United States Patent [11] 3,572,963

[72] Inventor John A. Marino
Palmyra, Pa.
[21] Appl. No. 841,737
[22] Filed July 15, 1969
[45] Patented Mar. 30, 1971
[73] Assignee Hauck Manufacturing Company
Lebanon, Pa.

[54] **INLET TURNING RING SEAL**
10 Claims, 3 Drawing Figs.

[52] U.S. Cl. 415/174, 415/212
[51] Int. Cl. F04d 29/66
[50] Field of Search 415/171, 174, 111 (B); 103/111 (C) 4, 111 (C) 2, 111 (C) 3, 111 (C) 5

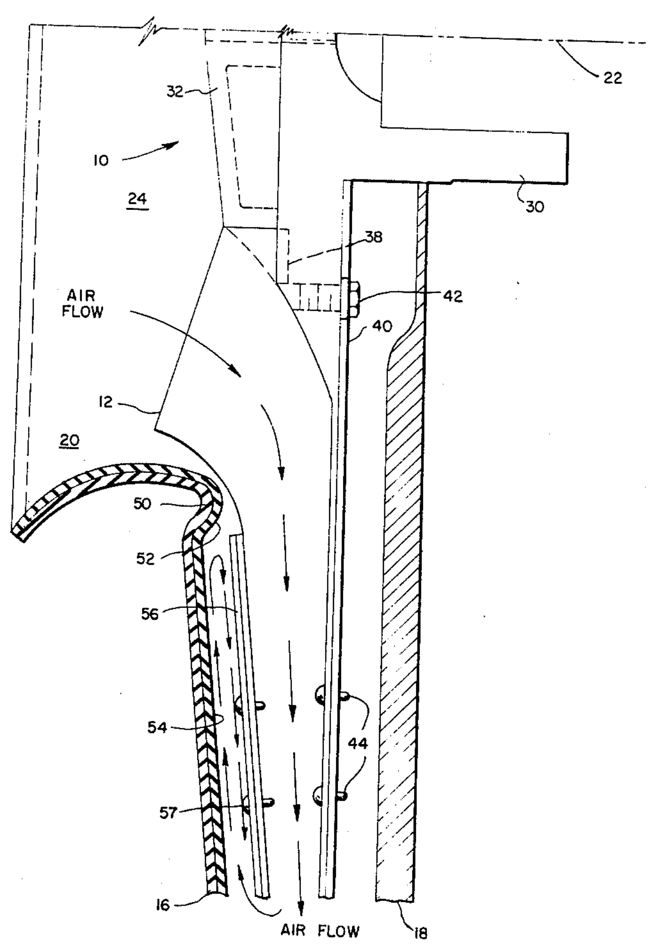
[56] **References Cited**

UNITED STATES PATENTS

2,013,499	9/1935	Meckenstock	415/174
2,851,289	9/1958	Pedersen	415/174
2,930,521	3/1960	Koehring	415/174
3,092,393	6/1963	Morley et al.	415/174

Primary Examiner—C. J. Husar
Attorney—Finnegan, Henderson & Farabow

ABSTRACT: An improved turning ring seal is provided at the inlet of a turboblower to prevent high pressure fluid from discharging back into the inlet of the impeller. The stationary portion of the seal is provided by an integral curved annular shoulder around the inlet of the casing. The rotating portion of the seal is provided by the inner diameter of the blade shroud.



2 Sheets-Sheet 1

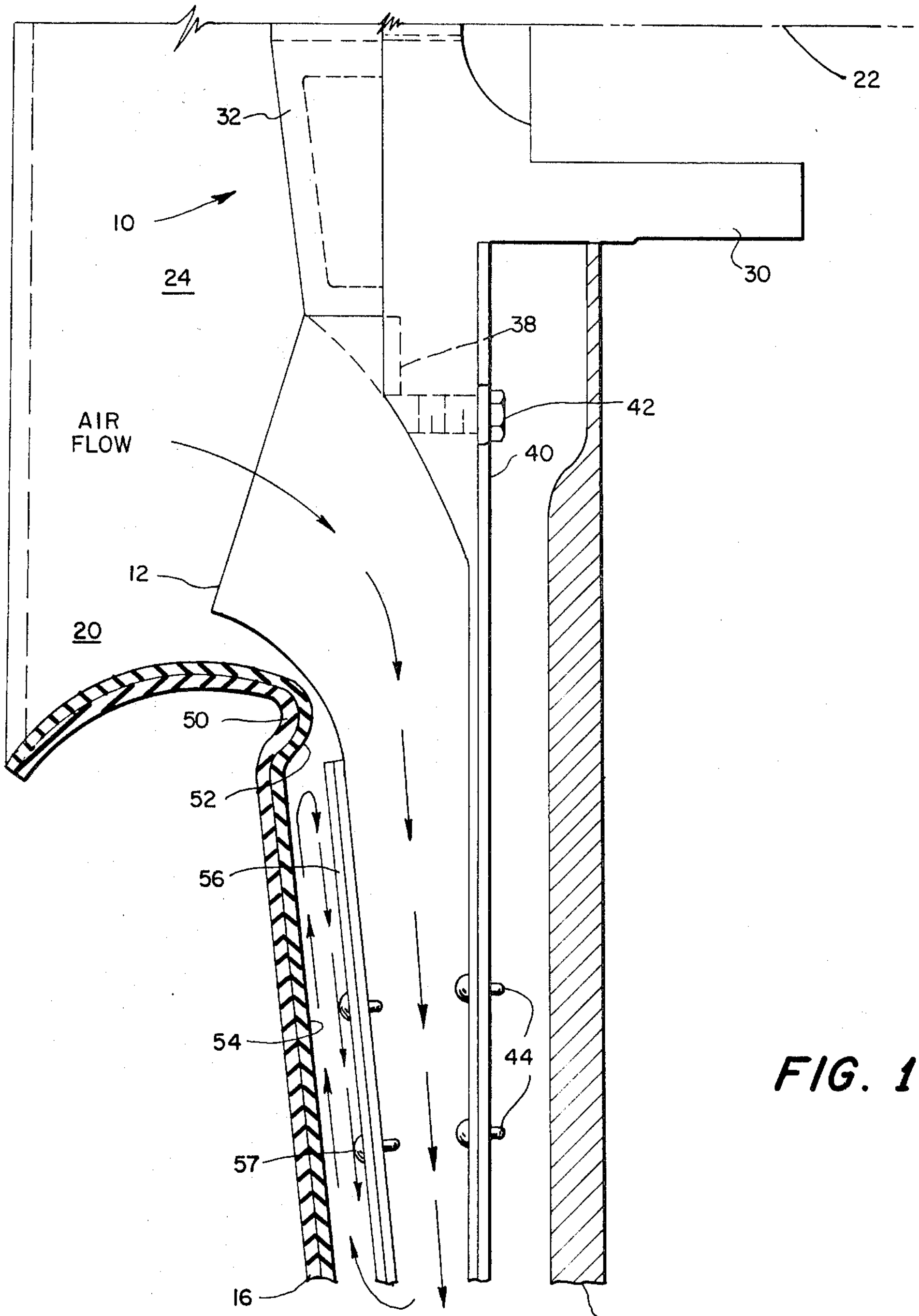


FIG. 1

INVENTOR
JOHN A. MARINO

Finnegan, Henderson & Farabow
ATTORNEYS

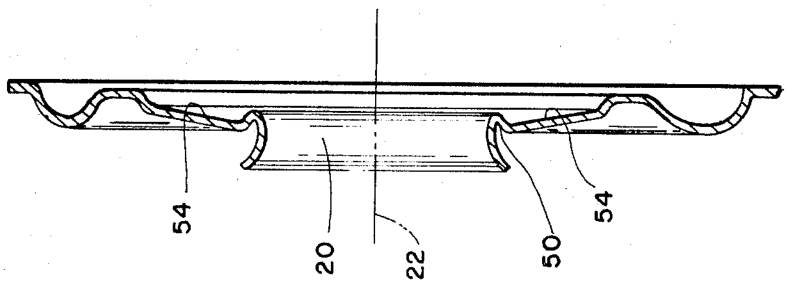


FIG. 3

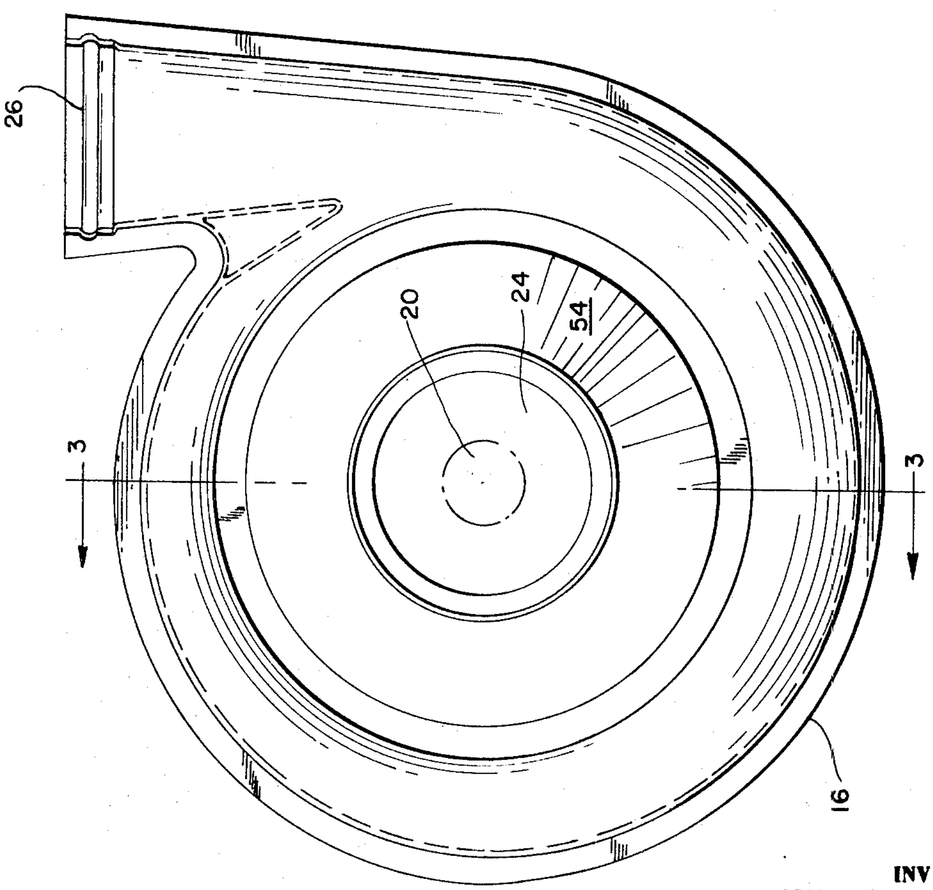


FIG. 2

INVENTOR
JOHN A. MARINO

Finnegan, Henderson & Farabow
ATTORNEYS

INLET TURNING RING SEAL

This invention relates to a ring seal, and more particularly to an improved turning ring seal for use in centrifugal blowers of the type including a casing, and a centrifugal impeller assembly which is enclosed by the casing.

Centrifugal air blowers, and particularly turboblowers, are used to provide large volumes of relatively low pressure air in numerous situations, for example as combustion blowers. Because large volumes of air are handled, smoothly contoured air flow conduits within the blower are desirable to minimize frictional power losses.

Flow in a radial flow compressor moves from an inlet opening located adjacent to the axis of the rotary machine to the outer diameter of the impeller blades. Since energy is added to the fluid, the pressure of the fluid is greater at the outer diameter of the impeller than at the inlet. Fluid will therefore have a tendency to move from the higher pressure discharge area back into the inlet of the impeller. Where this backflow coming from the discharge area of the impeller intersects the normal flow into the impeller inlet, significant turbulence occurs in the inlet flow, which lowers the machine's total efficiency.

While it is possible to machine the blades and the casing to very narrow tolerances, and thus obtain a seal, this precision machining is expensive and is impractical for prefabricated blower assemblies. For example, the running position of the blades would have to be precisely set during assembly of the blower and carefully maintained during use.

Another problem which exists in providing a seal against backflow of air is that the seal should not interfere with the desired inlet flow of air to the blades. In other words, the seal should not present sharp discontinuous surfaces which would block or sharply change the direction of inlet air flow.

The present invention provides a turning ring seal located near the casing inlet to the impeller that can prevent the return flow of air, and can function without creating an undesirable level of turbulence in the inlet flow of air.

The invention is used in a centrifugal blower or compressor comprising an impeller assembly having a hub and a plurality of impeller blades; and a generally disc-shaped casing enclosing the impeller assembly, and including an inlet opening extending through one face of the casing and positioned along the axis of the casing, and a discharge opening positioned adjacent the outer diameter of the impeller blades. The invention provides an improved turning ring seal to prevent backflow of high-pressure air to the inlet opening and is formed by a integral shoulder forming a part of the casing and extending around the perimeter of the inlet opening, the shoulder presenting a convex annular surface which protrudes inwardly of the relatively planar interior wall surface of the inlet face of the disc-shaped casing. The rotating portion of the seal is formed by the forward edge of the impeller assembly which is positioned a small distance from the shoulder, the distance being less than the distance from the forward edge of the impeller assembly to the casing to create a zone of high-pressure adjacent the shoulder. The seal thus reduces the flow area and restricts fluid flow from the clearance area, where the blades must be widely spaced from the casing, to the low pressure inlet region.

Preferably, the forward edge of the impeller assembly is a rotating shroud attached to said blades, the shroud comprising an annular plate having its interior diameter positioned closely adjacent the shoulder.

Preferably, the shoulder is contoured so that from its inner diameter the shoulder extends axially in the direction of flow and radially outward relative to the blower axis in a smooth curve from the inlet. Thus, the interior portion of the convex annular surface extends axially into the casing and in a radially outward direction from the axis of the casing opening.

Preferably, the interior surface of the shoulder is formed of a relatively soft abradable material and the material of construction of the blades and the shroud is harder than the soft abradable material so that the blades and shroud can wear away the shoulder, if the shoulder initially interferes with rotation of the blades and the shroud.

In the presently preferred form of the invention, the interior surface of the shoulder is formed by an elastomeric coating layer which deflects when contacted by the impeller blades or the shroud.

The invention consists in the novel parts, constructions, arrangements, combinations, and improvements shown and described. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate one embodiment of the invention and, together with the description, serve to explain the principles of the invention.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory, but are not restrictive of the invention.

In the drawing:

FIG. 1 is a fragmented horizontal section illustrating the ring seal of this invention installed in a centrifugal blower;

FIG. 2 is a side elevation of the interior wall surface of the inlet half of the casing of FIG. 1; and

FIG. 3 is a vertical section taken along line 3–3 of FIG. 2.

Referring to the embodiment illustrated in FIG. 1, the turning ring seal of this invention is shown in a centrifugal air blower that comprises a hub assembly, generally **10**, a plurality of impeller blades **12** which are attached to the hub assembly, and a disc-shaped casing which encloses the hub assembly and the blades. While a fabricated impeller assembly is illustrated it should be realized that the invention can be used with integrally cast impeller assemblies.

The casing is formed by an inlet shell **16** and an outlet shell **18**. An inlet opening **20** is located along the axis **22** of the disc-shaped casing and is defined by a bellmouthed wall surface **24** on shell **16**. A discharge opening **26**, best seen in FIG. 2, is positioned adjacent the outer diameter of impeller blades **12**.

Hub assembly **10** includes a hub **30** which can be mounted on a power driven shaft (not shown). A blade retainer **32** and a compression means such as a stud and lock nut (not shown) are provided to clamp blades **12** to hub **30**. The blades each have a tab **38** on their leading edge, which is clamped between the blade retainer and the hub.

A backplate **40** is attached to the hub **30** by bolts **42** and to blades **12** by rivets **44**. Backplate **40** thus cooperates with the blades in forming flow channels for the flow of air through the blower.

In accordance with the present invention, an inlet turning ring seal is provided by a stationary (nonrotating) curved annular shoulder **50** which is integral with and extends around the perimeter of the casing inlet opening, and presents a convex annular surface **52** which protrudes inwardly of the relatively planar interior wall surface **54** of inlet shell **16** of the casing. Shoulder **50** extends around the perimeter of inlet opening **20**, and thus forms an annular surface.

With reference to FIG. 1, shoulder **50** is contoured so that from its inner diameter it extends in the direction of flow and radially outward relative to axis **22** in a smooth curve from the wall surface of the inlet opening. The tip of the convex shoulder is also smoothly curved, as is the juncture of the outer diameter of shoulder **50** and the generally planar interior wall surface of inlet shell **16**. Thus, shoulder **50** besides cooperating to form a seal, provides at its inner portion a smooth curved contour for fluid to follow as its flow direction begins changing from axial to radial.

In the presently preferred embodiment of the invention, the interior surface of shoulder **50** is formed by an elastomeric coating layer which deflects when contacted by the impeller blades, or a shroud which is described below. The tip of the convex shoulder can be entirely elastomer to provide a flap-type lip. An elastomeric surface provides outstanding resistance to abrasive particles and thus is a desirable coating layer for the entire interior surface of shell **16**. Suitable elastomers include polyurethanes such as that sold under the trademark Adiprene by E. I. duPont De Nemours, and various other synthetic rubbers which exhibit good abrasion resistance to a small fluid-carried solid particles, such as sand. It should be realized that such elastomers while described as abrasion resistant with respect to small fluid-carried particles, are softer than, and can be abraded by contact with metal surfaces, the usual material of construction for the impeller blades and the shroud.

In accordance with the invention, the rotating portion of the inlet seal is provided by the inner diameter of a shroud which is attached to the impeller blades with its inner diameter positioned closely adjacent the shoulder. As here embodied, and as illustrated in FIG. 1, a shroud 56 is attached to the forward edge of impeller blades 12 by rivets 57. The shroud is annular and generally planar and extends in a radial direction from an inner diameter which is approximately equal to the outer diameter of shoulder 50, to an outer diameter which terminates adjacent the tip of the blades.

The inner diameter of shroud 56 is axially spaced a small distance behind the convex tip of shoulder 50 in the flow direction. This spacing is desirable because blade 12, to which the shroud is attached, should curve radially outwardly as it extends axially, to assist in changing the direction of fluid flow through the impeller.

Generally, the distance between the inner diameter of shroud 56 and the closest position of shoulder 50 will vary from about 0.20 inches to 0.40 inches depending on the pressure differential developed by the impeller assembly.

As illustrated in FIG. 1, shroud 56 is aligned parallel to the planar interior surface 54 of inlet shell 16. Thus, shoulder 50 which projects inwardly of surface 54 creates a reduced flow area for the backflow of air; that is, shoulder 50 is positioned closer to the adjacent portion of the impeller assembly than the spacing of the outer portions of the impeller assembly from the outer portion of the casing.

While the invention has been illustrated and described in relation to a single stage blower, it will be realized by those skilled in the art that the invention can be incorporated in one or more, and preferably every stage of a multistage blower.

The need for the present invention and its utility are graphically shown in FIG. 1 where arrows represent the direction of air flow in a single stage centrifugal blower operating at other than its design flow. As illustrated in FIG. 1, a design requirement for a large running clearance between the blades 12 and the blower casing permits high-pressure air located near the tip of the blades to flow back towards inlet 20 between the inlet shell 16 and shroud 56. This backflow of air, if permitted to contact the inlet flow of air, creates turbulence which markedly lowers the efficiency of the blower.

The seal provided by shoulder 50 and shroud 56 helps prevent the backflow of air from interfering with the inlet flow of air. All the reasons why the present seal is effective in reducing the volume of backflow and therefore frictional losses in a centrifugal blower are not precisely known. However, it is believed that a reduced flow area between the inner diameter of shroud 56 and shoulder 50 as compared to the area between wall surface 54 of inlet shell 16 and the outer portions of the shroud creates a restriction which reduces the amount of secondary flow able to reenter the inlet as shown in FIG. 1.

The preferred elastomeric interior surface layer of inlet casing 16 is desirably open cast into an open mold with a polyester backing layer subsequently bonded thereto according to the following procedure.

The mold surface which is to be reproduced is first treated with a mold release agent appropriate for the elastomer to be used. The elastomer, such as a polyether polyurethane, is then brushed onto the mold surface at the appropriate temperature to obtain the required physical properties. Urethane for example can be applied at room temperature. The elastomer is then cured until the exterior surface is just tack free. For example, room cured urethane can be allowed to cure from 12—72 hours. If high temperature cures are used, 15—30 minutes will obtain the required surface condition for the next step in the process.

Another thin coat of urethane is then similarly applied to the semicured surface of the first coat. Immediately, chopped fibers of the material to be used in reinforcing the plastic resin are deposited onto the liquid urethane surface and mechanically worked into this thin coating of wet urethane. Fibers of long enough length should be used to entirely coat the urethane surface and leave ends protruding from the wet surface. Fibers of 1-inch in length have been found to work well.

The surface is next painted or sprayed with a catalyzed liquid resin, such as a polyester, and thoroughly rolled with surface rollers to remove all entrapped air. Plastic resin and reinforcement can then be added to obtain the required stiffness and strength of the finished composite.

When all required curing is completed, the chopped fibers applied to the wet coat of urethane provide a mechanical linkage between the urethane surface and the reinforced plastic.

In summary the invention provides a turning ring seal in which the rotating portion of the seal is provided by the inner diameter of blade shroud 56 and the stationary portion of the seal is provided by a curved annular shoulder 50 which is an integral part of the casing. The inner diameter of the shroud and the diameter of the shoulder can be manufactured within a close tolerance without the need for supplemental machining or finishing operations. The running position of the seal in an assembled centrifugal blower is not dependent on manufacturing tolerances maintained during fabrication and assembly of the rest of the machine. Therefore, an inexpensive seal can be obtained by utilizing this invention.

The invention in its broader aspects is not limited to the specific details shown and described and departures may be made from such details without departing from the principles of the invention and without sacrificing its chief advantages.

I claim:

1. In a centrifugal blower comprising an impeller assembly having a hub and a plurality of impeller blades; and a generally disc-shaped casing that encloses the impeller assembly and includes an inlet opening extending through one face of the casing and positioned along the axis of the casing, and a discharge opening positioned adjacent the outer diameter of the impeller blades, the improvement comprising an improved turning ring seal to prevent backflow of high pressure air to the inlet opening, said seal having: a stationary shoulder which is an integral part of the casing and extends around the perimeter of the inlet opening, said shoulder presenting a convex annular surface which protrudes inwardly of the planar interior wall surface of the inlet face of the disc-shaped casing; and a rotating shroud attached to the blades, said shroud comprising an annular plate having its interior diameter positioned closely adjacent said shoulder.

2. The invention of claim 1 in which the interior portion of the convex annular surface extends axially into the interior of the casing and in a radially outward direction from the axis of the casing, said direction being generally aligned with the flow path of inlet air to the impeller blades to minimize frictional losses at the inlet opening.

3. The invention of claim 1 in which the interior surface of said shoulder is manufactured of a relatively soft, abradable material and the material of construction of the blade and said shroud is harder than said soft, abradable material so that the blades and said shroud can wear away said shoulder if said shoulder initially interferes with rotation of the blades and said shroud.

4. The invention of claim 2 in which shoulder is manufactured of a relatively soft, abradable material and the material of construction of the blades and said shroud is harder than said soft abradable material, so that the blades and said shroud can wear away said shoulder, if said shoulder initially interferes with rotation of the blades and said shroud.

5. The invention of claim 1 in which the surface of said shoulder is formed from an elastomer which deflects when contacted by the blades or said shroud.

6. The invention of claim 2 in which the surface of said shoulder is formed from an elastomer which deflects when contacted by the blades or said shroud.

7. The invention of claim 1 in which the inner diameter of said shroud is axially spaced a small distance behind the convex tip of said shoulder in the flow direction.

8. In a centrifugal blower comprising an impeller assembly having a hub and a plurality of impeller blades; and a generally disc-shaped casing that encloses the impeller assembly and includes an inlet opening extending through one face of the casing and positioned along the axis of the casing, and a discharge opening positioned adjacent the outer diameter of the impeller blades, the improvement comprising an improved turning ring seal to prevent back flow of high-pressure air to the inlet opening, said seal formed by a stationary shoulder forming a part of the casing and extending around the perimeter of the inlet opening, said shoulder presenting a convex annular surface which protrudes inwardly of the relatively planar interior wall surface of the inlet face of the disc-shaped casing; and a rotating forward edge of said impeller assembly, the forward edge of said impeller assembly being positioned a distance from said shoulder which is less than the distance from the forward edge to the relatively planar interior wall surface of the inlet face of the disc-shaped casing.

9. The invention of claim **8** in which the interior portion of the convex annular surface extends axially into the interior of the casing and in a radially outward direction from the axis of the casing, said direction being generally aligned with the flow path of inlet air to the impeller blades to minimize frictional losses at the inlet opening.

10. The invention of claim **8** in which the surface of said shoulder is formed from an elastomer which deflects when contacted by the blades or the shroud.