United States Patent

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[54] MOUNTING OF STATOR BLADES IN AXIAL COMPRESSORS

[72] Inventors: **Vaclav Kadera; Josef Novotny; Miloslav Vondruska; Jiri Feierfeil; Vlastimil Svoboda; Dusan Misarek; Miroslav Futera; Katerina Nacovska; Zbynek Janc; Adolf Nemec; Jiri Penkava; Zdenek Vitkovec**, all of Prague, Czechoslovakia

[73] Assignee: CKD Praha, oborovy podnik, Prague, Czechoslovakia

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[52] **U.S. Cl.** **415/149**

[51] **Int. Cl.** **F04d 27/00**

[58] **Field of Search** 415/148, 149, 150, 151, 160, 415/161, 162

[56] **References Cited**

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Primary Examiner—Henry F. Raduazo

Attorney—Richard Low and Murray Schaffer

[57] **ABSTRACT**

A compressor in which the blades of the stator are mounted in circular rows in a plurality of abutting axially aligned ring-shaped members secured in a recess in the inner wall of the stator, each ring is provided with an associated second annular ring in which is located link means extending into engagement with each of the blades mounted on the first ring. The link means are arranged to swivel the blades about their axes. Means are provided for oscillating the second ring member to actuate the link means.

9 Claims, 6 Drawing Figures

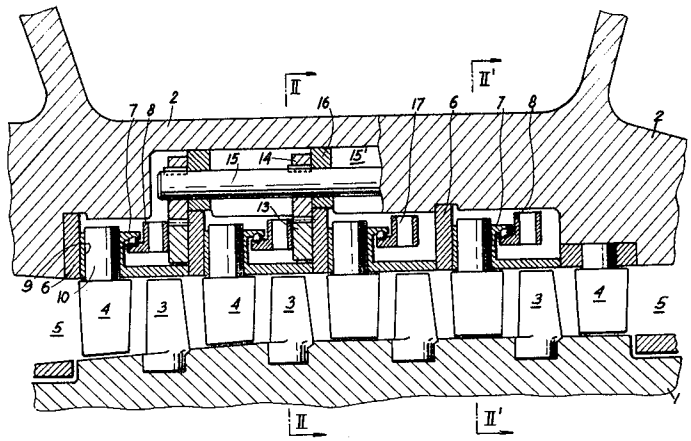


Fig. 2

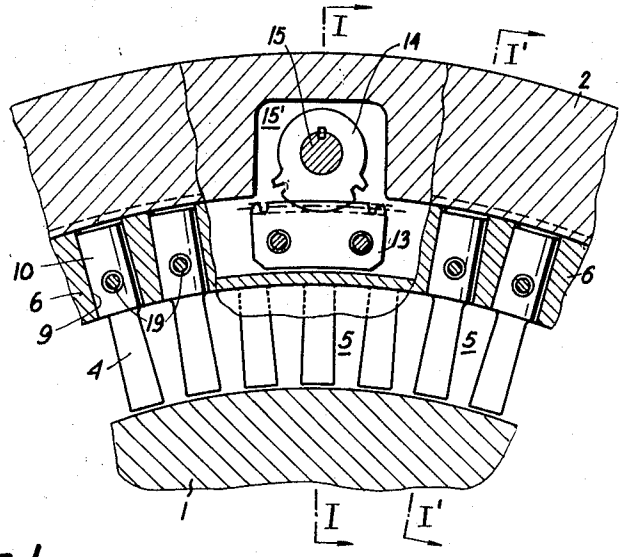


Fig. 1

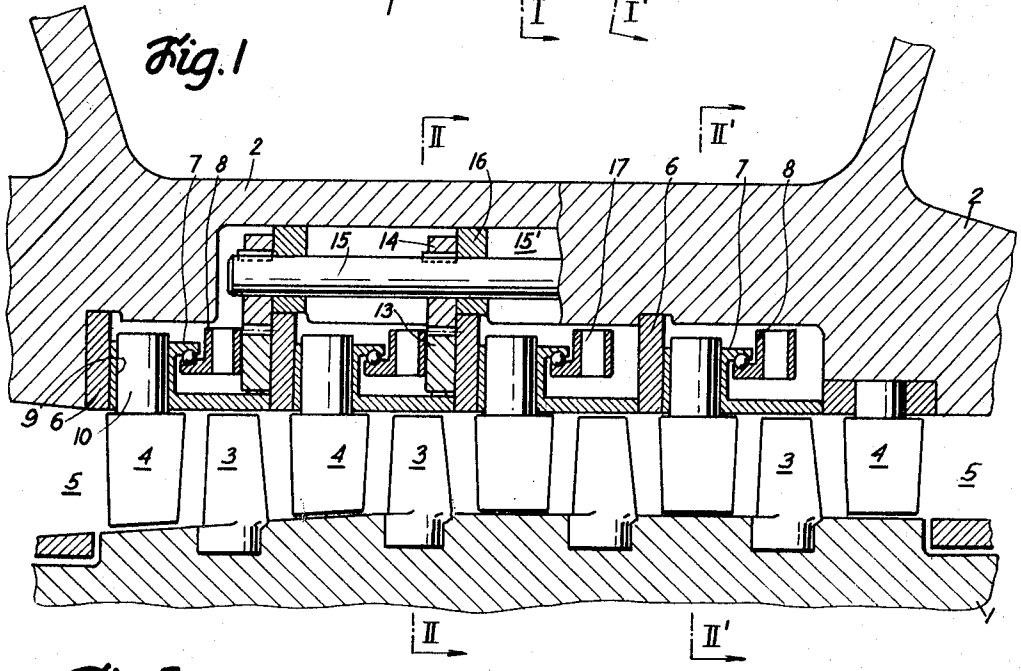
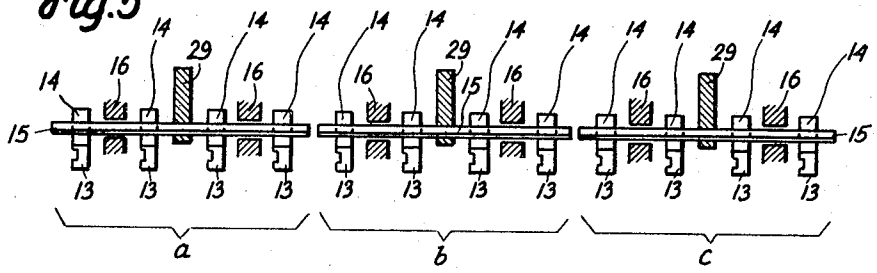


Fig. 5



INVENTOR
VACLAV KADERA, ET AL
BY
ATTORNEY

Fig.4

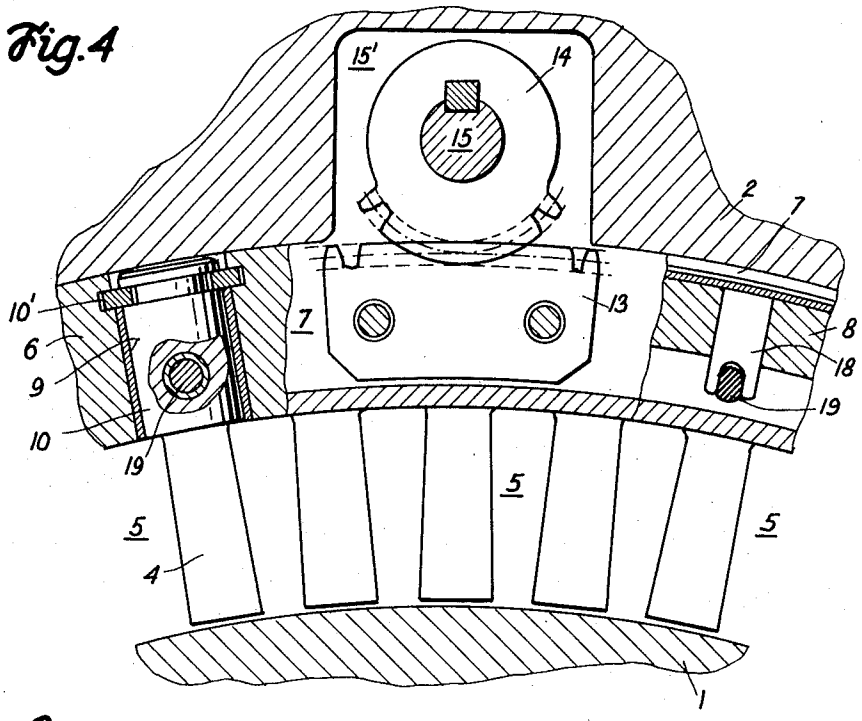


Fig.3

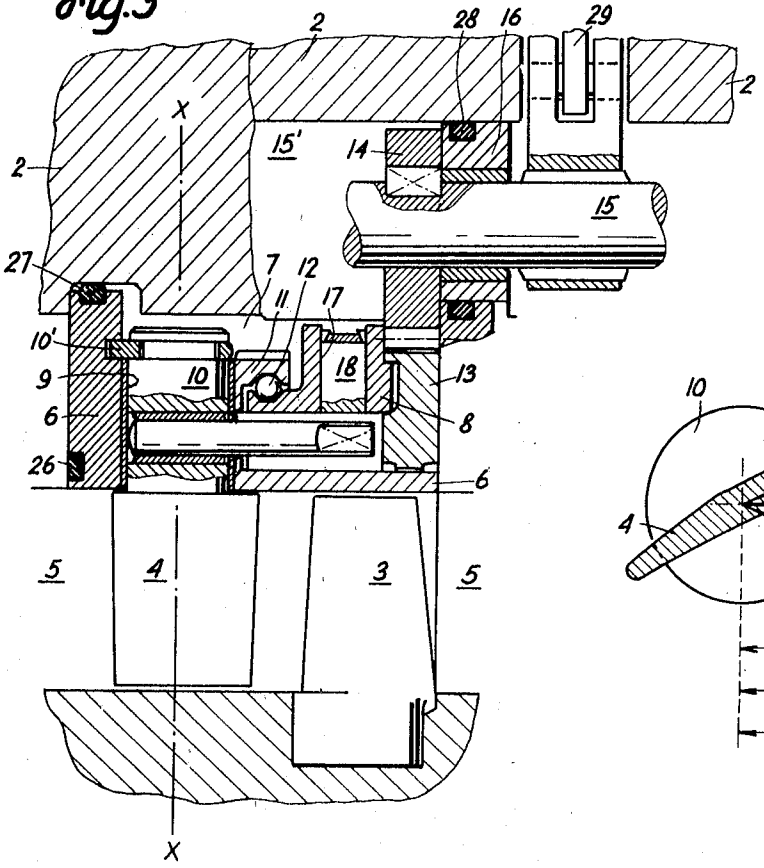
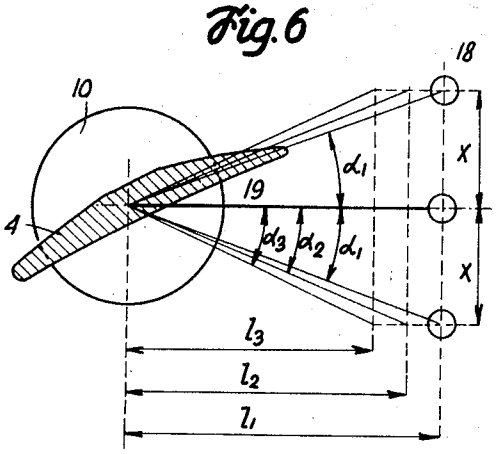


Fig.6



INVENTOR
VACLAV KADERA, et al
BY
Murray Schaffer
ATTORNEY

MOUNTING OF STATOR BLADES IN AXIAL COMPRESSORS

This invention relates to an axial flow compressor and, in particular, to mechanism for mounting and adjusting the position of the stator blades.

Conventional compressors comprise a rotor and a stator spaced therefrom to form an annular axial passage. The stator and rotor both are provided with blades extending radially into the passage. The stator blades are conventionally mounted so that their pitch or angular position about its own longitudinal (or radially directed) axis may be varied. It has been the custom to provide a control drum between the outer surface of the stator and the housing or shell of the compressor, which by appropriate linkage is connected to each of the blades. The control drum is movable either rotatably about the stator or axially therealong and when so activated adjusts to the position of the blades.

The prior art devices greatly enlarge the diameter of the compressor and add great weight to it. Furthermore, such constructions are difficult to seal and, consequently, the flow passage is open to contaminating influences and loss of gas pressure. The prior art has sought to overcome these disadvantages by the use of complex sealing and structural elements which only tend to increase size, weight and the complexity of the compressor.

It is the object of the present invention to provide apparatus for the mounting and adjustment of stator blades which overcome the aforementioned difficulties.

It is also an object of this invention to provide apparatus for mounting and adjustment of stator blades, which is simple, reduces size and weight and which is effective in eliminating loss of pressure.

It is also an object of this invention to provide apparatus for mounting and adjustment of stator blades which enhances the efficiency of the compressor and provides greater control over the supplied compressed gas.

SUMMARY OF THE INVENTION

In accordance with the present invention, the blades of the stator are mounted in circular rows in a plurality of abutting axially aligned ring-shaped members secured in a recess in the inner wall of the stator, each ring is provided with an associated second annular ring in which is located link means extending into engagement with each of the blades mounted on the first ring. The link means are arranged to swivel the blades about their axes. Means are provided for oscillating the second ring member to actuate the link means.

In a preferred form, adjacent annular rings are grouped together so that their blades may be pivoted conjointly. In this embodiment, it is also possible to vary the swivel of the blades to obtain a different degree of adjustment from row to row by varying the link means or the means for oscillating the rings.

Other features, additional objects and advantages will be seen together with a full disclosure of the invention from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following disclosure, reference is made to the accompanying drawings in which:

FIG. 1 shows a partial view of a compressor sectionalized along two longitudinal planes conforming to lines I—I and I'—I' of FIG. 2 to show the internal structure;

FIG. 2 is a cross section of the compressor of FIG. 1 sectionalized planes II—II and II'—II' to show the internal structure;

FIG. 3 is an enlarged detailed view of the portions shown in FIG. 2;

FIG. 4 is an enlarged detailed view of the portions shown in FIG. 1;

FIG. 5 is a schematic representation of a compressor; and

FIG. 6 is a diagrammatic view of the swivel adjustment of the blades shown in FIG. 1.

DESCRIPTION

Before turning to a detailed description of the present invention, it will be noted that the drawings and the description which follow show only those elements and features of a compressor which are necessary to understand the invention. In order to maintain the following disclosure as brief and concise as possible, an axial flow compressor is shown only schematically and in part. The general construction and operation of such apparatus is well known to those skilled in this art.

Referring now to the drawings, the compressor briefly comprises a large drum type rotor **1** having many rows of dynamically shaped blades **3** extending outwardly from it in a radial direction. The rotor **1** is surrounded by a fixed stator **2**, conventionally formed in two casing parts, and furnished with a number of rows of blades **4** similar to blades **3**, that extend inwardly between the rows of blades on the rotor **1**. When assembled, the two casing parts fit together about the rotor to form an annular passage **5**, into which the blades **3** and **4** extend and through which gas flows as it is compressed.

According to the present invention, the blades are supported in circular, axially arranged rows about the axis of the compressor. Each row comprises an annular ring support **6**, as seen in FIG. 2. A plurality of ring supports **6** are secured in abutting axial relationship within a recess **7** formed in the inner wall of the stator **2** (FIG. 1). In this manner, the blades **4** extend radially into the passage **5** in a predetermined array in association with the blades **3** of the rotor.

Each of the blades **4** are individually mounted so as to swivel about their own longitudinal axes X and are arranged in a suitable radial opening **9** in the support **6**, which has an L-shaped cross section with a horizontal or axially extending cylindrical portion (FIG. **1**) and a vertical or radial rib (FIG. **2**). Each support ring **6** is also divided into two horizontal parts to facilitate assembly of a second annular ring **8** in the space formed therebetween. The second ring **8** is coaxially aligned with the support ring **6** and is adapted to control the movement of each blade. The outer surface of each support is linear with the inner wall of the stator **2** so as to cooperate in defining the wall of passage **5**.

As seen in detail in FIG. **3**, each support **6** has a plurality of radial openings **9** into each of which is slidably fit the shank or journal end **10** of one of the blades **4**, which is retained by a ring washer **10'** located in an annular groove at its end. The contacting area between the support ring **6** and the control ring **8** is provided with corresponding grooves **11** in which ball bearings **12** or the like are situated.

The second ring **8** or control ring constitutes a part of the swivel actuating mechanism for each blade and is provided with a gear means comprising a segment **13** which is in engagement with a pinion **14** secured to the end of a shaft **15**. The shaft **15** is rotatably supported in bearings **16** in a channel **15'** formed in the body of the stator **2** (FIG. **4**).

The control ring **8** in association with each blade **4** is provided with link means for angularly positioning the blade. The ring **8** is formed with a radial bore **17** in which is secured a bolt **18** having a bifurcated or forked end, extending over an axially arranged pin **19** which extends from the sleeve **8** through the support **6** into a cross drilled hole in the shank or journaled end **10** of the blade. The engaging portions of the bifurcated bolt **18** and the pin **19** are flat and substantially rectangular as seen in FIG. **4**, so that movement of the bolt will be positively translated to the pin. It will then be apparent that on rotation of the shaft **15**, the rotary movement is translated by gear segment **13** into oscillation of the control ring **8**, which in turn causes, through bolt **18** and pin **19**, the angular adjustment of the blade **4**.

The shaft **15** may be manually activated by suitable linkages connected to the control panel or booth of the apparatus. Preferably, however, the shaft **15** is provided with a servomotor **29**, which may be remotely activated. Thus, the shaft **15** may be activated by an operator, or in response to an automatic throttle, speed or pressure control.

As will be seen from FIG. 5, it is possible to arrange some of the blades and their associated support and swivel mechanisms for joint activation by a common shaft **15**. Thus, axial groups of rings **6** and **8** such as *a*, *b* and *c* can be formed, each having a series of adjacent gear segments **13** joined to the common shaft. It is also possible to further vary the degree of swivel or angular movement of the blades **4**, as seen in FIG. **6**. This latter effect may be accomplished by forming the pins **19** to have one length (i.e., l_1) in one circular row of blades, and different lengths (i.e., l_1, l_2 and l_3) in different circular rows. Consequently, it is possible to obtain various magnitudes of angular adjustment (i.e., $\alpha 1$, $\alpha 2$, $\alpha 3$) in each row or in each section. A similar effect can be obtained by varying the gear ratio of segment **13** and pinion **14** of selected rings **8**.

The supports **6** divide the entire length of the recess **7** into a series of partial ring shaped chambers sealed one from another by rubber O-rings **26** and **27** located in suitable grooves on the front wall and the outer edge respectively of the rib of support **6**. In addition, sealing rings **28** are provided about the bearings **16** of the shaft **15**. These sealing means, prevent the escape of air from within the passage **5** even though the interior of the support **6** and sleeve **8** are open to it. Because the support and sleeve are open to the passage **5**, the gas pressure within these members is equal to that in the passage so that swinging of the blade **4** is not effected by it.

The support **6** with stator blades **4**, the control sleeve **8** and shaft **15**, etc. form an aggregate stator grid unit. Each grid unit may be made with varying or different parameters so that their arrangement about the stator can be predetermined and preselected to suit certain selected and desired operating criteria. As for example, certain blades may be made to swing or swivel on manual command, while others may be made to move as a function of the degree of gas compression and certain blades may be caused to swing in one direction while others swing in another.

It will therefore be apparent from the foregoing that simple effective means are provided for mounting stator blades for swinging or swiveling movement about their own axes. Operatively, all that is necessary is the activation of the servomotor **29** for a predetermined time and as a result, the blade will be caused to swing about a prescribed arc.

It will also be seen that the construction does not increase the size or weight of the compressor but utilizes the structure of the stator itself to house the swivel adjustment mechanism. Furthermore, the form of the rings effectively seals the flow passage preventing loss of power and contamination of the gas. Further, the rings provide a smooth inner surface for the gas flow.

Various modifications and changes may be made to the constructional details. Accordingly, it is intended that this disclosure be illustrative only and not limited to the present invention.

What is claimed is:

1. Apparatus for adjusting the position of stator blades in an axial flow compressor, the stator surrounding a rotor and spaced therefrom to form an annular passage therebetween coaxial with the axis of said compressor, comprising a first annular ring secured within a recess in the inner wall of said stator, a plurality of blades extending radially into said passage, a second annular ring rotatably mounted within said first ring coaxially therewith, link means connecting each of said blades to said second ring, said link means comprises a pin extending axially into engagement with shank of said blade, and a radial bolt located in said second ring and having a bifurcated end engaging with a mating portion form on said pin, said link means arranged to swivel said blades about their longitudinal axes on rotation of said second ring, means for selectively oscillating said second ring about the axis of said compressor whereby said oscillation swivels said blad to a predetermined adjustment.

2. The apparatus according to claim **1** including a gear segment secured to said second ring, a pinion secured to an axial shaft and meshing with said segment, and motion means for selectively rotating said shaft.

3. The apparatus according to claim **2** including bearing means for rotatably supporting said second ring within said first ring.

4. Apparatus for adjusting the position of stator blades in an axial flow compressor, the stator surrounding a rotor and spaced therefrom to form an annular passage therebetween coaxial with the axis of said compressor, comprising a plurality of first annular ring members secured in abutting axial relation within a recess in the inner wall of said stator, a plurality of individual blades extending from each of said first ring members radially into said passage, each of said blades having a shank rotatably journaled in said first ring member, a second ring member rotatably mounted within each of said first ring members, each of said second ring members having in association with each of the blades of said first ring member a pin extending into axial engagement with the shank of said blade, and a bolt secured in a radial bore engaging said pin for conjoint movement therewith, gear means for oscillating each of said second ring members, means for joining selected adjacent gear means to form jointly oscillating groups of second ring members, and motive means for operating said gear means to oscillate each of said selected groups whereby said oscillation is translated into rotation of said individual blades in each group into predetermined adjustment.

5. The apparatus according to claim **4** wherein the pins associated with one of said second ring members in each group are of a predetermined length, and the pins associated with the remaining second ring member in said group are of progressively different length.

6. The apparatus according to claim **4**, wherein said gear means comprises a gear segment mounted on said second ring member and a pinion gear mounted on a shaft, said shaft being common for each of said second ring members in each associated group, said shaft being connected to said motive means.

7. The apparatus according to claim **6** wherein said motive means is a remote controlled servomotor.

8. The apparatus according to claim **6** wherein the gear means of one of said second ring members in each group has a predetermined ratio and the remaining gear means in said group has progressively differing gear ratios.

9. The apparatus according to claim **4** including seal means for sealing said rings within said recess and in relationship to each other to prevent loss of gas from said passage.

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