March 9, 1954 H. F. HAGEN 2,671,604

MULTIPLE-STAGE, CENTRIFUGAL, REFRIGERANT COMPRESSOR

Filed Dec. 29, 1950 7 Sheets-Sheet 1

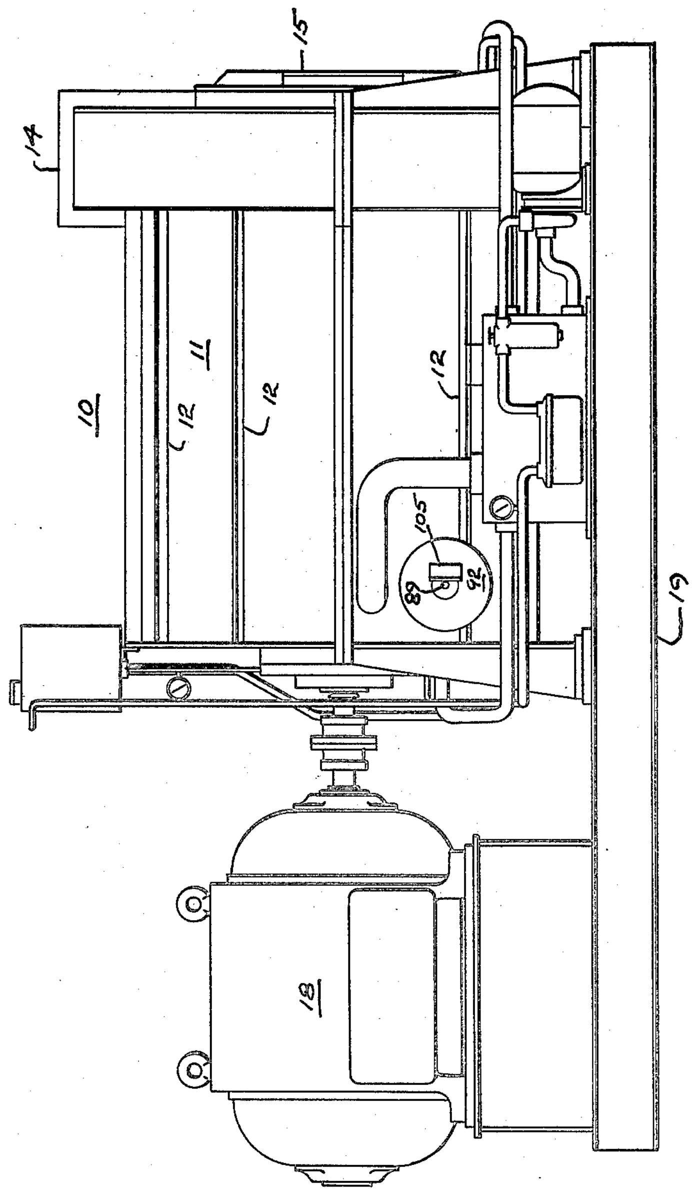

FIG. 1

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FIG. 2

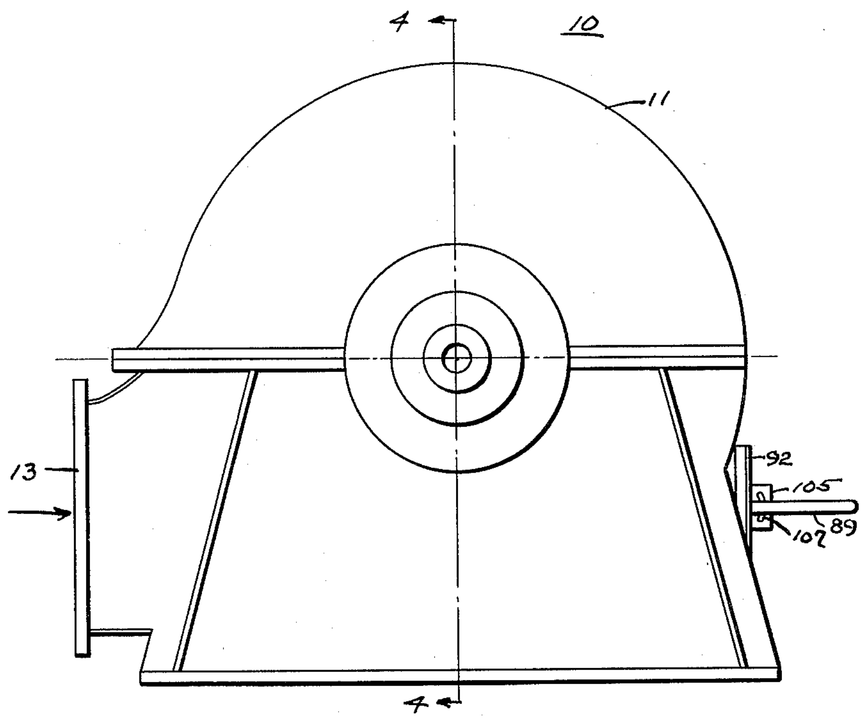

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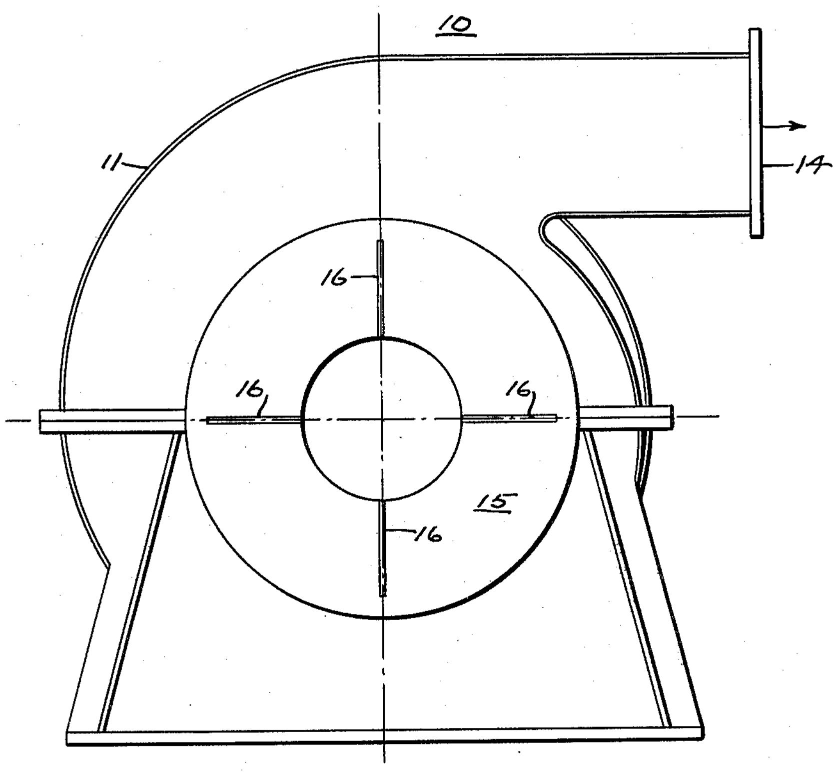
FIG. 3



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MULTIPLE-STAGE, CENTRIFUGAL, REFRIGERANT COMPRESSOR

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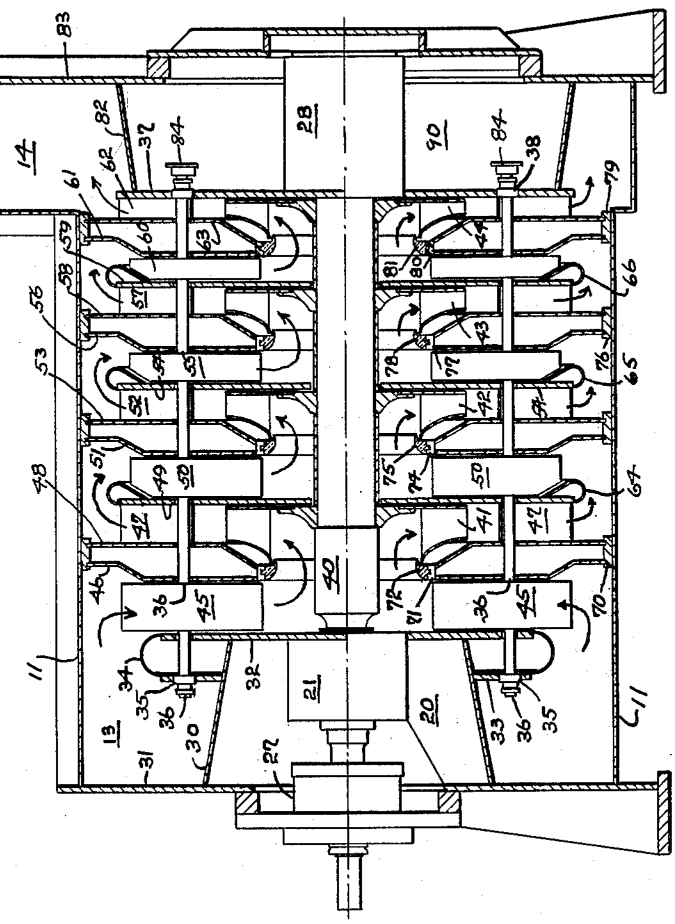
FIG. 4



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MULTIPLE-STAGE, CENTRIFUGAL, REFRIGERANT COMPRESSOR

Filed Dec. 29, 1950 7 Sheets-Sheet 5

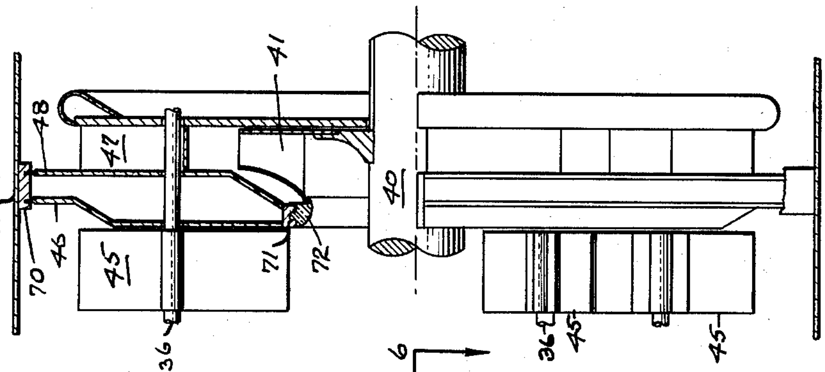

FIG. 6

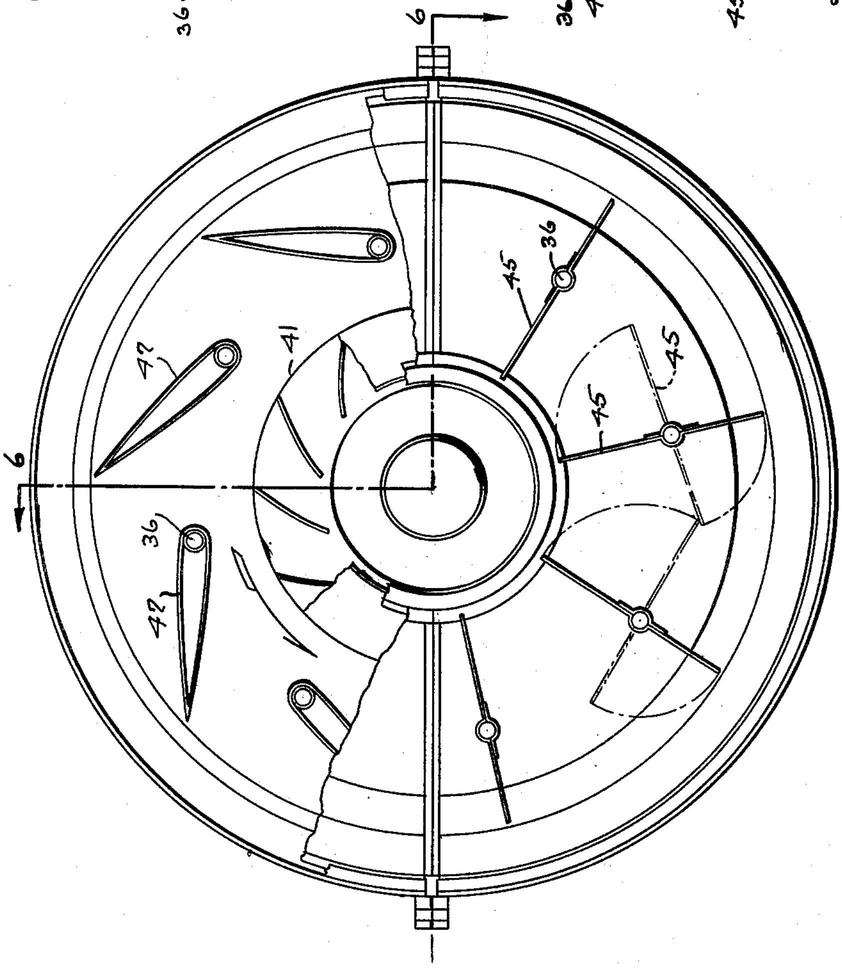

FIG. 5

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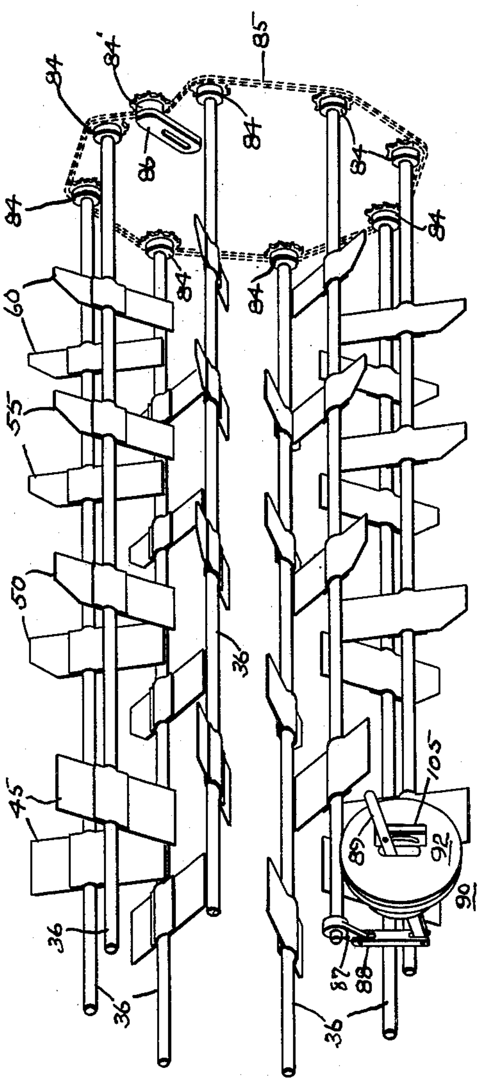

FIG. 7

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MULTIPLE-STAGE, CENTRIFUGAL, REFRIGERANT COMPRESSOR

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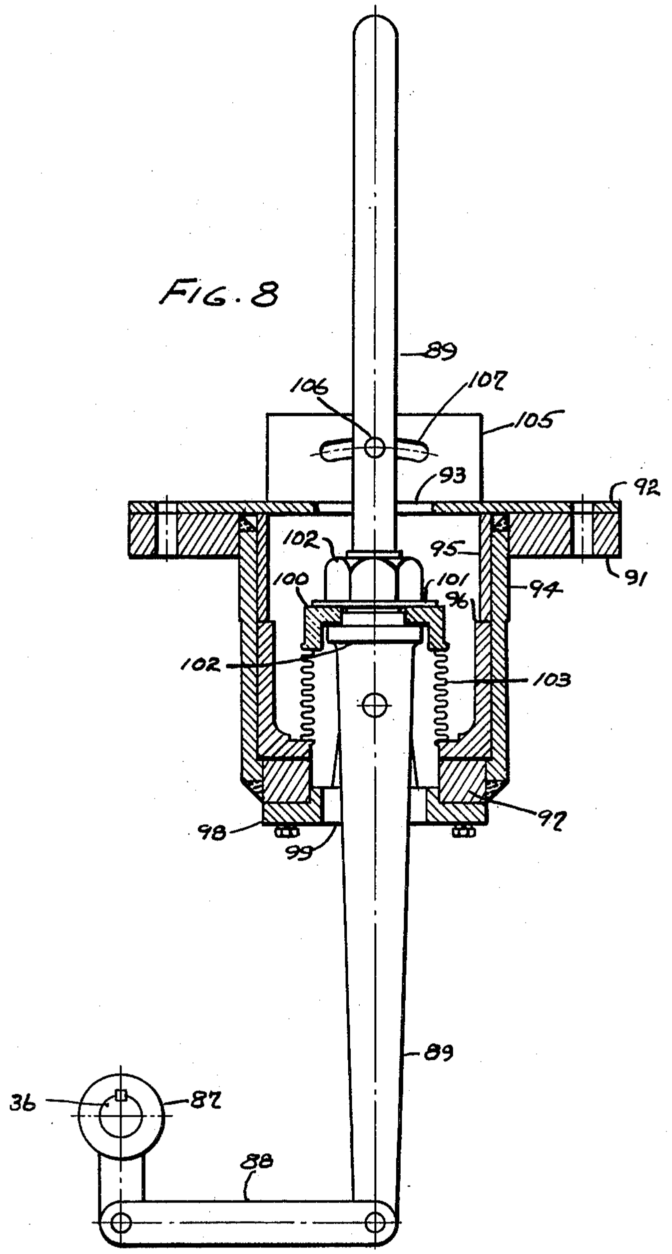
FIG. 8



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Patented Mar. 9, 1954

2,671,604

UNITED STATES PATENT OFFICE

2,671,604

MULTIPLE-STAGE, CENTRIFUGAL, REFRIGERANT COMPRESSOR

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Application December 29, 1950, Serial No. 203,316

6 Claims. (Cl. 230—114)

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This invention relates to multi-stage gas compressors, and relates more particularly to multistage, centrifugal, refrigerant compressors.

The conventional, multi-stage, centrifugal, refrigerant compressor utilizes many castings, and is relatively complex and costly. Another of its disadvantages is that it is designed for maximum efficiency at full capacity, and is substantially less efficient at reduced capacities. Refrigerant compressors used with air conditioning systems are operated at full capacity seldom, if at all, so that their inefficiencies at reduced capacities, result in unnecessarily high operating expense.

This invention reduces the cost of multi-stage, centrifugal compressors by fabricating them from sheet metal as is common in blower manufacture, and improves their efficiencies at reduced loads below full capacity by using spin inducing vanes of the type disclosed in my Patent No. 1,846,863.

An object of this invention is to reduce the cost of multi-stage, centrifugal, refrigerant compressors.

Another object of the invention is to increase the efficiencies of multi-stage, centrifugal, refrigerant compressors when operated at reduced loads below full capacity.

The invention will now be described with reference to the drawing, of which:

Fig. 1 is a side elevation of a centrifugal compressor embodying this invention, and of the electric motor for driving same;

Fig. 2 is an end elevation of the compressor looking into its inlet end;

Fig. 3 is an end elevation of the compressor looking into its outlet end;

Fig. 4 is a sectional view along the lines 4—4 of Fig. 2;

Fig. 5 is an end view looking into the first stage of the compressor, which is a typical stage except for dimensions of its components;

Fig. 6 is a view, partially in section, along the lines 6—6 of Fig. 5;

Fig. 7 is a perspective view of the spin inducing vanes, their adjusting mechanism, and of the diffusion vanes, and

Fig. 8 is an enlarged view of the vane adjusting lever with the seal against the leakage of refrigerant shown in section.

The compressor 10 has the cylindrical sheet metal casing 11 with the spaced, horizontally extending, stiffening braces 12 on its exterior. The casing has the flanged tangential inlet 13, and the flanged tangential outlet 14. The outlet end of the casing has the removable end plate 15 with the radial braces 16 thereon.

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The electric motor 18 for driving the compressor, is mounted, with the compressor, on the base 19.

The inlet ring 30 extends within the casing, around the conventional bearing 27 and seal 21, and contacts at one end the end wall 31 of the casing, and contacts at its other end the inlet end plate 32 which also is contacted by the inner end of the seal 21. Radially extending plates 20 support the seal and the inlet ring from the casing.

The splitter sheet 33 is attached to and extends around the inlet ring 30, and is parallel to and spaced from the end plate 32. The guide ring 34, semi-circular in section, which guides the refrigerant gas from the inlet 13 into the vanes and blading of the compressor as will be described in detail later, is attached to the outer ends of the splitter sheet and the inlet plate. The splitter sheet 33 is journalled at 35 for receiving the inner ends of the rods 36 on which the spin inducing vanes are supported as will be described later, and the outlet back plate 37 is journalled at 38, to receive the outer ends of the rods.

The shaft 40 of the compressor, has mounted thereon, the blower wheels 41, 42, 43 and 44, having axial inlets and peripheral outlets. The first stage, spin inducing vanes 45 are mounted on the rods 36 between the inlet end plate 32 and the sheet 46 which provide the gas passage into the axial inlet of the first stage blower wheel 41.

The first stage diffusion vanes 47 are mounted on the rods 36 between the sheet 48 and the stationary back plate 49 which provide the outlet passage from the wheel 41.

The second stage, spin inducing vanes 50 are mounted on the rods 36 between the back plate 49 and the sheet 51 which provide the inlet passage into the axial inlet of the second stage wheel 42.

The second stage diffusion vanes 52 are mounted on the rods 36 between the sheet 53 and the stationary back plate 54 which provide the outlet passage from the wheel 42.

The third stage, spin inducing vanes 55 are mounted on the rods 36 between the back plate 54 and the sheet 56 which provide the gas passage into the axial inlet of the third stage wheel 43.

The third stage, diffusion vanes 57 are mounted on the rods 36 between the sheet 58 and the stationary back plate 59 which provide the outlet passage from the wheel 43.

The fourth stage spin inducing vanes 60 are mounted on the rods 36 between the back plate 59 and the sheet 61 which provide the gas passage into the axial inlet of the fourth stage wheel 44.

The fourth stage diffusion vanes 62 are mounted on the rods 36 between the sheet 63 and the outlet back plate 37 which provide the passage from the outlet of the wheel 44 into the outlet 14.

The arrows of Fig. 1 of the drawing indicate the direction of gas flow through the above described passages.

The curved guide sheets 64, 65 and 66 on the outer ends of the back plates 49, 54 and 59 respectively, provide for smooth flow from the outlets of the wheels 41, 42 and 43 respectively, into the inlet passages of the wheels 42, 43 and 44 respectively.

The outer ends of the sheets 46 and 48 are attached to the ring 70 which, in turn, is attached to the inner surface of the casing 11. The inner ends of the sheets 46 and 48 are attached to the outer sides of the ring 71, to the inner side of which, is attached the curved ring 72 which directs the gas smoothly into the inlet of the first wheel 41.

The outer ends of the sheets 51 and 53 are attached to the ring 73 which, in turn, is attached to the inner surface of the casing 11. The inner sides of the sheets 51 and 53 are attached to the outer side of the ring 74, to the inner side of which, is attached the curved ring 75 which directs the gas smoothly into the inlet of the second stage wheel 42.

The outer ends of the sheets 56 and 58 are attached to the ring 76 which, in turn, is attached to the inner surface of the casing 11. The inner ends of the rings 56 and 58 are attached to the outer side of the ring 77, to the inner side of which, is attached the curved ring 78 which directs the gas smoothly into the inlet of the third stage wheel 43.

The outer ends of the sheets 61 and 63 are attached to the ring 79 which, in turn, is attached to the inner surface of the casing 11. The inner ends of the sheets 61 and 63 are attached to the outer side of the ring 80, to the inner side of which, is attached the curved ring 81 which directs the gas smoothly into the inlet of the fourth stage wheel 44.

The rods 36 extend through the diffusion vanes 47, 52, 57 and 62, which are air-foil shaped, as illustrated by Fig. 5 of the drawing.

Since for continuity of flow, it is essential that every stage of the compressor handle the same mass of gas, the downstream wheels 42, 43 and 44 are each designed to handle a smaller volume of gas than the wheel which precedes it. This is in order to compensate for the gas density increases in the downstream stages due to pressure increases. Likewise the spin and diffusion vanes for the downstream wheels are made smaller than those for the preceding upstream wheels.

The ring 82 is attached at one end to the outlet end plate 37, and at its other end to the outlet end wall 83 of the casing, and forms an enclosure around the downstream bearing 28 and around the outer ends of the vane supporting rods 36, isolating the latter and the bearing 28 from the refrigerant in the outlet passage. Radially extending plates 90 support the bearing 28 and the ring 82 from the casing.

The outer ends of the rods 36 have the sprockets 84 thereon which mesh with chain 85. An idler sprocket 84′ also meshes with the chain and is adapted to be adjusted by the lever 86 for varying the tension of the chain.

One of the rods 36 has a lever 87 on its inner end, and which is connected by the link 88 with the inner end of the vane adjusting lever 89. Since the outer end of the lever 89 is exposed to the atmosphere while its inner end is exposed to refrigerant, a seal is provided for preventing the leakage of refrigerant. This seal consists, as best illustrated by Fig. 8 of the drawing, of a circular end plate 91 with a cover 92 thereon, the cover having a central opening 93 therein through which the lever 89 passes.

The metal tube 94 extends at one end into a central opening in the plate 91 and is welded thereto. The tube 94 has the metal tube 95 therein which contacts the cover 92 at one end and which contacts the inner end of the brass tube 96 at its other end. The other end of the tube 96 contacts a metal ring 97 which is welded to the other end of the tube 94. The metal plate 98 which has a central opening 99 therein for the passage of the lever 89 is bolted to the plate 97.

The brass tube 100 has an inwardly extending portion which is held between the washer 101 and the flange 102 on the rod 89, the nut 102 being threaded onto the rod 89 against the washer 101. The accordion type, pleated metal seal 103 has its outer end seated against and soldered to the inner end of the brass tube 100, and has its inner end seated against and soldered to an inwardly turned portion of the inner end of the brass tube 96.

The outer end of the seal 103 through being attached to the rod 89 moves with it during its adjustment, and prevents the escape of refrigerant from the casing.

The plate 105 is attached to the cover 92 and contacts one side of the lever 89 which has a pin 106 extending through a slot 107 in the plate, the ends of the slot limiting the movement of the pin and lever.

The outlet 14 of the compressor would be connected to a condenser, and its inlet 13 would be connected to an evaporator in a closed circuit as is conventional.

The motor 18 ordinarily would be an alternating current motor, the speed of which cannot be easily adjusted. Therefore, in order to provide a reduced volume of refrigerant through the compressor at a reduced load below full capacity, with a proportional reduction in power, the spin inducing vanes adjusted by the lever 49 are provided.

In operation, at maximum load the spin vanes 45, 50, 55 and 60 would be placed in the full open position shown by the full lines on Fig. 5 of the drawing, in which positions they would impart no spin to the gas.

At a reduced load, the vanes would be adjusted towards their closed positions illustrated by the dash-dot lines on Fig. 5, the degree of adjustment depending upon the degree of load reduction. When the vanes are so adjusted they impart spin to the gas entering the wheels so that the wheels do less work on the gas providing a lower gas pressure and a lower driving power. This action is explained in detail in my said patent.

The diffusion vanes at the outlets of the blower wheels serve to convert the undesired spin imparted to the gas by the rotations of the blower wheels into pressure.

It should now be apparent that a relatively inexpensive yet efficient, refrigerant compressor has been provided, and the capacity of which may be varied from the exterior thereof by spin inducing vanes in the interior thereof, without leakage of refrigerant.

While one embodiment of the invention has been described for the purpose of illustration, it should be understood that the invention is not limited to the exact apparatus and arrangement of apparatus described, as modifications thereof may be suggested by those skilled in the art without departure from the essence of the invention.

What I claim as my invention, is:

1. A refrigerant compressor comprising a casing having a tangential gas inlet at one end and a tangential gas outlet at the other end, a rotary shaft extending longitudinally within said casing between said inlet and outlet, a plurality of spaced blower wheels having axial inlets and peripheral outlets, on said shafts, means forming a gas passage from said tangential inlet into the axial inlet nearest the tangential inlet, means forming gas passages connecting the outlet of each wheel, except the one nearest said tangential outlet, with the axial inlet of each downstream wheel with respect to gas flow, spin inducing vanes pivoted in said passages, said casing extending around said wheels, said passages and said vanes, means within said casing interconnecting said vanes for simultaneous rotation about their pivots, a lever extending from the interior of said casing to the exterior thereof and connected to said means for rotating said vanes from exterior said casing, and a seal around said lever and between said lever and said casing for preventing the escape of refrigerant from the interior of said casing along said lever where it extends through said casing.

2. A compressor as claimed in claim 1 in which

the seal comprises a bellows secured at one end to the lever and at the other end to a support attached to the casing.

3. A compressor as claimed in claim 1 in which the means for rotating the vanes comprises a plurality of rotary rods attached to the vanes to which the vanes are pivoted, said rods extending parallel the shaft and having rod rotating members thereon adjacent one end of the casing, an endless member contacting all of said rotating members, and linkage connecting one of said rotating members with said lever.

4. A compressor as claimed in claim 3 in which the seal comprises a bellows secured at one end to the lever and at its other end to a support attached to the casing.

5. A compressor as claimed in claim 3 in which the rotating members are sprockets and the endless member is a chain meshed with the sprockets.

6. A compressor as claimed in claim 4 in which the rotating members are sprockets and the endless member is a chain meshed with the sprockets.

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