

[54] **RADIAL BLOWER, ESPECIALLY FOR OIL BURNERS**

[75] Inventors: **Kurt Zenkner, Ettlingen; Franz Kozel, Lippstadt; Heike Thomsen, Schleswig, all of Germany**

[73] Assignee: **Punker GmbH Apparatebau und Wärmetechnik, Eckernförde, Germany**

[22] Filed: **Nov. 12, 1971**

[21] Appl. No.: **198,294**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 874,756, Nov. 7, 1969, abandoned.

Foreign Application Priority Data

Nov. 7, 1968 Germany..... 1807385

[52] U.S. Cl..... **415/53, 415/182, 415/206, 415/219 C**

[51] Int. Cl..... **F04d 17/08, F04d 29/46**

[58] Field of Search..... **418/53, 54, 182, 219 C, 418/204, 206**

References Cited

UNITED STATES PATENTS

801,304 10/1905 Davidson 415/204
820,397 5/1906 Davidson 415/54

820,398 5/1906 Davidson 415/204
820,399 5/1906 Davidson 415/204
2,164,869 7/1939 Brady, Jr. 415/53
2,290,423 7/1942 Funk 415/206
2,291,138 7/1942 Blom 415/53
2,951,630 9/1960 Murphy 415/182
3,209,989 10/1965 Eck 415/54
3,407,995 10/1968 Kinsworthy 415/204
3,415,443 12/1968 Glucksman 415/54

FOREIGN PATENTS OR APPLICATIONS

139,678 12/1934 Austria 415/204

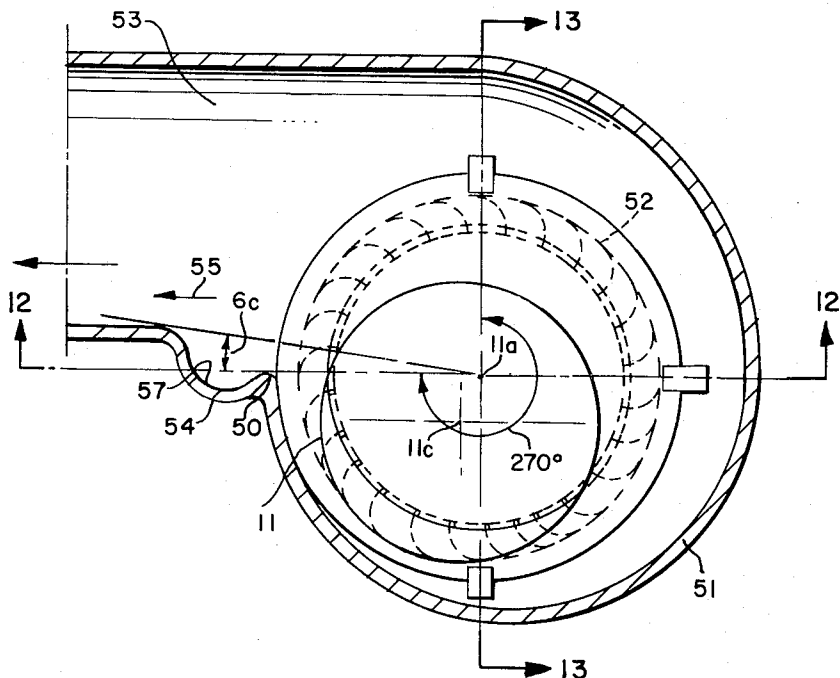
Primary Examiner—Henry F. Raduazo
Attorney, Agent, or Firm—Walter Becker

[57]

ABSTRACT

A radial blade fan for use in connection with burners, in which a fan rotor is surrounded by a volute casing so as to form a gap therewith and has a blade exit angle of at least 90° while the volute housing has an inlet nozzle, said nozzle and the axis of said rotor being so located relative to each other that at least portions thereof are eccentrically located with regard to each other. The said volute or spiral housing has a sharp bend in the region of the beginning point of the volute or spiral from which departs on the one side the volute or spiral and on the other side a transition or connecting piece to the fan outlet.

5 Claims, 13 Drawing Figures



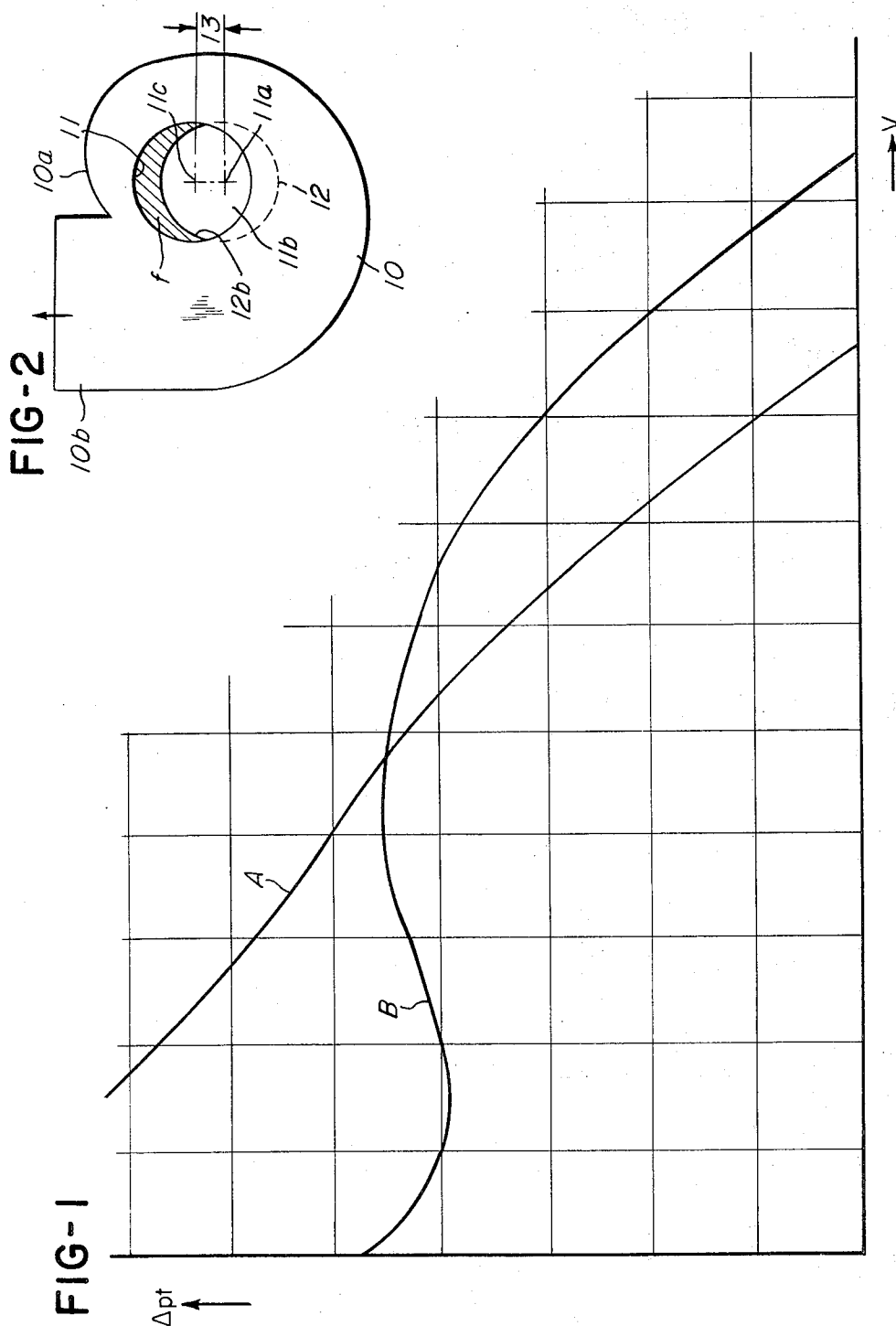


FIG-3

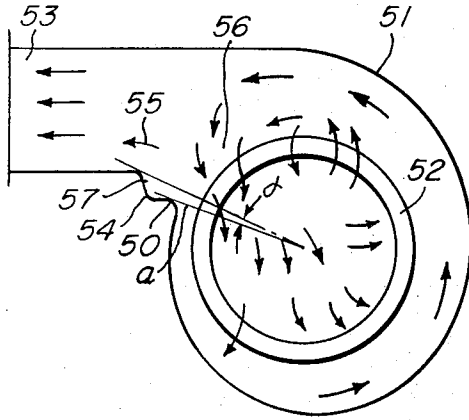


FIG-4

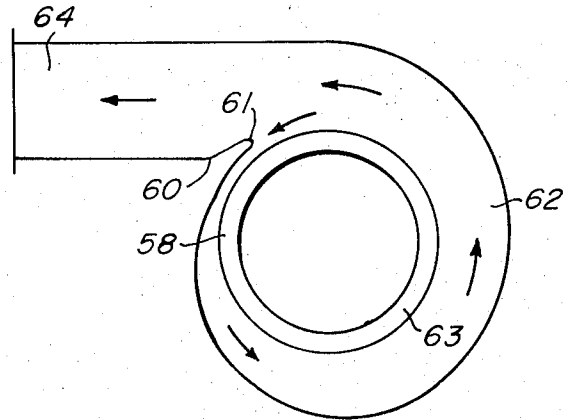


FIG-5

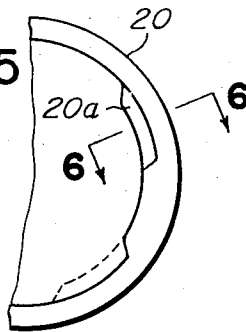


FIG-6

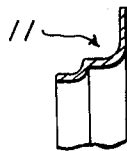


FIG-7

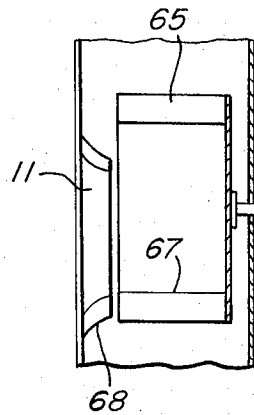


FIG-8

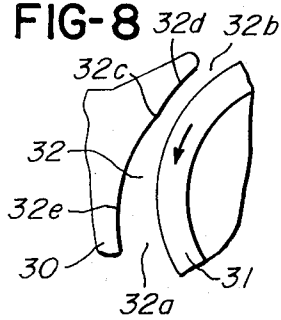


FIG-9

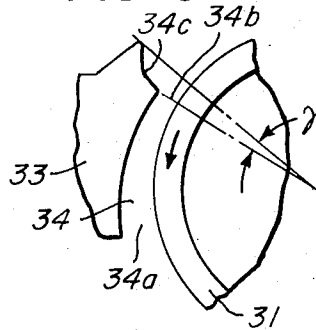
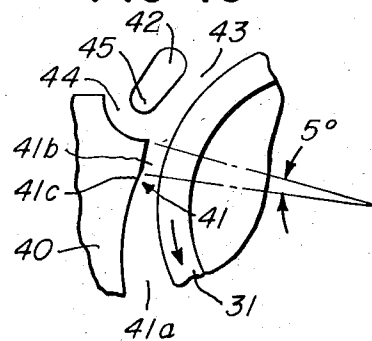


FIG-10



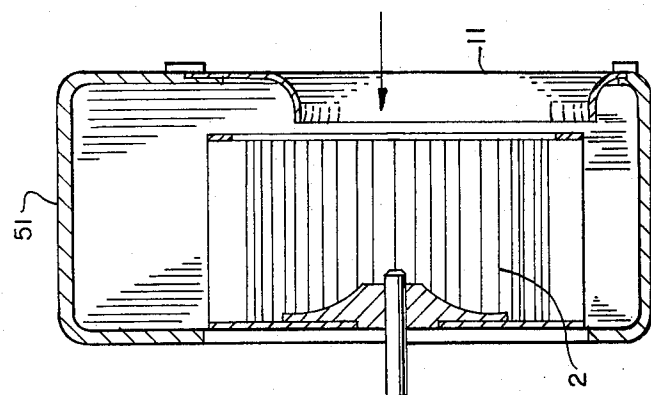


FIG. 13

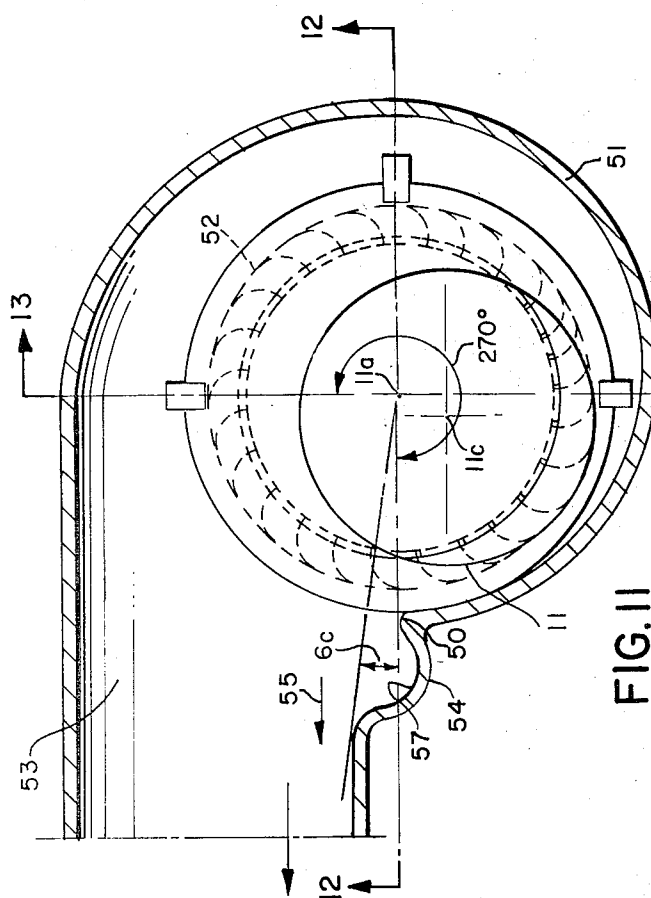


FIG. 11

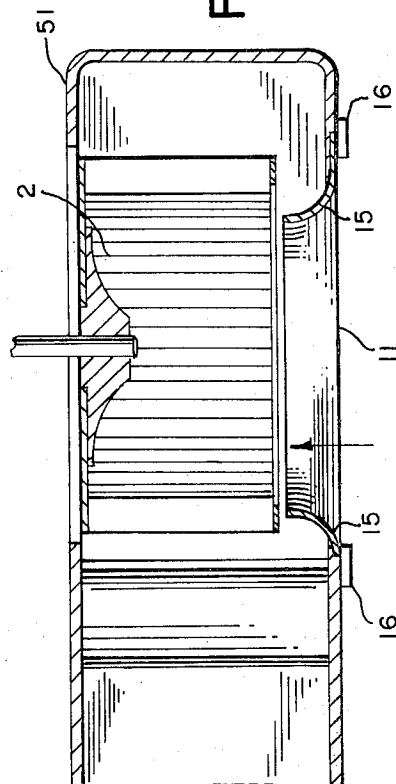


FIG. 12

RADIAL BLOWER, ESPECIALLY FOR OIL BURNERS

This is a continuation-in-part of co-pending application Ser. No. 874,756- Zenkner et al., filed Nov. 7, 1969 now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a radial fan for conveying combustion air in burners comprising in combination a rotor or impeller with a blade exit angle of at least 90° and a spiral casing or housing with a lateral inlet nozzle, whereby the beginning of the spiral of the housing lies in the area of the outlet i.e., the area in which the air leaves the impeller the spiral thereby embracing the periphery of the rotor along a distance which corresponds to an angle at the center of at least 270°.

2. Prior Art

Known radial blade fans of the kind here in question, for instance when used in connection with a burner, have a pressure volume rate of fluid flow characteristic curve which has certain drawbacks and corresponds approximatively to the characteristic curve A in FIG. 1. In practice, there is used just the descending branch of the characteristic curve. More specifically, if in a burner installation comprising a fan of the above kind the resistance to flow changes, for instance because of a fouled filter, deposits of dust or carbon or also as a result of pressure shocks when starting up or the like, the volumetric rate of fluid flow falls very considerably, a very undesirable feature from the point of view of burner operation. In this respect radial blade fans having blade exit angles less than 90° have a more favorable characteristic. With decreasing blade exit angles the shape of the characteristic curve improves, but at the same time the pressure gain coefficient is reduced and a fan of larger size must be provided. This is undesirable.

SUMMARY OF THE INVENTION

It is the object of the present invention to provide a radial blade fan of the above specified kind which, despite relatively small dimensions, has a steep characteristic coupled with a high pressure gain when the volumetric rate of fluid flow is low.

Another object of the present invention consists in to provide a fan of the above described general character with which the housing on the one side and the inlet nozzle on the other side present the combination of the following features:

- a. between the beginning point of the spiral of the housing which corresponds to the point of the narrowest distance between the housing and the periphery of the impeller on the one side and the blower or fan outlet on the other side there is provided as transition and connecting piece a housing portion, whereby the distance between the said housing portion and the periphery of the impeller is, as seen over its length and in direction towards the blower or fan outlet, either constant or increasing towards the said outlet, said housing portion being allotted or associated to an arc along the periphery of the impeller which corresponds to a small arc at the center, for instance, of 5 deg.;
- b. the transition between the beginning point of the spiral of the housing and the portion of the housing

serving as transition or connecting piece to the blower outlet has the shape of a sharp bend;

- c. the beginning point of the spiral of the housing corresponding to the place of the narrowest or smallest distance between the housing and the periphery of the impeller extends only about a point-like distance as seen in the direction of the impeller and is situated at such a distance from the periphery of the impeller that at this point the space between the housing and the impeller is not sealed and these parts are not close to one another, so that air can flow through the space between the casing and the periphery of the impeller, whereby this point of the narrowest distance between the housing and the impeller in association and co-operation with the housing wall portion serving as transition and connecting piece serves the purpose of diverting a part of the air exiting from the impeller and reintroducing it into the interior of the impeller by passing it through the impeller blading;
- d. the periphery of the inlet nozzle so differs at certain locations or points from the circle described with the radius of the nozzle about the impeller axis that there results a difference of at least 2 percent with respect to the cross-sectional surface enclosed by the said circle.

Yet another object of the present invention consists in to provide a fan of the above mentioned type in which a steep increase of the pressure is obtained with decreasing volume rates and with which, therefore, even with great and considerable pressure variations no volume variations at all or only small volume variations can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings. In the drawings:

FIG. 1 illustrates a pressure volume rate of flow characteristic curve of a conventional fan and a corresponding curve of a fan according to the invention cooperating with an oil burner.

FIG. 2 is a side view of the casing of a fan according to the invention,

FIGS. 3 and 4 show two alternative embodiments of the fan according to the invention each in a vertically sectioned schematical side view,

FIG. 5 is a fragmentary side view of an embodiment of an inlet nozzle formed with a cross sectional constriction on one side.

FIG. 6 is a section taken on the line VI—VI in FIG. 5.

FIG. 7 shows the casing of a fan according to the invention having an eccentrically disposed inlet nozzle in a schematical and sectional frontview,

FIG. 8 is a representation of the gap between the fan wheel and the internal wall of the casing and of a special nose at the beginning of the casing, i.e., where the volute casing is narrowest on a greater scale,

FIG. 9 is a modified form of construction of the initial area of the volute casing in the same manner of representation as in FIG. 8, and

FIG. 10 is another modification of the initial section of the volute casing in which this initial region is preceded by a wedge element defining a by-pass channel.

FIG. 11 shows the inlet nozzle in the structure of FIG. 3.

FIGS. 12 and 13 are cross sections on lines 12—12 and 13—13, respectively, of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, FIG. 1 shows the pressure volume rate of flow characteristic curve A of a fan according to the present invention with forwardly curved blades co-operating with a burner. B is the corresponding characteristic curve of a conventional fan of the same diameter and rotating at the same speed. It will be readily seen that with the fan according to the invention substantially higher pressure heads can be obtained at low volume rates of fluid flow.

Consequently, in its use with a burner a fan according to the invention is capable of providing better starting conditions. Therefore, as will be understood from FIG. 1, with the fan according to the invention, there is obtained a steep characteristic curve and high pressure figures also in the range of smaller output volume figures, the pressure of the medium increases, therefore, rapidly or steeply when the volume rates of flow decrease. Since with burners it is desirable that with great pressure variations no output volume variations at all or only small output volume variations should occur, in order not to change or alter the outcome of results of the combustion operation, the invention is especially suited for the use with burners, all the more as the above requirement is of great importance with burners just nowadays as the boiler resistances become greater and greater.

In FIG. 2 shows schematically the casing 10 of a fan according to the invention in side view. 10a is the initial or beginning section of the volute casing, whereas 10b is the blower outlet. The volute casing or spiral housing has means defining an inlet nozzle which is marked with 11 in FIGS. 2 and 6. In this case, the inlet has a circular cross section and its axis 11c is eccentrically displaced by an amount 13 in relation to the position shown in dotted lines of an imaginary inlet nozzle of same magnitude disposed coaxially with the fan wheel axis 11a and having the same likewise circular cross section. The eccentric disposition of the inlet nozzle 11 with cross-circular section and with respect to impeller or fan wheel axis results in an overlapping of the surface of the real nozzle arranged eccentrically and of the surface of the imaginary centric nozzle by a certain amount. This amount, by which the free cross sectional area of the inlet nozzle differs from the area of the circle described with the radius of the nozzle around the axis of the rotor is so chosen that there results a difference of at least 2 percent. This difference is shown in FIG. 2 as shaded surface and is marked with "f."

FIG. 5 illustrates another embodiment of an inlet nozzle according to the invention. This inlet nozzle is here arranged centrically and generally indicated by reference number 20. At 20a there are inward lobes so that the inlet nozzle is constricted and constructed by having the wall surrounding the opening somewhat flattened. The constriction amounts to at least 2 percent of the total cross section of the circular nozzle. Therefore, the difference between the real and effective opening of the nozzle, the cross-section of which is smaller by the flattened portion, and the cross-section of the circle described around the axis of the rotor with

the radius of the nozzle amounts to 2 percent or more. The direction, by which the nozzle is staggered with respect to the circle described with the radius of the nozzle around the axis of the rotor, may be changed within some limits, the nozzle and its eccentricity can be, therefore, adjusted somewhat in order to adapt the arrangement to different conditions. It is preferred, however, to provide an eccentricity of the nozzle within the area of the first quadrant so that the nozzle is eccentric towards the pressure side. Naturally, the constriction need not be shaped as shown in the drawings. It is quite arbitrary. For example, an inlet nozzle of basically circular cross section might be flattened on one side.

In FIG. 7, the arrangement according to FIG. 2 — fan and eccentrically arranged inlet nozzle — is shown in a schematical and sectional front view. The rotor is marked with 65, 66 is the outline of the casing, 11 is the inlet nozzle. 67 is the inner diameter of the blading, and 68 is the part of the eccentrically arranged inlet nozzle which is farthest outside the inner diameter of the blading.

By the above measures and features the fluid medium or at least a part of this medium is forced repeatedly or for several times through the blading which fact explains why the pressure increases with small volume rates of flow and the characteristic curve is so steep. To this purpose there serves also the new shape of the volute casing and especially of the initial area of this casing. As can be taken from the drawings and especially from FIGS. 2 and 4, with the volute casing of the arrangement according to the invention the beginning of the spiral of the casing lies in the area of the outlet and embraces the periphery of the rotor along a distance which corresponds to an angle at the center of at least 270 deg. As shown in FIG. 11, the inlet opening is offset relative to the impeller by the amount of the displacement of its axis 11 from the axis 13 of the impeller, so that the side wall covers the circumferential portion of the impeller ahead of the outlet and the opening exposes the opposite circumferential portion of the impeller. The inlet nozzle is formed by a converging portion extending inwardly toward the impeller and a flat, peripheral flange 15 held on the side wall by lugs 16. With the arrangement according to FIG. 3 there is provided between the beginning of the spiral of the casing corresponding to the point 50 of narrowest distance between the housing or casing 51 and the periphery of the rotor 52 on the one side and the fan or blower outlet 53 on the other side as transition and connecting piece a housing portion 54 of the housing the distance of which to the periphery of the rotor increases as seen in direction towards the blower or fan outlet according to the arrow 55, said housing portion being allotted or associated to an arc "a" along the periphery of the impeller which corresponds to a small arc alpha at the center, for instance, of 5 deg. The transition between the beginning of the spiral of the housing at the point 50 and the housing portion 54 serving as transition or connecting piece to the blower or fan outlet has the shape of a sharp bend. This point 50 — which at the same time represents the beginning of the spiral and is situated at the smallest distance to the periphery of the impeller so that it corresponds to the narrowest interspace between the impeller and the periphery of the rotor — extends only about a point-like distance as seen in the direction of the impeller and thereby faces only a point on the periphery of the impeller and does not cover an

arc of this impeller periphery. The distance of this point 50 to the periphery of the impeller is so great that at this place the space between the housing and the impeller is not sealed and these parts are not close to one another so that medium can pass between the periphery of the rotor and the housing from the initial or beginning area of the housing. Due to such a shape of the casing and of the impeller and due to the eccentric position of the nozzle there takes birth a vortex core which is arranged approximatively in the area of the periphery of the impeller and serves together with the point 50 of the housing closest to the periphery of the impeller and with the housing portion 54 serving as transition and connecting piece to divert a part of the air exiting from the impeller according to the arrows 56 and reintroduce it into the interior of the impeller and let it flow from there to the exterior by passing it through the impeller blading. Due to the fact that the air flow is repeatedly passed through the blading of the impeller, the interchange of energy between the blading and the air flow is substantially enhanced and the blading imparts to the air flow additional energy. Due to the fact that the air can leave the impeller already directly after the point of narrowest distance between the housing and the impeller, pressure is built up in the diffuser-like interspace between the housing and the periphery of the impeller at an early stage, namely directly after this point of narrowest distance. By these means there is obtained with the blower or fan according to the invention such a high pressure figure. In the throttled stage of the fan the vortex core is at a greater distance from the point of narrowest distance between the housing and the periphery of the rotor than in the unthrottled stage, since upon throttling the vortex core travels away from the point of narrowest distance, but remains within the area of the periphery of the impeller or rotor. It results therefrom that with small volume rates of flow there is branched off a greater amount of air which is then reintroduced into the impeller for repeating the interchange of energy. Due to the fact that the vortex core more and more floats towards the fan outlet upon decreasing of the throttling, the distance between the point of narrowest distance and the vortex core becomes smaller when the fan is not throttled so that the amount of issuing air which is branched off by the point 50 of narrowest distance and the adjoining housing portion 54 and which thereafter is reintroduced into the impeller becomes smaller and smaller in relation to the total amount of issuing air so that, as a further consequence, the pressure figure decreases with increasing volume rate of flow.

Whereas with the arrangement according to FIG. 3 the portion 54 of the wall of the casing has an indent or notch 57 which promotes the tendency that a portion of the medium to be conveyed passes several times through the impeller so that the pressure substantially increases with smaller volume rates of flow, with the arrangement according to FIG. 4 such an indent or notch is no more present. Here, the transition and connecting piece 60 between the point 61 of the narrowest distance between the volute casing 62 and the periphery of the rotor 63 and the outlet area 64 is constructed without any indent or notch, whereby this point 61 of narrowest distance represents also a transition in the shape of a sharp bend and with point-like extension and whereby the diffuser-like enlargement of the interspace between the volute casing and the periphery of the im-

PELLER begins at this point of narrowest distance which covers or screens only a point of the periphery of the impeller. With this embodiment also the air flow is the same as described above with reference to FIG. 1.

In FIG. 8 there is shown schematically an embodiment of the initial region of the volute casing according to the invention. 31 is the impeller or rotor and 30 is a nose which defines the gap 32 between the casing or housing and the impeller at the beginning of the casing. As will be understood from the drawings, the gap 32 at the initial area 32b is concentric with the fan wheel along an arc corresponding to an angle at the center of at least 5°, said gap area 32b having constant width. In the region 32b the gap merges into the usual scroll shape which is not here represented.

At the point 32c, therefore, the wall of the casing which embraces the impeller makes a sharp bend, the transition between the wall portions 32d and 32e takes place as a sharp bend as at 32c, whereby this point 32c and the area 32d lie nearest to the periphery of the impeller. FIG. 9 shows a somewhat modified form of construction of the initial section of the casing. 33 is the nose which defines a channel 34 of which the end portion is marked with 34c and of which the narrowest portion is marked with 34b. The channel has a constriction at 34b and then widens again, as indicated at 34a. The angle at the center, which corresponds to the initial portion 34c up to the constriction 34b, may amount up to 10 deg.

FIG. 10 is yet another modification in which the nose defining the gap at the initial region is marked with 40. 41 is the beginning or initial region of the gap comprising an initially concentric portion 41b merging into a widening portion at 41a, whereby these two portions are separated by the bend 41c. In the prolonged axis of the nose 40 there is provided a wedge element 42 which forms a gap 43 between itself and the fan wheel 31 as well as a by-pass channel 44. This form of construction further facilitates re-entrainment of the fluid or repeated interchange of energy. Conveniently, the wedge element 42 is pivotably mounted on a shaft represented by its axis 45 to permit the cross sections of the gap 43 and of the by-pass channel 44 to be varied, for example, to be varied in directions contrary to one another in order that the characteristic curve of the fan be adjusted accordingly.

The proposed construction of the fan is not limited to the use in connection with burners although this is the preferred use.

Although our invention has been illustrated and described with reference to the preferred embodiments thereof, we wish to have it understood that it is in no way limited to the details of such embodiments, but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed our invention, what we claim is:

1. A radial fan for conveying air comprising a rotor impeller having blades extending approximately radially of the rotor and a casing having axially spaced sides with a lateral inlet in one side and a spiral wall extending approximately 270° about said impeller and integral, parallel continuations of the ends of said spiral wall forming parallel walls of an outlet of said casing, said spiral wall having its first end spaced from said impeller with the spacing of said spiral wall from said impeller increasing toward the other end, said first end

being joined to the corresponding parallel wall by a transition portion which is concave toward the opposite parallel wall and is joined to the first end of said spiral wall by an integral sharp bend forming a projection directed in a direction opposite to the direction of rotation of said impeller, so that the air from said impeller blades is divided into a main current out from said impeller discharged through said outlet, and another current deflected by said concave transition portion toward the periphery of said impeller into said blades, said inlet being offset relative to the axis of said impeller so that said side wall covers one circumferential portion of said impeller on one side and the inlet opening exposes a circumferential portion of said impeller on the opposite side and said inlet has a converging nozzle projecting inwardly from said side wall toward said impeller.

2. The radial fan in combination according to claim

1, wherein before the beginning of the spiral of the housing as seen in direction towards the fan outlet there is arranged a wedge-shaped nose defining together with the housing wall portion serving as transition and connecting piece a by-pass channel.

3. The radial fan in combination according to claim 2, wherein the said wedge-shaped nose is mounted pivotably about an axis parallel to the impeller axis.

4. The radial fan in combination according to claim 1, wherein the said inlet nozzle is circular in cross-section and is arranged eccentrically to the axis of the impeller.

5. The radial fan in combination according to claim 4, wherein the said inlet nozzle is staggered with respect to an exactly centrally arranged nozzle in direction towards the region in which the air leaves the impeller.

* * * * *

20

25

30

35

40

45

50

55

60

65