Aug. 20, 1946. O. ZWEIFEL 2,406,126

BLADE ARRANGEMENT FOR AXIAL COMPRESSORS

Filed June 7, 1943

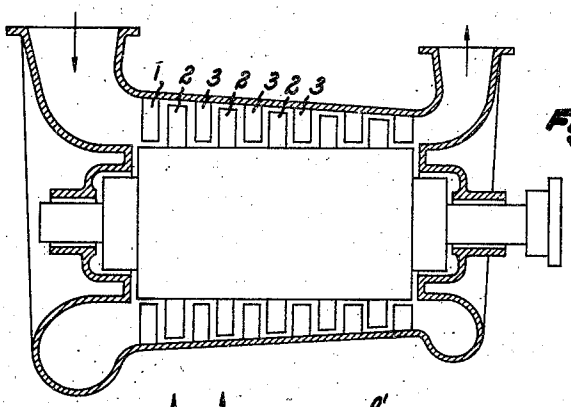


Fig. 1.

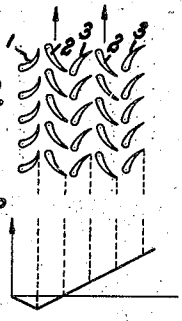


Fig. 2.

Fig. 3.

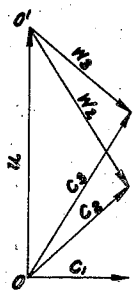


Fig. 4.

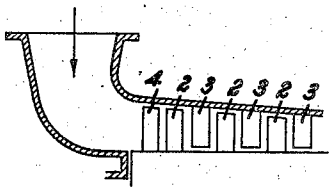


Fig. 5.

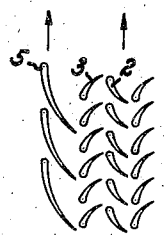


Fig. 9.



Fig. 6.

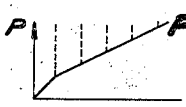


Fig. 7.

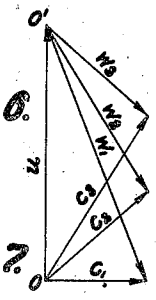


Fig. 8.

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Patented Aug. 20, 1946 2,406,126

UNITED STATES PATENT OFFICE

2,406,126

BLADE ARRANGEMENT FOR AXIAL COMPRESSORS

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Application June 7, 1943, Serial No. 489,978
In Switzerland March 21, 1942

3 Claims. (Cl. 230—122)

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For manufacturing reasons the blading of multi-stage axial type compressors is generally composed of as many similar stages as possible; the majority of the rows of moving blades as well as most of the rows of stationary blades being each of the same kind. In the special case of the so-called symmetrical blade arrangement the moving and stationary blades are not merely of the same design but the moving and stationary blades are also the image of each other. The entrance and exit angles are also repeated from stage to stage, the only difference between the stages being the length and twist of the blades. Amongst these blades, which on account of their similarity are designated as "normal stages" there is a kind where the absolute path of the flow both in front of the stationary blade as well as in front of the moving blades diverges considerably from the axial direction. In order to obtain a smooth entrance into the first stage of such blading it is necessary to give the medium which has to be compressed a certain swirling motion which diverts the flow into the desired circumferential direction.

It is known to produce this entering swirl by giving the entrance spiral of the casing a special form or by means of a row of stationary blades with nozzle-like guide elements or by combining both these devices. A disadvantage of all these devices is, however, that the required swirling effect is only achieved at the expense of a drop in pressure which can only be compensated by additional stages and this means further losses.

The present invention concerns a blade arrangement for axial compressors with a plurality of rows of the same stationary and the same moving blades or at least geometrically similar blades, so-called normal stages, and with a flow of the medium which is to be compressed which diverges considerably from the axial direction both in front and after each guide row, so that the medium which is to be compressed in order to achieve a smooth entry must receive a certain swirl, this swirl being mainly produced by a moving blade row which is located in front of the first moving blade row of the normal stage blading. The normal construction of blading according to one form of the invention thus commences with two rows of moving blades the second of which is a moving blade row of a "normal stage."

The invention is explained by means of three constructional examples shown in the accompanying drawing the first of which, Figs. 1 to 4, refers to the hitherto known arrangement of blading, whilst the second example illustrated in

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Figs. 5 to 8 deals with the novel construction according to the invention and Fig. 9 shows a special modified form of the invention.

The axial blower shown diagrammatically in section in Fig. 1 comprises five symmetrical normal stages which each include a row of rotating blades **2** and a row of stationary blades **3**. The swirl which must be imparted to the flow in order to obtain in accordance with the direction of flow c_2 (Fig. 4) a smooth entry into the first moving blade row (Fig. 2) is achieved by the stationary blade row **1**. This blade row consists of heavily curved guide blades in which the medium has its axial velocity c_1 changed to a velocity c_2. Corresponding to the increase in velocity there is a decrease in pressure (Fig. 3) which can only be compensated again in the subsequent compressor stages.

With the arrangement according to the invention the guide row **1** in Fig. 1 is replaced by a specially shaped moving blade row **4** as shown in Figs. 5 and 6. The relative velocity w_1 (Fig. 8) corresponding to the absolute axial velocity c_1 is reduced to w_2 due to being diverted in the moving blade row **4**. w_2 in direction and magnitude thus gives the same absolute velocity as c_2 in Fig. 4. Since, however, this velocity has been obtained by a reduction in velocity there will be an increase in pressure as shown in Fig. 7 and not a pressure drop as is the case with the known arrangement previously described.

As can be seen from Figs. 6 and 8 the moving blade row located in front of the normal stages differs from the normal moving blades in various respects. The circumferential components of the relative velocities of the additional moving blade row are considerably higher than those of the moving blade rows of the normal stages and the entrance angles are therefore acuter. The blade does, however, not need to be bigger.

Although the usual form of the invention is with two independent rows of moving blades it is also possible to combine both rows to form a single row. The profile of these combined moving blades is then composed of a blade part which at the inlet possesses the angle and profile conditions of the guide blades in the supplementary moving row and of a trailing blade part which has the same angle and profile conditions as a moving compressor blade of the "normal stages."

This combined construction is shown in Fig. 9. In the blade **5** which is a combination of the blades **2** and **4** the velocity w_1 of Fig. 8 must be directly reduced to w_3. The advantage of this combination is that a row of blades can be dispensed with.

Slightly higher flow losses due to the greater deviation have, however, to be taken into account. Since the first row of moving blades of the normal stages is combined with the supplementary row in front of the normal stages the first moving row is immediately followed by a normal stationary row 3.

Under certain conditions it is also possible to use the same profiles for the supplementary moving blades as for the moving rows of the normal stages. The blades of the supplementary row must, however, be so arranged that their angle to the circumferential direction is considerably more acute than the entrance angle of the succeeding normal stages.

In addition to the moving blade row the shape of the inlet casing can also assist in impart a swirling effect on the medium.

I claim:

1. In an axial flow gas compressor, the combination with a plurality of compressor stages comprising alternately arranged rows of rotating and of stationary blades of geometrically similar profile, of a first compressor stage preceding said plurality of compressor stages; said first compressor stage comprising a row of stationary blades of the same profile as the rows of stationary blades of said plurality of compressor stages, and rotating blade means preceding said row of stationary blades for imparting a circumferential component to the gas as it enters said first compressor stage and for discharging the gas therefrom at substantially the same angle as that at which gas is discharged from the rotating blades of each of said plurality of compressor stages, said rotating blade means having an entrance angle more acute with respect to the axial direction of gas flow than the corresponding entrance angle of the rotating blades of said plurality of compressor stages and having a discharge angle identical with the corresponding discharge angle of the rotating blades of said plurality of compressor stages.

2. In an axial flow gas compressor, the invention as recited in claim 1, wherein said rotating blade means comprises an inlet row of blades having said more acute entrance angle, and a second row of blades between said inlet row and said row of stationary blades of the first compressor stage, said second row of blades having the same profile as the rotating blades of said plurality of compressor stages.

3. In an axial flow gas compressor, the invention as recited in claim 1, wherein said rotating blade means comprises a single row of blades having entrance portions of said more acute entrance angle and trailing portions of the same angle and profile as the rotating blades of said plurality of compressor stages.

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