May 8, 1962 R. COESTER 3,033,441

TURBOMACHINE

Filed May 8, 1957 2 Sheets-Sheet 1

Fig. 1

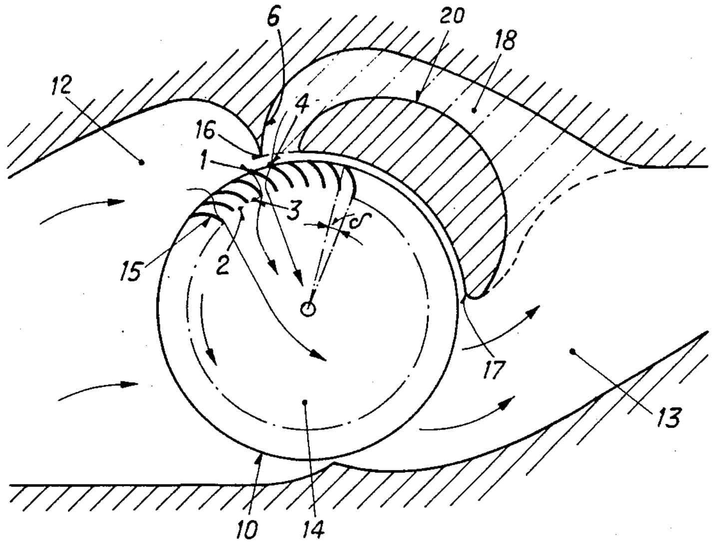

Fig. 2

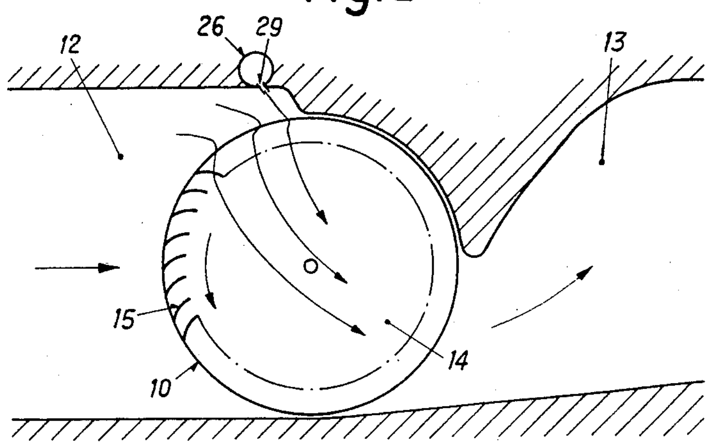

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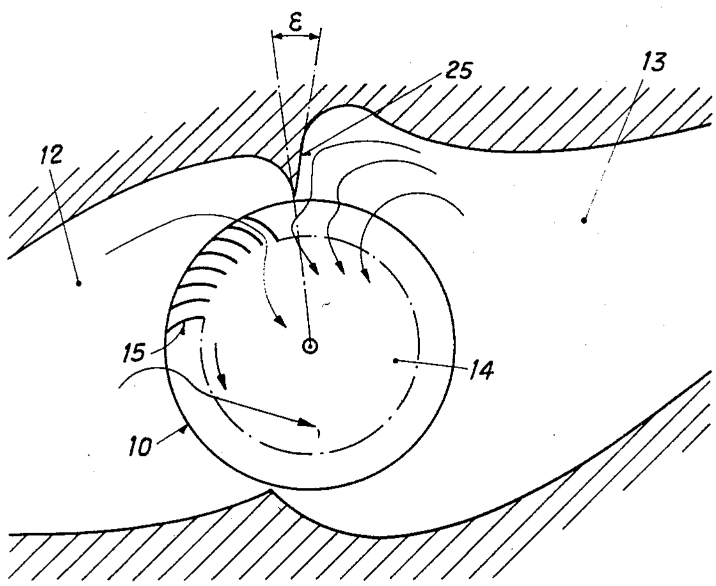
Fig. 3



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TURBOMACHINE

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The present invention relates to a pressure generating turbomachine and in particular to a transverse flow blower in which a space is by means of a feed rotor divided into a high pressure and a low pressure. The invention has for its object to improve the efficiency of turbomachines and to increase the specific feed pressure in particular at small specific quantities delivered.

It is known that transverse flow blowers in which the rotor is shielded by a closely fitting housing wall between the outlet of the high pressure chamber and the inlet of the low pressure chamber achieve comparatively high efficiency at high quantities supplied. With smaller quantities supplied, however, pressure and efficiency drop considerably. The determining factor is the undimensional coefficient

$$\varphi=\frac{Q}{D.b.u}$$

in which Q is the quantity delivered, D the rotor diameter, b the rotor width in axial direction of the rotor and u the circumferential speed of the rotor periphery. Small coefficients are frequently desirable, such as in fan units where the flow rates are required to be as low as possible, or in blowers and pumps for small deliveries compared to the feed pressure.

It has been suggested to return part of the medium delivered from the rotor into the latter between the outlet of the high pressure chamber and the inlet of the low pressure chamber since experience has shown that the flow in the rotor is somewhat improved, particularly with coefficients φ smaller than approximately .5. The present invention relates to means substantially increasing pressure and efficiency over that of known turbomachines and partly displaying purely structural advantages for reasons disclosed below.

According to the present invention means are provided which cause the pressure on the rotor periphery to be increased at least substantially at the place where the rotor blades enter the low pressure chamber.

An embodiment of the invention is described in conjunction with the attached drawings in which:

FIG. 1 is a diagrammatic cross-section of a turboblower to illustrate the operation of the arrangement according to this invention;

FIG. 2 is a cross-section of a turboblower with a device enabling a stabilizing jet to be generated by means of a separate source of pressure; and

FIG. 3 is a cross-section of a turboblower in which the configuration of the inner housing wall is selected so that the jet is generated by the inner wall.

FIG. 1 is a cross-section of a turbomachine known as a "transverse flow blower." By means of a blower rotor 10, the blower is divided into two chambers 12 and 13 along lines parallel to the axis of the rotor where the walls closely approach the rotor as shown in FIG. 1. Blower rotor 10 consists of sheaves 14 the circumference of which has connected thereto blades 15 mounted at a certain angle and spaced apart circumferentially less than their dimension radially of the rotor. The air entering chamber 13 on rotation of the rotor does not at first have the full pressure but an increased speed which is transformed into pressure in the course of the flow. The

front chamber 12 will therefore be termed low pressure chamber, the next following chamber in the direction of flow, high pressure chamber 13.

In order to explain the invention, it is assumed that the rotor is covered from point 17, where the blades leave the high pressure chamber, to point 16, where the blades enter the low pressure chamber, i.e. that space 18 is filled or not provided.

It has been found that a substantial increase in pressure and efficiency can be obtained in transverse flow blowers if a jet bound at its circumference and having a static pressure and a total pressure raised relative to the condition in the low pressure chamber, is supplied at least substantially at the place of entry of the rotor periphery into the low pressure chamber, for the following reasons:

A fluid flow entering the rotor at point 1 from the low pressure chamber is accelerated in the circumferential direction of the rotor by the rotor blades and leaves them approximately at point 2. For reasons of continuity, as much fluid must emerge at point 3 of the blade channel as has entered at point 1, at least while the flow rates do not approach the velocity of sound. This is possible without substantial disturbance if a fluid flow containing the necessary quantity of fluid enters the rotor at point 4 as well. For this latter fluid flow, the same conditions will apply. Its passage through the rotor can, however, be forced by applying the fluid flow to point 4 under elevated pressure. It is thus possible to limit the quantity of medium supplied to the rotor to a minimum. A jet width of a maximum of 3.5δ with δ as the angle at which a rotor blade appears when viewed from the axis. The value 3.5δ is critical. It is obvious that the auxiliary jet should preferably be applied substantially radially inwardly.

In order to obtain such an auxiliary jet, a duct 18 is provided which is connected, on the one hand, with the high pressure chamber and ends approximately at the point where the rotor blades 15 enter the low pressure chamber. This point is approximately identical with the said point 4. At the end of duct 18, a nozzle-type device (not shown) may be provided; it is also possible to baffle the medium entering through duct 18 at the transverse wall 6 and thus to obtain a particularly advantageous distribution of velocity since the speed of entry into the rotor in the vicinity of the transverse wall 6 is highest and then gradually decreases. Moreover, there exists the possibility of connecting the duct 18 with a separate source of pressure and thereby to obtain the auxiliary jet.

Without this auxiliary jet the flow directed at the rotor in the low pressure chamber seen in the direction of rotation can be obtained only gradually and the more slowly, the smaller the total throughput or the volume coefficient φ is. A wider or narrower zone with a lesser flow is created in which the losses due to unfavourable flow angles and owing to circulation are substantially larger than the losses unavoidable in the application of the auxiliary jet according to this invention.

As further shown in FIG. 1, the duct 18 can be formed by covering the portion of the rotor projecting into the high pressure chamber by means of a body 20 so that duct 18 is formed above the said body. The air supplied by the blower flows to the right in the high pressure chamber when the direction of rotation is as indicated, while owing to the elevated pressure in chamber 13 a return flow is obtained through the upper duct 18. This causes the transverse wall 6 to perform a damming action whereby the jet stabilizing the main flow in the manner described is produced.

The angle at which the duct 18 appears at the rotor periphery seen from the rotor axis is most favourable if it is .5 to 3.5 times the value of angle δ, i.e. the angle at which a rotor blade appears when viewed from the axis of rotation. This angle is preferably below 30°.

FIG. 2 shows an embodiment in which the jet according to the invention is produced by a separate source of pressure, by way of example a further compressor. In the turbomachine here shown a tube **26** provided with nozzles or slots **29** is arranged at the point of entry of the rotor parallel with the axis of rotation. This tube permits a rise of pressure, by way of example in the magnitude of one-third to one-half of the stage pressure differential, to be produced at the shown point of entry of the rotor into the low pressure chamber. The high pressure in tube **26** relative to the underpressure chamber is produced by a separate source of pressure.

FIG. 3 shows an embodiment in which a pressure surge at the point of entry of the rotor into the low pressure chamber is generated solely by the configuration of the inner housing wall. If a transverse wall **25** is provided at the partition between high pressure and low pressure chambers, the air, which returns at all events, is baffled so that a pressure surge due to the damming effect is obtained. It should be noted that a largely free supply is possible to this transverse wall or partition. The transverse wall should be inclined towards the rotor radius at the point of entry of the rotor into the low pressure chamber by not more than 30° at the end of the said radius (angle ϵ in FIG. 3). To adapt the housing to the flow, the transverse wall may be somewhat less inclined with increasing distance from the point of rotation.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In a transverse flow blower, a housing comprising spaced walls, a rotor mounted in said housing for rotation about an axis parallel to said walls, said walls extending closely adjacent said rotor along two circumferentially spaced axial lines so as to separate low and high pressure chambers on opposite sides of said rotor, said rotor having blades on its periphery spaced a less distance than their radial dimension and arranged parallel to the axis of rotation and forwardly inclined at an angle to a radial plane so that said blades form a hollow space within said rotor, said rotor rotating in a forward direction so that fluid enters said rotor from between said walls to form said low pressure chamber and is discharged on the other side between said walls which confine said fluid to form said high pressure chamber, the wall of said housing adjacent said rotor at the axial line at the entry of its periphery into said low pressure chamber extending away from said periphery at an angle not greater than 30° to a radial plane at said line of entry to form an abutment facing said high pressure chamber, said wall from said abutment extending in a smooth curve to the wall of said high pressure chamber and spaced outwardly of said rotor, a second wall spaced inwardly of said first wall and extending closely adjacent the periphery of said rotor for a substantial portion of said periphery from said high pressure chamber toward said abutment and having a smooth, continuous outer surface to form with said wall from said abutment a duct between said walls extending from said high pressure chamber beyond said rotor to the line of entry of the periphery of said rotor into said low pressure chamber, said abutment and the adjacent end of said second wall being spaced a greater distance than the space between adjacent blades and less than said walls of said duct at said high pressure chamber and forming the outlet of said duct to direct a flow of fluid under pressure from said high pressure chamber in a generally radial direction between the blades of said rotor at its line of entry into said low pressure chamber.

2. The apparatus defined in claim 1, in which the spacing of said abutment and the adjacent end of said second wall subtends an angle at the center of the rotor not greater than 3.5 times the angle subtended by the circumferential space between adjacent blades.

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