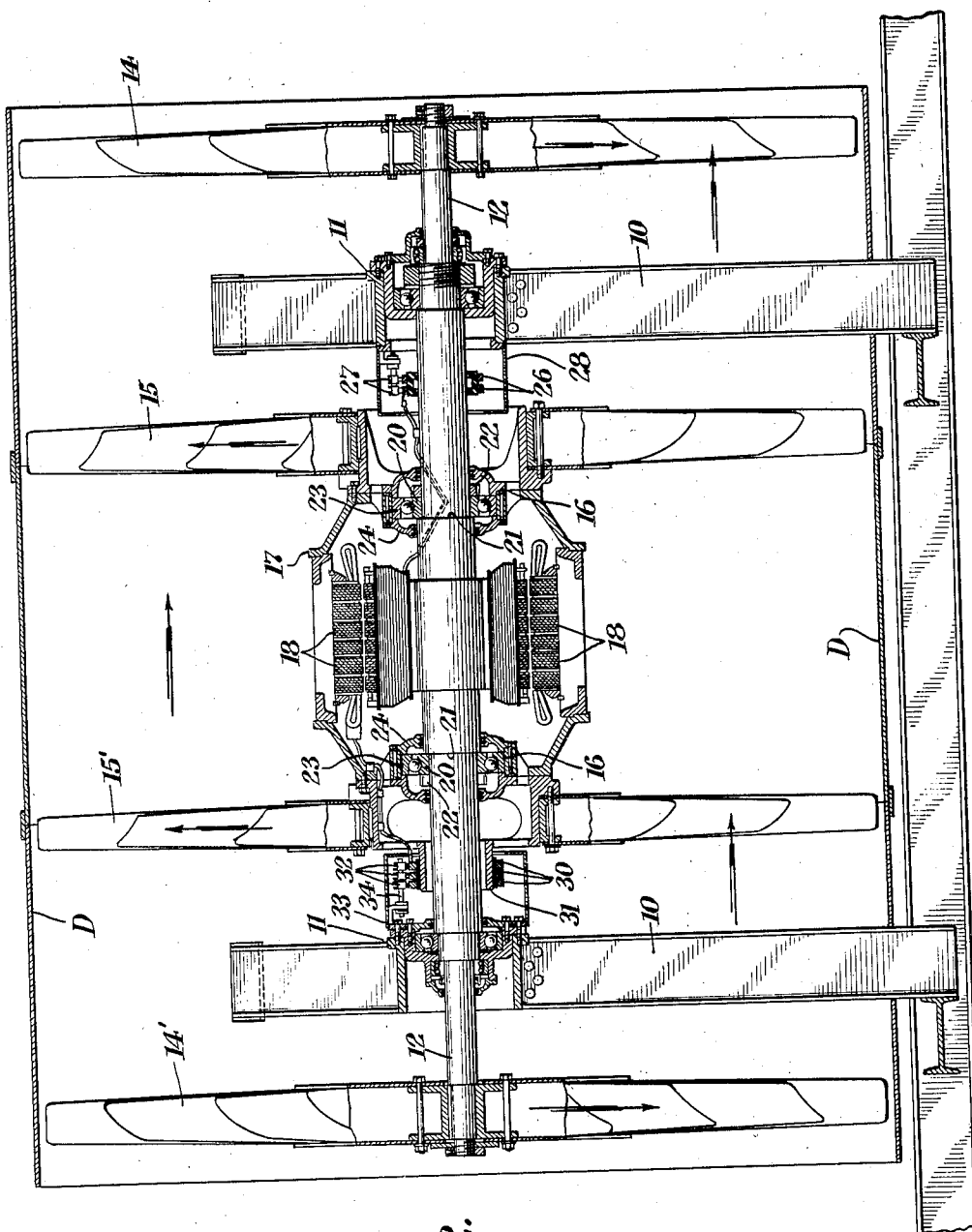


Fig. 2.

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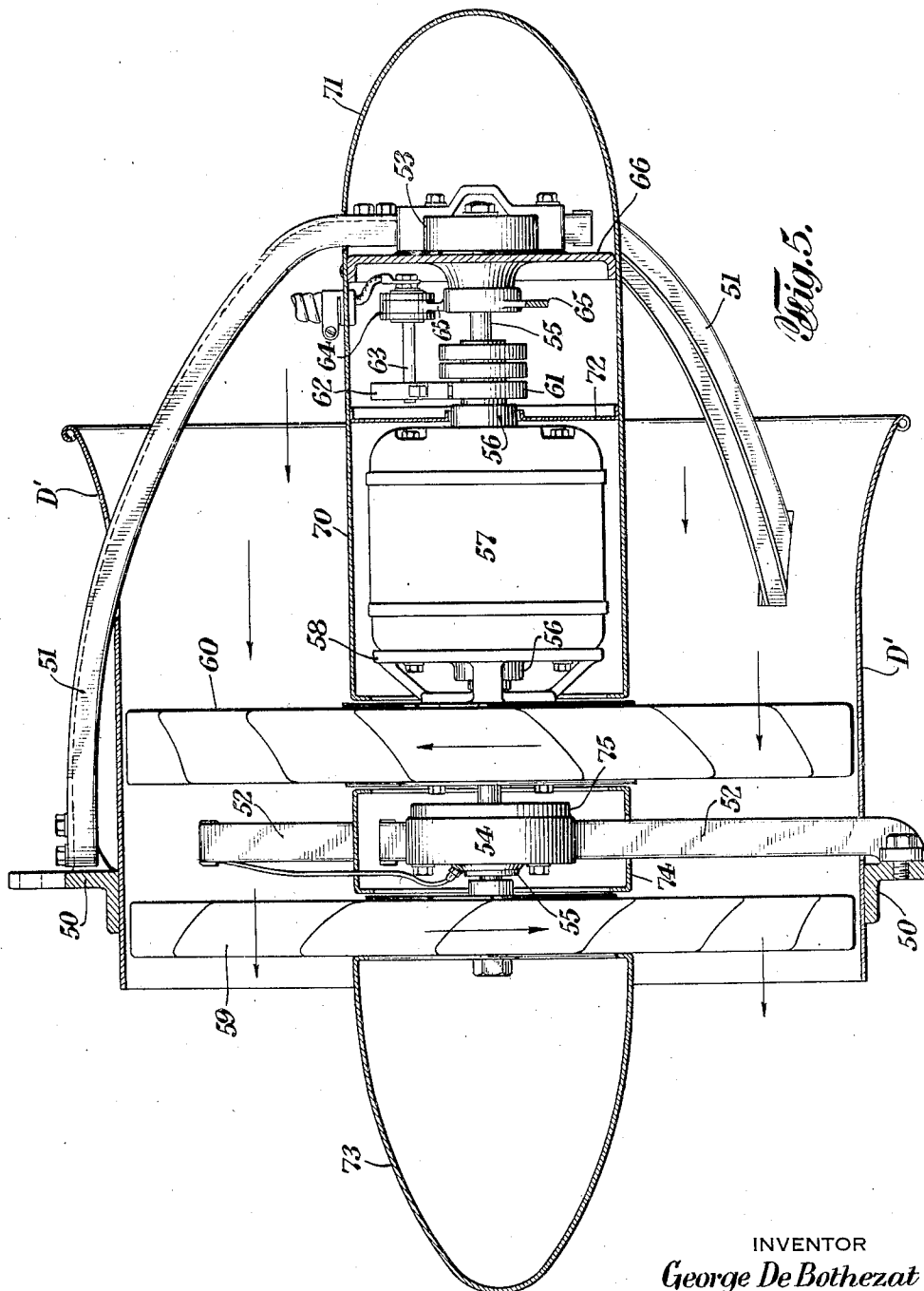
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DISK FAN

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4 Sheets--Sheet 3



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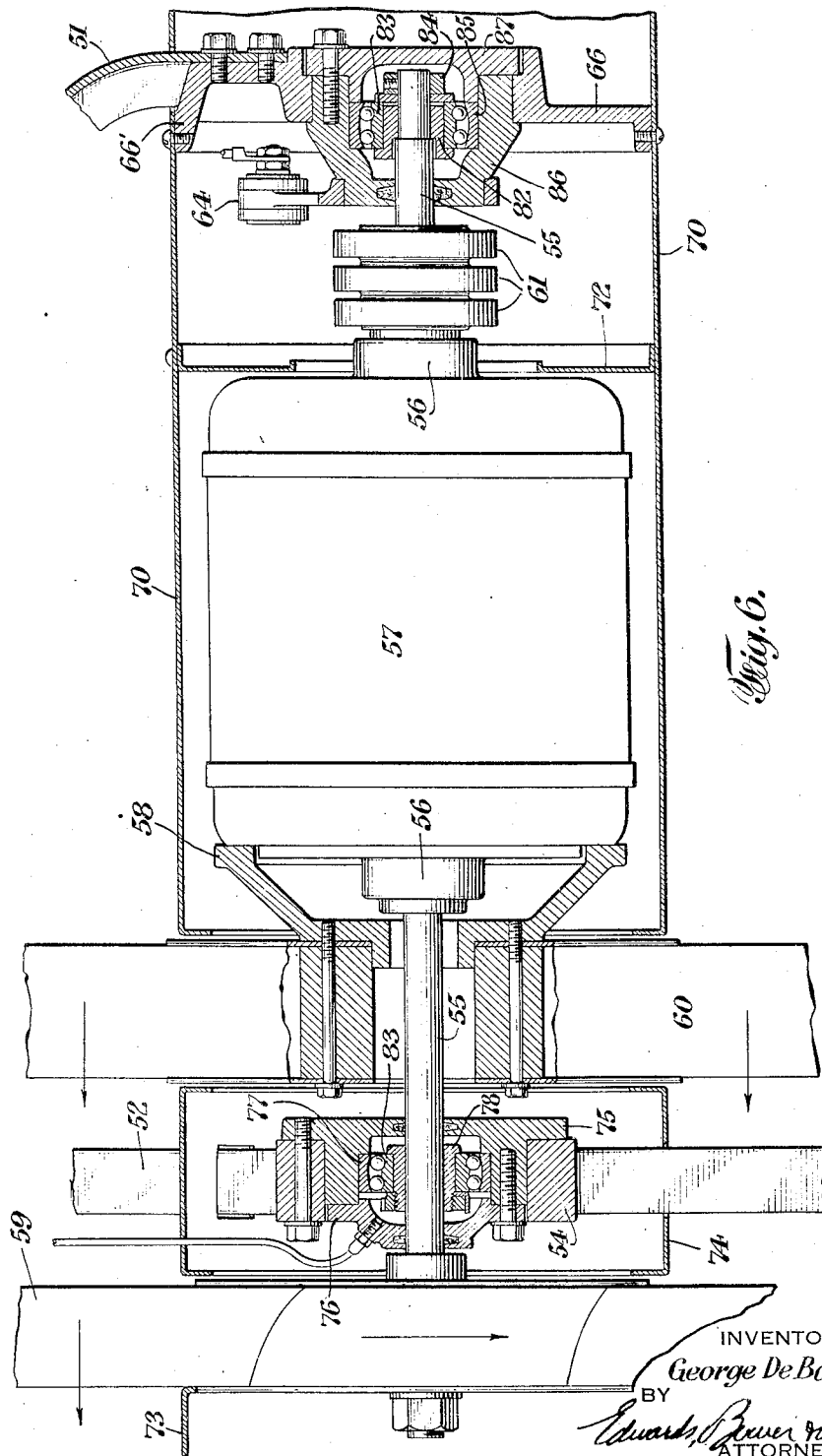
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2,121,073

DISK FAN

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Application June 8, 1935, Serial No. 25,534
Renewed November 11, 1937

6 Claims. (Cl. 230—123)

This invention relates to fans of the disk type, and particularly to such fans combining two or more fan rotors in series.

The main object of the invention is to provide a combination of successive fans of the disk type in series in a duct and mated so that the fan rotors of each pair rotate in opposite directions, and are relatively so constructed as to deliver the air stream with little or no rotation, while at the same time being capable of maintaining said stream against relatively high back pressures.

Another object of the invention is to provide a combination of fan rotors and driving means therefor, which, while mounting one or more of the fans on the shaft of an electric motor, will drive the remaining fan or fans in the opposite direction by the cooperating housing or "stator" of the motor.

I have found that by having the motor housing carrying the outer "field" coils rotatably mounted on the shaft carrying the inner "armature" coils of the motor, and this shaft in turn rotatably supported in stationary bearings in the duct structure, an efficient stream line construction can be provided with a balanced pair of disk fans at one end or each end of the driving motor. The resulting structure is simple and compact, and permits the fan rotors of each pair to be properly spaced with relation to each other. Since the speed of the revolving motor parts is just twice as great in reference to each other as with reference to the speed of each fan to the duct casing, a much smaller, much more efficient motor can be used and will occupy correspondingly restricted space in the air stream.

In the accompanying drawings illustrating the invention

Fig. 1 is a sectional diagrammatic view illustrating the main elements of a fan structure of the type shown more in detail in Fig. 2;

Fig. 2 is a vertical sectional view illustrating one embodiment of the invention combining four disk fans in series with the driving motor between the pairs of fans at each end;

Fig. 3 is a similar view of a modified form in which the driving motor is between the fan rotors forming the cooperating pair;

Fig. 4 is a diagram illustrating the relation of efficiency and static pressure and air delivery with a fan of the type illustrated in Fig. 3;

Fig. 5 is a vertical sectional view of a further modification showing a pair of fan rotors at one end of the driving motor; and

Fig. 6 is a vertical sectional view on enlarged

scale of a portion of apparatus similar to that shown in Fig. 5 but illustrating a modification.

In the device diagrammed in Fig. 1, an air duct D has within it the supporting spiders 10 carrying hub bearings 11 for the motor shaft 12 carrying the inner motor winding 13. The disk fans 14, 14' are mounted at opposite ends of shaft 12 and rigidly fixed thereon to be driven therewith. The inner disk fans 15, 15' are rotatably mounted by bearings 16 on the shaft 12, and these disk fans carry between them the motor housing 17 carrying the outer motor winding 18. Means (not shown) supplies current to motor winding 13 or 18, or both, so that the shaft 12 with its fans 14, 14' is driven in one direction while the housing 17 with its fans 15, 15' is driven in the opposite direction with equal and opposite torque. By properly forming the blading of fans 15 and 14' with relation to the blading of fans 14 and 15' respectively, any rotational components impressed on the stream by the fans 14 and 15' will be substantially neutralized by the action of the following fans 15 and 14', and the air stream from each pair of fans 14, 15, and 15', 14' will be delivered axially with substantially no rotation.

In Fig. 2 the construction of the system of Fig. 1 is shown more in detail. The spider bearings 11 are formed to retain the shaft 12 against longitudinal movement, and the bearings 16 between the motor shaft and the motor housing are also formed to retain the shaft and housing in axial alignment. For instance, (Fig. 2) the inner ring 20 of bearing 16 is retained between the shoulder 21 of shaft 12 and the clamping nut 22, while the outer ring 23 is rigidly held in the inner portion 24 of the motor housing 17. These bearings 11, 16, therefore, maintain accurate longitudinal positioning of the relatively rotatable parts.

The inner coils 13 on shaft 12 are supplied with current through slip rings 26 from brushes 27 in casing 28.

The coils 18 of the motor housing 17 receive their current supply through the slip rings 30 mounted on the bushing 31 carried by the housing. Brushes 32 in the casing 33 are carried by the stationary bolt member 34 supported from the arms of the adjacent spider 10. The cable (not shown) supplying current to the brushes 32 is brought in through the spider openings and along the arms of the spider 10.

This construction brings the four fan rotors and the motor in coaxial relation and in series with each other, and permits any desired spacing

of the members of each pair of fan rotors. Preferably, the blades of the leading rotors 14 and 15' will be at higher angles (relative to the plane of rotation) and of larger number than the lower angled fewer blades of the second stage or following rotors 15 and 14'. The driving relation will automatically apply equal and opposite torques to the rotors 14, 14' on one hand and rotors 15, 15' on the other. With the construction as shown the blading of rotor 14 will develop a torque equal and opposite to that of the rotor 15, and similarly, the rotors 14' and 15' of the other pair will develop equal and opposite torques. These equal and opposite torques will tend to balance the equal and opposite torques of motor windings 13, 18 so that the shaft 12 and housing 17 will rotate at substantially equal and opposite speeds with relation to the duct casing. Whatever rotation is imparted to the air stream by the leading rotors 14, 15' is substantially neutralized by the following rotors 15, 14' so that the discharge stream is delivered with little or no rotation around the axis, and all of the fan's energy goes into propelling the stream axially with high efficiency.

In Fig. 3 a modification is shown in which the leading rotor 36 is at one end of the motor, and the discharge rotor 37 at the other, the leading rotor 36 being carried by the motor housing 17' and the discharge rotor 37 being driven by the shaft 12'. Current is supplied to the motor through the slip rings 38 of the supply brushes 39 mounted on bracket 40 from the arm of spider 10. This provides a very short and compact construction with the motor of small size in the central space between the hub disks of the fan rotors. The motor, therefore, occupies space out of the way between the rotors and within an area not used by the air stream.

In the modification shown in Fig. 5 the entire installation is supported from the wall ring 50 carrying the spider arms 51, which overhang and extend down to the hub ring 66, carrying one bearing 53 for the motor shaft 55; this wall ring 50 also has fastened to it the spider arms 52 carrying the hub bearing 54 for the other end of the shaft 55. Bearings 56 intermediate the ends of the shaft 55 rotatably carry the motor housing 57 at one end of each. The bracket 58 supports the first stage rotor 60, the second stage rotor 59 being carried by the extreme left end of the motor shaft 55. To supply current to the motor, slip rings 61 are provided and contacted by brushes 62 carried by the shaft 63 of hub 64 on arms 65 carried in turn by the plate ring 66.

In Fig. 6 details of shaft supporting bearings 53' and 54 are shown. The spider arms 52 are bolted to the support bushing 75, which has a cooperating flange ring 76 and clamps the outer bearing ring 77 in place with relation to the spider. On the shaft 55 the clamp type bearing bushing 78 is fastened as shown. In bearing 53 the shaft ring 82 is keyed to the shaft 55 and carries the inner bearing ring 83 clamped against the ring shoulder by the end nut 84 and its washer. The outer bearing ring 85 is held firmly between the shoulders of the bushing 86 and end plate 87 carried by the plate ring 66', which in turn is supported from the spider arms 51.

In the fan construction of Figs. 5 and 6, a sectional air flow casing is provided giving a smooth core for the annular air stream. This casing comprises the cylinder 70 and conical end 71

forming a unit carried by the plate ring 66 and having a diaphragm 72 separating the motor from the slip ring compartment. The casing section 73 in generally conical form is rotatable and is carried by the disk of the fan rotor 59, while the intermediate section 74 of the casing is stationary and is carried by the spider arms 52. These casing units are of substantially uniform diameter with rounded ends providing smooth stream lines for the air flow to and from the propelling fans.

In all of these construction no belts, pulleys or idlers are used, and the supporting and driving structure is simple in construction and sturdy in service. There is a minimum of interference with the air stream. The smooth annular stream is without abrupt changes in direction and is symmetrically formed around the central core. Waste of energy in rotation of the stream is reduced to a minimum. High efficiencies resulting from all of these factors are illustrated by the typical efficiency curve shown in Fig. 4.

The relatively low speed of rotation of the disk fans correspondingly reduces the tip speed and gives a very quiet operation, even under conditions of high static back pressure. With the accurately balanced rotors of this invention the power requirements are substantially constant under any pressure from free delivery to no delivery, so that there is no overloading of the driving motor and the power capacity of the driving motor can be accurately gaged to furnish the necessary supply at all deliveries.

This application is a continuation-in-part of my co-pending application, Serial No. 561,524, filed September 8, 1931.

I claim:

1. Apparatus for producing an axially directed current of air comprising an outer member forming a duct, supporting means extending inward therefrom, shaft bearings carried by said supporting means in spaced relation, a rotatable motor shaft member spanning the space between said bearings and rotatable therein to be carried thereby, motor bearings and a motor rotor carried by said shaft between said supports, a motor casing member rotatable on said motor bearings, and oppositely rotating fan rotors driven by said shaft and said casing respectively.

2. Apparatus as set forth in claim 1 in which there are a plurality of fan rotors driven in one direction by the casing and a plurality of fan rotors driven in the opposite direction by the shaft.

3. Apparatus as set forth in claim 1 in which both supports extend inward from a single peripheral bracket means to carry coaxial spaced bearings.

4. Apparatus as set forth in claim 1 in which the fan rotors are positioned in a coaxial duct casing and the supports extend inward from said casing.

5. Apparatus as set forth in claim 1 in which the motor casing parts are exposed to the current of air passing through the fan rotors.

6. Apparatus as set forth in claim 1 in which there are a plurality of fan rotors driven in one direction by the casing and a plurality of fan rotors driven in the opposite direction by the shaft, the fan rotors driven by the casing being positioned between the fan rotors driven by the shaft.

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