Dec. 29, 1936. M. S. LEONARD 2,065,716

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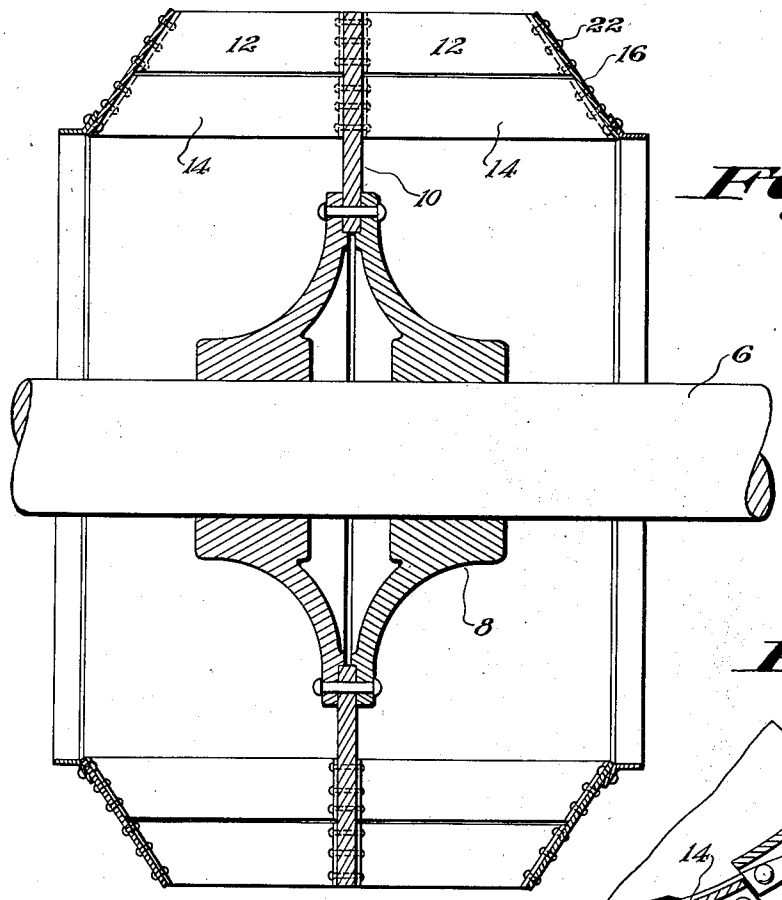


Fig. 1

Fig. 3

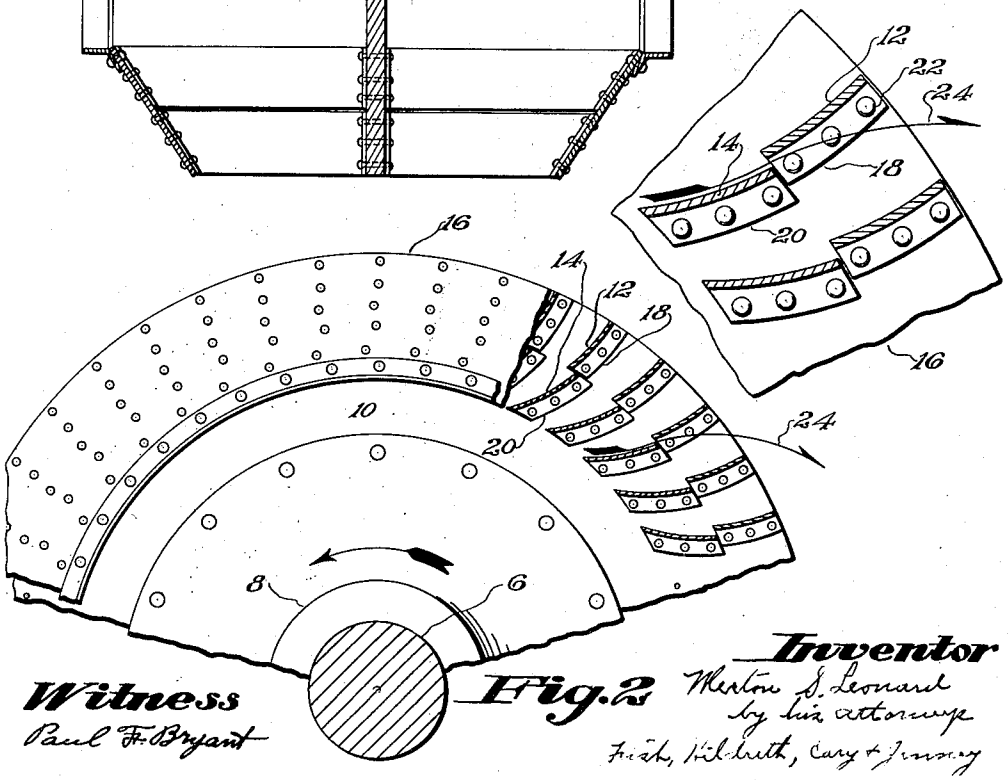


Fig. 2

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7 Claims. (Cl. 230—134)

The present invention relates to fans, and particularly to fans which are required to handle air or gases in which abrasive material is present. For example, fans used for induced draft in power plants handle considerable quantities of cinders or fly ash along with the flue gases. Such abrasive material causes a rapid and destructive erosion in the fan, particularly at the high rotational speeds now being employed in those fans. It is the object of the present invention to eliminate this destructive action of abrasive material in passing through the fan.

In the co-pending application of Gardner C. Derry, Serial No. 719,131, filed April 5, 1934, is shown a blade structure for fan rotors designed particularly to reduce or prevent the erosive action at the points where ordinarily the greatest erosion occurs, namely, at the point of contact of the blades with the supporting plate and shrouds. The present invention represents a further development, eliminating not only this localized erosion at the ends of the blades, but also any general erosion throughout the whole surface of the blades, without to any substantial degree reducing the operating efficiency of the fan or increasing the cost of manufacture.

In a common type of induced draft fan, the blades are riveted to a center plate and to the side plates or shrouds. It is customary to employ a blade shape which has considerable forward curvature in that portion of the blade nearest the center of the rotor, and lesser forward curvature in the outer portions, and with the tip of the blade substantially radial. When such a fan is used in induced draft installations, the cinders present in the flue gases produce a violent scouring action on the radially outer portions of the supporting blades, supporting plates, and shrouds of the rotor, especially at high fan speeds, causing erosion of the metal at these portions and even cutting off the rivets holding the blades to the shrouds and plates. The erosion is so rapid that after only a short period of use the rotor structure is dangerously weakened, and must be repaired, with replacement of the eroded parts. This involves not only considerable expense, but also loss of use of the fan during the period of repair. The present invention provides a fan in which this destructive erosion is eliminated, thus permitting the fan to be operated for long periods without repair or replacement of the rotor or any of its parts.

This has been accomplished by using a type of blade which consists of inner and outer portions with an opening intermediate these portions through which the abrasive material may pass and be discharged from the rotor without coming into scouring contact with the outer portions of the blades of the rotor. These inner and outer blade portions in effect constitute a single blade, although for convenience in manufacture they may be made in separate parts instead of integral. The space or opening between the inner and outer blade portions serves as a material discharge opening, and has no appreciable effect on the flow of the air or gases from the inner to the corresponding outer blade portions or on the efficiency of the fan as a whole.

Referring to the accompanying drawing, which illustrates 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 a portion of the rotor; and Fig. 3 is a sectional detail of the blade structure, illustrating what is considered to be the principle of operation of the invention.

The illustrated embodiment of the invention comprises a fan rotor or wheel having a shaft 6, a supporting hub 8, a center disk or plate 10 supported by the hub, side plates or shrouds 16, and a series of blades secured at one end to the center plate and at the other to the side plates. 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, each blade consists of inner and outer portions 12 and 14 with their respective riveting flanges 18 and 20 by which the blades are attached to the center plate 10 and to the shroud 16 by rivets 22.

The outer portions 12 are substantially radial at their tips, and have only a slight forward curvature at their inner edges. The inner portions 14 have considerable forward curvature. The outer edges of the portions 14 are off-set peripherally with respect to the inner edges of the outer portions 12 in the direction of rotation of the fan. This is illustrated in the enlarged section in Fig. 3. The inner and outer portions thus in effect form a single blade but with a non-continuous face, having an opening between the outer edge of the inner portion and the inner edge of the outer portion.

In a fan having blades of the conventional type, it has been found that the erosion is most marked in the outer portions of the blades. This is believed to be due to the action of the fan blades striking against the abrasive particles in the air or gases. Due to inertia, the heavier material is slower to adopt the changed path necessitated by the driving effect of the blades than the lighter air or gases, and hence the abrasive material becomes concentrated in a layer adjacent to and in scouring contact with the blades. As the material moves outwardly over the faces of the blades, the pressure of the material on the blade faces increases, due to the increase in linear velocity of the outer portions of the blades because of their greater radius, and also because of the centrifugal force developed by the change of direction in

passing over the curved face of the blade. It is the passage of this concentrated layer of abrasive material over the blade under the substantial pressure developed that causes the destructive erosion of the metal.

In the present invention the abrasive material passes through the fan out of contact with the outer portions of the blades, and without developing sufficient pressure on the inner portions of the blades to cause erosion thereof. The space between the inner and outer portion of each blade allows the abrasive material to escape through the blade to the rear of the outer portion, and to pass behind such portion and in front of and out of contact with the following blade, until finally discharged from the periphery of the rotor. The path of the abrasive material is substantially shown by arrow 24 of Fig. 3.

The pressure developed by the inner portions of the blades serves to concentrate the abrasive material adjacent to the blade, but is not sufficient to cause erosion. Before the pressure increases to the point where erosion takes place, the abrasive material escapes through the discharge space in this concentrated stream. With a properly proportioned opening only a relatively small amount of air will pass through with the material, the major portion of the air flowing in a substantially uninterrupted stream from the inner to the corresponding outer blade portions. In effect, the inner and corresponding outer blade portions constitute a single blade surface with respect to the air, and the outer blade portions, which do most of the work on the air, may be designed for the most efficient handling of gases without fear of erosion.

Thus the elimination of erosion is achieved with a simple rotor structure which may be built at no substantial increase in cost and may be operated with little if any loss in efficiency.

While preferably the outer portions of the blades are peripherally off-set or spaced from the inner portions, the present invention is not necessarily limited to such a construction except where so specified in the claims, as in its broader aspects it contemplates the provision of an opening or port in the face of the blade through which the cinders may pass to avoid erosion of the outer portions.

Having thus described the invention, what is claimed is:

1. A centrifugal fan rotor having blades and supporting means therefor, each blade having an inner and an outer portion with a long narrow opening therebetween extending in a direction parallel to the axis of the rotor to permit the discharge therethrough of a shallow stream of abrasive material rearwardly of and out of scouring contact with the outer blade portion, while compelling the main air stream to pass over said opening from the inner to the outer portion of the blade.

2. A centrifugal fan rotor having blades and supporting means therefor, the blades having inner and outer portions spaced to form a long narrow opening between said portions extending axially of the blade, the transverse width of the opening being materially less than one-half the peripheral distance between the inner edges of the outer portions of adjacent blades, to permit the discharge therethrough of a shallow stream of abrasive material peripherally of the rotor in the rear of the outer portion of said blade and sufficiently in advance of the next following blade to be out of scouring contact therewith.

3. A centrifugal fan rotor having blades and supporting means therefor, each blade having an inner and an outer portion, the outer portion being set slightly in advance peripherally of the inner portion in the direction of rotation to form a long narrow space extending parallel to the axis of the rotor and through which a shallow stream of abrasive material may pass to the rear and out of contact with the outer blade portion, while the main air stream passes over said space and from the inner to the outer portion of the blade.

4. A centrifugal fan rotor having blades and supporting means therefor, each blade having a long narrow slot extending axially across the face of the blade between the inner and outer portions of the blade, the transverse width of the slot being materially less than one-half the peripheral distance between the inner edges of the outer portions of adjacent blades, through which slot a shallow stream of abrasive material may pass to the periphery of the rotor and out of scouring contact with the blades of the rotor, while the main stream passes over the slot and from the inner to the outer portion of the blade.

5. A centrifugal fan rotor having blades and supporting means therefor, the inner portion of each blade being backwardly inclined with respect to the outer portion and with the outer edge of the inner portion of the blade offset peripherally to the rear of the inner edge of the outer portion a distance materially less than one-half the peripheral distance between the inner edges of the outer portions of adjacent blades to form a long narrow slot extending transversely of the blade to permit the passage therethrough of a shallow stream of abrasive material while compelling the main air stream to pass over the slot and from the inner to the outer portion of the blade.

6. A centrifugal fan rotor having blades and supporting means therefor, the blades being forwardly curved at their inner portion and substantially radial at their outer portion, and being provided with a long narrow opening through the blade extending axially thereof and positioned intermediate the forwardly curved inner portion and the substantially radial outer portion to permit the passage therethrough of a shallow stream of abrasive material from the inner portion out of scouring contact with the outer portion, while compelling the main air stream to pass over the opening and from the inner to the outer portion of the blade.

7. A centrifugal fan rotor having blades and supporting means therefor, each blade comprising separate inner and outer sections, each having end attaching flanges, and means for securing the flanges to the plates with the outer section peripherally in advance of the inner section in the direction of rotation a distance less than the width of the flanges to form an opening for the passage of a shallow stream of abrasive material therethrough from the front face of the inner section to the rear of the outer section, while compelling the main air stream to pass over the opening and from the inner to the outer portion of the blade.

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