June 24, 1969 R. B. TOSH 3,451,614

CAPACITY CONTROL MEANS FOR ROTARY COMPRESSORS

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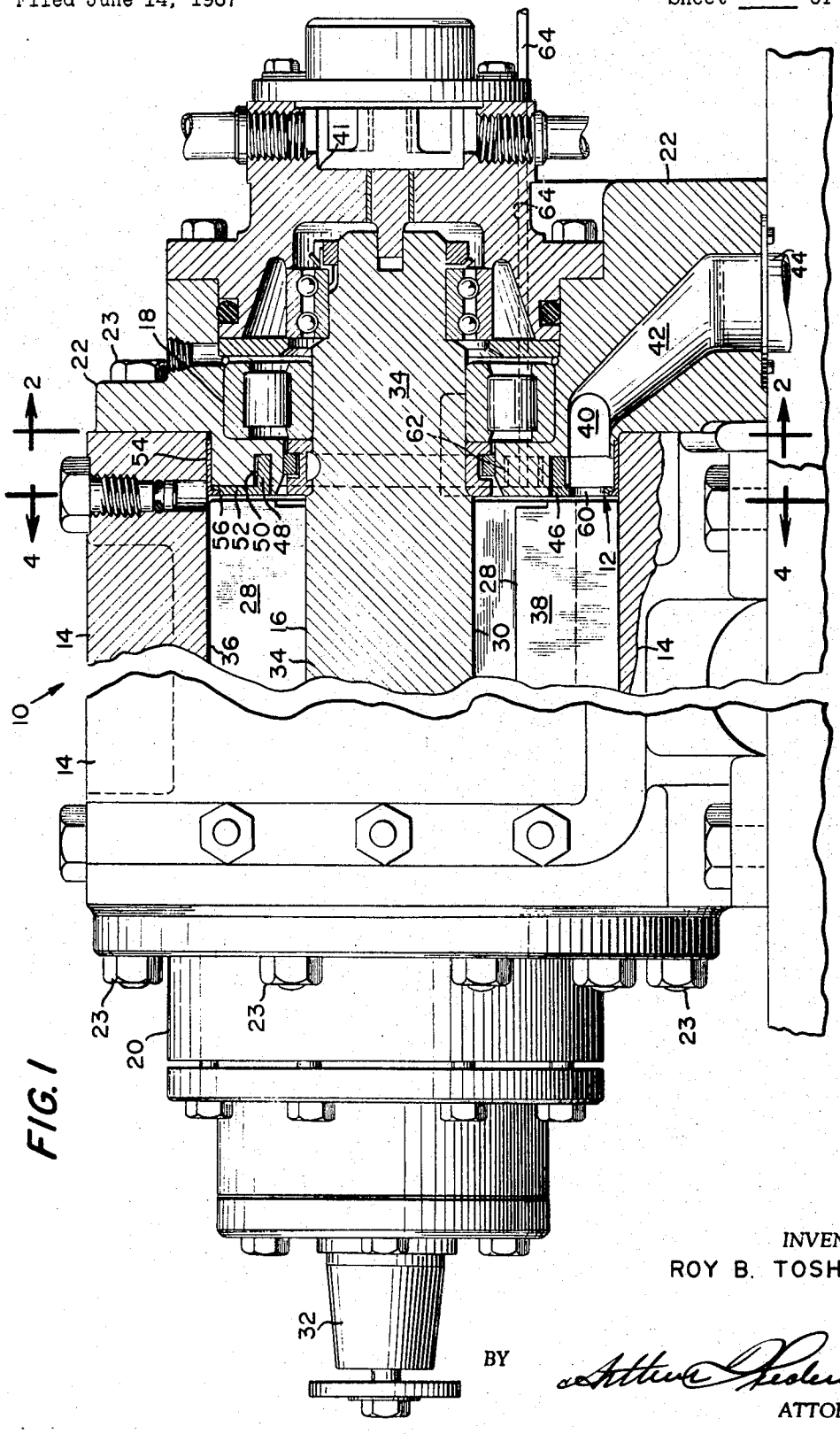


FIG. 1

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CAPACITY CONTROL MEANS FOR ROTARY COMPRESSORS

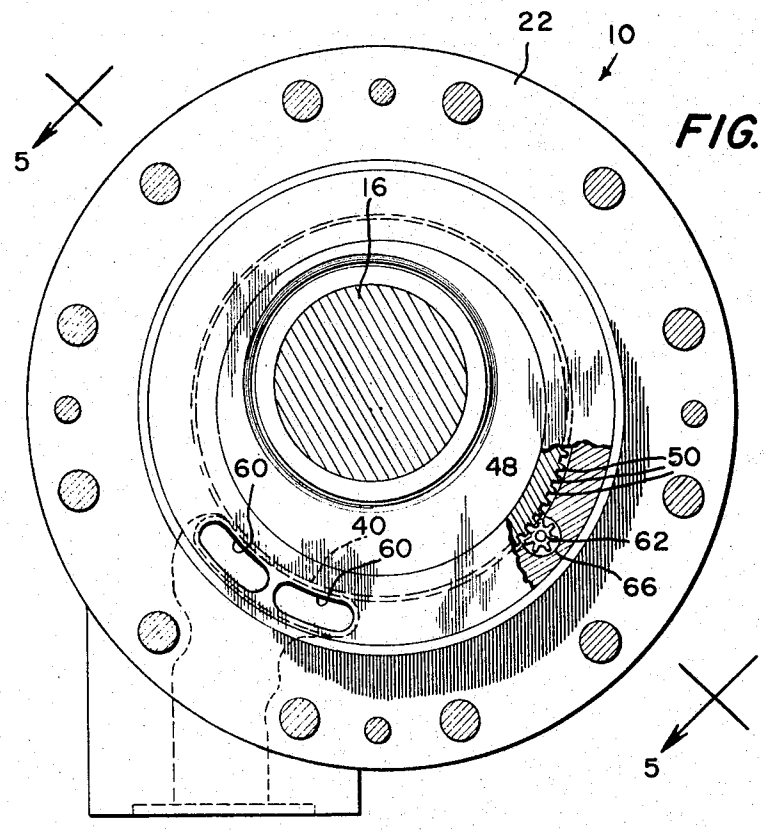


FIG.2

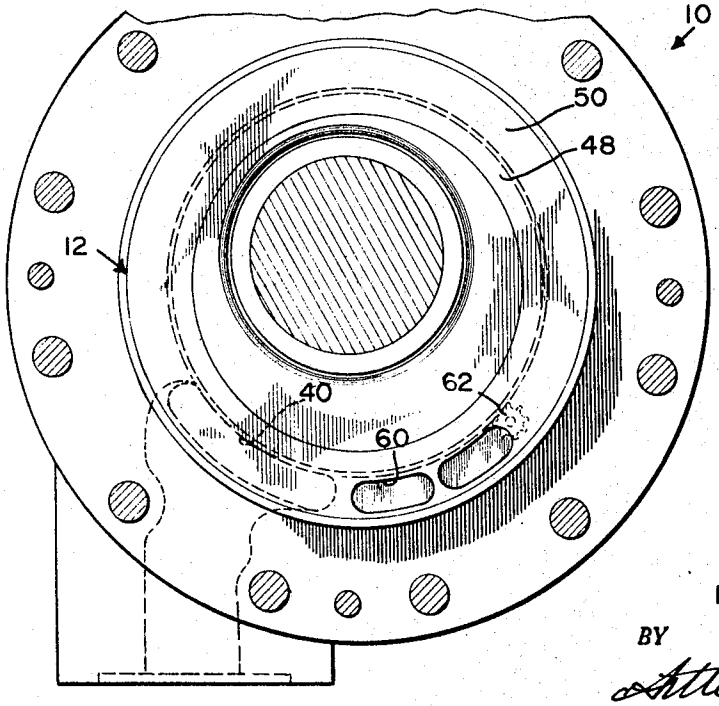
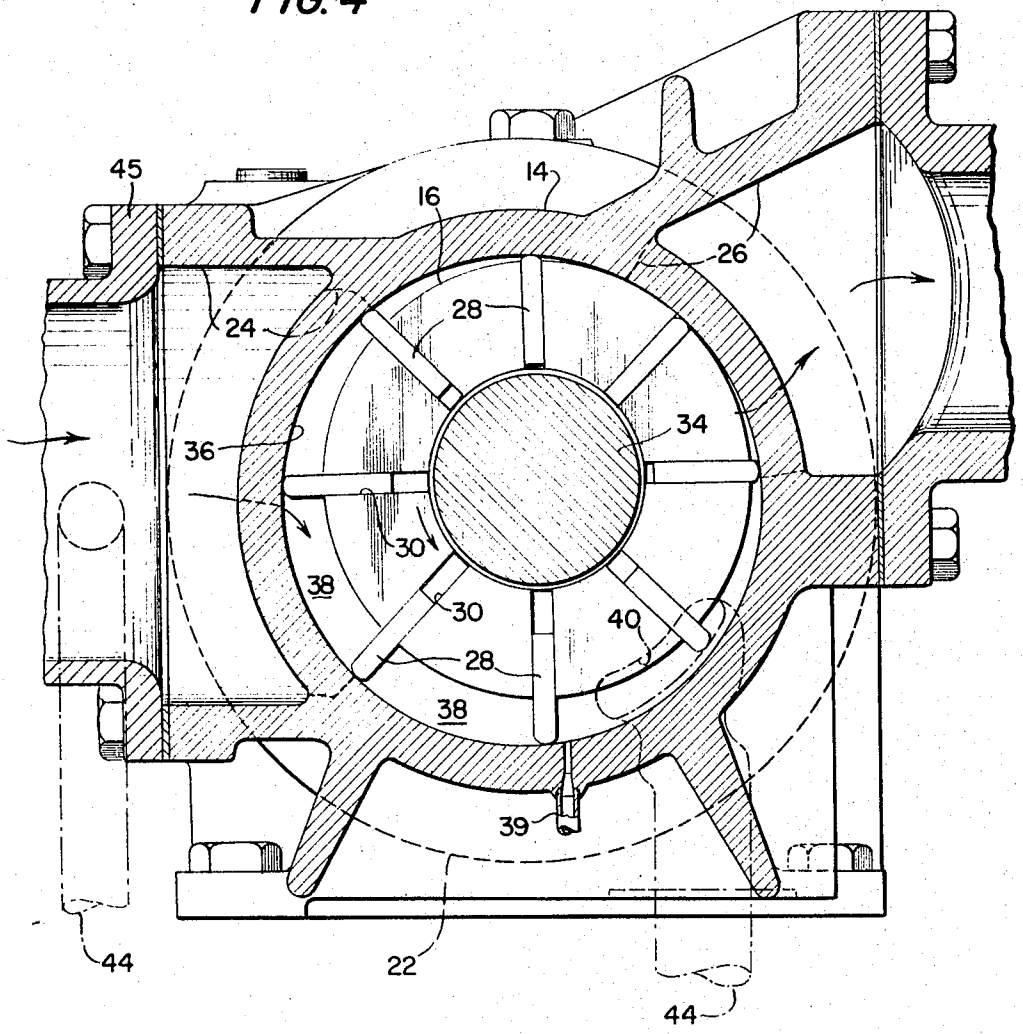


FIG.3

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CAPACITY CONTROL MEANS FOR ROTARY COMPRESSORS

FIG. 4

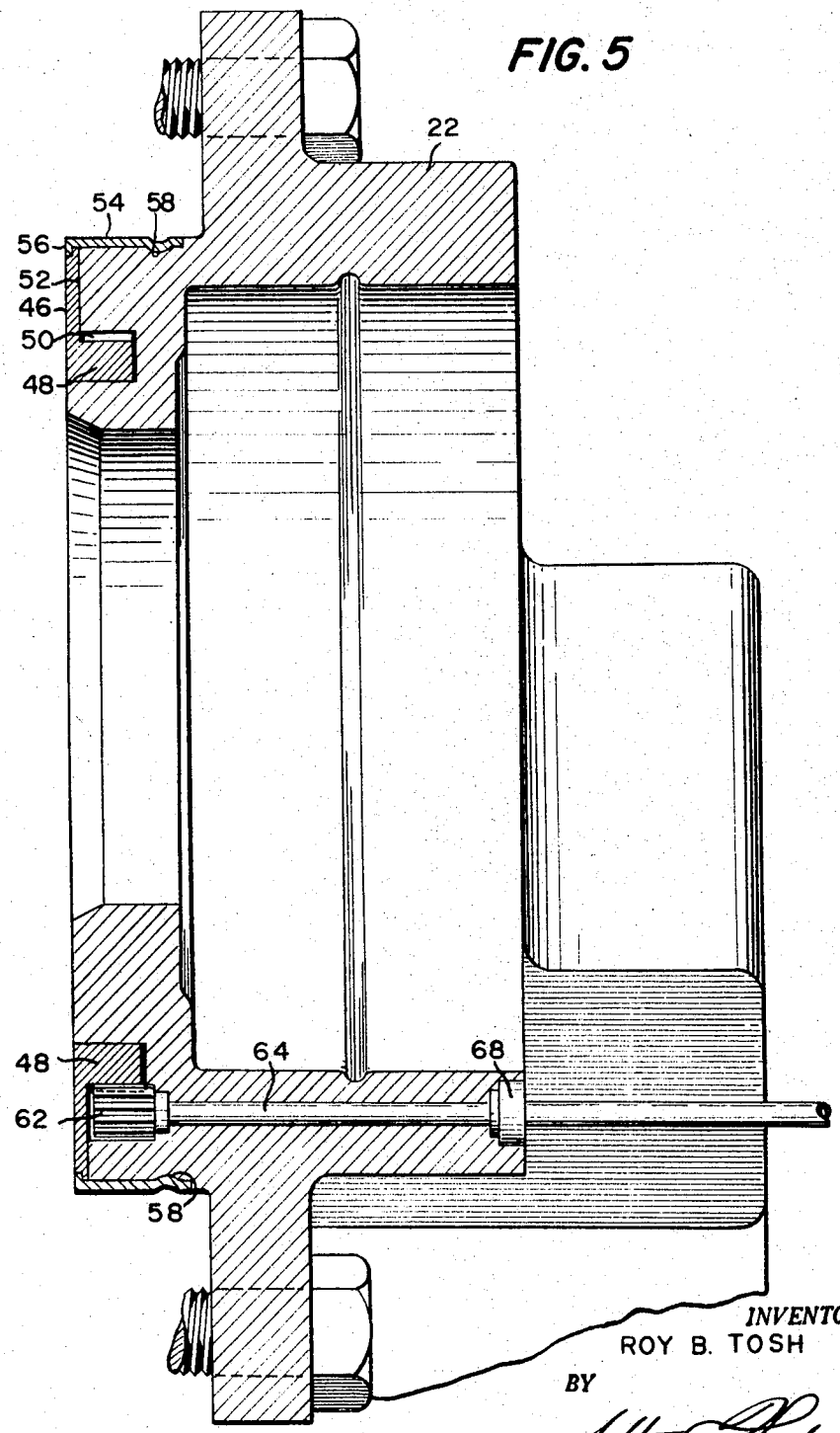


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CAPACITY CONTROL MEANS FOR ROTARY COMPRESSORS

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FIG. 5



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CAPACITY CONTROL MEANS FOR ROTARY COMPRESSORS

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U.S. Cl. 230—138 2 Claims

ABSTRACT OF THE DISCLOSURE

The capacity control device for a rotary compressor of the sliding vane type comprises a bypass port means, including a bypass conduit, in an end wall of the compressor and constructed and arranged to communicate with the fluid compression pockets formed between next adjacent vanes prior to substantial compression of the fluid trapped in such pockets and to pass the fluid from the pocket into the bypass conduit which is in communication with the compressor suction or inlet port. The device also includes a valve means consisting of an arcuate plate disposed to overlie the bypass port means and supported for rotation relative to the bypass port means to vary the area at the bypass port means and the fluid flow therethrough. The arcuate plate is connected to an actuating means which, in turn, is connected to a source of rotary power for effecting rotation thereof in response to the demand requirements on the compressor.

This invention relates to compressors and, more particularly, to rotary compressors and means for controlling the capacity of such compressors in accordance with the demand thereon.

In rotary compressors of the type comprising a barrel or housing and a rotor, carrying circumferentially spaced, sliding vanes, eccentrically supported for rotation in the barrel (hereinafter simply referred to as a rotary compressor), it has been common practice to provide a bypass means, including valve means, for communicating the compressor discharge outlet port with the suction or inlet port of the compressor to thereby recirculate all or a portion of the discharged fluid back to the inlet of the compressor in accordance with the load or demand on the compressor. This means of compressor capacity control is inefficient because the compressor is always extending the same amount of energy to compress the entire fluid capacity regardless of the demand. In other words, the compressor in less than full capacity operation is unnecessarily fully recompressing the bypassed fluid.

Another known compressor capacity control means is one which comprises plurality of spaced unloading or dumping valves, one or more of which is open for less than full capacity operation. In view of structural limitations, the number of such valves is limited so that it is not possible to obtain very accurate capacity adjustment in relation to the demand.

Accordingly, it is one of the objects of the present invention to provide an improved capacity control means for a rotary compressor, which means is more efficient, in that it effects a conservation of the power to drive the compressor, than heretofore known capacity control devices.

It is another object of this invention to provide an improved capacity control means for a rotary compressor, which means is capable of infinite steps of adjustment of capacity.

It is a further object of the present invention to provide an improved capacity control means which is relatively inexpensive to manufacture, low in maintenance cost and

desirable from the standpoint of results obtained and cost of operation.

In view of the foregoing, the present invention contemplates an improved capacity control means for a rotary compressor, which means comprises a bypass port means formed in an end wall of the compressor housing in communication with the compression pockets or working chambers formed between next adjacent vanes before substantial compression of the fluid trapped therein and a bypass conduit which communicates with the compressor inlet port. Also, a valve means is disposed adjacent the bypass port means and supported for slidable arcuate movement relative to the bypass port means to control flow of fluid, through the bypass port means, into the bypass conduit. An actuating means is constructed and arranged to engage said valve means to arcuately move the latter in response to compressor demand.

The invention will be more fully understood from the following description thereof when considered in connection with accompanying drawings in which:

FIG. 1 is a view partly in cross-section and partly in elevation of a rotary compressor having a capacity control means according to the present invention;

FIG. 2 is a transverse cross-sectional view taken substantially along line 2—2 of FIG. 1, looking in the direction of the arrows, showing the fully open position of the capacity control means;

FIG. 3 is another operative view of the parts shown in FIG. 2 showing the fully closed position of the capacity control means;

FIG. 4 is a transverse cross-sectional view taken substantially along line 4—4 of FIG. 1, looking in the direction of the arrows and with the bypass port of the capacity control means shown in dash-dot lines;

FIG. 5 is a fragmentary view in section taken along line 5—5 of FIG. 2 on a somewhat enlarged scale.

Now referring to the drawings and more particularly to FIG. 1, the reference number **10** generally designates a rotary compressor which is provided with a capacity control means, generally designated **12**, according to the present invention.

The rotary compressor **10** is of the sliding vane type and may be similar in construction to that disclosed in United States Patent No. 3,291,384. While the compressor is shown and will be hereinafter described as being of the type disclosed in the aforementioned United States patent, it is to be clearly understood that the invention is not to be construed as limited thereto. The capacity control means **12** has application to any rotary compressor of the sliding vane type without departing from the scope and spirit of this invention.

As shown in FIG. 1, rotary compressor **10** consists of a barrel or housing **14**, a rotor **16** eccentrically supported in the housing by bearings **18** disposed in end walls or bearing housings **20** and **22** secured to housing **14** by a plurality of bolts **23**. As best shown in FIG. 4, the compressor is also provided with an inlet or suction port **24** disposed in housing **14** and connected to receive fluid to be compressed and an outlet or discharge **26** disposed in housing **14** to discharge compressed fluid. Rotor **16** carries a plurality of circumferentially spaced vanes **28** which are disposed for slidable movement within grooves **30** formed in rotor **16**. The end **32** of rotor shaft **34** is connected either directly or indirectly to a suitable source of rotary power, such as an electric motor (not shown). Upon rotation of rotor **16**, the outer vane edges sweepingly engage the inner surface **36** of housing **14** while the opposite end edges slidably abut the inner surfaces of bearing housings **20** and **22**. As best shown in FIG. 4, inlet port **24** and outlet port **26** are arranged in housing **14** in relation to the eccentricity of rotor **16** so that fluid to be compressed enters into a working chamber or com-

pression pocket 38 formed between next adjacent vanes 28, by reason of the negative pressure in the pocket as the pocket expands and comes into communication with the inlet port, and is trapped therein as the trailing vane 28 passes inlet port 24, the trapped fluid being compressed upon further rotation of rotor 16 and discharged from the pocket into the outlet port 26 when the pocket comes into communication with the latter. To assist in effecting a seal at the vane edges, lubricate and assist in cooling the compressor, a lubricant is injected into the housing through the nozzle 39. An oil pump 41 is connected to the rotor shaft 34 to effect circulation of lubricant to various parts of the compressor, including nozzle 39.

Obviously, the compressor herein described must be provided with some device for regulating its capacity in relation to demand or load changes on the compressor. Since it is more economical to control compressor capacity by unloading the working chambers thereof rather than by means for effecting changes in the r.p.m. of the compressor, compressor 10 is provided with capacity control means 12, which according to the present invention functions to unload the working chambers or compression pockets 38.

The capacity control means 12 comprises a bypass port 40 formed in bearing housing 22 so as to communicate with the compression pockets 38 after the trailing vane has sealed pocket 38 but before substantial compression of the fluid trapped in the pocket. In other words, the bypass port 40 is so located that the trapped fluid is compressed sufficiently to provide a pressure differential relative to the fluid pressure in inlet port 24 to cause fluid flow to the latter, but before unnecessary compression of the fluid to be bypassed. The bypass port 40 includes a bypass passage 42 which is also formed in bearing housing 22. A conduit or pipe 44 is connected at one end to bearing housing 22 to communicate with bypass passage 42. The opposite end of pipe 44 is connected to communicate with inlet port 24 to deliver bypassed fluid to the latter through a suction manifold 45.

To control flow through bypass port 40, a valve plate 46 is disposed in abutment against the inner face of bearing housing 22 to overlie bypass port 40. The valve plate 46 is a flat ring shaped member with a hub portion 48 on which is formed a ring gear 50. As best shown in FIG. 5, the inner face of bearing housing 22 is provided with an annular recess 52 of L-shape cross-sectional configuration to receive therein valve plate 46. The recess 52 is so dimensioned that valve plate 46 is free to rotate within the recess and a flat surface is presented to the lateral edges of vanes 28. A retaining ring 54, having an inwardly projecting flange 56, is secured to bearing housing 22 so as to hold valve plate 46 for rotative movement relative to the bearing housing. The peripheral portion of valve plate 46 is recessed to receive flange 56 so that the flange and surface of valve plate 46 lie in the same plane. As shown, retaining ring 54 may be secured to the bearing housing by deforming the ring into an annular notch 58 in bearing housing 22 or by any other suitable means. The valve plate is preferably provided with two closely spaced elongated slots 60 which move into and out of registry with bypass port 40 when valve plate 46 is rotated. While two elongated slots 60 are preferred, it is contemplated that one large slot or more than two openings may be provided in valve plate 46 without deviating from the scope and spirit of the present invention.

Oscillatory movement of valve plate 46 is effected by an actuating means, including a pinion gear 62, supported for rotation on a shaft 64 in bearing housing 22. As best shown in FIGS. 2 and 5, pinion gear 62 is disposed in an arcuate recess 66, formed in bearing housing 22 to intersect recess 52, and in meshing relationship with ring gear 50 of valve plate 46. The shaft 64 is supported within bearing housing 22 by bearings 68 and is connected to a source of rotary power (not shown) which is responsive to demand on compressor 10. For example, the source of rotary power could be a rectilinear hydraulic motor connected to receive oil from the oil pump 41 and having a spring biased piston carrying a gear rack which is in mesh with a second pinion gear (not shown) mounted on shaft 64.

In operation of the capacity control means 12, herein disclosed, rotation of shaft 64 by any suitable source of rotary power (not shown) in response to demand on compressor 10, causes rotation of valve plate 46. As shown in FIG. 2, for ease in start-up of the compressor, the valve plate is positioned so that slots 60 are in full registry with bypass port 40, thereby fully unloading the compressor. To provide for full capacity operation of compressor 10, valve plate 46 is rotated so that slots 60 are completely out of registry with bypass port 40 as shown in FIG. 3. If the demand on compressor 10 decreases, valve plate 46 is rotated by pinion gear 62 to bring slots 60 into registry with bypass port 40 to the extent required to bypass sufficient fluid to cause the compressor fluid output or discharge to match the demand. Obviously, the capacity control means 12 provides an infinite step adjustment of fluid bypass to thereby accurately match compressor output to demand in response to changes in the latter.

When valve plate 46 is rotated to bring at least a portion of a slot 60 into registry with bypass port 40, the fluid escaping from pockets 38 into bypass port 40 flows into passageway 42 and, thence, into bypass pipe 44. After the fluid flows through bypass pipe 44, it discharges into inlet or suction manifold 45, which communicates with compressor suction port 24 (see FIG. 4). As best illustrated in FIG. 4, bypassing of fluid is achieved after some compression of all of the fluid trapped in pockets 38 but only enough compression to insure sufficient pressure differential between the fluid in pocket 38 and fluid pressure in suction manifold 45 to effect flow of bypassed fluid to suction manifold 45.

The compressor lubricant injected into housing 14, through nozzle 39, also lubricates the surfaces between valve plate 46 and bearing housing 22 and gears 50 and 62. The lubricant also serves to seal the interstices between valve plate 46 and bearing housing 22 to prevent fluid flow through slots 60 when the slots are completely out of register with bypass port 40 and through the portions of or all of slot 60 when the valve plate is not in the fully closed position shown in FIG. 3.

It is believed readily apparent from the foregoing disclosure that an improved capacity control means has been provided for rotary compressors which is relatively simple and inexpensive and is capable of infinite increments of adjustment to accurately match compressor output or demand. It is also a control means which effects a conservation of compressor drive power by bypassing fluid before such bypassed fluid is substantially compressed.

Although but one embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the arrangement of parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

I claim:

1. A rotary compressor having means for controlling the amount of fluid being compressed comprising a housing having a generally cylindrical bore, a pair of end caps closing the opposite ends of said housing, a valve plate rotatably mounted on one of said end caps adjacent to said bore, said housing having an inlet on one side and a discharge on the other side providing communication between the exterior of said housing and said bore, bearing means mounted within each of said end caps, a rotor carrying a plurality of circumferentially spaced sliding vanes, said rotor being eccentrically mounted within said bore and defining a generally crescent shaped chamber, said sliding vanes adapted to engage the walls

of said bore and said valve plate at one end and the other end cap at the opposite end and defining compression pockets within said chamber for receiving compressible fluid from said inlet, said one end cap having a bypass port in communication with said chamber between said inlet and said discharge on the compression side of said rotor, conduit means connecting said bypass port to said inlet, said valve plate having an opening therethrough registrable with said bypass port, and means for moving said valve plate opening into and out of registration with said bypass port in accordance with demand, whereby said valve plate can be moved so that the opening therein is in full or partial registration with said bypass port to discharge varying amounts of fluid from said compression pockets or said valve plate can be moved so that the opening therein is out of registration with said bypass port to prevent discharge of fluid from said compression pockets.

2. The structure of claim 1 in which said means for moving said valve plate includes gear and pinion means driven by a motor means.

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