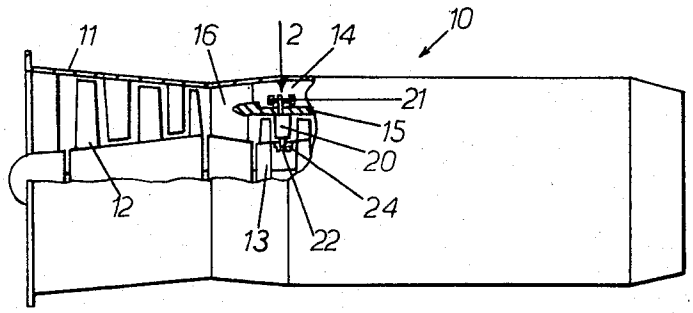
Dec. 26, 1967 D. H. WILLIAMSON ETAL 3,360,240

VANE OPERATING MECHANISM

Filed Dec. 19, 1966

FIG. 1.



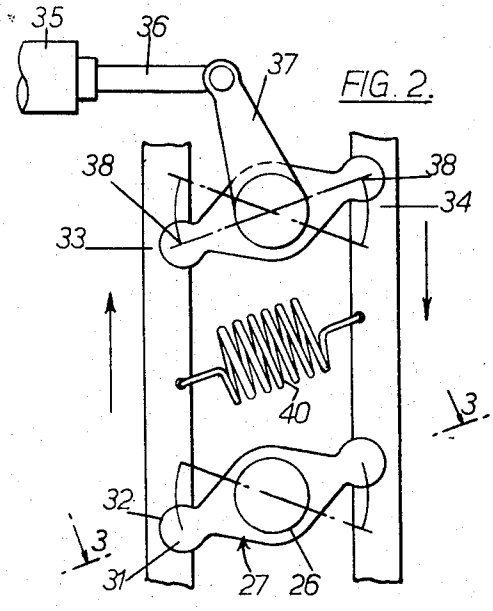


FIG. 2.

FIG. 4.

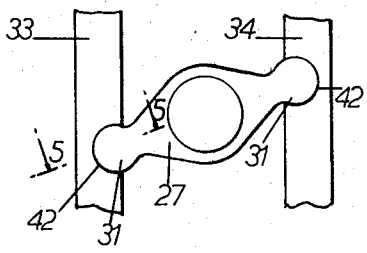


FIG. 3

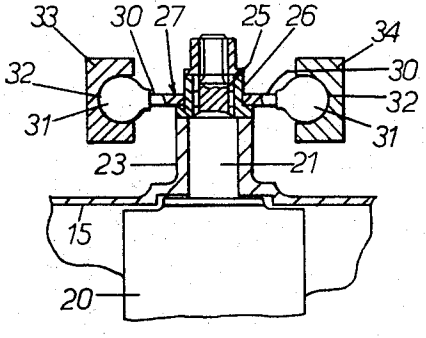
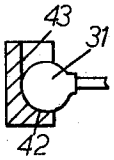


FIG. 5.



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VANE OPERATING MECHANISM

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8 Claims. (Cl. 253—78)

ABSTRACT OF THE DISCLOSURE

A vane operating mechanism having two oppositely rotated rings with levers therebetween, pivotal movement of which adjusts the positions of vanes connected to the levers.

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

According to the present invention, there is provided a vane operating mechanism comprising two axially spaced rings which are rotatable in opposite directions about a common axis, a set of angularly spaced apart vanes which are arranged about the said axis and each of which is secured to a lever pivotal movement of which effects pivotal movement of the respective vane, opposite ends of the levers being pivotally connected to the said rings, and means for simultaneously rotating the said rings in opposite directions to apply couples to the levers such as to effect pivotal movement of the vanes.

The said opposite ends of the levers may be provided with ball-shaped portions which are respectively received in part-spherical recesses in the rings.

Thus, each of the part-spherical recesses may be substantially hemi-spherical. Alternatively, each of the part-spherical recesses may be more than hemi-spherical but may be cut away to permit the introduction thereinto of the respective ball-shaped portion.

Means may be provided for urging the rings into engagement with the said opposite ends of the levers. The said means may comprise springs which also assist in urging the rings towards predetermined relative angular positions. Thus, the last-mentioned means may comprise a plurality of springs opposite ends of each of which are connected to the said ring.

A common power operated mechanism may be provided for simultaneously rotating the said rings in opposite directions.

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 compressor of the engine.

It should be understood that the term "vanes" is used in this specification in a broad sense as including blades.

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 according to the present invention,

FIGURE 2 is a broken-away plan view looking in the direction of the arrow 2 of FIGURE 1,

FIGURE 3 is a broken-away sectional view taken on the line 3—3 of FIGURE 2,

FIGURE 4 is a broken-away plan view illustrating a modification, and

FIGURE 5 is a broken-away sectional view taken on the line 5—5 of FIGURE 4.

Referring first to FIGURES 1–3 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 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 being mounted concentrically within the engine casing 11 and constituting the outer casing of the high pressure compressor 13. The upstream end of the casing 15 is supported from the engine casing 11 by a plurality of angularly spaced apart struts 16.

The high pressure compressor 13 is provided with at least one set of angularly spaced apart variable stator vanes 20 which are arranged about the engine axis. Each of the stator vanes 20 is provided at radially opposite ends thereof with spindles 21, 22. Each of the spindles 21 is rotatably mounted in bearing structure 23 (FIGURE 3) forming part of the casing 15, and each of the spindles 22 is rotatably mounted in bearing structure forming part of an inner wall 24.

Each of the spindles 21 has a spigot portion 25. The radially outer end of the spigot portion 25 is threaded and extends through a collar 26 forming part of a lever 27. Thus, pivotal movement of a lever 27 effects pivotal movement of the respective stator vane 20.

Each lever 27, on opposite sides of its pivot axis, may be provided with flexible portions 30 which are relatively thin and which accommodate the flexing to which the lever 27 is subjected in operation.

The opposite ends of each of the levers 27 are provided with ball-shaped portions 31 which are respectively pivotally received in substantially hemi-spherical recesses 32 in two axially spaced rings 33, 34, the rings 33, 34 being rotatable in opposite directions about the engine axis by means of a pair of diametrically opposite disposed rams 35 (only one shown).

Each ram 35 has a rod 36 which is pivotally connected to a lever 37 which is secured to one of the spindles 21. Thus operation of the rams 35 simultaneously rotate the rings 33, 34, in opposite directions to apply couples to the levers 27 such as to effect pivotal movement of the stator vanes 20.

A plurality of angularly spaced apart springs 40 (only one shown) are provided for urging the rings 33, 34 into engagement with the ball shaped portions 31, the opposite ends of each spring 40 being connected to the rings 33, 34. The springs 40 take out the slack in the linkage between the stator vanes 20 and the rams 35 and thus tend to reduce wear due to vibration. The springs 40 may also be used to assist in urging the rings 33, 34 towards predetermined relative angular positions.

In FIGURES 4 and 5 there is shown a modification in which the ball-shaped portions 31 are received in recesses 42 in the rings 33, 34. The recesses 42, however, unlike the recesses 32, are more than hemi-spherical so as to prevent withdrawal of the ball-shaped portions 31. As shown in FIGURE 5, each of the recesses 42 has a cut away portion 43 to permit the introduction of the ball-shaped portion 31.

Since the variable stator vanes 20 are pivotally moved by applying couples thereto, there is substantially no reaction on the pivots 21, 22, and the friction on the spindles 21, 22 is therefore reduced.

We claim:

1. A vane operating mechanism comprising: two axially spaced rings rotatable in opposite directions about a common axis; a set of angularly spaced apart vanes arranged about said axis; a lever fixedly secured to each of said vanes for effecting pivotal movement thereof; ball-shaped portions on opposite ends of each of said

levers, each of said ball-shaped portions having an axis coinciding with the longitudinal axis of the respective lever to which it is attached; part-spherical recesses in facing surfaces of said rings for rotatably receiving the respective ball-shaped portions on the opposite ends of the respective levers; and means for rotating said rings simultaneously in opposite directions to apply couples to the levers so as to effect pivotal movement of the vanes without subjecting said ball-shaped portions to a bending moment about the longitudinal axis of the levers.

2. Vane operating mechanism as claimed in claim **1** in which each of the part-spherical recesses is substantially hemi-spherical.

3. Vane operating mechanism as claimed in claim **1** in which each of the part-spherical recesses is more than hemi-spherical but is cut away to permit the introduction thereinto of the respective ball-shaped portion.

4. Vane operating mechanism as claimed in claim **1** including means urging said rings axially towards each other with their recesses engaging the ball-shaped portions on the opposite ends of the respective levers.

5. Vane operating mechanism as claimed in claim **4** in which the last-mentioned means comprises a plurality of springs opposite ends of each of which are connected to the said rings.

6. Vane operating mechanism as claimed in claim **1** comprising a common power operated mechanism for simultaneously rotating the said rings in opposite directions.

7. A gas turbine engine provided with a vane operating mechanism as claimed in claim **1**.

8. A gas turbine engine as claimed in claim **7** in which the said vanes are variable stator vanes of a compressor of the engine.

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EVERETTE A. POWELL, JR., *Primary Examiner.*