May 13, 1952 A. BUCHI 2,596,647

OUTLET GUIDING ARRANGEMENT

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FIG. 1

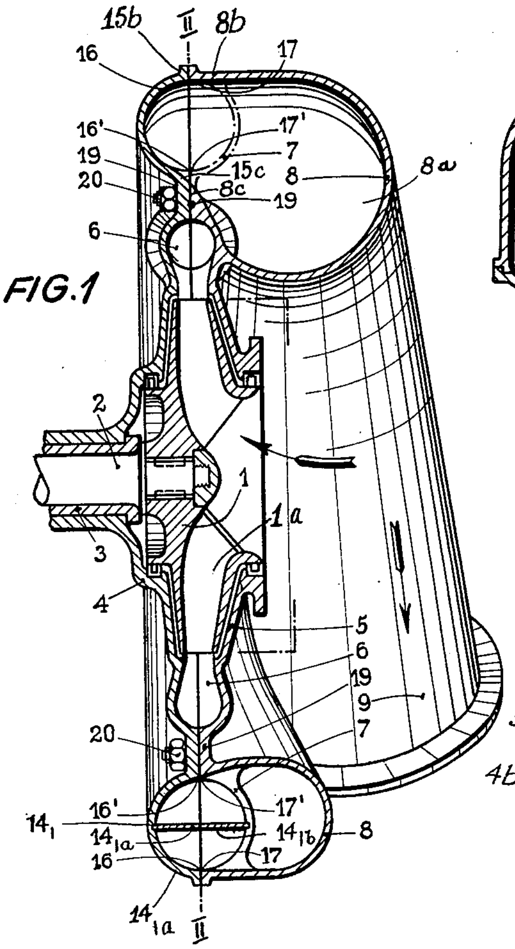


FIG. 3

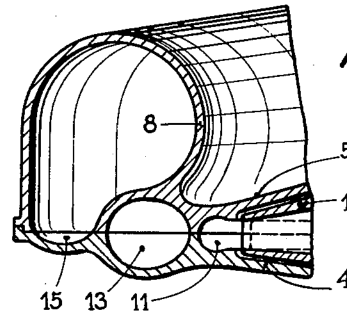


FIG. 4

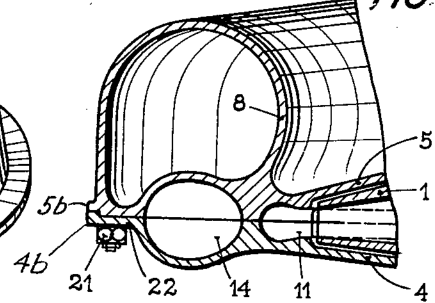


FIG. 5

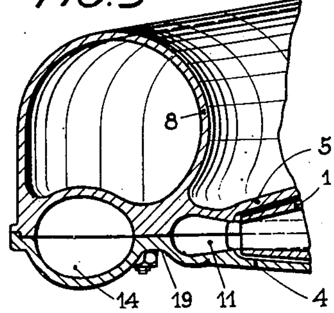
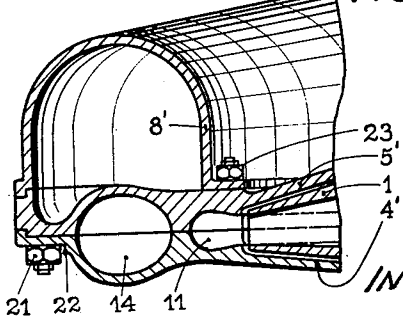


FIG. 6



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OUTLET GUIDING ARRANGEMENT

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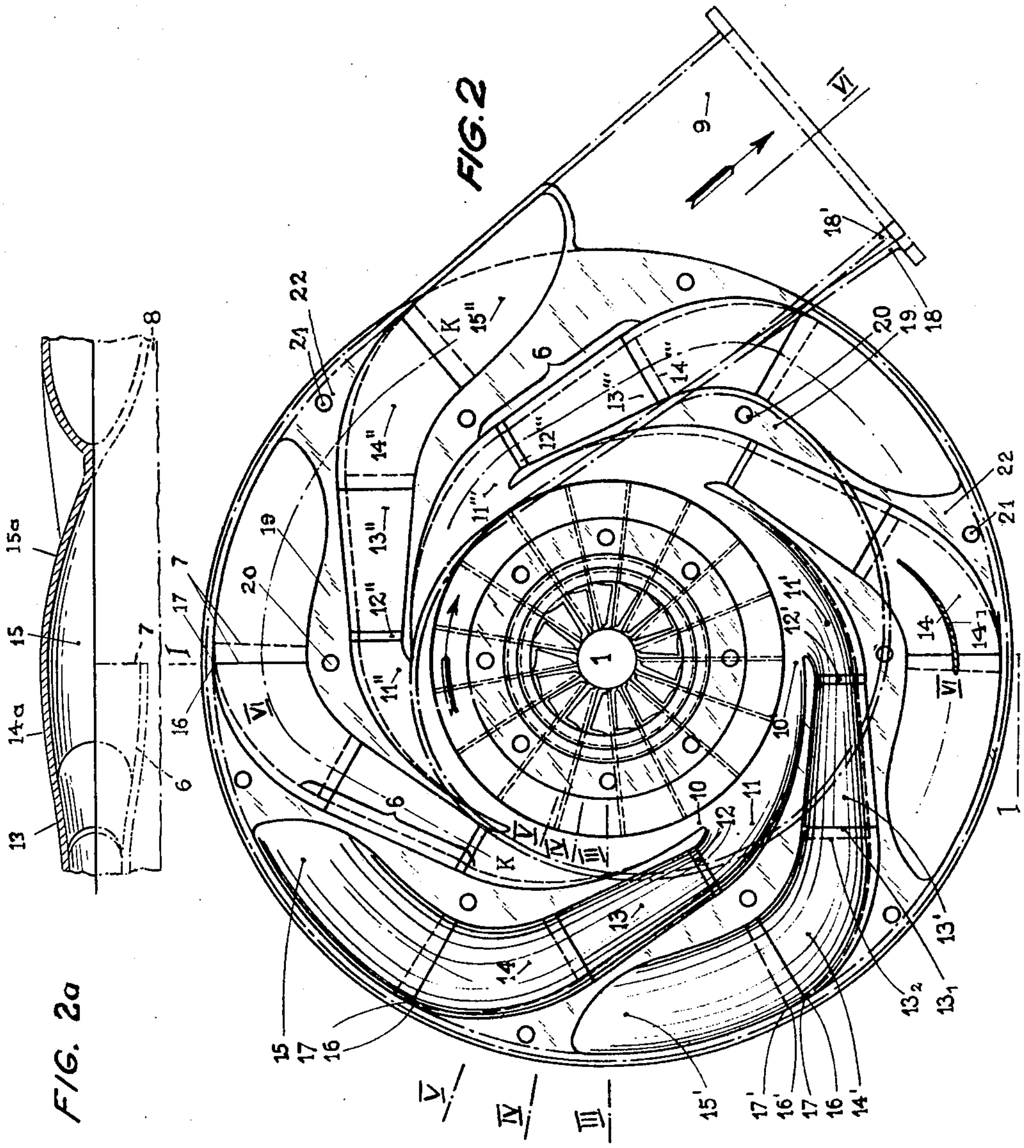

FIG. 2

FIG. 2a

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FIG.7

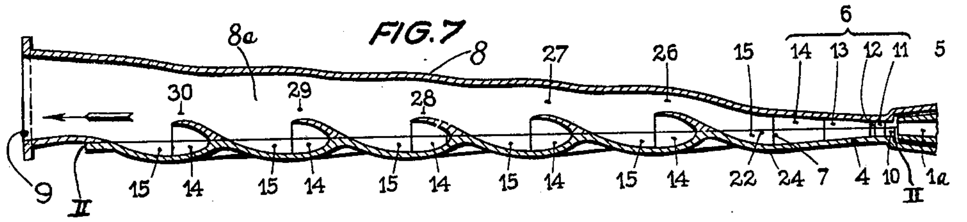


FIG.8

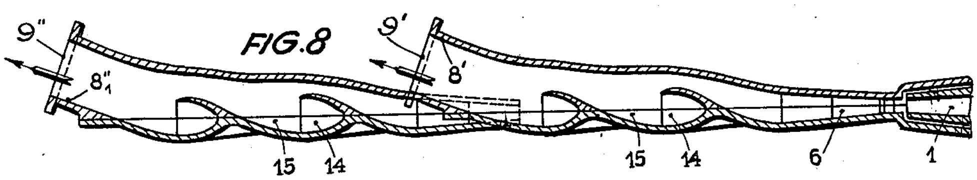
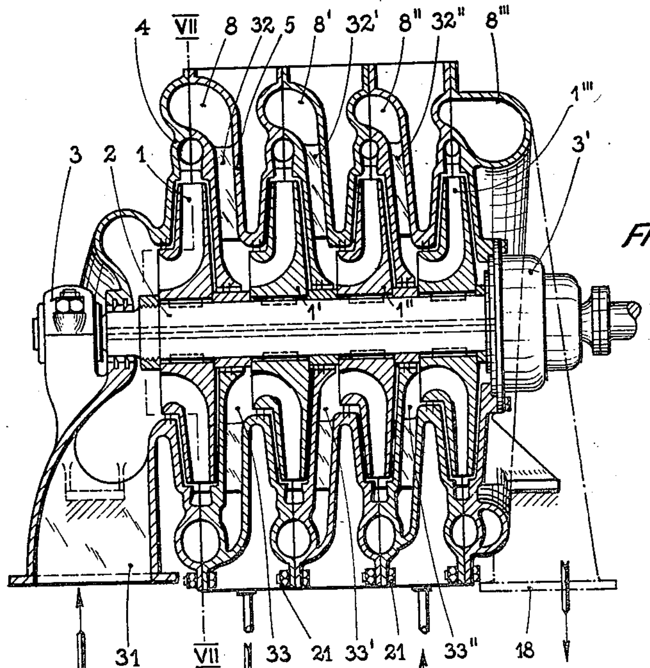


FIG.9



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OUTLET GUIDING ARRANGEMENT

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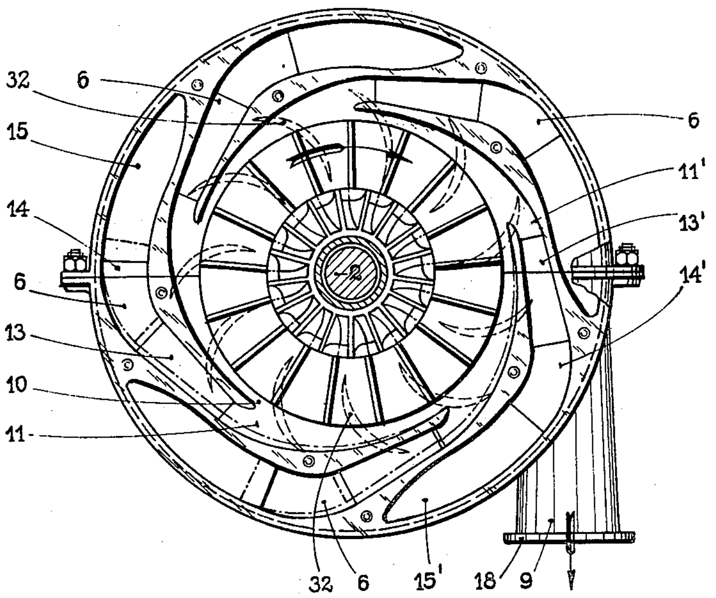

FIG.10

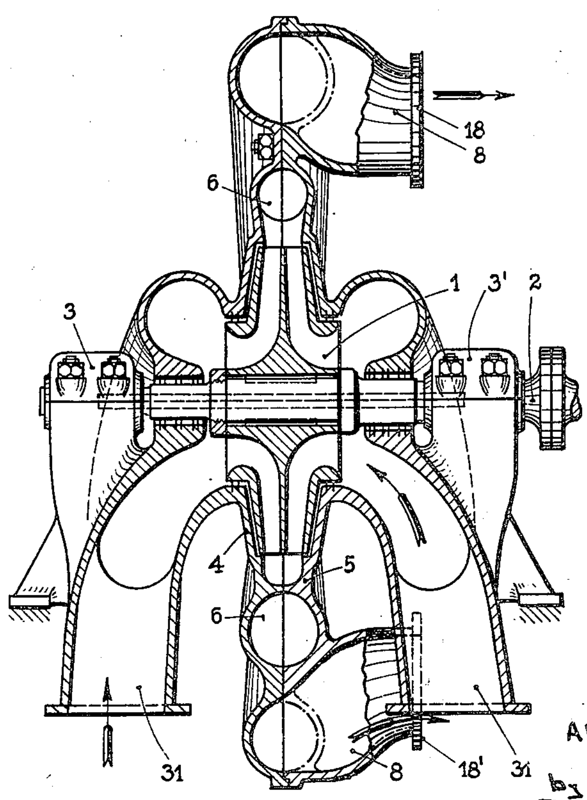

FIG.11

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UNITED STATES PATENT OFFICE

2,596,647

OUTLET GUIDING ARRANGEMENT

Alfred Buchi, Winterthur, Switzerland

Application October 17, 1951, Serial No. 251,742
In Switzerland March 6, 1946

13 Claims. (Cl. 103—103)

This invention relates to improvements in outlet guiding arrangements for centrifugal blowers and pumps. This application constitutes a continuation-in-part of my application Serial No. 732,639, filed March 5, 1947, which has been abandoned.

As I have pointed out in my copending application Serial No. 251,741, filed on the same date herewith, the efficiency of a centrifugal pump or blower depends not only upon such factors as the rotor speed, bearing friction, rotor disc friction, shock losses at the rotor intake and outlet, but also upon the duct arrangement whereby the fluid leaving the periphery of the rotor blading under high velocity and in a direction having a substantial tangential component is captured, its velocity converted into pressure, and the fluid guided into one or more streams of desired definition and direction. It is desirable that such a guide duct arrangement effect a smooth and shock-free flow of the pressure fluid within a minimum passage length and such is a primary object of my invention.

In my aforementioned copending application, I have described and claimed certain inventions relating to outlet guiding arrangements for centrifugal blowers and pumps. In this application, I shall describe and claim other inventions relating to different arrangements of this general character.

My invention described and claimed herein provides in its preferred embodiment a series of guide duct diffusers disposed substantially in a plane normal to the rotor axis and radiating with a substantial tangential component from the periphery of the blower disc. Laterally offset from the blower rotor, I further provide a scroll case into which each of the guide duct diffusers discharges its pressure fluid. This is accomplished according to my present invention, by disposing the scroll casing in such manner relative to the diffuser outlets that a portion of each diffuser outlet cross section, preferably not more than one-half, lies in the scroll space; and further by extending and shaping that portion of each diffuser wall which is most remote from the scroll space to form a deflecting wall which is concavely curved with respect to the normal plane in which lie the axes of the diffusers. This curved wall, in addition to deflecting the pressure fluid issuing from the diffuser of which the wall represents an extension, may also form that portion of the wall of the next succeeding diffuser which projects into the scroll space.

It is also an object of my invention to permit

the effecting of a substantial conversion of the fluid velocity into pressure before the fluid streams are deflected toward the laterally offset scroll space, thereby to reduce flow losses.

It is also an object to permit the introduction of the several fluid streams into the scroll space in such manner that, at the time they join the stream or streams already flowing in the scroll space, they are moving in substantially the same direction and at substantially the same velocity, thereby to minimize impact losses.

It is also an object to effect the circumferential deflection of the fluid streams into the scroll space under the widest radius of curvature.

It is a further object to provide a device which may easily be die cast in sections and thereafter put together.

These and other objects may be attained by the apparatus hereafter described in which is shown in

Fig. 1, an axial section through a single stage blower, taken on the line I—I, of Fig. 2;

Fig. 2, an axial view of the blower shown in Fig. 1, taken from the right hand side of and on a plane of juncture II—II;

Fig. 2*a*, a view in section of one of the diffusers seen by looking at the line K—K of Figure 2 from outside of the blower housing;

Figs. 3-5, axial sections through the rim portions of the guiding-arrangement and the scroll case, taken respectively on the lines III—III; IV—IV and V—V of Fig. 2;

Fig. 6, a section similar to that of Fig. 4, but illustrating a different embodiment of my invention;

Fig. 7, in development, a spiral section through the first guiding passage and each subsequent passage to the blower outlet header.

Fig. 8, a section similar to that of Fig. 7, in an embodiment having two separate discharge headers.

Fig. 9 and Fig. 10, an embodiment of my invention in a multistage blower, Fig. 9 being an axial section of the blower, and Fig. 10 a view seen in axial direction from the left along the line VII—VII of Fig. 9.

Fig. 11, an embodiment in a single-stage blower, the blower disc of which is bladed on both sides.

In Fig. 1, the reference character **1** represents a blower disc which is keyed onto shaft **2**. The latter rotates within the bearing **3**, itself disposed in the portion **4** of the blower casing which, in this preferred embodiment, is additionally constituted of the mating portion **5** defining the blower intake. These two portions are detachably secured together by means, such as bolts 20. About the periphery of the blower disc 1, I preferably provide an annular clearance gap 10 in which the pressure fluid is received from the blading 1*a*. Leading off from this gap 10 are a series of openings 11 into which the fluid is passed. Each of these openings 11 communicates with a guide duct diffuser arrangement 6 having its axis lying substantially in a plane II—II (Fig. 1) normal to the blower axis. In the preferred embodiment shown in Figs. 1 and 2, the diffuser arrangement is constituted of a first rectilinear portion 13 and a second curvilinear portion 14. The latter opens at 7 into a scroll space 8*a* defined by the scroll case portion 8 of the blower casing. This scroll space 8*a* is laterally offset relative to diffuser arrangement 6, and is further provided with a pressure header 9 into which the fluid stream moves after it has been collected in the scroll space 8*a* from each of the diffuser outlets 7.

The character 12 denotes a cylindrical port of entry to the rectilinear diffuser 13 which I preferably include to reduce vortex action. After the pressure fluid flows through the rectilinear diffuser portions 13, it passes through the transitional area, points of which are indicated by 16 and 17, and thence through the guide-passage portions 15. The latter having no defining walls beyond 7 on the side of the scroll space 8*a*, the pressure fluid streams simply merging with and becoming a part of the streams collected from preceding guide duct passages and moving in the scroll space 8*a* toward the pressure header 9. On the opposite side from the scroll space 8*a*, each guide passage portion 15 is defined by a deflecting wall 15*a* which commences as an extension of the wall 14*a* (defining the curvilinear diffuser portion) and curves axially of the blower towards the scroll space 8*a* concavely with respect to the plane II—II which is normal to the blower axis and in which lie the axes of the diffuser arrangements 6. This curved wall 15*a* curves gently to deflect the fluid stream issuing from the diffuser portions 14, into the scroll space 8*a* where it joins with minimum turbulence and impact, the streams previously collected and moving in the scroll space 8*a*. It should also be noted, that in my preferred construction, the portion 15*b* of the wall 15*a* which is radially outermost of the blower is brought adjacent the radially outermost portion 8*b* of the scroll casing 8. The portion 8*b* is flattened and extended axially of the blower to meet 15*b* beginning at the points of transition 16, 17.

Moreover, I also shape the inner portion 8*c* of the wall of scroll casing which is adjacent the guide duct arrangement 6 so that it merges with the inner portion 15*c* of the duct defining wall 15*a*, which is radially innermost of the blower axis, beginning at the points of transition 16′, 17′.

The manner in which the blower housing sections 4, 5 and guide duct diffuser defining walls 13*a*, 14*a* are preferably integrated with the scroll casing 8, is illustrated in the several sections of Figs. 3, 4 and 5. From these sections it will be seen that, in order to keep the pressure fluid moving in the scroll case at substantially the same speed as it is moving from the several curved guide duct diffuser outlets in accordance with one of the prime principles of my invention, it is necessary to maintain at least constant the cross sectional areas of the scroll space where each succeeding diffuser arrangement approaches the radially outer scroll space portion into which the pressure fluid is discharged as heretofore described. Moreover, to accomplish the object of maintaining constant speed of the fluid throughout the whole extent of the scroll space, it will be seen from Figs. 1, 2 and 7 that I provide a predetermined increase in the cross-sectional areas of the scroll space as the stream from each diffuser joins the streams previously collected therein.

The pressure header 9 into which the collected pressure fluid streams pass from the scroll space may be constructed either as a diffuser-like header 18 or as a parallel wall 18′ (shown by dash-and-dot lines in Fig. 2), depending upon whether it is desired to effect a further conversion of the fluid velocity into pressure or to maintain the pressure heretofore created by the diffuser ducts.

In laying out the scroll space 8*a* and pressure header 9 with respect to the several guide duct diffusers 6, I preferably arrange one guiding passage 11‴, 12‴, 13‴ and 14‴ to constitute the origin of the scroll space, and at least the last of the succeding guiding passages 11″, 12″, 13″, 14″ (emptying into the same header) to open directly into the header 9 in a substantially identical discharge direction.

While my invention will attain its objective quite satisfactorily without them, I have thought it desirable in some instances to provide curved guide vanes 14_1 in the curved diffuser sections in order to obtain relatively greater radii of curvature in the duct passages, especially at points of greater deflection. When vanes of this type and purpose are provided, I place them preferably at right angles to the abutting faces of the two sections 4, 5 which, when brought together, form the blower housing and the guide duct diffuser arrangement. These vanes 14_1 may each be constituted of two sections 14_{1a}, 14_{1b}, one section being disposed in each half of the duct defining wall 14*a*, and the two sections 14_{1a}, 14_{1b} being constructed to join with each other in the plane of separation. In one of the diffuser sections 14 in Figs. 1 and 2, I have shown such a vane construction. These vane sections may be cast integrally with the duct defining wall 14*a*, or slotting 14_2 may be provided into which the vane sections may be inserted after the casting and machining of the duct walls.

As above indicated, in my preferred embodiment, my guide duct arrangement and scroll casing are constructed of at least two sections 4, 5 divided by and intended to be brought together along a plane II—II substantially normal to the rotor axis as shown in Fig. 1. I have stated above that bolts 20 serve to secure together these two sections. It is a further feature of my invention that these bolts 20 or other screw connections be disposed in the areas 19 between the guide ducts, which areas have a substantial extent radially of the blower axis. Such disposition of the bolting 20 insures a good juncture of the two sections 4, 5. This manner of securing the casing sections 4, 5 may be supplemented by providing further screws or bolting 21 about the casing periphery, disposed in areas between the discharging outlets of the several curvilinear diffusers 14, and by providing interengaging shoulders 4*b*, 5*b* in the casing periphery (Figs. 2, 4). It would also be possible to employ peripheral bolting without the internal bolting 20.

The guide passage scroll case arrangement of my invention may also be constructed of three sections 4', 5', 8' as shown in Fig. 6. In this embodiment, sections 4', 5' when brought into registry, form the blower disc housing and the guide passage portions 10—14; and the two sections 5', 8' when properly joined, constitute the discharge exits and scroll space disposed according to my invention. The advantage of this three-sectional construction is that all three sections may be manufactured without casting about cores for hollow spaces, i. e., they may be die cast or pressed out of sheet material. In this arrangement, the section 8' may be secured to 5' by stud-bolts and nuts 23, or by any other suitable means. In putting together this three-sectional embodiment, sections 4', 5' and 8', should first be centered axially with respect to each other, and then fixed in a circumferential direction relative to each other to ensure a positive fit.

The manner in which pressure fluid leaving the rotor blading 1a passes through my guide-duct arrangement to the pressure header outlet 9 may be seen quite clearly in Fig. 7. Upon leaving the blading 1a, the fluid is first impelled into the gap 10 from whence it enters the initial guide passage 6, the components 11, 12, 13, 14 of which have been heretofore fully described. The axes of all of these components, as previously mentioned, lie substantially in the plane II—II which is disposed normal to the blower axis. When the fluid leaves the outlet 7 of the curvilinear diffuser portion 14, it passes into the passage portion 15 where it is deflected axially of the blower by the wall 15a at a great radius of curvature and into the axially offset scroll space 8a over the outside wall defining the guide passage portions 13—15 of the next succeeding guide duct arrangement. Each succeeding guide duct arrangement functions in the same manner. All streams are thereby brought into the scroll space 8a, one after another joining the preceding streams as they move toward the pressure header 9.

It should be stressed at this point that the passage portion 15 should preferably be so dimensioned as to maintain over its entire cross section the same velocity as prevails in the cross-section 7 of the outlet of the curvilinear diffuser portion 14. Moreover, the inflection commencing at the point 24 should be given a radius of curvature of such length as to decrease the transitional losses which normally would arise as the fluid moves through passage portion 15 into the scroll space 8a. In this preferred layout, interengaging shoulders 22 are produced in portion 4 where the wall of the latter closely approaches the plane of juncture II—II of portions 4 and 5. These shoulders 22 may be used for locating the connecting means 21 (seen in Figs. 2 and 4) so that the connecting means 21 do not have to be passed through any portion of the actual fluid guide passages.

Also, as previously indicated, the outside wall 8 of the scroll should preferably be shaped and dimensioned to substantially equal velocities throughout the scroll space 8a. To accomplish this, the cross-sectional area of the scroll space 8a at, for example, 26 should be equal to the cross-sectional area of the curved diffuser discharge at 7; and the cross-sectional areas at points 27—30, should be respectively substantially two, three, four and five times as large.

In the Fig. 8 arrangement, two separate scroll case portions 8' and 8'' have been provided which portions each collect pressure fluid from three guide passages 6 and pass the collected fluid respectively into headers 9' and 9''. These separate scroll positions and the guide passages leading thereinto are constructed according to the principles of my invention discussed above with respect to the embodiment of Fig. 7.

The application of the principles of my present invention to multistage blowers is illustrated in Figs. 9 and 10. Reference characters 1, 1', 1'' and 1''' designate the four runners keyed onto the shaft 2 which shaft turns within the bearings 3 and 3'. The suction intake is designated by 31, and the pressure header by 18. It will be noted from Fig. 10 that five guide passages are provided for collecting the pressure fluid from each runner. It will be seen from Fig. 9 that the cross sections of the scroll cases 8, 8' and 8'' are made substantially equal at their narrowest points in all radial sections. Moreover, only the leading passage of each set of five guide passages has to deflect the fluid axially into the scroll space. From each scroll case 8, 8' and 8'', the pressure fluid is conducted by the vanes 32, 32' and 32'' respectively into the inner collecting chamber 33, 33' and 33'' of the next blower stage. The last scroll case 8''' may be of a design similar to that of the blower of Fig. 1 with an increasing flow profile.

In the embodiment of Fig. 11, the runner 1 is bladed on both sides, each being fed by a separate intake 31. The pressure fluid discharged by this double-bladed runner is collected by a guide-passage arrangement which may be similar to the arrangement of Fig. 1 with a single scroll case and pressure header, or it may comprise a dual-series scroll, such as is illustrated in Fig. 8, with two headers 18 and 18' as shown in Fig. 11.

While I have shown and described several different types of single stage blowers in each of which the scroll is disposed laterally offset towards the blower intake, this is simply a matter of choice and it will be obvious that the scroll may be laterally offset towards the opposite side from the intake just as is normally the case in multistage blowers (see Fig. 9).

I claim:

1. In a centrifugal pump or blower having a bladed rotor and a casing enclosing said rotor, an outlet guiding arrangement for delivering pressure fluid from said rotor including a plurality of guide duct diffusers receiving the pressure fluid delivered by the rotor blading, the axes of said diffusers lying substantially in a plane normal to the rotor axis, said casing having a portion defining a scroll space, said space being at least partially laterally offset from, and directed substantially parallel to said plane, said casing portion further partially defining the diffuser outlets, said outlets extending at least partially into said scroll space and being directed substantially parallel with the direction of flow in the scroll space, said casing portion further including a deflecting wall for each diffuser, said wall beginning at that side, most remote from the central area of the scroll space, of the outlet of such diffuser, and said deflecting wall being concavely curved with respect to said plane and extending at least partially axially of the blower into the scroll space, whereby the pressure fluid is deflected into said partially offset scroll space.

2. The outlet guiding arrangement as described in claim 1 wherein the diffusers have, for at least part of their extent, curvilinear axes, said axes curving in a direction circumscribing the rotor.

3. The outlet guiding arrangement as described in claim 2 wherein at least one guide vane is disposed in the curvilinear portion of each dif-

fuser, said guide vane being curved in tangential direction and with the axes of said diffuser.

4. The outlet guiding arrangement as described in claim 2 wherein at least one guide vane is disposed in the curvilinear portion of each diffuser, said guide vane being curved in tangential direction and with the axis of said diffuser, each of said diffusers and each of said guide vanes being divided into two parts along said normal plane, one part being disposed on each side of said plane.

5. In a centrifugal pump or blower having a bladed rotor and a casing enclosing said rotor, an outlet guiding arrangement for delivering pressure fluid from said rotor, comprising a plurality of rectilinear diffusers disposed within said casing radially beyond the rotor blading, the axes of said diffusers lying approximately in a plane normal to the rotor axis, a curvilinear diffuser communicating with each rectilinear diffuser through which curvilinear diffuser said fluid is further passed, the axis of each said curvilinear diffuser also lying substantially in said plane, said casing having a portion defining a scroll space, said space being at least partially laterally offset from, and directed substantially parallel to said plane, said casing portion further partially defining the diffuser outlets, said outlets extending at least partially into said scroll space and being directed substantially parallel with the direction of flow in the scroll space, said casing portion further including a deflecting wall for each diffuser, said wall beginning at that side, most remote from the central area of the scroll space, of the outlet of such diffuser, and said deflecting wall being concavely curved with respect to said plane and extending at least partially axially of the blower into the scroll space, whereby the pressure fluid is deflected into said partially offset scroll space.

6. In a centrifugal pump or blower having a bladed rotor and a housing enclosing said rotor, an outlet guiding arrangement for delivering pressure fluid from the rotor of said pump or blower comprising a plurality of rectilinear diffusers to receive the pressure fluid from the rotor, a curvilinear diffuser for, and communicating with, the outlet of each rectilinear diffuser from which latter diffuser said fluid is further received, the axes of all said diffusers lying substantially in a plane normal to the rotor axis, all said diffusers being integrated with the walls of said housing, said housing providing additionally a scroll defining a scroll space, said space being at least partially laterally offset from, and directed substantially parallel to said plane, said scroll further having a radially outer housing wall, the discharge orifices of said curvilinear diffusers being disposed within said space contiguous to the inside surface of the said outer housing wall, said orifices being directed substantially parallel with the direction of flow in the scroll space, said housing further including a deflecting wall for each curvilinear diffuser, said wall beginning at that side, most remote from the central area of the scroll space, of the discharge orifice of such diffuser and curving at least partially axially of the blower and concavely with respect to said plane into the scroll space to form, adjacent to the radially outer housing wall, deflected passages extending from each said curvilinear diffuser discharge orifice on the side of said plane opposite from said scroll space, into said scroll space, whereby the pressure fluid is directed smoothly over a surface portion of the outer wall of each preceding diffuser guide-duct and peripherally over an arc having a large radius of curvature, into the scroll space.

7. The outlet guiding arrangement as described in claim 1 wherein there is additionally provided outlet header means in communication with the scroll via which means the fluid received in the scroll may be discharged, the said scroll having such cross-sectional dimensions increasing in the direction of the flow that the pressure fluid entering the scroll successively from the curvilinear diffusers is maintained at substantially uniform velocity, and is thus guided into the outlet header means.

8. The arrangement as described in claim 1 wherein the scroll is variably formed to assist in the maintenance of substantially uniform velocity of the fluid flowing therethrough as received successively from the outlets of the several diffusers.

9. The arrangement as described in claim 1 wherein the diffusers and the casing are divided along said normal plane into two sections, said sections having depressed areas between each diffuser and the diffuser next adjacent thereto to accommodate means within the overall diameter of the casing for securing together said two sections along said normal plane.

10. An outlet guiding arrangement as defined in claim 1 in which the said guide-duct diffusers are constituted of a surface of a first casing part, said surface being appropriately formed to define a portion of said diffusers, and of an oppositely formed surface of a second separate casing part, said two surfaces being brought together in a plane normal to the axis of the pump or blower to register the corresponding formation of both said surfaces.

11. An outlet guiding arrangement as described in claim 10 wherein one of said casing parts additionally forms by its side opposite said surface, a portion of the wall of the scroll space, said wall portion being discontinued in the areas of the diffuser outlets thereby to provide for direct communication between said diffuser outlets and the scroll space.

12. An outlet guiding arrangement as described in claim 1 wherein the said guide-duct diffusers are constituted of a surface of a first outer casing part, said surface being appropriately formed to define a portion of said diffusers and of an oppositely formed surface of a separate middle casing part, said two surfaces being brought together in a plane normal to the axis of the pump or blower to register the corresponding formations of both said surfaces, the other side of said middle casing part having a surface forming the wall defining the side of the scroll space adjacent the diffusers, said middle casing part being discontinued in the areas of the diffuser outlets thereby to provide for direct communication between said diffuser outlets and the scroll space, and of a third convoluted casing portion, the last said portion being formed with a surface to provide the remaining wall defining the scroll space and the said side of the middle casing part forming the wall being joined in a second plane normal to the rotor axis with the thus formed wall of the third casing part to register their corresponding surfaces.

13. The arrangement as defined in claim 1 wherein the deflecting wall for one diffuser extends axially of the blower past said plane and into the scroll space, the curvature of said wall in cross section in the flow direction of the fluid

being reversed to convex with respect to said plane beginning approximately where said wall crosses said plane, and said convexly curved portion of said wall forms a partial defining wall for the outlet portion of the next succeeding diffuser.

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