Dec. 20, 1955 R. D. MADISON ET AL 2,727,680

CENTRIFUGAL FAN

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Fig. 1.

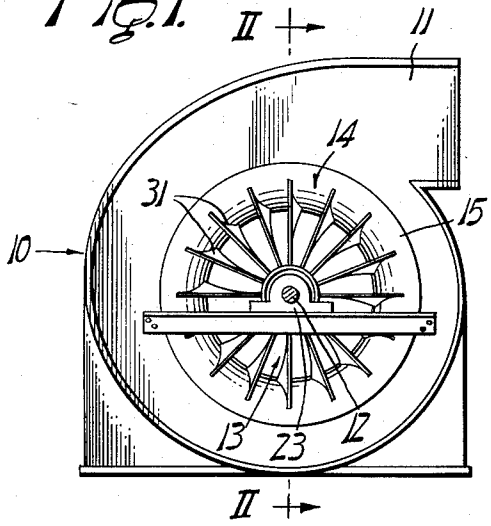


Fig. 2.

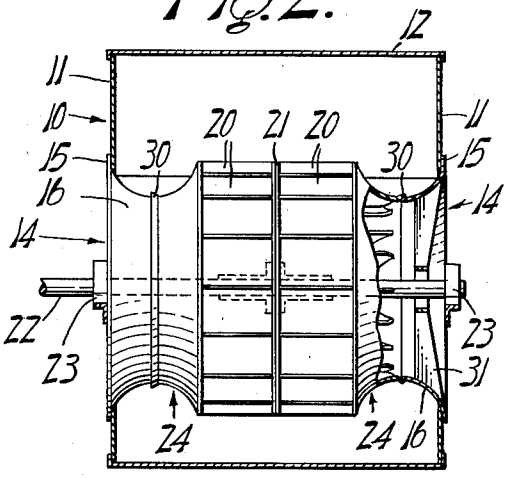


Fig. 3.

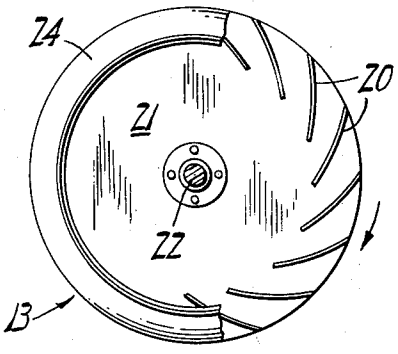


Fig. 4.

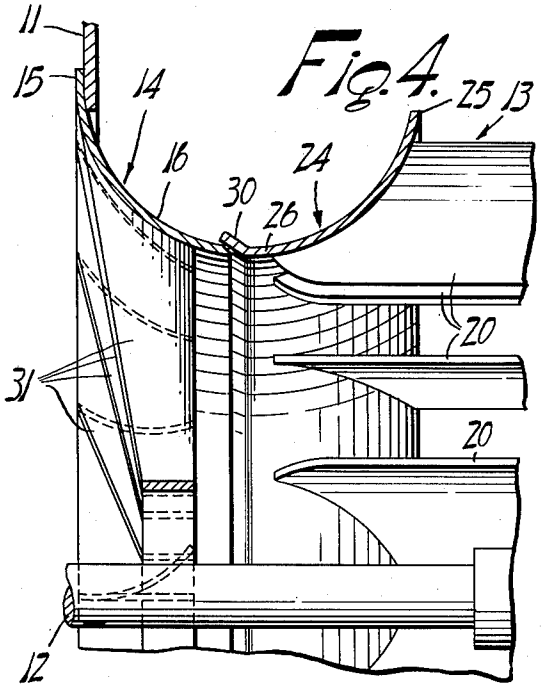
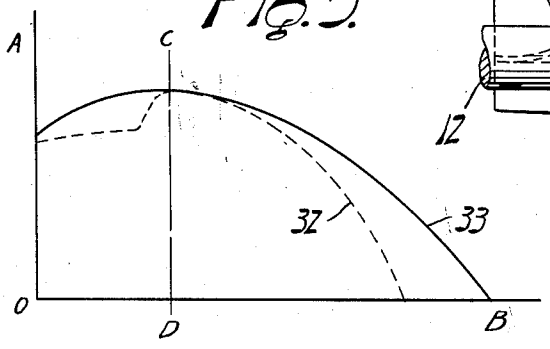


Fig. 5.



INVENTORS
RICHARD D. MADISON
HOWARD C. BURGIN
BY WALTER R ELLIOT AND
ROBERT O. ROGSON
Bean, Brooks, Buckley & Bean.
ATTORNEYS

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CENTRIFUGAL FAN

Richard D. Madison, East Aurora, Howard C. Burgin, Buffalo, Walter R. Elliot, Orchard Park, and Robert D. Robson, Buffalo, N. Y., assignors to Buffalo Forge Company, Buffalo, N. Y., a corporation of New York

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3 Claims. (Cl. 230—128)

Our invention relates in general to centrifugal fans and particularly to that type of fan which is used in ventilation work.

It is well known to those skilled in the art that present day fans designed for this type of work are usually provided with substantially flat blades arranged perpendicularly with respect to the back plate of the fan wheel and inclined backwardly with respect to the direction of wheel rotation. The wheel diameter of such a fan wheel is usually the same as the diameter of the shroud ring, and, in such structures, the shroud ring is slightly curved and relatively shallow in depth and narrow in width. In this type of fan, the air does not enter the inlet or eye in a purely axial direction but has an outward component, and to make the air flow smoothly at the point of junction of the shroud ring and the inlet bell, the adjacent portion of the inlet bell must be made smaller than the inlet of the shroud ring. A further disadvantage of a fan of this type is that a certain amount of leakage must be allowed to occur between the inlet eye or bell and the shroud ring in order to keep the blade passage filled and to prevent boundary separation resulting in even greater loss. Such leakage is not only critical but represents a considerable loss in the efficiency of the fan.

The flow of air produced by a fan of the above mentioned type is unstable at approximately the point of high pressure performance which is near the point of highest efficiency. Such a condition, as is well known, is undesirable since the full benefit of high efficiency cannot be realized. In such fans the pressure curve breaks very quickly as the capacity is reduced beyond the point of maximum efficiency so that the performance of this type of fan at or near this point is very critical.

The principal object of our invention is to provide a fan having high efficiency, and one in which the instability of performance, hereinbefore referred to, is removed entirely, or is shifted to a place remote from the point of high efficiency performance of the fan.

In order to accomplish these results, we have produced a fan having an inlet eye having an annular wall of substantially quadrant shape. The shroud ring is likewise formed with an annular wall of substantially quadrant form. These two elements have substantially the same minimum diameter and have their adjacent edges closely arranged so that the air will flow around the contiguous convex surfaces thereof in a gradual manner with little tendency to boundary separation. The fan wheel is provided with blades which are inclined backwardly and are curved convexly in the direction of rotation. Means are also provided in the inlet eye for giving the air a spin in the direction of rotation.

Another advantage of our construction is that the shape of the inlet eye and shroud ring are substantially identical, and they are so arranged that their adjacent edges are closely fitting, thereby preventing leakage of air at the joint therebetween.

Furthermore, in our invention the wheel blades are curved, and inlet vanes are provided to give to the air

a tangential component of velocity in the direction of wheel rotation.

The above objects and advantages have been accomplished by the device shown in the accompanying drawings, of which:

Fig. 1 is a side elevation of the centrifugal fan embodying our invention;

Fig. 2 is a sectional elevation thereof taken on line II—II of Fig. 1;

Fig. 3 is an end elevation of the fan wheel of our invention with portions thereof broken away;

Fig. 4 is an enlarged fragmentary sectional view taken on line II—II of Fig. 1; and,

Fig. 5 is a performance curve showing the performance of our centrifulgal fan is comparison with the performance of a fan of the type in general use today.

As shown in the drawings, **10** represents the housing of the centrifugal fan to which our invention is applied. The housing has side walls **11** and a volute casing **12**; and, for illustration, a double inlet fan is shown, having two inlet eyes **14**. Rotatably mounted within the housing is the fan wheel **13** which is of the double ended type and which is provided with a series of blades **20** arranged on each side of a central wall or septum **21**. The wheel is mounted upon a shaft **22** which is rotatably carried by suitable bearings **23** supported by the side walls **11** of the housing.

As shown in Fig. 3, the blades **20** of the fan wheel are inclined outwardly and backwardly with respect to the direction of rotation and are of such width that their inner edges extend inwardly beyond the minimum diameter of the shroud ring **24** to which their outer ends are secured. The convex sides of the blades are presented to the air, and the inner edges thereof are substantially parallel to the wheel shaft and in spaced relation therewith, as clearly shown in Fig. 4. As shown in this figure, the inner edges of the blades extend inwardly a distance equal to substantially 95% of the minimum diameter of the shroud ring. Moreover, the inclination of said blades is such that a plane touching the substantially parallel inner and outer edges of each of them will be tangent to a cylinder slightly smaller in diameter than the minimum diameter of said shroud ring.

Each of the inlet eyes **14** of our invention is arcuate in cross section and has its surface struck from a common center, thus substantially forming a quadrant of a circle. Each of the eyes is provided with a flange portion **15** and a quadrant portion **16**. Each shroud ring **24** of the wheel is also arcuate in cross section having its surface struck from substantially the same center as that of the inlet eye. Each of the shroud rings has a flange portion **25** and a quadrant portion **26**. The parts of our fan are so arranged that the quadrant portions of the eyes extend inwardly into the housing and lie adjacent and close to the contiguous quadrant portions **26** of the shroud rings, the minimum diameter of the quadrant portions of adjacent parts being substantially the same. The adjacent edges of the convex surfaces of the eyes and the shroud rings are, therefore, so arranged that there is provided substantially continuous surfaces of semi-circular or torus cross section over which the air may smoothly flow. The edge of the quadrant portion of each shroud ring is provided with a closure flange **30** which overlaps the inner edge of the inlet eye, as clearly shown in Fig. 4, whereby the space between the two adjacent parts is reduced to a minimum, and a smooth flow of air over the surfaces of these parts thereof is assured. Boundary separation of the air is also thereby prevented. It will be obvious from the foregoing that our invention has a further advantage in that both inlet eyes and shroud rings can be made from

the same set of dies since these parts are similarly shaped and are substantially identical.

In order to further improve the performance of our fan, we provide fixed guide vanes 31 in each inlet eye which are radially arranged and which are curve-shape in cross section, having their concave surfaces facing the entering air so as to give to it a spin in the direction of wheel rotation.

In Fig. 5, we show in a diagrammatic manner the performance of our fan in relation to the performance of a fan now generally used in ventilating work. In this diagram line O—A represents the pressure of air produced by the fan, and line O—B the quantity of air being handled. The performance of the present day fan is shown by the dotted line curve 32 and the performance of our fan by the full line curve 33. Line C—D shows the location of the point of high efficiency operation, and it will be seen by the broken line curve that in the fan of present day design there is a very definite break in the pressure curve at a point close to this high efficiency line, thus making high efficiency performance of the fan very critical. In contrast, and as shown by the full line curve, the performance of our fan is such that the sudden drop in pressure does not occur but the pressure is substantially sustained over this critical point of performance.

It will be obvious, therefore, that by means of the various novel features of our invention we are able to produce a fan having very marked improvement in performance over fans of present day construction, and by it we have eliminated the critical point of performance in such fans, hereinbefore referred to. While we have shown and described our invention as having an inlet eye and coacting shroud ring of arcuate shape and of quadrant form, it is obvious that the shape and form of these parts may be varied somewhat without departing from the spirit of our invention or the scope of the appended claims.

What we claim is:

1. A centrifugal fan comprising, a housing formed with an inlet eye having an annular wall of substantially quadrant shape when cut by a plane passing through the diametrical center of said fan, a shaft concentric with said inlet eye, a fan wheel rotatably disposed within said housing and mounted upon said shaft, said wheel having a substantially flat disk, a plurality of blades carried by said disk and extending axially toward said inlet eye and inwardly from points near the outer periphery of said disk, said blades terminating in inlet side ends, said blades being curved outwardly from said shaft and rearwardly with regard to the direction of rotation of said wheel and having inner and outer edges substantially parallel to each other and parallel with said shaft, a shroud ring carried on the inlet ends of said blades, said ring having an annular wall of substantially quadrant cross section when cut by a plane passing through the diametrical center of said wheel, said blades terminating in axially extending inner edges spaced radially from the axis of said wheel and coincident with a cylinder having a diameter substantially less than the minimum diameter of said shroud ring, the inlet edges of said blades terminating short of the inlet edge of said shroud ring, said blades being so inclined that a plane passing through their inner and outer edges will be tangent to a cylinder smaller in diameter than the minimum diameter of said shroud ring, and the quadrant-shaped wall of said inlet eye and the quadrant-shaped wall of said ring being fixed relative to each other to present an inner surface formed by the assembled parts, whereby a substantially continuous surface of semicircular shape is provided for the smooth flow of air through the inlet eye and into the fan wheel.

2. A centrifugal fan comprising, a housing formed with an inlet eye having an annular wall of substantially quadrant shape when cut by a plane passing through the diametrical center of said fan, a shaft concentric with said inlet eye, a fan wheel rotatably disposed within said housing and mounted upon said shaft, said wheel having a substantially flat disk, a plurality of blades carried by said disk and extending axially toward said inlet eye and inwardly from points near the outer periphery of said disk, said blades terminating in inlet side ends, said blades being curved outwardly from said shaft and rearwardly with regard to the direction of rotation of said wheel and having inner and outer edges substantially parallel to each other and parallel with said shaft, a shroud ring carried on the inlet ends of said blades, said ring having an annular wall of substantially quadrant cross section when cut by a plane passing through the diametrical center of said wheel, said blades terminating in axially extending inner edges spaced radially from the axis of said wheel and coincident with a cylinder having a diameter equal substantially to nine-tenths the minimum diameter of said shroud ring, the inlet edges of said blades terminating short of the inlet edge of said shroud ring, said blades being so inclined that a plane passing through their inner and outer edges will be tangent to a cylinder smaller in diameter than the minimum diameter of said shroud ring, and the quadrant-shaped wall of said inlet eye and the quadrant-shaped wall of said ring being fixed relative to each other to present an inner surface formed by the assembled parts whereby a substantially continuous surface of semicircular shape is provided for the smooth flow of air through the inlet eye and into the fan wheel.

3. A centrifugal fan comprising, a housing formed with an inlet eye having an annular wall of substantially quadrant shape when cut by a plane passing through the diametrical center of said fan, a shaft concentric with said inlet eye, a fan wheel rotatably disposed within said housing and mounted upon said shaft, said wheel having a substantially flat disk, a plurality of blades carried by said disk and extending axially toward said inlet eye and inwardly from points near the outer periphery of said disk, said blades terminating in inlet side ends, said blades being curved outwardly from said shaft and rearwardly with regard to the direction of rotation of said wheel and having inner and outer edges substantially parallel to each other and parallel with said shaft, a shroud ring carried on the inlet ends of said blades, said ring having an annular wall of substantially quadrant cross section when cut by a plane passing through the diametrical center of said wheel, said blades terminating in axially extending inner edges spaced radially from the axis of said wheel and coincident with a cylinder having a diameter substantially less than the minimum diameter of said shroud ring, the inlet edges of said blades terminating short of the inlet edge of said shroud ring, said blades being so inclined that a plane passing through their inner and outer edges will be tangent to a cylinder smaller in diameter than the minimum diameter of said shroud ring, the quadrant-shaped wall of said inlet eye and the quadrant-shaped wall of said ring being fixed relative to each other to present an inner surface formed by the assembled parts whereby a substantially continuous surface of semicircular shape is provided for the smooth flow of air through the inlet eye and into the fan wheel, and a plurality of inlet vanes mounted in said inlet eye and each having a concave surface facing the incoming air and inclined inwardly and forwardly in the direction of rotation of said wheel.

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