June 15, 1937. G. C. DERRY 2,083,833

FAN

Filed April 5, 1934

Fig. 1

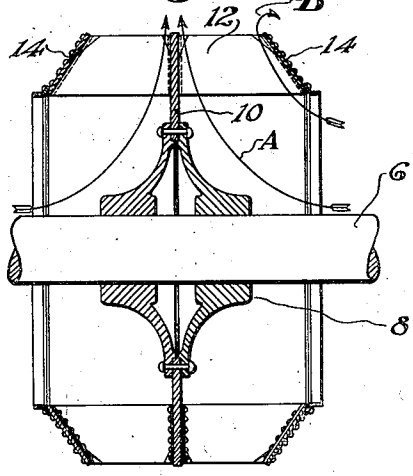
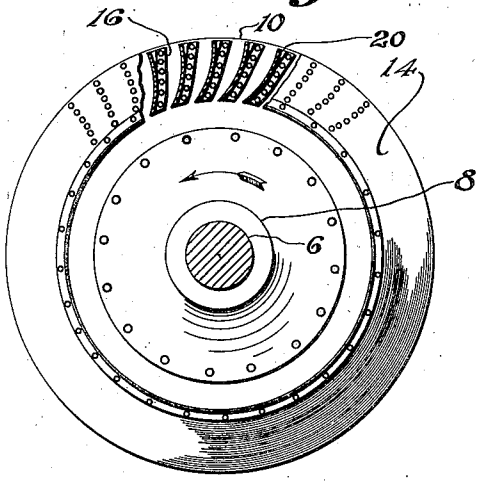


Fig. 2



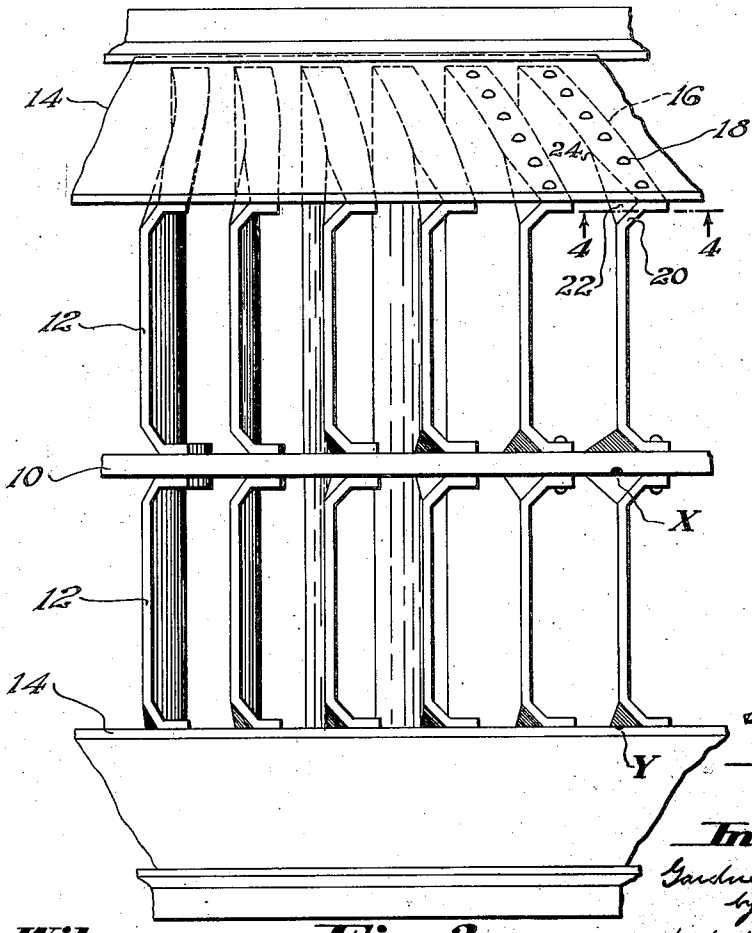


Fig. 3

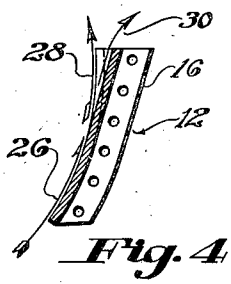


Fig. 4

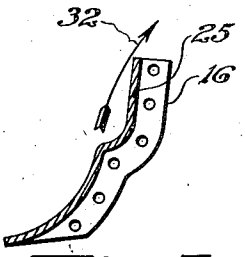


Fig. 5

Witness
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FAN

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8 Claims. (Cl. 230—134)

The present invention relates to fans and particularly to fans which are subjected to the erosion action by abrasive material passing through the fan, as for example, the cinders or fly ash which are carried through induced draft fans of power plants.

In the usual type of induced draft fan, the fan blades are riveted to side plates, or shrouds, and center plates. In operation, the fan is required to handle flue gases which contain a quantity of abrasive cinders. Owing to the centrifugal forces acting on the cinders during their passage through the fan, the cinders ordinarily localize in different paths adjacent to the points of attachment of the blades to the supporting plates. The scouring action of the cinders moving at high velocity and pressing with considerable force on the blades, results in rapid wear on the plates and ultimately causes shearing of the attaching rivets until the rotor is dangerously weakened. As a consequence, it is necessary to replace certain portions of the rotor at frequent intervals, resulting in excessive expense not only for repairs but for the loss of use of the equipment during shutdowns. It is the object of the present invention to prevent this destructive action of the cinders or other abrasive material, and to provide a fan which may be operated for long periods without requiring the repair or replacement of the rotor or of any of its component parts.

I have discovered that abrasion may be avoided or at least greatly minimized by forming the outer edges of the blades with set-back portions which apparently have the effect of providing a path for the cinders out of contact with the plates or blades of the rotor. Since the cinders or abrasive particles are acted on more strongly by centrifugal force than the flue gases, the cinders tend to localize in paths which cover only a small portion of the blade. Therefore, the set-back portions may be of relatively small extent, insufficient to have any appreciable effect on the operating characteristics of the fan. It has been found possible with the present invention to operate a fan for months without appreciable wear, as contrasted with the necessity of repair of certain parts at periodic times with the conventional type of fan.

In the accompanying drawing illustrating what is now considered the preferred form of the invention, Fig. 1 is a sectional elevation of the rotor; Fig. 2 is an end view, partly in section, of the rotor; Fig. 3 is a plan view of a portion of the rotor on an enlarged scale; Fig. 4 is a sectional detail on line 4—4 illustrating what is considered to be the principle of operation of the improved fan; and Fig. 5 is a similar sectional detail with a modified form of blade.

The illustrated embodiment of the invention comprises a fan rotor or wheel having a shaft 6, a supporting hub 8, a center plate 10 supported by the hub, a set of blades 12 and side plates or shrouds 14 to which the blades are attached. The rotor is mounted in a double inlet scroll casing of conventional form which, for the sake of simplicity, is not shown.

As illustrated in the drawing, the blades 12 are of the combined radial and forwardly curved type, each blade having at the ends suitable rearwardly bent riveting flanges 16 for attachment to the center plate 10 and to the shroud 14 by rivets 18. Between the main portion of the blade and the flange 16, the blade is formed with a triangular portion 20 which is at an angle with respect to such main portion and the flange 16. As shown in Fig. 3, the portion 20 is formed in a manner to leave a wedge-shaped space or pocket 22 between the blade and the plate to which it is attached. The portion 20 tapers to a point 24 a short distance inwardly from the outer edge of the blade. From the point 24 to the inner edge, the blade is of practically conventional form. It will be noted that the riveting flanges 16 are necessarily somewhat wider than in the conventional fan and that the outermost rivets are disposed slightly to the rear of the position which they would normally assume in the ordinary fan. Thus, as shown in Fig. 2, the line of rivets does not follow the curvature of the main portion of the blade but lies in back of the actual line of contact of the blade with the plate.

In Fig. 5 is shown in transverse section a form of blade in which the outer portion 25 is set back throughout the entire length of the blades, instead of at the ends only as in Fig. 4.

To explain the freedom of the present fan from abrasion, I have developed the following theory which is believed to be correct, although it is to be understood that the invention is not to be considered as limited to a fan which operates upon this particular theory. As shown in Fig. 1, the cinders or abrasive particles entering the inlet and passing through the fan take principally the course of the streamlines indicated at A, most of the cinders concentrating in a path adjacent to the center plate 10. Although the distribution of flue gas over the blade is substantially uniform, the cinders tend to localize in the path adjacent the back plate

because of the greater centrifugal forces acting on them. It has been found that in the ordinary fan, wherein the blades are of the combined forwardly curved and radial type, the abrasive action occurs in that portion of the blade which extends outwardly from where the blade shape changes from forwardly curved to radial, as indicated at *x* in Fig. 3. By reason of the change in direction, the particles get an increased acceleration which increases the erosive action as the particles move outwardly. The cinders, which at the outer margin or edge of the blade, are at their maximum velocity, not only scour the plate but also find a point of entrance between the blade and the plate and soon shear through the outermost rivet. As the opening between the blade and the plate increases through the scouring action of the cinders, the entrance of the cinders is facilitated, so that a shearing action occurs on the second rivet, and so on until the fan becomes unsafe for use.

The same action, although to a less virulent degree, occurs on the inlet side of the blade, that is to say, the side at which the blade is connected to the shroud **14**, as indicated at *y* in Fig. 3. This secondary action is believed to occur primarily because of the inclination of the shroud which concentrates at one point on the outer edge of the blade the cinders passing over a considerable length of inner edge, and also to some extent through unavoidable recirculation of the gas between the rotor and the casing, as indicated by the streamline B in Fig. 1. The abrasion may eventually cut through the shroud and also weaken the connection of the blades to the shroud.

According to the present invention, it is believed that the wedge-shaped pockets **22** afford a path for the cinders out of contact with any metal parts. As illustrated in Fig. 4, the gas over the main portion of the blade is forced to traverse a path represented by the arrows **26** and **28**. During the passage of the cinders over about the first half of the blade, no appreciable abrasive action occurs, presumably because the cinders have not yet acquired a tendency to concentrate in any particular path in scouring relation to the blade. Over the latter part of the travel with respect to the blade, the cinders having been acted on centrifugally, and also due to increased acceleration due to change in direction, tend to take a path indicated by the arrow **30**. This arrow is tangential to the curved portion of the blade at the point where the cinders start to enter the wedge-shaped pocket, and is shown curved to indicate the path of the cinders with relation to the outer edge of the blade. In the conventional form of blade, it will be seen that this arrow **30** would lie in back of the edge of the blade and that the tendency would be for the cinders to enter the space between the blade and the supporting plate.

Similarly in Fig. 5 the arrow **32** represents the path of the cinders relatively to the outer portion of the blade.

According to the present invention, the face of the triangular portion **20** is in back of the normal path **30** of the cinders so that the cinders instead of sliding over the outer edge of the blade under the heavy pressure created by the rotation of the fan wheel, pass through the zone of the outer blade portion either suspended in a stream of air or in such light pressure contact with the set back portion that no deleterious scouring or abrasion results, the inner portions of the blade developing the centrifugal action or movement required. In other words, the blade is so constructed that the inner portion constitutes the cinder moving portion, and the cinders have no scouring or abrasive contact with the outer portion.

In the specific constructions illustrated in the drawing where an integral or one-part blade is employed, the setting back of the metal surfaces with respect to the normal path of cinders is such that the outer portions of the blade never overtake the scouring stream of cinders. In the illustrated embodiment of Fig. 4 this theory applies only to the ends of the blade which are attached to the plates **10** and **14**, the cinders ordinarily not being sufficiently concentrated to produce any important erosive action over the main portion. In the form shown in Fig. 5, where the outer portion is set back throughout the length of the blade, this same relative movement of blade and cinders will take place in the middle portion as well as at the ends of the blade.

It has been found that with the present invention, not only is shearing of the rivets prevented, but erosion of the plates **10** and **14** is greatly minimized. With the conventional type of fan, the erosion of the plates at points *x* and *y* is severe whereas with the present invention, such erosion is negligible. It is believed that with the ordinary fan, the cinders are forced to travel in a fine concentrated stream at this point, whereas in the present invention the stream is widened out within the limits of the wedge-shaped pocket **22**, and becomes so attenuated as to produce little or no abrasive action on the plates. In any event, whatever the correct theory may be, the present invention has been found to provide remarkable freedom from abrasive effects.

The invention has been described as embodied in a blade which is forwardly curved (i. e. concave toward the direction of rotation) at its inner portion, and substantially radial at its tip. With such a blade, it has been found that the concentration and velocity of the cinders are not ordinarily sufficient to produce appreciable abrasion until the cinders reach that portion of the blade which is definitely approaching the radial direction, somewhat more than halfway from the inner edge to the tip in the blade shown in the drawing. With the integral type of blade the set back portion extends to a point below that at which abrasion would normally start.

One of the principal advantages of the specific construction illustrated in Fig. 4 is that it permits use of a blade which over the greater part of its surface may be constructed purely from the standpoint of operating characteristics. Whatever effect the spaces **22** may have on fan efficiency is entirely negligible.

Having thus described the invention, what is claimed is:

1. In a centrifugal fan rotor for handling erosive materials, supporting plates, and a plurality of blades attached to the plates, each blade having a riveting flange at the end thereof and the surface of the blade at the outer edge adjacent the flange being formed with a pocket of progressively increasing depth and width from a point intermediate the inner and outer edges to the outer edge to form a passage for the erosive material.

2. A centrifugal fan rotor for handling fluid containing abrasive material having a supporting

plate and a plurality of blades, the rotor being arranged to receive fluid axially and to discharge it at the periphery whereby under the action of centrifugal force the abrasive material tends to concentrate in a scouring stream near the outer edge portion of the blades, each blade being substantially straight along elements parallel to the axis of rotation for the greater part of its length, and a part only, measured axially, of the outer edge portion of each blade being offset peripherally with respect to the inner portion and rearwardly with respect to the direction of rotation to provide a space on the working face of the blade for passage of abrasive material without scouring contact with the blade.

3. A centrifugal fan rotor for handling fluid containing abrasive material having a supporting plate and a plurality of blades, the rotor being arranged to receive fluid axially and to discharge it at the periphery, each blade being substantially straight along elements parallel to the axis of rotation for the greater part of its length, and a part only measured axially, of the outer edge portion of each blade being set back with respect to the inner portion peripherally counter to the direction of rotation to provide a space on the working face of the blade for passage of abrasive material without scouring contact with the blade.

4. In a centrifugal fan rotor for handling abrasive material, supporting plates, and a plurality of blades attached to the plates, the blades being substantially straight along elements parallel to the axis of rotation for the greater part of their length and having a riveting flange at the ends thereof substantially at right angles to the blade, and an oblique portion adjacent the outer edge and the flange and extending the lesser part of the length of the blade to form a pocket on the working face thereof for the passage of erosive material.

5. A blade for centrifugal fan rotors for handling abrasive materials having a flange at the end thereof at substantially right angles to the main portion of the blade, the outer edge portion of the blade adjacent the flange being angularly disposed to form a pocket on the working face of the blade, the pocket extending part way only across the width of the blade and being inclined rearwardly with respect to the direction of rotation, the remainder of the width of the blade being straight.

6. A centrifugal fan rotor for handling fluid containing abrasive material having a supporting plate and a plurality of blades, the rotor being arranged to receive fluid axially and discharge it at the periphery, the outer edge portions of the blades being substantially straight along elements parallel to the axis of rotation for the greater part of their axial length, the lesser part of such outer edge portion being inclined backwardly with respect to the direction of rotation to form a pocket on the advancing face of the blade for the passage of abrasive material without scouring contact with the blade.

7. A centrifugal fan rotor for handling fluid containing abrasive material having a supporting plate and a plurality of blades, the rotor being arranged to receive fluid axially and discharge it at the periphery, the outer edge portion of each blade being inclined rearwardly in the direction of rotation with respect to the inner edge portion, the angle of backward inclination of the outer edge portion with respect to the inner portion of the blade being such as to permit the abrasive material to pass said outer edge portion out of scouring contact therewith while maintaining the passage between adjacent blades unreduced in width from blade to blade from the inner portion to the outer edges of the blades.

8. A centrifugal fan rotor for handling fluid containing abrasive material having a supporting plate and a plurality of blades, the rotor being arranged to receive fluid axially and discharge it at the periphery, the outer edge portion of each blade being offset rearwardly in the direction of rotation with respect to the inner edge portion to permit the abrasive material to pass said outer edge portion out of scouring contact therewith while maintaining the passage between adjacent blades substantially unreduced in width from blade to blade from the inner portion to the outer edges of the blades.

GARDNER C. DERRY.