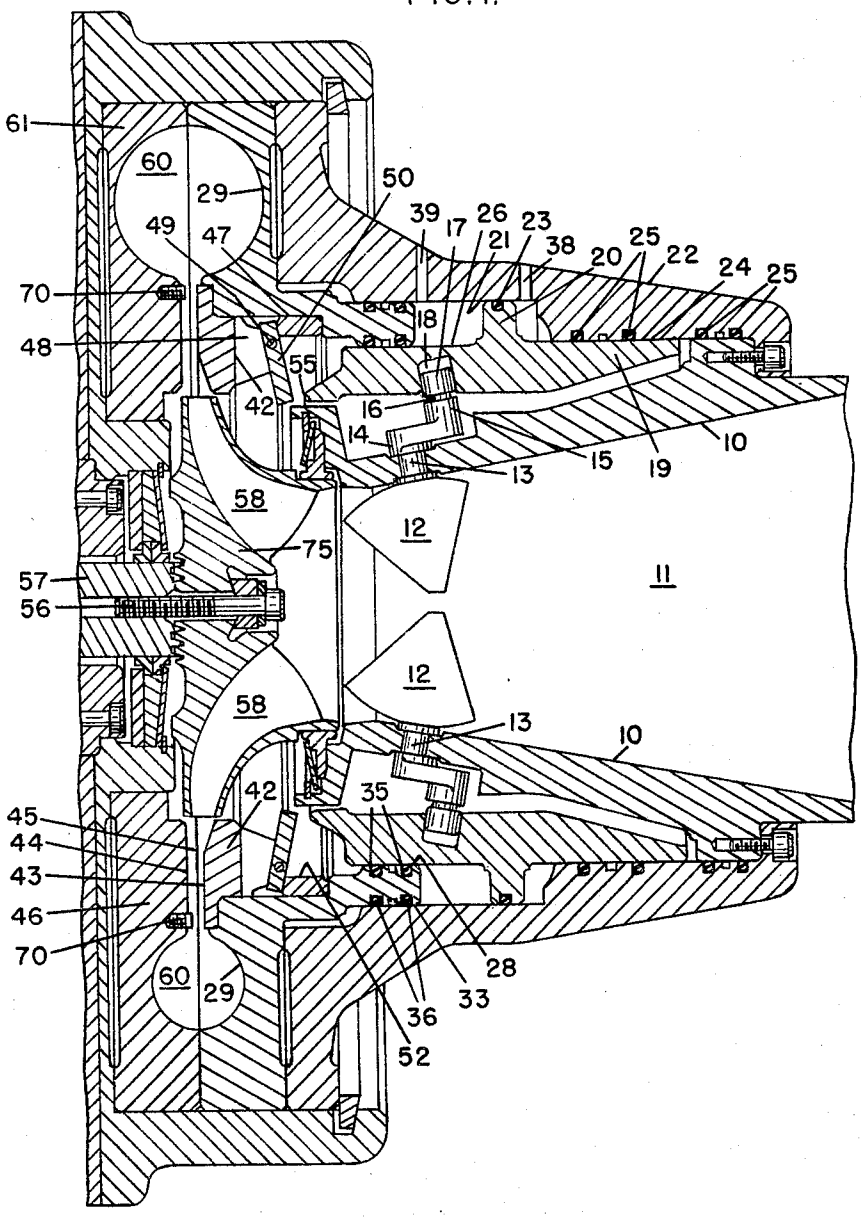
Dec. 6, 1966 G. R. WOOD 3,289,919

CENTRIFUGAL GAS COMPRESSORS

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FIG. 1.



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FIG. 2.

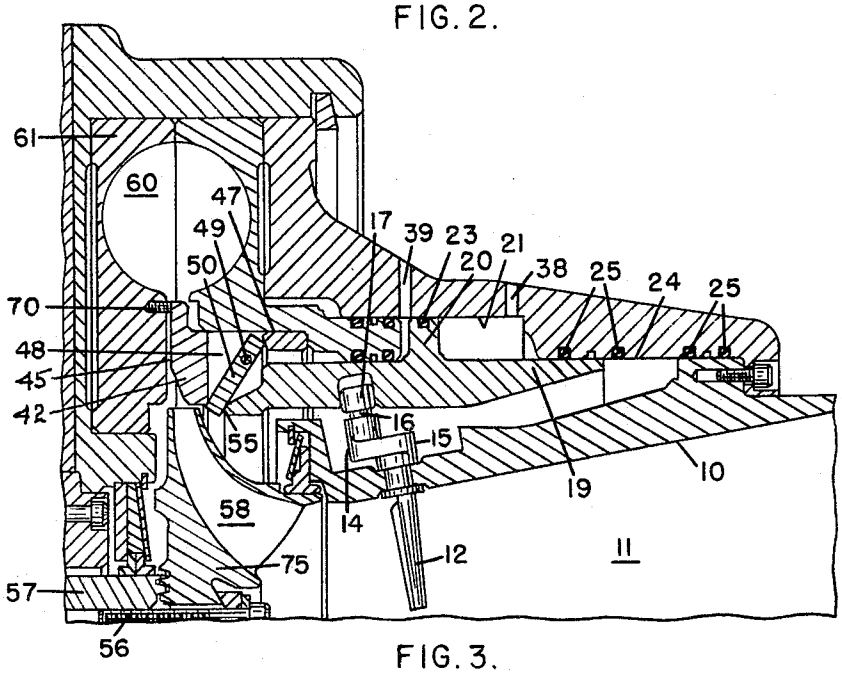
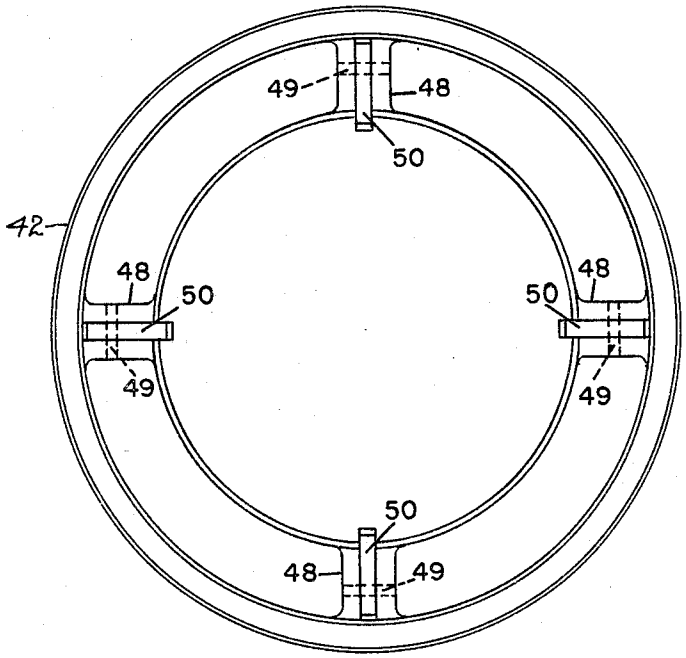


FIG. 3.



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CENTRIFUGAL GAS COMPRESSORS

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5 Claims. (Cl. 230—114)

This invention relates to centrifugal refrigerant compressors having spin inducing vanes in their inlets, and having movable diffuser walls.

Centrifugal refrigerant compressors have radially extending passages around the tips of their blades, known as "radial diffusers." Such diffusers are usually designed for maximum flow rates. The loads on the compressors may vary over a wide range, and at low loads they may be operated at such low flow rates that the diffusers are too large for efficient operation, and stall pulsations may occur, causing undesired vibrations and noise.

Adjustable spin inducing vanes are widely used in the inlets of constant speed, centrifugal compressors for adjusting their outputs. The advantages and methods of operation of such vanes are fully disclosed in the U.S. patents of H. F. Hagen, Nos. 1,846,863 and 1,999,413. The copending application of R. W. Wolfe and R. R. Young, Serial No. 280,606, filed May 15, 1963, now Patent No. 3,251,539, discloses how the mechanism for adjusting the spin inducing vanes of a centrifugal refrigerant compressor can be used to move an outer wall of a radial diffuser towards an opposite fixed wall of the diffuser for automatically decreasing the width of the diffuser when the vanes are adjusted towards closed positions. The inner end of an annular piston which adjusts the spin vanes directly contacts a ring which is in contact with the movable wall of a diffuser when the vanes are near closed positions, and the width of the diffuser is decreased in direct proportion to the movement of the piston as it adjusts the vanes further towards fully closed positions.

My invention is an improvement on that of the Wolfe-Young application in that it provides a leverage system between the inner end of such a piston and the movable wall of such a diffuser for reducing the rate of movement of the movable wall of the diffuser towards its fixed wall below that of the piston which causes such movement. In one embodiment of my invention, the inner end of an annular piston contacts ends of levers after the piston has been moved a predeermined distance inwardly. The levers are pivoted to the movable diffuser wall with their other ends in contact with a fixed surface. When the piston is moved further inwardly, the levers are caused to move the movable wall inwardly. The levers have such ratios that the rate of inward movement of the movable wall is less than that of the piston after the piston has started the inward movement of the movable wall. Thus, the width of the diffuser is adjusted in accordance with flow rates in the intermediate and lower ranges of the flow rates, increasing efficiency, and reducing the tendency for occurrence of stall pulsations.

An object of my invention is to improve means used in centrifugal compressors for automatically reducing the widths of radial diffusers when spin vanes are adjusted towards closed positions.

My invention will now be described with reference to the annexed drawings, of which:

FIG. 1 is a side section of a compressor embodying my invention, with its spin vanes shown in fully open positions, and the radial diffuser in its widest position;

FIG. 2 is a view similar to the upper half of FIG. 1 except that the spin vanes are shown in almost fully closed positions, and the diffuser in its narrowest position, and

FIG. 3 is an end view of the movable diffuser wall

with its pivoted levers, with the levers in the positions shown by FIG. 1.

The compressor has a wall 10 around a converging inlet passage 11. Spin vanes 12, only two of which are shown by FIG. 1, are supported for rotation within the inner end portion of the passage 11 by pivot rods 13 which are journalled for rotation within openings in the wall 10. The rods 13 are attached to inner ends of arms 14, the outer ends of which have hub portions 15 in which are journalled pins 16 having rollers 17 in annular slot 18 in the inner surface of annular piston 19. The piston 19 has an outwardly projecting portion 20 having an outer surface in slidable contact with cylindrical inner surface 21 of compressor wall 22 which extends around the inner portion of the wall 10. The piston portion 20 has a seal ring 23 in contact with the surface 21. The piston 19 has a cylindrical surface to the right of its portion 20 in slidable contact with cylindrical inner surface 24 of the wall 22, with the surface 24 containing seal rings 25. The piston 19 has a cylindrical surface 26 to the left of its portion 20 in slidable contact with cylindrical inner surface 28 of compressor wall 29, the surface 28 containing seal rings 35. The wall 29 has an outer cylindrical surface 33 in contact with the surface 21. The surface 33 contains seal rings 36.

The wall 22 has a passage 38 for the supply of fluid under pressure against the left side of the piston portion 20, and has a passage 39 for the supply of fluid under pressure against the right side of the piston portion 20.

A ring 42 is movable outer wall of radial diffuser 45, and has an inner surface 43 forming the outer surface of the diffuser, the inner surface of which is formed by outer surface 44 of compressor wall 46. The ring 42 has a cylindrical outer portion in slidable contact with cylindrical inner surface 47 of the wall 29. The ring 42 has four, equally spaced apart, outwardly projecting portions 48 to which are pivoted by pins 49, levers 50. The levers 50 have at the outer sides of the pins 49, short lengths, with their outer ends in contact with the inner, substantially radially extending surface of ring 52 which is press fitted to the wall 29. The levers 50 have long lengths at the inner sides of the pins 49, the inner ends of which are adapted to be contacted by and moved axially inwardly by inner end 55 of the piston 19 when the latter is moved inwardly as will be described later.

A conventional rotor 75 attached by bolt 56 to shaft 57, has the usual blades 58 which discharge into the inner end of the radial diffuser 45. The usual outlet passage 60 formed between the wall 29 and another compressor wall 61 extends around the outer end of the diffuser 45. Screws 70 threaded into the wall 46 limit the innermost travel of the outer surface 43 of the diffuser 45 towards the inner surface 44 of the latter.

Operation

In operation, rotation of the blades 58 draws refrigerant gas through the passage 11 past the spin vanes 12. At a maximum load, the spin vanes 12 are in their wide open positions, and the diffuser 45 has its largest width so that the compressor operates at full capacity. The blades 58 compress the gas and supply it through the diffuser 45 and the passage 60 as usual to a condenser which is not shown.

On a reduction in load, fluid under pressure from a conventional source which is not shown, is supplied through the passage 38 against the right side of the piston portion 20, moving the piston 19 to the left, and causing the vanes 12 to be rotated towards closed positions for inducing spin in the gas entering the inlet of the rotor 75, thereby reducing the output of the compressor as disclosed in the previously mentioned Hagen patents. When the piston 19 is moved to the left sufficiently to have adjusted the

vanes **12**, for example, to about their mid-positions, the left end **55** of the piston **19** moves against the inner ends of the levers **50**, causing through the pivoting of the latter to the ring **42**, and the contact of the outer ends of the levers **50** with the ring **52**, the ring **42** to be moved inwardly to narrow the diffuser **45**. By way of example, the travel of the piston may be 1.0", it may move 0.2" before its inner end **55** contacts the inner ends of the levers **50**, and the levers may have a 4:1 ratio. Thus, the rate of inward movement of the ring **42**, and the consequent narrowing of the diffuser **45**, is substantially less than the rate of inward movement of the piston **19** which causes such narrowing.

FIG. 2 of the drawings, shows the piston **19** in its innermost position, shows a spin vane **12** near its closed position, and shows the diffuser **45** almost closed.

Upon an increase in load, the reverse action takes place, fluid under pressure being supplied through the passage **39** against the left side of the piston portion **20**, causing the piston **19** to move to the right and to rotate the vanes **12** towards their open positions, and causing the diffuser **45** to be widened.

What is claimed is:

1. A centrifugal gas compressor having an axial inlet passage, having spin vanes supported for rotation in said passage, having a bladed rotor, having an axial diffuser around said rotor, said diffuser having a wall movable to vary the width of said diffuser, means for rotating said vanes towards closed positions, and leverage means movable by said rotating means for moving said wall to narrow said diffuser when said vanes are rotated towards closed positions at a rate less than the rate at which said vanes are rotated.

2. A centrifugal gas compressor having an axial inlet passage, having spin vanes supported for rotation in said passage, having a bladed rotor, having an axial diffuser around said rotor, said diffuser having an outer wall movable inwardly to decrease the width of said diffuser, means movable axially inwardly for rotating said vanes towards closed positions, and leverage means moved inwardly by said axially movable means for moving said wall inwardly to narrow said diffuser when said vanes are rotated towards closed positions at a rate less than the rate at which said axially movable means is moved inwardly.

3. A centrifugal gas compressor comprising a rotor having radial flow blades, said compressor having a converging wall forming an axial inlet passage to said rotor,

said compressor having movable outer and fixed inner walls forming a radial diffuser around the tips of said blades, spin vanes in said passage having pivot rods journalled for rotation in said converging wall, said compressor having another wall around said converging wall, said other wall having a cylindrical surface around and concentric with said inlet passage, an annular piston having an intermediate portion in slidable contact with said surface, said piston having surfaces on opposite sides of said portion forming with said surface of said other wall an annular cylinder passage, means for supplying fluid into the outer end of said cylinder passage against the outer side of said piston portion for moving said piston inwardly, means for supplying fluid into the inner end of said cylinder passage against the inner side of said piston portion for moving said piston outwardly, said piston having another surface radially inwardly of said piston surfaces with an annular slot therein, said pivot rods having arms extending radially therefrom, rollers in said slot journalled for rotation in the outer ends of said arms, said slot, said rollers, said arms and said pivot rods being so arranged that when said piston is moved inwardly said vanes are rotated towards closed positions, and leverage means between the inner end of said piston and said movable wall for moving said movable wall towards said fixed wall when said piston is moved inwardly at a rate less than the rate at which said piston moves inwardly.

4. A centrifugal gas compressor as claimed in claim **3** in which said inner end of said piston is spaced from said leverage means when said vanes are in wide open positions and contacts said leverage means when said piston has been moved inwardly sufficiently to have rotated said vanes partially towards closed positions.

5. A centrifugal gas compressor as claimed in claim **4** in which said leverage means comprises a plurality of levers pivoted to said movable wall, said levers having inner ends opposite said inner end of said piston, and having outer ends in contact with a fixed surface of said compressor, and in which the pivots of said levers are closer to their said outer ends than to their said inner ends.

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