

March 30, 1965

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3,175,577

RING PLATE VALVE UNIT FOR STATIONARY AIR COMPRESSORS

Filed July 3, 1962

2 Sheets-Sheet 1

FIG. 1

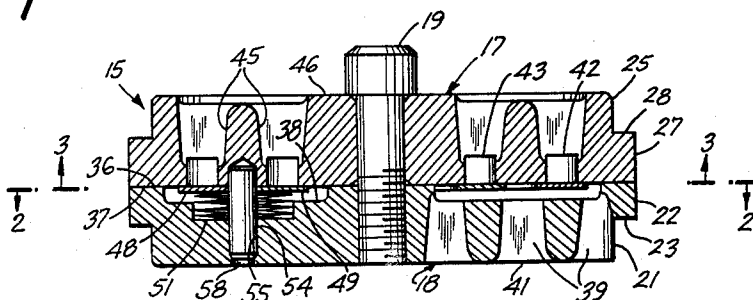


FIG. 2

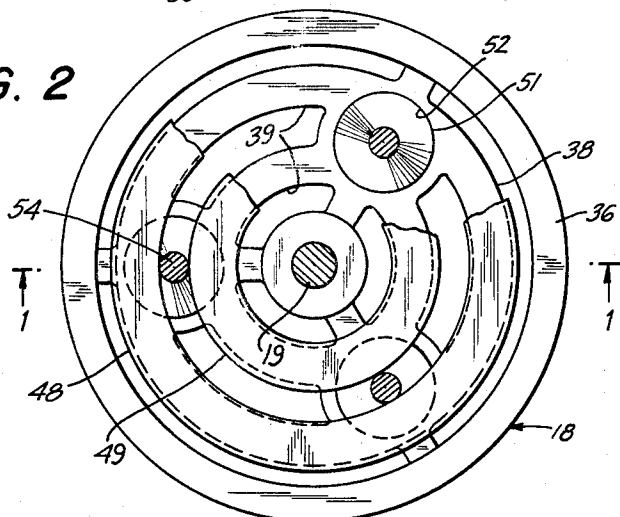
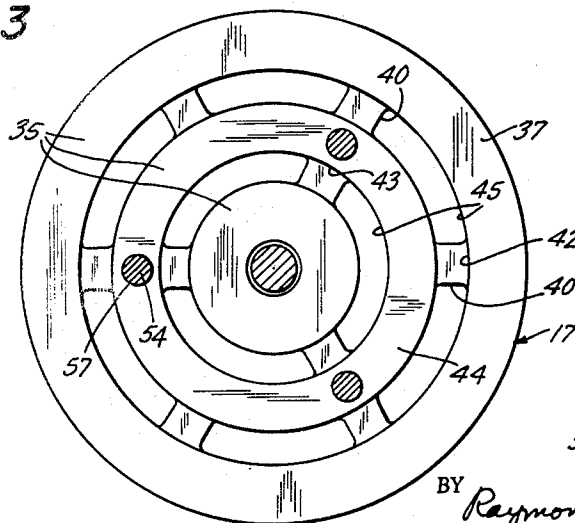


FIG. 3



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FIG. 4

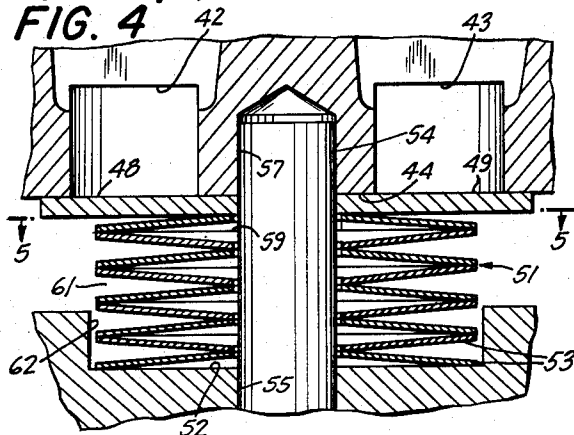


FIG. 5

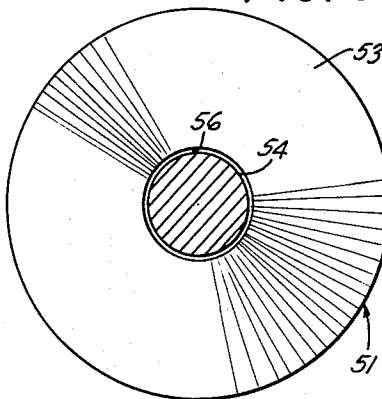
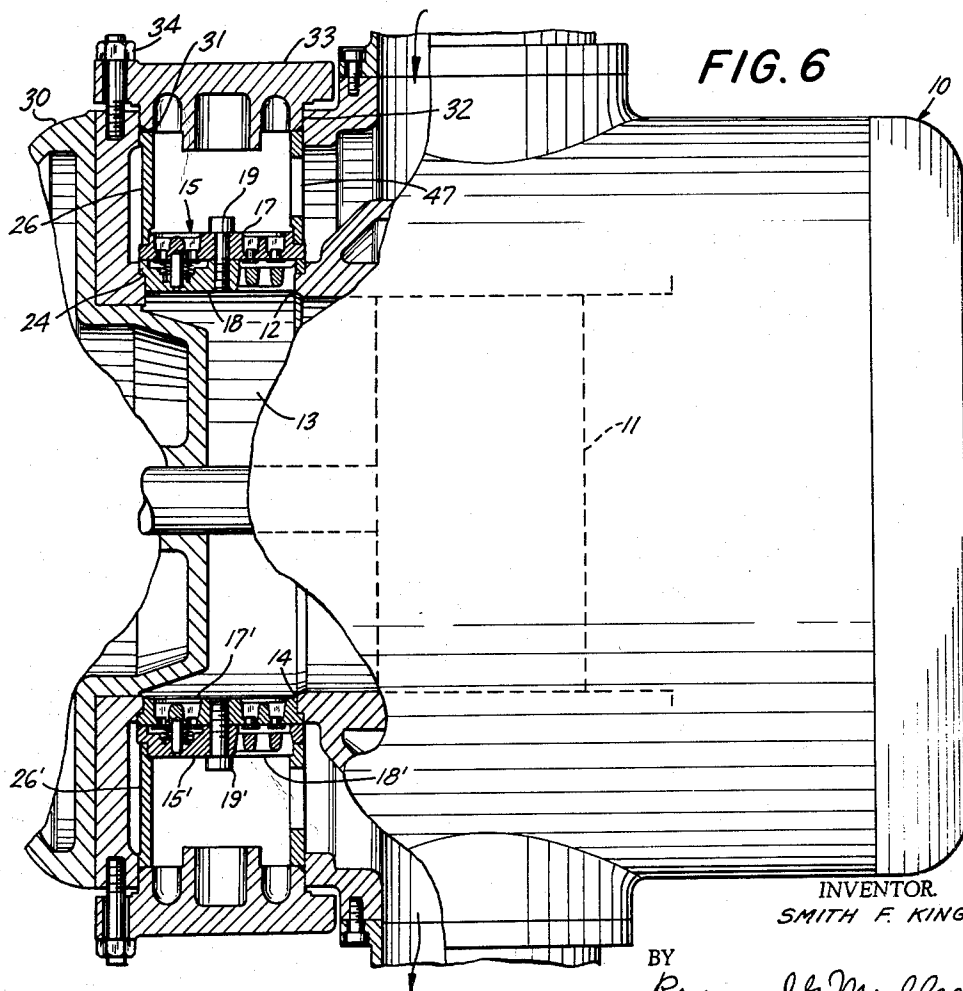


FIG. 6



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RING PLATE VALVE UNIT FOR STATIONARY
AIR COMPRESSORS

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9 Claims. (Cl. 137-512.1)

This invention relates to new and useful improvements in a ring plate valve unit intended especially for use in a stationary air compressor of the piston cylinder type.

The valve unit may be used in a discharge opening as well as in an intake opening of the piston cylinder to control air flow into and out of the latter. The valve plates in this type of unit are arranged concentrically between a seat member and a keeper member over a plurality of annular ports. The valve plates move relative to the ports accordingly as predetermined differentials in air pressure develop on opposite sides of the valve plates due to alternate suction and compression actions of the piston.

A general object of this invention is to provide in an air compressor of the piston type an improved ring plate valve unit which is practical and economical in its structure, and which is quiet and efficient in its operation.

A feature of the invention is a desirable arrangement of return springs which fluidly follow the opening and closing action of ring plate valves whereby the valves are enabled to open and close simultaneously and quietly without forcefully rebounding relative to a common seat.

A further feature of the invention is an advantageous arrangement of guide pins associated with the springs. These pins serve to guide the valve plates as well as the springs in their movements. They also control the degree of cushioning provided by the springs to the valve plates. A further advantage of the pins is that they are long lasting, subject to rotative adjustment relative to the valve plates, and are readily replaceable.

The invention further lies in its particular construction and also in the relative arrangement and cooperative association of its various components, whereby the beneficial results intended herein are obtained.

The foregoing and other objects and advantages of this invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein an embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawings are for purposes of illustration and description, and they are not to be construed as defining the limits of the invention.

In the accompanying drawings:

FIG. 1 is a cross section of a ring plate valve unit embodying the invention;

FIG. 2 is a section taken on line 2-2 of FIG. 1;

FIG. 3 is a section taken on line 3-3 of FIG. 1;

FIG. 4 is a fragmentary detail view showing a cross section through a ring pack;

FIG. 5 is a section taken on line 5-5 of FIG. 4; and

FIG. 6 illustrates the valve unit mounted in an air compressor of the piston type.

In the drawing is disclosed an air compressor 10 (FIG. 6) of the piston type. The compressor includes a piston 11 which on its forward or intake stroke causes air to be drawn through an intake opening 12 into a piston chamber 13, and which on its return or compression stroke compresses the air previously drawn into the chamber 13 and discharges it through a discharge opening 14. Seated in the intake opening 12 and controlling flow of air into the piston chamber 13 is a valve unit, generally designated 15, embodying the present invention.

The valve unit 15 includes a housing (FIGS. 1-5) of symmetrical design, comprising a circular valve seat mem-

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ber 17 and a complementary valve keeper member 18 held in face to face contact as a unit by fastening means 19.

The keeper member 18 has a reduced cylindrical end portion 21 which has a slide fit in the intake opening 12 of the compressor; the keeper member also has at its opposite end an enlarged thick flange 22 defining an annular shoulder 23 which seats upon a complementary annular shoulder 24 about the intake opening 12. The seat member 17 has a reduced cylindrical end portion 25 which is sleeved over by the lower end of a thick clamping sleeve member 26 (FIG. 6); and the seat member further has a thick annular flange 27 about its opposite end which defines an annular shoulder 28 upon which the bottom end wall of the sleeve 26 abuts. The upper peripheral marginal surface of sleeve 26 bears against the wall of an annular opening 31 of the housing 30 of the compressor 10. An annular skirt portion 32 of a clamping cover plate 33 depends with a slide fit into the opening 31 of the housing 30 and abuts against the corresponding end wall of the sleeve 26. The cover plate 33, which is tightly drawn to the housing 30 by bolts 34, acts through its skirt 32 and the sleeve 26 to clamp the valve unit 15 fast upon the shoulder 24 of the intake opening 12. The pressure exerted by the sleeve 26 upon the valve unit is uniform over the shoulder 28 of the seat member, whereby any possibility of distortion or warping occurring in the seat and keeper members is avoided. It is clear that the valve unit 15 may, when necessary, be removed for replacement through the housing opening 31 after the cover plate 33 and sleeve 26 have been removed.

The fastening means 19 is a headed screw the shank of which extends slidably through the seat member 17 and is threadedly tightened in the keeper member 18. It is to be noted in this respect that no part of the screw 19 extends into the piston chamber 13, and that the head of the screw is located externally of the piston chamber 13. This arrangement is of decided advantage in that there is no possibility of the screw becoming loose and dropping into the piston chamber to cause damage. Nor is there associated with the screw any nut element that might loosen and drop into the piston chamber.

Describing the valve unit in further detail, the keeper member 18 has an inner level face 36 which is held by means of the fastening means 19 in contact with an opposed level face 37 of the seat member. The keeper member has an annular air flow recess 38 in its face which communicates by means of a plurality of connected arcuate ports 39 through the bottom end 41 of the keeper with the piston chamber 13 (FIG. 6). Recessed in the inner face 37 of the seat member is an outer annular air flow channel 42 and an inner annular air flow channel 43. These channels are concentric, and are spaced apart by an annular portion 44 of the inner face of the seat member. The channels open out directly above the recess 38 of the keeper member. A plurality of arcuate ports 45 formed in the body of the seat member in communication with the channels 42, 43 open through the outer face 46 of the seat member, whereby intake air entering through a port 47 of the sleeve 26 of the compressor (FIG. 6) may flow through the arcuate ports 45 into the annular channels 42, 43. The arcuate ports 45 are separated from one another by radial rib portions 40.

The areas 35 of the face 37 of the seat member 17 bordering the channels 42, 43 defines a seat which is common to a pair of radially spaced concentric ring plate valve elements 48, 49. The latter control flow of air from the channels 42, 43 of the seat member into the recess 38 of the keeper member 18.

A plurality of annular spring packs 51, here three in number and spaced circumferentially 120 degrees apart, yieldably press the valves 48, 49 upon their seat closed

over the channels 42, 43. Each spring pack is seated at its lower part in a separate cylindrical well 52 formed in the bottom of the recess 38 of the keeper member and centered below the valves. Each spring pack comprises a plurality of dished or frusto-conical annular springs 53 stacked one upon the other in reverse relationship (FIGS. 1 and 4). A cylindrical guide pin 54 seated in a hole 55 axially of the bottom of each well extends closely through aligned holes 56 in the stacked springs of the related spring pack; and beyond the spring pack each pin extends between the valves 48 and 49 in bearing relation to the latter. By this arrangement, the valves and the spring packs are guided in their respective axial movements. The pins also prevent those spring members of a pack which are disposed above the well in the wider recess 38 from slipping radially relative to the valves.

As the piston 11 of the compressor reciprocates and causes differential air pressures to develop alternately over opposite faces of the valves 48, 49, the latter repeatedly move to open and closed position. In order that the valves will not move in the wider recess 38 radially in their seating relation relative to the channels 42 and 43, they are arranged to bear against the pins 54 as they open and close.

The valve elements 48, 49 are rigid, and are formed of hardened non-rustable metal, such as stainless steel. This structural nature of the valves avoids not only rusting and distortion of the valves; but also consequent undesirable valve seating. As the hard steel valves reciprocate in bearing relation to the pins 54, they tend to wear down and create consequent undesirable flats on the latter, even though the pins themselves are formed of hardened steel. To avoid any tendency of the pins to rotate relative to the moving valve elements, the pins are press fitted in their holes 55 and are thus restrained against rotation. Worn pins may be replaced or repositioned relative to the valve elements 48 and 49.

Each pin 54 is cylindrical and flat ended. It extends for a short distance beyond the valves 48, 49 into a hole 57 formed in the body of the seat member 17. These projecting ends of the pins are slidably receivable in the holes 57 of the seat member, thus enabling the latter to be readily assembled and guided in such assembly with the keeper member. Because of the extension of the pins into the seat member, the latter is also restrained against relative creeping or rotative displacement about the fastening element 19 relative to the keeper member.

Each pin hole 55 terminates in a reduced bore 58 that opens through the bottom face of the keeper member. This bore is of decided benefit. After the seat member 17 has been removed from the keeper member 18 during disassembly of the valve unit, a probe may be forcefully entered into the bore 58 against the pin 54 to dislodge the latter from the keeper for replacement or adjustment. After a pin has been knocked out of its hole, it may be replaced in the hole in an adjusted rotated position so that unworn peripheral areas of the pin may be presented to the valve elements. Accordingly, the pins may be used for a considerable length of time before it becomes necessary to replace them with new ones.

The spring packs 51 are centered by means of the pins 54 relative to the valve elements 48, 49 so as to equally underlie both of the latter. By this arrangement, each spring pack acts with equal force upon both valves, so that in a seating or expansion action of the springs both valves are caused to seat evenly and simultaneously over the corresponding channels 42 and 43. Further, in an opening action of the valves both of the latter are yieldably resisted to an equal degree by each spring pack, thus enabling both valves to simultaneously open to an equal degree.

Because of the arrangement and structure of the components of the spring packs, the latter also serve to cushion the operating action of the valves as the latter

open and close. Due to the coned shape of the springs 53 and due to their reverse relationship (FIG. 4), an inner air pocket is defined at 59 between each pair of opposed springs, and an outer air pocket 61 is defined between the outer ends of each separate pair of springs. Because of its close relation to the spring pack, the surrounding wall 62 of the well 52 substantially closes the open ends of the outer pockets 61; and the close relationship of the guide pin 54 to the wall area of the axial holes 56 of the springs substantially closes the open ends of the inner pockets 59. Because of this arrangement, during a suction or forward stroke of the piston 11 of the compressor, each spring pack is compressed as intake air forces the valves open. As the spring pack is compressed, the restricted flow of air from the inner and outer pockets 59, 61 cushions the opening action of the valves. During a compression stroke of the piston the pressurized air in the piston chamber 13 before escaping through the discharge opening 14 of the compressor, returns the valves to their seat. As the latter action occurs the spring elements of each spring pack expand and follow the closing action of the valves, the pockets 59 and 61 filling up with air as the spring elements 53 expand. In this opening and closing action of the valves each spring pack fluidly follows the axial movement of the valve elements, whereby violent opening and violent closing of the valve elements is avoided. It is clear that the circular holes or inner diameters 56 of the springs may be so dimensioned relative to the pins 54 as to allow a desired restricted flow of air about the pins and thereby obtain a desired cushioning follow up action of the springs against the valves.

The intake and discharge openings 12, 14 of the compressor unit are symmetrical. In the lower left hand portion of FIG. 6 a valve unit 15' embodying the invention is shown seated in the discharge opening 14 of the compressor, but is reversed in its position so as to control discharge of air from the compressor. This valve unit 15' is identical in structure to the valve unit 15, described above, except that the fastening screw 19' is reversed.

In this instance the valve seat member 17' is disposed on the shoulder 24' of the discharge opening 14 and the valve keeper member 18' is associated with the sleeve member 26' of the clamping means. The threaded relation of the fastening screw 19' is reversed so that the head of the screw will in this case also be outside of the piston chamber 13.

Having described and illustrated my invention as above, it is my intent, however, to claim the invention not only as shown and described but also in all such forms and modifications thereof as may be reasonably construed to fall within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A valve unit for association with an air flow passage in the cylinder of a piston type air compressor, comprising a seat member having a pair of concentrically arranged air intake channels, a separate hard metal ring plate valve movable to open and closed position relative to each channel, a keeper member complementing the seat member and held fast thereto, the keeper member having an annular air flow recess allowing reciprocating movement of the valves relative to the channels, a plurality of cylindrical wells in the air flow recess spaced equally apart and centered below the valves in common relation to both valves, an annular spring pack seated in each well composed of a stack of individual dished spring elements wherein each alternate spring element is in reverse relation to the next adjacent spring element, each spring pack yieldably exerting equal seating pressure upon both valves, and a cylindrical pin removably seated in each well passing closely and axially through the corresponding spring pack and passing between the valves in bearing relation thereto.

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2. A valve unit as defined in claim 1, wherein each pin is of uniform diameter throughout.

3. A valve unit as defined in claim 1, wherein each pin has a press fit in a hole at the bottom of the related well so that it is restrained against rotation relative to the valves as the latter operate.

4. A valve unit as defined in claim 3, wherein each pin extends beyond the valves and has a slide fit in a hole in the seat member, so that the seat member is restrained against rotative disalignment with respect to the keeper member and is guided in its assembly to the keeper member.

5. A valve unit as defined in claim 3, wherein the hole in which the pin is seated communicates axially with a bore of reduced diameter opening through the bottom end of the keeper member, the said bore allowing entrance of a probe to forcefully dislodge the pin for replacement or rotative adjustment.

6. A valve unit as defined in claim 1, wherein a plurality of air pockets defined between opposed inner faces of the spring elements of each spring pack have a predetermined close escape vent defined by a predetermined closeness of the periphery of the related pin to the surrounding wall of the axial hole of the spring pack.

7. A valve unit as defined in claim 1, wherein a plurality of air pockets defined between opposed outer faces of the spring elements of each spring pack have a predetermined close escape vent defined by a predetermined closeness of the periphery of the spring pack to the surrounding wall of the related well.

8. A valve unit as defined in claim 1, wherein the keeper member and seat member together define a symmetrical housing for the valve unit having a peripheral flange about its center and annular shoulders about opposite faces of the flange, whereby the housing is selectively

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seatable, in one position in an air intake passage of the air compressor and in a reverse position in an air discharge passage of the air compressor.

9. A valve unit of the character described including complementary keeper and seat members bolted together to define a housing for the unit, a pair of concentrically arranged ring plate valves movable to and from seated condition relative to arcuate port slots of the seat member, a plurality of circumferentially and equally spaced annular spring means disposed between the keeper member and the valves, each spring means being centered below the valves in common relation to both valves and yieldably exerting equal seating pressure upon both valves, and a separate cylindrical pin of uniform diameter removably seated in part in the keeper and seat members passing closely and axially through each spring means and further passing between both valves in bearing relation thereto, the pin being releasably restrained against rotation relative to the valves.

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