

July 30, 1940.

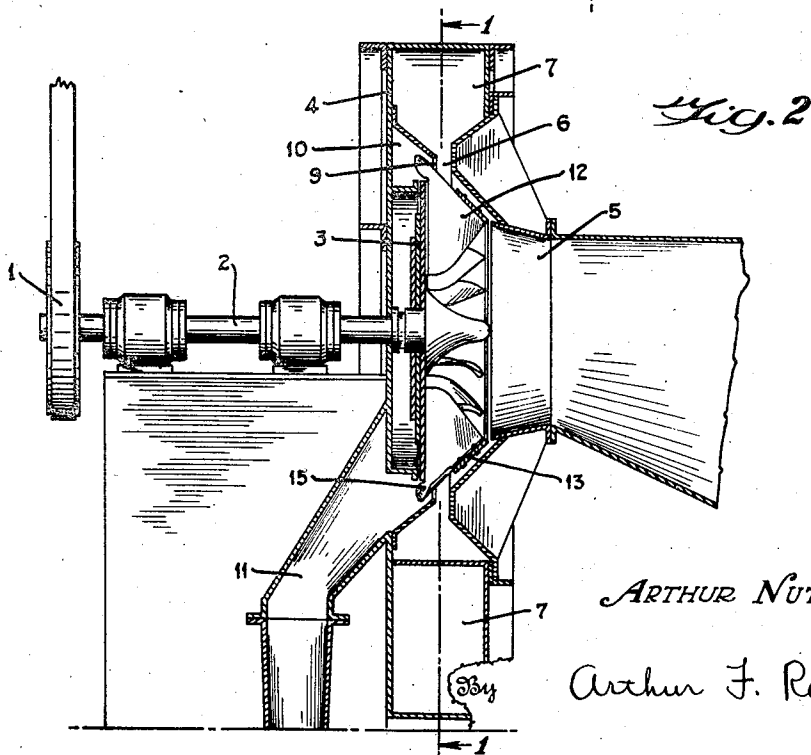
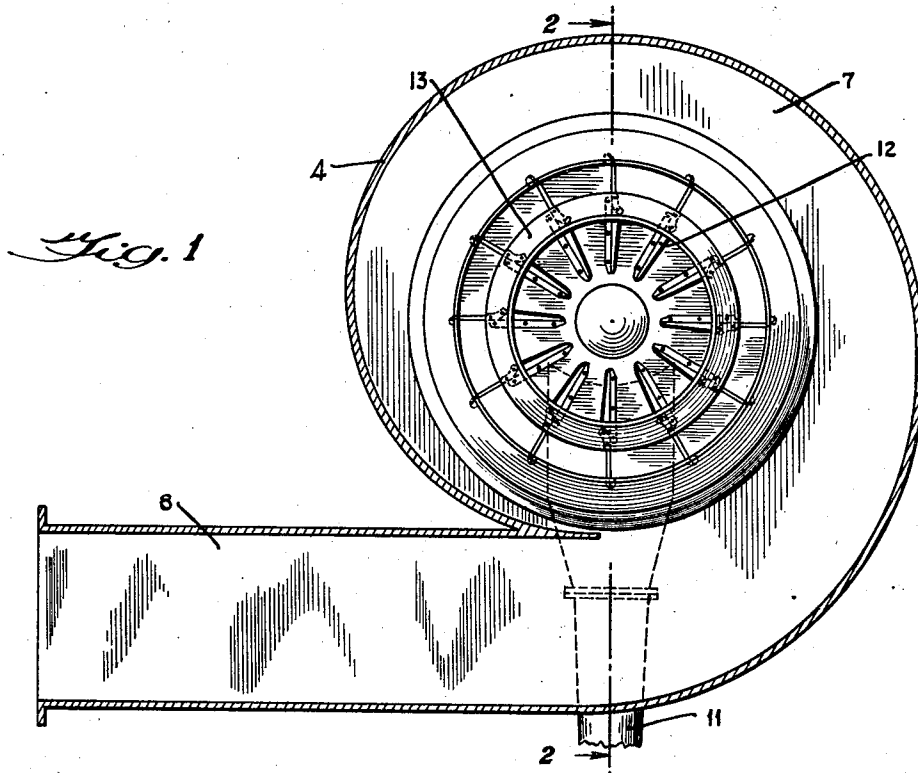
A. NUTTING

2,209,607

BLADE TIP FOR ROTARY DUST SEPARATORS

Filed Aug. 1, 1938

2 Sheets-Sheet 1



Inventor

ARTHUR NUTTING

Arthur F. Robert

Attorney

July 30, 1940.

A. NUTTING

2,209,607

BLADE TIP FOR ROTARY DUST SEPARATORS

Filed Aug. 1, 1938

2 Sheets-Sheet 2

Fig. 3

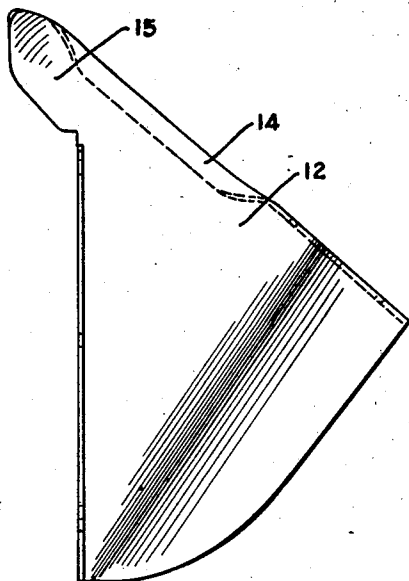


Fig. 4

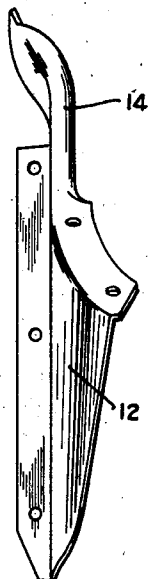


Fig. 5

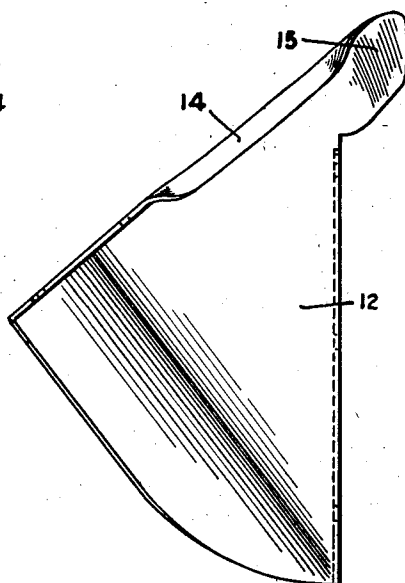


Fig. 6

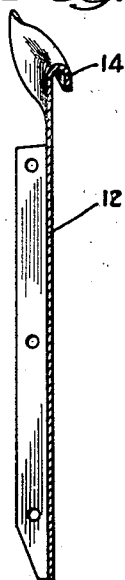


Fig. 8

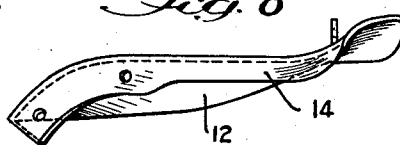


Fig. 9

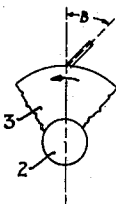
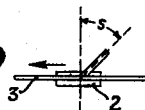


Fig. 7

Fig. 10



Inventor

ARTHUR NUTTING

By

Arthur F. Robert

Attorney

UNITED STATES PATENT OFFICE

2,209,607

BLADE TIP FOR ROTARY DUST
SEPARATORS

Arthur Nutting, Louisville, Ky., assignor to
American Air Filter Company, Inc., Louisville,
Ky., a corporation of Delaware

Application August 1, 1938, Serial No. 222,405

6 Claims. (Cl. 183-77)

This invention relates to rotary dust separators of the character having an annular air or gas passage extending from the axial inlet outwardly or radially beyond an annular particle receiving slot to a clean air outlet and having, in such passage, a rotatable impeller which, when rotated in one direction, operates to centrifuge the air whereby particles are precipitated upon the blades of the impeller and then to direct the precipitated particles toward and cause them to pass through the slot whereby they are separated from the main air flow. The dust slot connects the centrifuging passage with a dust chamber which, in Patent No. 1,941,499 granted Jan. 2, 1934, is in a form known as a dust ring. The body of air within the dust ring rotates, about the impeller axis, due to its contact at the dust slot with the main body of air being centrifuged. It is proposed in Patent No. 2,039,127 granted April 28, 1936, to augment such rotation by providing the impeller blades with tips projecting radially through the slot into the ring and facing tangentially i. e. at right angles to the direction of rotation.

It has also been proposed to set up a secondary air flow through the dust chamber by passing a portion of the intake air through the slot into the dust chamber and then discharging it either into a sewer or into a dust collecting device as shown in the copending application of Stig Sylvan Serial No. 73,142, filed April 7, 1936. Such arrangement is further improved, as shown in my copending application, Serial No. 183,428, filed January 5, 1938, by spraying the blades of an impeller, having tips extending radially into the dust chamber, with water which combines with the precipitated particles on the blades to form a sludge.

With an apparatus of this general character, some difficulty has been experienced in connection with the flow of secondary air. It is desirable to maintain the volume of secondary air above 6% of the intake air and, as a practical matter, it usually approximates 10% of the intake air, when the machine is operating at its rated capacity. It is a simple matter to obtain a 10% secondary flow at rated capacity, but it has been found difficult to maintain a 10% secondary flow when operating at less than rated capacity. In such cases, it appears that a reduction of say 15% in primary air delivery is accompanied by a reduction of more than 15% in the secondary air flow. In the very low ranges of primary air delivery, which correspond to the smaller damper openings in the primary air flow,

the reduction of secondary air flow is so substantial that a serious drop in cleaning efficiency necessarily results and, under some conditions of operation, so exaggerated that a reverse flow of secondary air occurs. It is, of course, possible to correct this condition by increasing the secondary air flow, at rated capacity, to a value greater than 10% of the intake air, but this involves a corresponding sacrifice of primary air; hence, has the disadvantage of either reducing the rated capacity of the same machine or requiring the use of a larger machine to provide the same capacity.

The principal object of the present invention is to overcome the foregoing objections and limitations without either sacrificing primary air or requiring the use of a larger machine, and to do so in a simple, inexpensive but effective manner.

As stated before, in the impellers heretofore used, the air propelling surface of each blade tip has been made to extend radially and to face tangentially. It will be appreciated that the volume of air delivered by the tips will decrease as they are bent or twisted sidewise from such position, and will reach zero when they extend radially but face axially i. e. in a direction parallel to the axis of rotation. Similarly, the volume of air delivered by the tips will decrease as the blades are bent backward from said radially-extending, tangentially facing position, and will reach zero when they extend tangentially rearward and face radially outward. I have discovered, however, that, despite the expected decrease of tip delivered air, the volume of secondary air flow through the dust chamber increases when the blade tips are bent "rearwardly" within what may be termed the leakage reducing angle. By "rearwardly" is meant either or both bending the tips backwardly or twisting them sidewise in a direction which moves the advancing faces of the tips away from the main air flow. When the blade tips are thus made to extend within the leakage reducing angle the volume of secondary air flow accordingly increases while the cleaning efficiency is substantially improved.

The reason for this unexpected result, while not definitely known, is believed to be due to the negative pressure conditions existing around the dust slot. For example, at rated capacity, a relatively higher negative pressure condition exists along the primary flow side of the slot than does on the secondary flow side thereof. This condition, doubtless, causes leakage, i. e. causes some of the air, delivered by the tips, to be drawn

back through the slot to the primary side. As the primary air flow is throttled, the difference, between the negative pressure on the primary side and that on the secondary side, increases with the result, apparently, of increasing leakage. Under some operating conditions, this difference may become great enough to cause a reversal of the secondary air flow. However, when the blade tips are properly bent "rearwardly," the actual volume of air leaving the tips is decreased to a certain extent, but leakage apparently is decreased to a greater extent; consequently, an actual increase in the volume of secondary air flow results. It is realized, of course, that any bending of the tips tends to change the delivery angle of the air and it may be that such change is effective to remove the tip delivered air from the influence of the primary suction sufficiently to cause the reduction which undoubtedly takes place in the leakage. Whatever the cause may be, it has been definitely ascertained that the operation of the machine in the lower ranges of its capacity is substantially improved without any appreciable change in the effectiveness of its operation at the higher capacities.

A further object of the invention is, therefore, to provide means for reducing leakage in the lower capacity ranges of machines of this character.

An embodiment of the invention is illustrated in the drawings wherein:

Figure 1 is a central vertical sectional view of my invention, taken on line 1—1 of Figure 2;

Figure 2 is a similar view, taken on line 2—2 of Figure 1;

Figures 3 to 8, inclusive, are detail perspective views of one of the impeller blades shown in Figures 1 and 2;

Figure 9 is a schematic view of the backwardly bent blade tip; and,

Figure 10 is a similar view of the blade tip bent sidewise.

The illustrated embodiment of the invention comprises a suitable driving means 1 for rotating a shaft 2 upon which the uni-directional impeller body 3 of a rotary dust separator is mounted. The impeller is located within a separator casing 4, having an axial inlet 5, and cooperates with that casing to define a centrifuging air passage 6, extending annularly from the axial inlet 5, outwardly to the clean air scroll 7, which discharges the air into outlet pipe 8. The scroll 7 is located slightly beyond the annular dust receiving slot 9, which connects the centrifuging passage 6 to a dust chamber 10, having an outlet pipe 11. The slot 9 is located between, and is defined by, the periphery of the impeller and that partition of the casing 4 which, in the embodiment shown, separates the clean air scroll 7 from the dust chamber 10.

In operation, the blades 12 of the impeller draw air through the inlet 5 and centrifuge that air in passage 6 causing particles to be precipitated on the blades. The precipitated particles are directed, with say approximately 10% of the intake air at rated capacity, through the slot 9 into the dust chamber 10 from which both air and dust (or sludge where water is sprayed on the blades) may be ultimately discharged through pipe 11. The main air stream passes from the centrifuging passage 6 outwardly into the clean air scroll 7, from which it is ultimately discharged through pipe 8.

The blades 12 may be shaped and arranged in

suitable fashion. Each blade shown has: its advancing face concavely curved; its opposite side margins flanged to facilitate securement, respectively to the impeller body 3 at the dust separating side of the flow, and the conical band 13 at the clean side of the flow; and its clean air delivery edge, which slants outwardly across the air flow from the clean to the separating side of the flow, bent to provide a channel 14 for directing, through the slot 9, such precipitated matter as may tend otherwise to escape from the blade into the clean air scroll.

The blades are further provided with tips 15, which project obliquely through the slot 9 into dust chamber 10. Heretofore, the air propelling surface of each tip, as a whole, was made either to extend more or less radially and face tangentially, or to extend forwardly between the radial and the tangential. In accordance with my invention, however, they are bent rearwardly, i. e., either twisted sidewise or bent backward or both twisted and bent, sufficiently to bring them within what may be termed the effective leakage reducing angle, i. e., the range wherein the reduction in tip delivered air is exceeded by the reduction in leakage.

The range within which the reduction in tip delivered air is exceeded by the reduction in leakage may be readily explained in connection with Figures 9 and 10 of the drawings. For example, in Figure 9, what may be termed a radial-axial plane, is indicated by the dotted line extending radially from the axis 2 of the impeller body 3. Now, as a tip 15 is bent backwardly through the angle B from a radially extending tangentially facing position in such plane toward a tangentially extending radially facing position at right angles to such plane, the volume of tip delivered air and the volume of leakage both decrease, but the decrease in leakage apparently is greater because the volume of secondary air flow is noticeably increased when the angle B reaches 5° and continues to increase until the angle B is approximately 30°. Further bending reduces the advantage, but may be continued beneficially up to approximately 45°. The angle B between 5° and 45° in which such advantage obtains, may be designated as the effective leakage reducing "radial" angle, since it is within it that the secondary air flow is increased despite the fact that the total amount of tip delivered air is decreased.

With reference to Figure 10, the radial-axial plane is indicated by a dotted line extending axially along the axis 2 of impeller body 3. As a tip 15 is bent sidewise through the angle S from a radially extending tangentially facing position in such plane toward a radially extending axially facing position at right angles to such plane, the same result obtains, namely, the volume of secondary air flow is noticeably increased at 5° and continues to increase until the angle S is approximately 30°. As before, further bending reduces the advantage, but may be continued beneficially up to approximately 45°. Thus the angle S between zero and 45°, in which such advantage obtains, may be designated as the effective leakage reducing "axial" angle, since within its limits, the secondary air flow is, likewise, increased.

Naturally, since the greatest gain in secondary air flow occurs when the blade tips are bent backwardly 30° and, at the same time twisted sidewise 30°, such degree and character of bending and twisting is preferred. Where both bending and twisting are used, the air propelling surface

of the tip extends rearwardly at an "oblique" angle between the radial, the axial and the tangential. For the sake of clearness, such angle may be specifically designated as the effective leakage reducing oblique angle.

The advancing faces of the tips may be flat, but I prefer to have them convexly curved, so as to bring about a gradual change in the direction of air ultimately discharged by the tips. It is not necessary to bend the tips throughout their length, but they should be bent along a substantial portion of their length and preferably adjacent their air delivery ends.

The claims of this application are directed to the leakage reducing blade tip feature. All other inventive subject matter disclosed in it and in my co-pending application, Serial No. 183,428, filed January 5, 1938, are claimed in the latter application.

Having described my invention, I claim:

1. An improvement in rotary devices of the character wherein a bladed impeller operates to centrifuge air annularly from an axial inlet outwardly, the main flow of air passing beyond a dust receiving slot to a main air passage and a secondary flow of air passing through said slot into a secondary air chamber, comprising: means arranged within said chamber, adjacent the slot, for directing the secondary air away from the slot and discharging it—in relation to an axial plane passing radially through the slot—rearwardly within a leakage reducing angle not substantially less than 5° or substantially greater than 45°.

2. An improvement in rotary devices of the character wherein a bladed impeller operates to centrifuge air annularly from an axial inlet outwardly, the main flow of air passing beyond a dust receiving slot to a main air passage and a secondary flow of air passing through said slot into a secondary air chamber, comprising: means

arranged on said impeller within said chamber, adjacent the slot, for directing the secondary air away from the slot and discharging it—in relation to an axial plane passing radially through the slot—rearwardly within a leakage reducing angle not substantially less than 5° or substantially greater than 45°.

3. The improvement defined in claim 2 wherein said means include tips extending from the impeller blades through the slot into said chamber, the advancing faces of the tips presenting air propelling surfaces which extend rearwardly to discharge within said leakage reducing angle.

4. The improvement defined in claim 2 wherein said means include tips extending from the impeller blades through the slot into said chamber, said tips extending rearwardly to discharge within said leakage reducing angle.

5. The improvement defined in claim 2 wherein said means include blade tips projecting through the slot into said chamber, said tips having their advancing faces convexly curved rearwardly to discharge within said leakage reducing angle.

6. A uni-directional impeller for rotary devices of the class described comprising: an impeller body having an axis of rotation and an outwardly extending face; a series of air propelling blades secured to said face; and blade tips extending from adjacent the air delivery ends of the blades obliquely outward over the outer edge of said impeller body, said tips being bent to present advancing face surfaces adjacent their discharge ends which extend—in relation to an axial plane passing radially through the impeller—rearwardly within a leakage reducing angle not substantially less than 5° or substantially greater than 45°.

ARTHUR NUTTING.