Nov. 14, 1967 J. A. PETRIE 3,352,537

VANE OPERATING MECHANISM FOR FLUID FLOW MACHINES

Filed Dec. 12, 1966 2 Sheets-Sheet 1

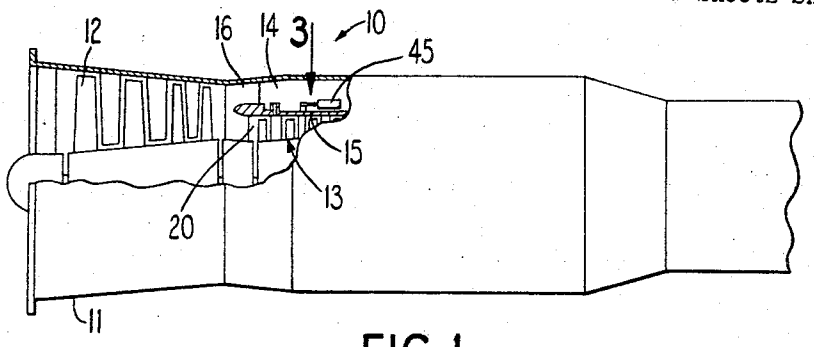


FIG. 1

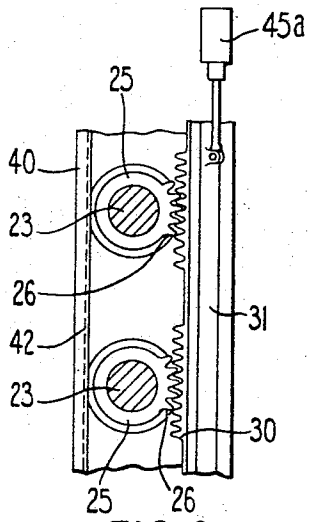


FIG. 6

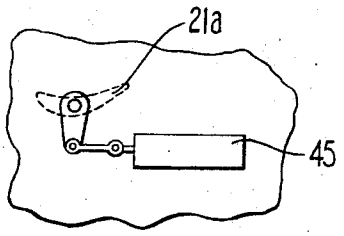


FIG. 3

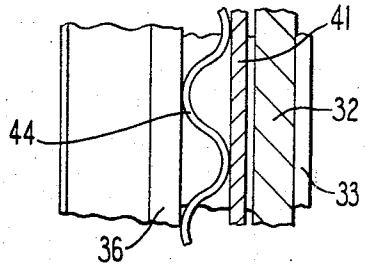


FIG. 4

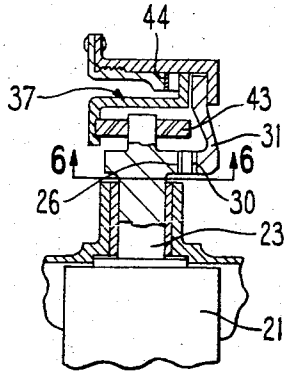


FIG. 5

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VANE OPERATING MECHANISM FOR FLUID FLOW MACHINES

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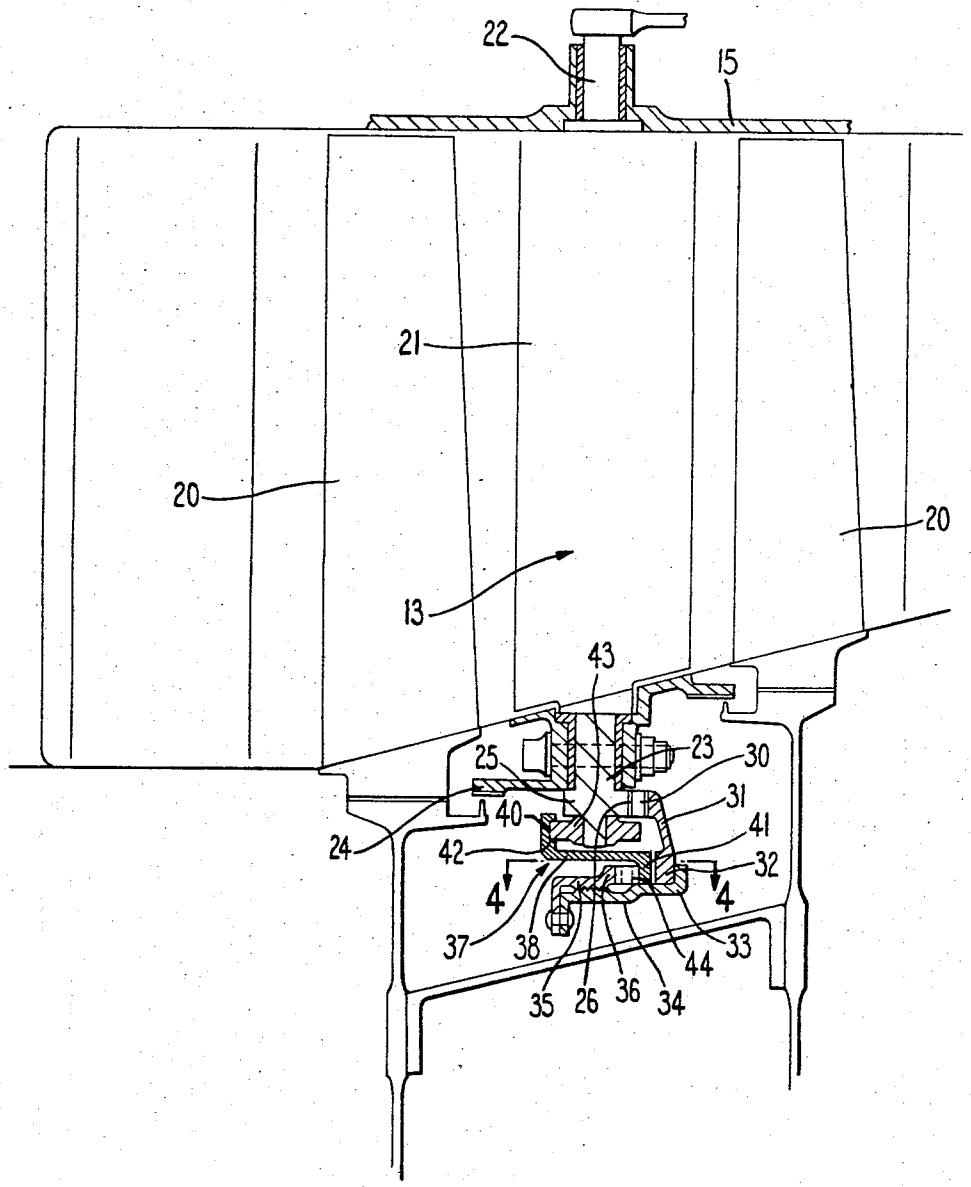


FIG. 2

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VANE OPERATING MECHANISM FOR FLUID FLOW MACHINES

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5 Claims. (Cl. 253—78)

ABSTRACT OF THE DISCLOSURE

A vane operating mechanism for fluid flow machines, such as gas turbine engines, comprising a rotatable spindle connected to each vane and having gear teeth which mesh with gear teeth on a rotatable ring, an annular spring biasing the gear teeth of the spindles in a mesh-maintaining direction, the spring bearing against a track which engages with a roller carried by each spindle, and rams for rotating the ring and thus the spindles rotation of which causing pivotal movement of the vanes.

This invention concerns a vane operating mechanism for fluid flow machines and, although the invention is not so restricted, it is more particularly concerned with a vane operating mechanism for operating variable stator vanes of a gas turbine engine.

According to the present invention, there is provided a vane operating mechanism for fluid flow machines comprising a ring which is formed on one side thereof with gear teeth means, for rotating the ring about its axis and through a predetermined angular range, a plurality of angularly spaced apart pivotally mounted vanes which are arranged about the said axis, a radially extending rotatable spindle connected to each said vane, rotation of a said spindle effecting pivotal movement of the respective vane, each spindle being provided with gear teeth which are in mesh with the gear teeth on the ring, at least one spring which urges the gear teeth of the spindles axially towards and into mesh with the gear teeth of the ring, and a track member against which said at least one spring bears, a roller being associated with and carried by each said spindle, each roller engaging the said track member.

Thus each spindle may carry a roller which engages a track member against which bears the said spring.

Both the track member and the said spring are preferably annular. Thus the track member may have an axially extending cylindrical portion, which is concentric with the said axis, and end flanges which respectively extend radially inwardly and outwardly, one of said flanges being provided with a track which engages the rollers and the other of said flanges being engaged by the annular spring.

Each spindle may be provided with gear teeth about a portion only of its periphery.

The invention also comprises a gas turbine engine provided with a vane operating mechanism as set forth above. Thus the said vanes may be variable stator vanes of a high pressure compressor of the engine.

The invention is illustrated, merely by way of example, in the accompanying diagrammatic drawings, in which:

FIGURE 1 is a view, partly in section, of a gas turbine engine provided with a vane operating mechanism in accordance with the present invention,

FIGURE 2 is a broken-away sectional view showing part of the structure of FIGURE 1 on a larger scale,

FIGURE 3 is a broken away plan view looking in the direction of the arrow 3 of FIGURE 1,

FIGURE 4 is a broken-away sectional view taken on the line 4—4 of FIGURE 2,

FIGURE 5 is a broken-away sectional view illustrating a modification, and

FIGURE 6 is a broken-away sectional view taken on the line 6—6 of FIGURE 5.

Referring first to FIGURES 1–4 of the drawings, a gas turbine by-pass engine 10 has an engine casing 11 within which there are mounted in flow series a low pressure compressor 12, a high pressure compressor 13, combustion equipment (not shown) and high pressure and low pressure turbines (not shown).

Part of the air compressed by the low pressure compressor 12 is supplied to a by-pass passage 14 which is defined between the engine casing 11 and a casing 15. The casing 15 is mounted concentrically within the engine casing 11 and its upstream end is supported by a plurality of angularly spaced apart struts 16.

The high pressure compressor 13 has a plurality of axially spaced stages of rotor blades 20 between each of which there is a plurality of angularly spaced apart pivotally mounted variable stator vanes 21 (FIGURE 2) which are arranged about the engine axis.

Each of the vanes 21 has a radially outwardly extending spindle 22, which is rotatably mounted in the casing 15, and a radially inwardly extending spindle 23 which is rotatably mounted in a casing 24.

Each of the spindles 23 has an enlarged diameter portion 25, a portion only of whose periphery is provided with bevel gear teeth 26.

The gear teeth 26 of each of the spindles 23 is in mesh with a set of bevel gear teeth 30, the various sets of gear teeth 30 being provided on the upstream side of the radially outer edge of a common ring 31 which is mounted concentrically about the engine axis, and which is rotatable about the engine axis through a predetermined angular range.

The ring 31 has a radially inner edge 32 which is located against an end flange 33 of an annular member 34. The annular member 34 is in threaded engagement with, and is riveted to, an annular member 35 which is mounted on top of the annular member 34. The annular member 35 is provided at its downstream end with a flange 36.

An annular track member 37 has an axially extending cylindrical portion 38 which is mounted radially inwardly of the spindles 23 and is concentric with the engine axis. The track member 37 has a radially outwardly extending flange 40 at its upstream end and a radially inwardly directed flange 41 at its downstream end.

The flange 40 is provided with an annular track 42. Each of the spindles 23 is provided with a roller 43 which is received partly within and which engages the track 42. The roller 43 may be made of a low friction material such, for example, as that marked under the trademark "Tufnel."

An annular spring 44 of sinuous form (see FIGURE 4) bears against both the flange 36 and the flange 41, and thus urges the vanes 21 and rings 31 relatively towards each other axially, whereby to maintain the gear teeth 26, 30 in mesh. The annular spring 44 will, moreover, hold the ring 31 firmly against vibration. The annular spring 44 also serves to take the reaction from the forces applied in turning the vanes 21.

Two diametrically oppositely disposed vanes 21, one of which is indicated at 21*a* in FIGURE 3, are respectively rotatable through a predetermined angular range by respective pneumatic or hydraulic rams 45. Thus the rotation of the diametrically oppositely disposed vanes effects rotation of the ring 31 and hence effects rotation of the spindles 23 of the remaining vanes 21.

The construction which has been described above, is subject to relatively little friction and the spindles 22, 23

can, as shown, be mounted in relatively light mountings, since they are not subjected to distorting forces.

In the arrangement of FIGURES 1–4, the structure for effecting rotation of the vanes **21** is mounted radially inwardly of the vanes. This is because the engine **10** is a by-pass engine where the space radially outwardly of the vanes is very limited.

In an engine where the space radially outwardly of the vanes is not so limited, however, the structure for effecting rotation of the vanes **21** may be mounted radially outwardly of the vanes, as shown in FIGURES 5 and 6, and the ring **31** may be rotated directly by a ram **45***a* instead of being rotated via diametrically oppositely disposed vanes. Apart, however, from these differences, there is no difference of any importance between the structure of FIGURES 5 and 6 and that of FIGURES 1–4, and it will not therefore be described further, similar reference numerals indicating like parts to those described above.

I claim:

1. A vane operating mechanism for fluid flow machines comprising a ring which is formed on one side thereof with gear teeth, means for rotating the ring about its axis and through a predetermined angular range, a plurality of angularly spaced apart pivotally mounted vanes which are arranged about the said axis, a radially extending rotatable spindle connected to each said vane, rotation of a said spindle effecting pivotal movement of the respective vane, each spindle being provided with gear teeth which are in mesh with the gear teeth on the ring, at least one spring which urges the gear teeth of the spindles axially towards and into mesh with the gear teeth of the ring, and a track member against which said at least one spring bears, a roller being associated with and carried by each said spindle, each roller engaging the said track member.

2. Vane operating mechanism as claimed in claim **1** in which both the track member and the said spring are annular.

3. Vane operating mechanism as claimed in claim **2** in which the track member has an axially extending cylindrical portion which is concentric with the said axis, and end flanges which respectively extend radially inwardly and outwardly, one of said flanges being provided with a track which engages the rollers, and the other of said flanges being engaged by the annular spring.

4. Vane operating mechanism as claimed in claim **1** in which each spindle is provided with gear teeth about a portion only of its periphery.

5. In a gas turbine engine having, in flow series, a low pressure compressor, a high pressure compressor, combustion equipment, high pressure turbine, low pressure turbine and an exhaust assembly; a plurality of stator vanes in said the high pressure compressor, said stator vanes being of variable angle of incidence; a vane operating mechanism for varying said angle of incidence of said stator vanes comprising a ring which is formed on one side thereof with gear teeth, means for rotating the ring about its axis and through a predetermined angular range, said plurality of stator vanes being angularly spaced apart and pivotally mounted about the said axis, a radially extending rotatable spindle connected to each said vane, rotation of a said spindle effecting pivotal movement of the respective vane, each spindle being provided with gear teeth which are in mesh with the gear teeth on the ring, at least one spring which urges the gear teeth of the spindles axially towards and into mesh with the gear teeth of the ring, and a track member against which said at least one spring bears, a roller being associated with and carried by each said spindle, each roller engaging the said track member.

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