

Oct. 26, 1937.

S. F. SHAWHAN ET AL

2,096,926

CENTRIFUGAL FAN

Filed May 8, 1935

2 Sheets-Sheet 1

Fig. 2.

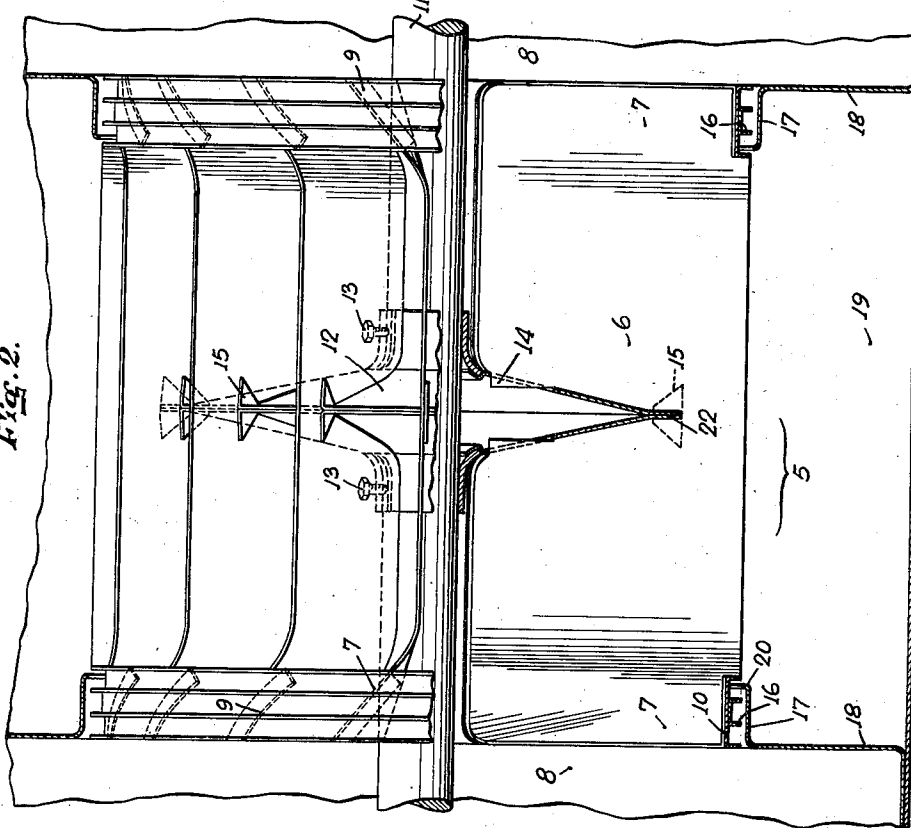
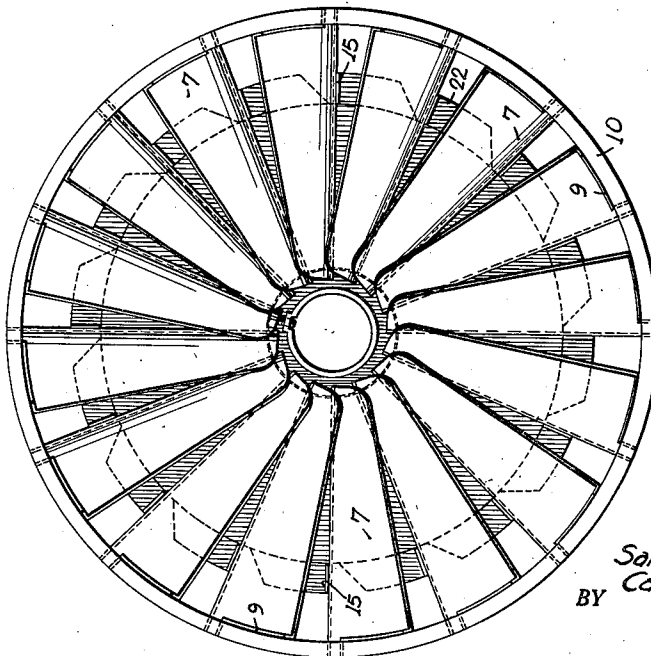


Fig. 1.



INVENTORS  
Samuel F. Shawhan  
Carlyle M. Ashley  
BY *Herman Reid*  
ATTORNEY

Oct. 26, 1937.

S. F. SHAWHAN ET AL

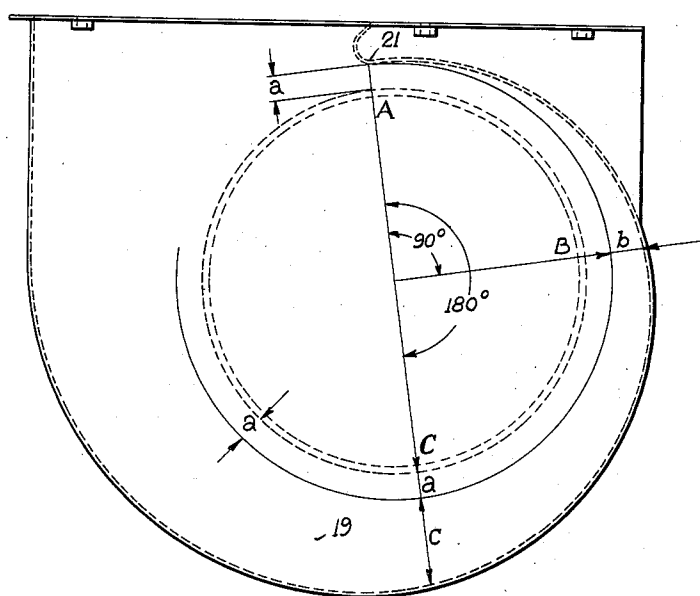
2,096,926

CENTRIFUGAL FAN

Filed May 8, 1935

2 Sheets-Sheet 2

**Fig. 3.**



INVENTORS  
Samuel F. Shawhan  
Carlyle M. Ashley  
BY Herman Reid  
ATTORNEY.

## UNITED STATES PATENT OFFICE

2,096,926

## CENTRIFUGAL FAN

Samuel F. Shawhan and Carlyle M. Ashley, Maplewood, N. J., assignors, by mesne assignments, to Carrier Corporation, Newark, N. J., a corporation of Delaware

Application May 8, 1935, Serial No. 20,320

4 Claims. (Cl. 230—128)

This invention relates to fans, and more particularly to improvements in fans of the centrifugal type.

Fans may be classified in accordance with the direction of air flow therethrough. In the fan of the propeller type, air flow is parallel to the fan axis: in fans of the centrifugal type, the air flow is radial, i. e., parallel with the radius of rotation. Fans of the propeller type are well adapted to applications in which air is to be moved against low or moderate resistances. On the other hand, where higher resistances are encountered, as in systems in which there is extensive ductwork, centrifugal fans are preferred and are used almost exclusively.

It is an object of this invention to provide an improved fan of the centrifugal type embracing, in novel combination, certain features of fans of the propeller type.

It is an object of the invention to provide an improved centrifugal fan which may be drawn through the side of the fan scroll.

It is another object of the invention to provide an improved method of fan construction and assembly, affording accurate alignment of the fan.

It is another object of the invention to provide an improved fan scroll, which is more efficient than those heretofore available.

It is another object of the invention to provide a fan structure in which air leakage is greatly reduced.

It is another object of the invention to provide a fan which is relatively quiet in operation.

Still another object of the invention is to provide for the equal distribution of air over the blades of a centrifugal fan.

A feature of the invention resides in the provision of a centrifugal multi-blade fan in which the inlet ends of the blades are curved.

Another feature of the invention resides in the provision of a series of labyrinth rings on the fan rim, the labyrinth rings working against a cylindrical drawn surface on the fan scroll to effectively reduce air leakage. In a preferred form of the invention, a flange is formed at an end of the drawn cylinder between two of the labyrinth rings, further to reduce air leakage.

Another feature of the invention resides in the method of assembling the apparatus, according to which the fan blades and end rings are first fastened together, and then welded to the hub, the resultant structure then being mounted and adjusted within the fan scroll.

Another feature of the invention resides in

the provision of a fan scroll in which the velocity of a volume of air is progressively reduced as the air travels around the scroll.

Still another feature of the invention resides in so proportioning the number and shape of the blades, in relation to the distance between the wheel and the cut-off, that the air streams leaving the wheel merge before they strike the cut-off.

Other objects, features and advantages, of the invention, will be more apparent from the following description, to be read in connection with the accompanying drawings, in which:

Fig. 1 is a plan view of a rotor element in accordance with the invention;

Fig. 2 is an elevational view, partly in section, of the rotor element and a portion of the casing; and

Fig. 3 illustrates the design of the fan scroll, according to the invention.

Referring now to the drawings, the numeral 5 designates generally a fan blade. The central portion 6 of blade 5 is preferably flat, although, if desired, any other suitable blade section may be employed. The end portions 7 of each blade 5, at the fan inlet, are curved at a desired angle to the plane of rotation of the fan. These curved end portions 7 present the appearance of disc or propeller fans, as viewed in Fig. 1, and, in effect, constitute such fans. In operation, these disc fans serve to draw air from inlet passages 8 and to distribute it substantially evenly over the flat blade portions 6, greatly reducing inlet losses and increasing the overall efficiency of the fan. Tabs 9, formed at the extremities of the blade portions 7, are secured to fan rims 10 in any suitable manner. Preferably, however, tabs 9 and rims 10 are spot-welded together. Fan blades 5 are mounted on shaft 11 in any suitable manner. As illustrated, blades 5 are mounted on a hub 12, which is, in turn, secured to shaft 11. The central portion of hub 12 comprises a pair of juxtaposed frusto-conical members, joined at their bases through flat annular rings 22. The end portions of hub 12 are cylindrical, encompassing shaft 11 and adapted to be rotated thereby, as by means of the set screws 13, which extend through the hub and abut the shaft holding the two in fixed relationship. In addition, the hub may be suitably keyed to the shaft, if desired. Blades 5 are adapted to receive the frusto-conical members of hub 12, a portion of each blade section 6 being cut away for this purpose. Tabs 14, of the blade 5, and tabs 15, of the rings 22, serve to provide union between blades 5 and

hub 12, the tabs and the hub preferably being welded together.

On the outer surface of the fan rim 10 are formed a plurality of labyrinth rings 16. Encircling the labyrinth rings 16 and spaced therefrom are the drawn cylinders 17 formed on the sides 18 of the fan scroll. Applicants thus provide an effective air seal between the air inlet passages 8 and the scroll discharge passage 19, the high resistance to air flow of the path through the labyrinth rings serving to limit air leakage to a low value. As a further means of reducing air flow at this point, the ends of the drawn cylinders are slightly turned in to form a flange 20 which provides an orifice located between two of the labyrinth rings 16. It is to be observed, therefore, that while in this arrangement the running clearance between the end of the flange 20 and the rim 10 is quite great, any air leaking around the periphery of the fan must pass in a very circuitous path. The minimum diameter of annular flange 20 is slightly greater than the outside diameter of labyrinth rings 16. Thus, the fan structure may be drawn out through the side of the scroll as an integral unit, comprising the blades, rim, hub and shaft, with a minimum of effort and in a minimum of time.

The velocity of the air leaving the tips of the fan blades and the corresponding velocity pressure is greatly in excess of that ordinarily required in the duct system, while the static pressure is too low. By enclosing the fan wheel in a casing having a properly designed scroll, this velocity is reduced, and a part of the velocity pressure is converted to static pressure. It is conventional practice to design fan scrolls in such a manner that air travels through the scroll at uniform velocity from the cut-off around to the discharge.

Applicants have found, however, that a decreasing air velocity around the scroll is productive of higher static pressures in the duct system, and higher operating efficiencies. Accordingly, applicants' scroll is so designed that the cross-sectional area of passage 19 increases at such a rate, from cut-off to discharge, that air delivered thereto by the fan passes therethrough at progressively decreasing velocities.

Referring to Fig. 3, it will be noted that at the point of cut-off, A, the fan wheel is separated from the scroll by a distance "a". Ninety degrees around the fan, at B, the wheel is separated from the scroll by a distance which is greater than "a" by the increment "b". One hundred and eighty degrees around the fan, at C, the wheel is separated from the scroll by a distance which is greater than "a" by the increment "c". In operation, a certain amount of air re-enters the scroll at the point of cut-off and, in effect, continues to rotate with the fan in that portion of the scroll which is defined by the dimension "a". Substantially all of the air issuing from the fan and passing around the scroll travels in that portion of passage 19 which is defined by the dimensions "b" and "c". These latter dimensions determine, therefore, what may be termed the "free" or "effective" scroll areas. In applicants' scroll, the dimension "b" is less than half as great as the dimension "c". Passage 19 being preferably of uniform co-axial length, it follows that the effective cross-sectional area of the scroll at the point B, halfway around the fan wheel between the cut-off and the point C, is less than half of the effective cross-sectional area of the scroll at the

point C. Since substantially equal volumes of air are discharged by the fan segment A—B, and the fan segment B—C, the velocity of air traveling around the scroll will be lower at C than at B. As will be understood, the scroll is designed to provide correspondingly increasing effective areas at intermediate points, and beyond the point C.

Since no air inlet vanes are required in combination with applicants' improved fan wheel, and since the above described design affords a compact and efficient scroll, applicants' fan units are particularly well adapted to applications where space is limited.

In the construction of the fan, it is preferred to first weld together the fan blades 5 and the rims 10. The resultant structure is aligned with respect to the axis of the hub and is then welded to the hub 12. The assembled rotor element is then aligned within the fan scroll. This practice permits more accurate alignment of the rim of the fan than would otherwise be possible. Accurate alignment, in turn, permits the use of relatively small clearances between the fan and the scroll. Thus, air leakage is reduced and the efficiency of the fan is increased.

It is to be noted that the end of applicants' blade is flush with the edge of the scroll. This arrangement is preferable, since the wheel is less affected by the direction from which the air approaches the fan than it would be if the inlet were coned back.

By proportioning the number and shape of the blades in relation to the distance "a" between the periphery of the wheel and the cut-off, as illustrated in the drawings, the air streams issuing from the fan between adjacent blades may be caused to merge before they strike the cut-off. This substantially completely eliminates siren noise, which results from the striking of the cut-off by individual streams of air in rapid succession.

While applicants have illustrated and described their invention as applied to a fan of the double inlet type, it is to be understood that fans of the simple inlet type are deemed within the purview hereof.

Since many modifications may be made in applicants' invention without departing from the spirit or the scope thereof, it is intended that this specification and the accompanying drawings be regarded as illustrative only, applicants limiting themselves only as indicated in the appended claims.

In the claims, the expression "effective cross-sectional scroll area" is to be understood to refer to the cross-sectional area through which air issuing from the fan wheel flows in travelling around the fan scroll, said area being less than the total cross-sectional area of the fan scroll substantially by the cross-sectional area of the fan scroll at the point of cut-off.

In the claims, the expression "cylindrical rim" shall be understood to refer to the cylinder 17.

We claim:

1. In a fan of the centrifugal type having a shaft, a plurality of blades, an inlet opening and a discharge scroll, an air seal comprising a plurality of labyrinth rings, a cylindrical rim proximate the edges of said labyrinth rings, said cylindrical rim comprising a turned-in portion of the discharge scroll.

2. In a fan of the centrifugal type having a shaft, a plurality of blades, an inlet opening and

a discharge scroll, an air seal comprising a plurality of labyrinth rings, a cylindrical rim proximate the edges of said labyrinth rings, a flange positioned opposite the space between two of said labyrinth rings, said cylindrical rim and said flange comprising bent portions of the discharge scroll.

5 3. In a fan of the centrifugal type having a rotor including a shaft and a plurality of blades, an inlet opening and a discharge scroll, an air seal comprising a cylindrical rim carried on said fan scroll, a plurality of labyrinth rings and a fan rim, said fan rim being carried on said fan rotor, said labyrinth rings comprising the sides of a U-  
10 shaped channel member secured to said fan rim.  
15

4. In a fan of the centrifugal type having a rotor including a shaft and a plurality of blades, an inlet opening and a discharge scroll, an air seal comprising a first sealing element and a second sealing element, one of said elements consisting of a U-shaped channel member whose sides provide a plurality of labyrinth rings, the other of said sealing elements comprising a cylindrical rim positioned proximate the sides of said channel member, one of said sealing elements being carried on said fan rotor, the other of said elements being carried on said discharge scroll. 5 10

SAMUEL F. SHAWHAN.  
CARLYLE M. ASHLEY.

15