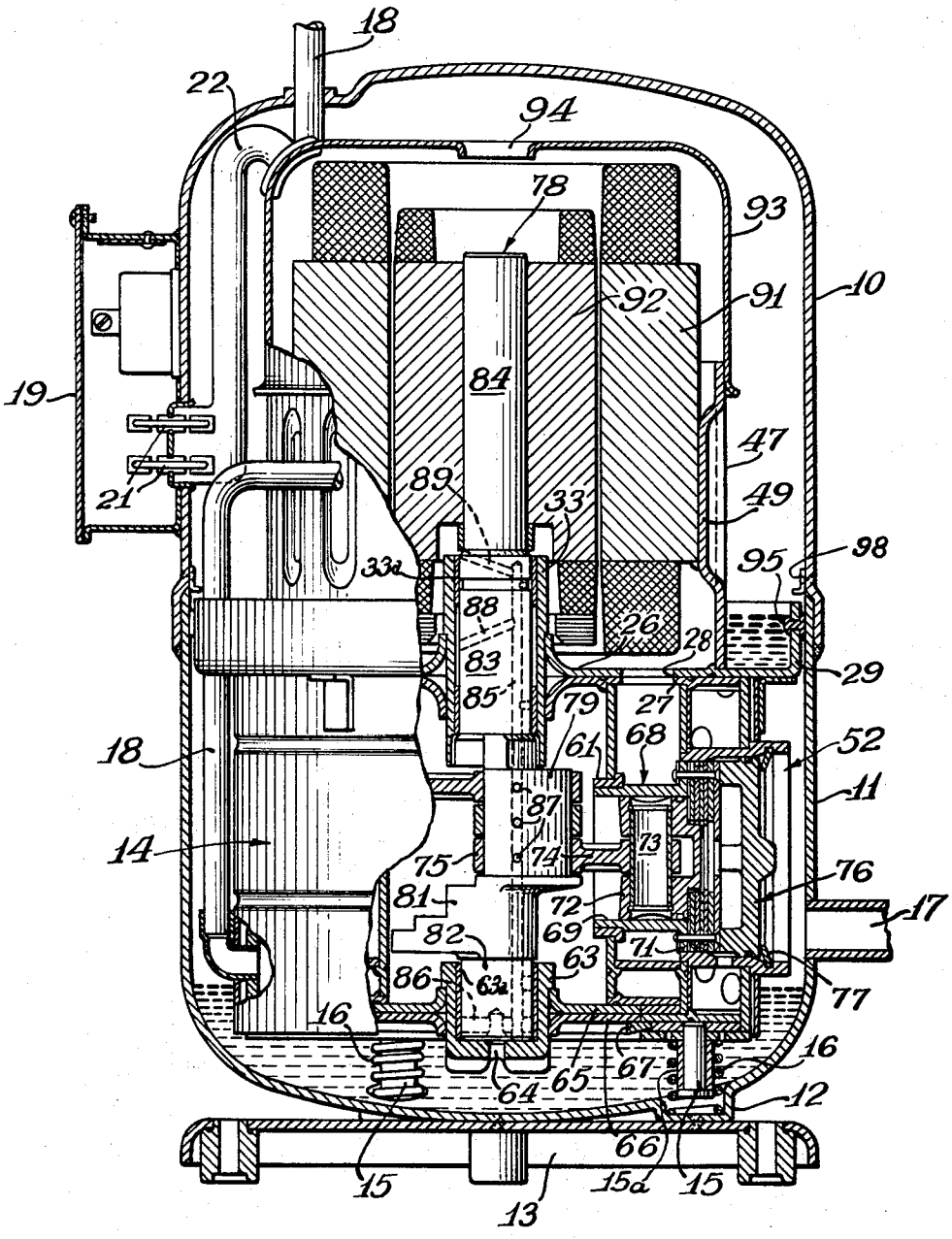
May 28, 1968 S. A. PARKER 3,385,515

REFRIGERANT RECIPROCATING COMPRESSOR

Filed Oct. 17, 1966 3 Sheets-Sheet 1

FIG. 1.



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REFRIGERANT RECIPROCATING COMPRESSOR

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FIG. 2.

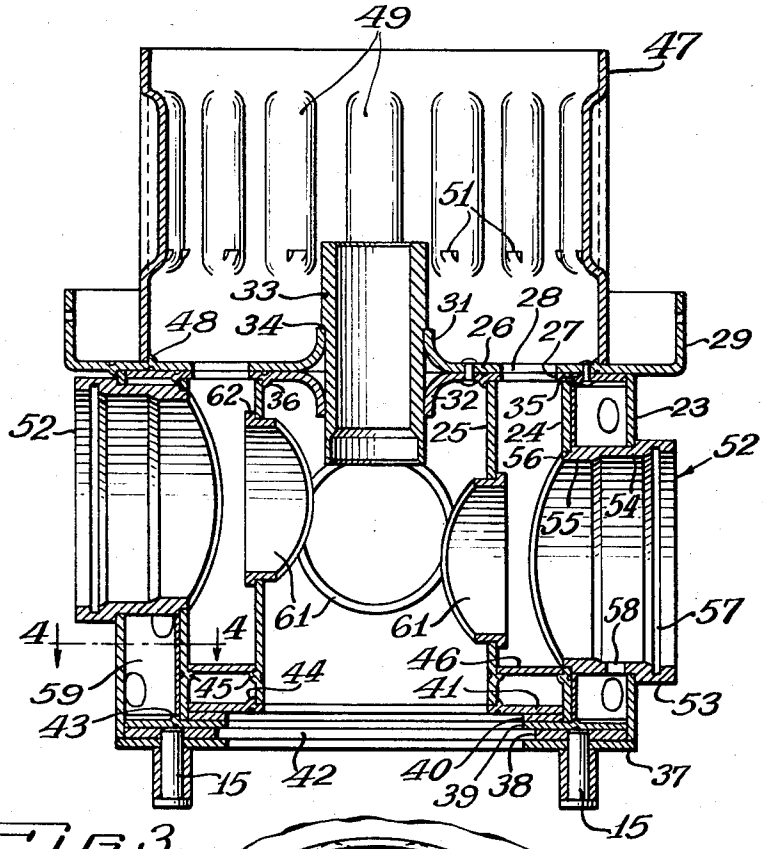
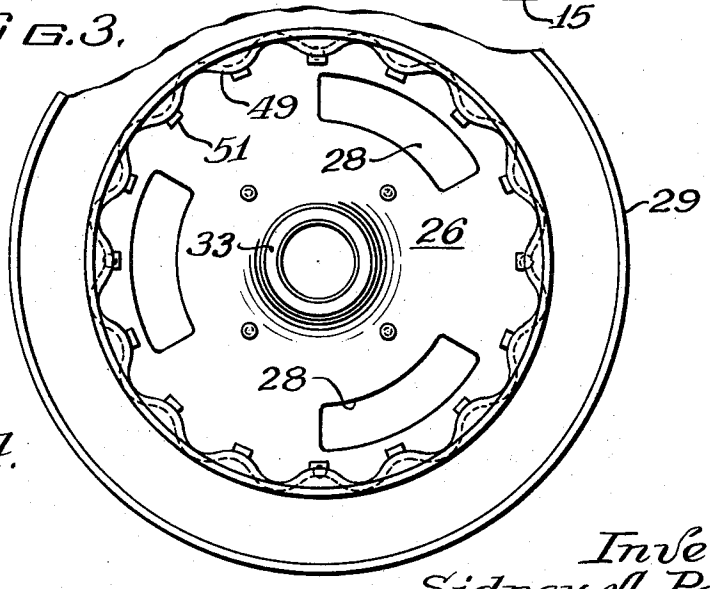


FIG. 3.



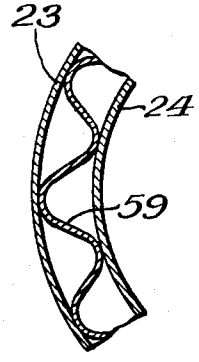


FIG. 4.

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REFRIGERANT RECIPROCATING COMPRESSOR

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FIG. 5.

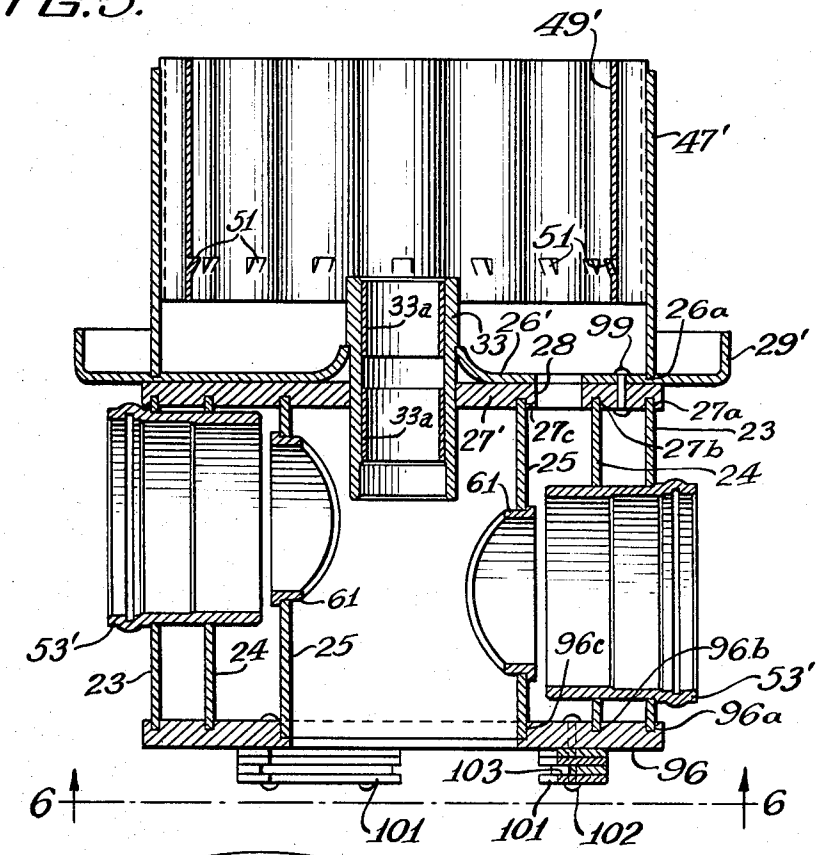
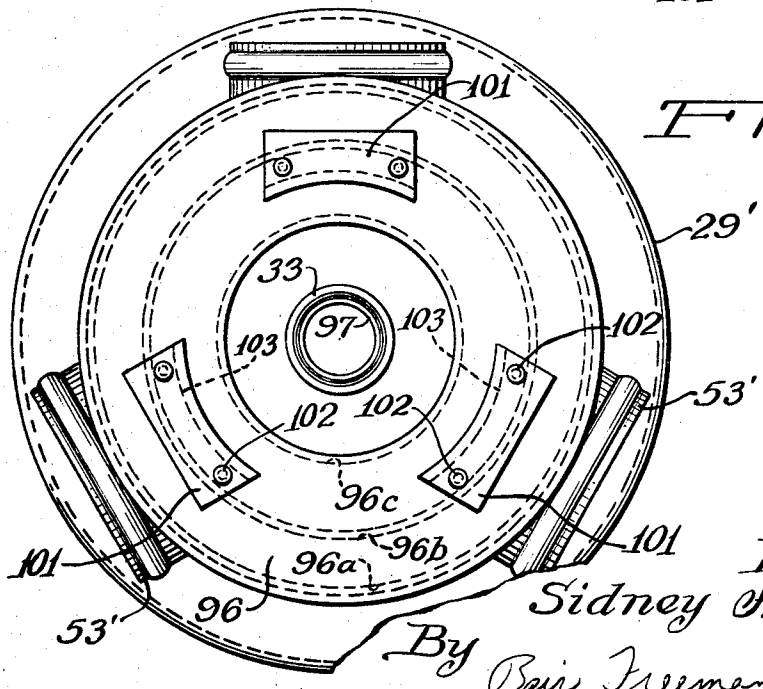


FIG. 6.



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United States Patent Office 3,385,515 Patented May 28, 1968

3,385,515

REFRIGERANT RECIPROCATING COMPRESSOR

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Filed Oct. 17, 1966, Ser. No. 587,005
12 Claims. (Cl. 230—232)

This invention relates to a refrigerant reciprocating compressor and, more particularly, to an improved crankcase construction for such compressors.

Heretofore it has been customary to form compressor crankcases of castings, and in many cases to cast a supporting sleeve for the stator of an electric driving motor integral with the crankcase. One such construction embodying a cast crankcase structure is disclosed, for example, in Patent No. 3,073,515.

A cast crankcase structure is subject to a number of disadvantages. Among these are the cost of castings, the weight due to the necessity for relatively thick walls, the necessity for and difficulty of machining a large number of surfaces and the difficulty of removing all the sand from the casting and particularly from the suction annulus and discharge annulus within the casting.

It is accordingly one of the objects of the present invention to provide a refrigerant reciprocating compressor in which the crankcase is formed of sheet metal stampings secured together by hydrogen brazing or chemical adhesives to define a complete crankcase assembly.

According to a feature of the invention, a valve housing is permanently secured in the crankcase assembly by brazing and one or more cylinder inserts and the crankshaft for reciprocating the pistons are assembled in the crankcase later.

Another object of the invention is to provide a refrigerant reciprocating compressor in which the crankcase has permanently secured thereto a sleeve for supporting the stator of a driving motor and in which substantially all of the parts are formed of sheet metal.

Among the several advantages of forming a crankcase of sheet metal parts are that the walls of the assembly may be made much thinner and lighter due to the greater strength of sheet metal over cast iron or cast aluminum, the necessity for machining after assembly is eliminated and the necessity for cleaning is also eliminated. These several features not only result in a better crankcase structure, but also one which is less expensive.

The above and other objects and features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawings, in which:

FIG. 1 is an axial section with parts in elevation of a complete compressor assembly embodying the invention;

FIG. 2 is an axial section through the crankcase assembly;

FIG. 3 is a top view of the assembly of FIG. 2;

FIG. 4 is a partial section on the line 4—4 of FIG. 2;

FIG. 5 is an axial section through a modified crankcase assembly; and

FIG. 6 is a bottom view of the modified crankcase assembly taken generally along line 6—6 of FIG. 5.

A complete compressor embodying the invention as shown in FIG. 1 comprises a gas-tight housing formed by an upper shell 10 and a lower shell 11 which are cup-shaped and are joined by welding or the like. The bottom of the lower shell is preferably formed with three or more outwardly cupped projections 12 which are secured to a base or mounting plate 13 by which the compressor assembly may be mounted in any desired position.

A crankcase embodying the present invention and indicated generally at 14 is mounted within the housing. For this purpose the crankcase preferably carries a plurality

of downwardly extending legs or pins 15 at its bottom corresponding in number and spacing to the projections 12. Springs 16 surround the pins 15 and sleeves 15*a*, made from nylon or like material and are seated in the hollow projections 12 to locate and support the crankcase assembly properly within the housing. The housing is provided with a suction gas inlet connection 17 and with a discharge gas conduit 18.

Electric power for operating the motor is supplied through a control box or terminal box 19 mounted on the side of the housing and carrying leads as indicated at 21 which extend through the housing wall in sealed relationship and through a conduit 22 into the upper part of the crankcase assembly.

The crankcase assembly per se, as best seen in FIGS. 2–4, is made up of three concentric sleeves 23, 24 and 25. The sleeves are confined between upper and lower annular plate members to which they are permanently secured as by hydrogen brazing, or chemical adhesives. The upper plate member, as shown, is formed of two annular plates 26 and 27 which are connected in face-to-face relationship and which are formed with registering arcuate openings 28 therethrough for the passage of suction gas as will be described more fully hereinafter. The upper plate 26 extends beyond the outer sleeve 23 and is formed with an upwardly turned flange 29 which, as best seen in FIG. 1, lies closely adjacent to the inner wall of the housing. The flange 29 is formed with a series of openings in its periphery which receive resilient bumpers, such as the rubber buttons 95 shown in FIG. 1 to bear against the inner wall of the housing, thereby to assist in supporting the crankcase assembly in the housing. The flange 29 may cooperate with the sleeve surrounding the motor to define an oil reservoir for holding oil pumped from the sump during compressor operation. Suitable passage means (not shown) may be provided to communicate the crankshaft pump means with the reservoir.

At their inner edges, the plates 26 and 27 are flared in opposite directions as indicated at 31 and 32, respectively. A tubular bearing housing 33 fits into the opening defined by the flanges 31 and 32 and is preferably formed with an external shoulder as indicated at 34 to rest on the flange 31. The bearing housing 33, which may be made from powdered metal, is permanently secured to the flared flanges during the brazing assembly operation. Since the flanges engage and are secured to the bearing housing 33 at points spaced relatively widely lengthwise thereof, they provide a rigid and accurately aligned support for the bearing housing. Bearings 33*a* are provided in the housing for journalling shaft 78.

In order accurately to locate the three sheet metal sleeves 23, 24 and 25 prior to and during assembly, the lower plate member is made of a size to enter the upper end of the outer sleeve 23. Thus, the sleeve 23 will be accurately positioned radially and the abutment of its upper edge against the upper plate 26 will locate the end member accurately in an axial direction with respect to the sleeves. The lower plate member 27 is also formed with a pair of radially-spaced annular beads or protrusions 35 and 36 which engage the ends of the intermediate sleeve 24 and inner sleeve 25. These sleeves are thus accurately positioned with respect to the upper end member and are held accurately in position during the assembly and brazing operations.

The lower plate member is formed by a series of stacked annular sheet metal plates 37, 38, 39, 40 and 41. The outermost plate 37 is formed with a series of spaced openings therein through which the pins 15 project. The next adjacent plate 38 has a larger central opening than the plate 37 so that its inner edge is spaced radially out-

ward from the inner edge of plate 37 as shown. The plate 39 completely overlies the plate 37 and has a smaller opening therethrough than the plate 38 so that its inner edge extends radially inwardly from the inner edge of plate 38. In this way an annular groove 42 is formed between the plates 37 and 39 to receive a snap ring as described more fully hereinafter.

The plate 41 abuts at its outer edge against the intermediate sleeve 24 and extends under the lower edge of the inner sleeve 25 as shown. Plate 40 is preferably also of the same external diameter as the plate 41 and abuts at its outer edge against the intermediate sleeve 24. The plate 41 has a smaller central opening therethrough than the plate 40 so that it projects inwardly beyond the inner edge of the plate 40 for a purpose to appear more fully hereinafter.

The lower edges of the sleeves 23, 24 and 25 are accurately located relative to the bottom closure member in a manner similar to that in which the upper edges of the sleeves are located. Thus, the annular plates 38 and 39 fit within the lower end of the outer sleeve 23 and the plate 39 is formed with an annular bead 43 which engages the outer surface of the intermediate sleeve 24. The upper plate 41 and the plate 40 fit within the intermediate sleeve 24 and the sleeve 41 is formed adjacent to its inner edge with an annular bead 44 which engages and locates the outer surface of the inner sleeve 25. Preferably, the sleeves 24 and 25 are also formed with beads 45 which support and locate an annular ring 46 lying between these two sleeves and spaced above the bottom member of the crankcase assembly.

In order to support a motor in the crankcase assembly, a sleeve 47 is secured to the upper plate 26 of the top member and is accurately located thereon by an annular bead 48 projecting upwardly from the top member. The sleeve 47 is formed with a series of circumferentially spaced inwardly extending corrugations 49 which are adapted to receive and support a motor stator as described more fully hereinafter. Preferably, each of the corrugations is formed adjacent to its lower end with a punched out tongue 51 against which the lower edge of the motor stator will seat to position the motor stator accurately in the crankcase assembly. The sleeves 23, 24 and 25 are provided at one or more points around their circumference with radially aligned openings, the opening in the outer sleeve 23 being slightly larger than that in the intermediate sleeve 24, and the opening in the inner sleeve 25 being smaller than the opening in the sleeve 24. The openings in the outer and intermediate sleeves are adapted to receive tubular valve housings 52. Normally, for a four cylinder compressor there will be four such valve housings whose axial positions with respect to the sleeves are staggered as indicated in FIG. 2. Each valve housing has an outer ring portion 53 of maximum diameter which is slightly larger than the diameter of the opening in the outer sleeve 23. This ring portion is joined by a tubular body portion having a maximum diameter portion 54 joining the ring portion and an inner minimum diameter portion 55 at the inner end thereof. The inner edge of the valve body is stepped as shown at 56 to fit into the opening in the intermediate sleeve 24 and to define a shoulder abutting against the outer surface of that sleeve. The outer ring portion 53 of the valve body is formed with an annular internal groove 57 to receive a retaining ring as described more fully hereinafter.

The space between the outer sleeve and the intermediate sleeve constitutes an annular discharge gas chamber into which compressed gas passes from the valve. For this purpose the valve housing is formed with one or more openings 58 communicating with the discharge space. In order to muffle the noise of the discharge gas, an annular corrugated perforated sheet metal strip 59 is positioned in the space between the outer and intermediate sleeves and is secured thereto by brazing during the assembly operation. As the gas flows through the discharge chamber and through the perforations in the strip 59, its flow will be muffled.

The openings in the inner sleeve 25 receive annular members 61 which fit closely in the openings and which are preferably provided with outer annular flanges 62 to engage the outer surface of the inner sleeve as shown.

It will be observed that all parts of the crankcase assembly as so far described with the possible exception of the bearing housing 33, the valve housing 52 and the sleeve 61 are formed of sheet metal. All of the parts are relatively simple ones which can be stamped out of standard sheet steel and which can be assembled and held in proper position relative to each other by simple jigging. The bearing housing 33, valve housing 52 and sleeve 61 may be screw machine parts or could, if desired, be formed of powdered metal or in any other desired way. These parts can easily be inserted in the openings provided for them and will be accurately located and retained by the shoulders formed thereon. With the several parts assembled as shown in FIG. 2 and held in assembled relationship by suitable jigs or fixtures, the entire assembly may be placed in a hydrogen brazing furnace and the parts may be rigidly brazed together. It will be understood that the portions of the several different sheet metal parts where they meet may be precoated with suitable brazing and fluxing compounds so that when the assembly is heated to a proper brazing temperature, normally about 2050° F., all of the parts will be rigidly and permanently secured together.

Once the crankcase assembly is completed as described above, the remaining parts necessary to complete the compressor may easily be assembled therewith. A bearing is provided for the lower end of the compressor crankshaft. As shown in FIG. 1, the bearing comprises a cup-shaped bearing housing member 63 formed adjacent to its upper edge with a projecting flange. The lower part of the cup-shaped member is preferably formed with an opening 64 which constitutes the inlet of the impeller or pump means which are defined within the crankshaft to be referred to hereinafter. The bearing housing 63 is secured to a supporting plate defined by two annular plates 65 and 66 whose inner edges are flared outwardly in substantially the same manner as the inner edges of the plates 26 and 27. The bearing housing 63 fits into the opening defined by the flared inner edges of plates 65 and 66, with the shoulder at the upper end thereof abutting against the flared upper edge of the plate 65 accurately to locate the bearing housing in an axial direction. The bearing housing is preferably secured to the flared edges of the plates 65 and 66 by brazed in the same manner that the sheet metal parts of the crankcase assembly are secured together.

To assemble the bearing housing 63 in the crankcase, the plates 65 and 66 are inserted through the central opening of the bottom or outer plate 37 with the upper face of plate 65 abutting the lower surface of the plate 41 and with the outer edges of the plates 65 and 66 engaging the inner edges of the plates 40 and 39, respectively. In this way, the bearing plates 65 and 66 and the bearing housing 63 are accurately located in the crankcase assembly. Bearing 63*a* is press fit or otherwise secured in housing 63. To secure the bearing in place, a snap ring 67 is inserted in the groove 42 as shown in FIG. 1 and engages the lower surface of the plate 66 to secure it and the entire lower bearing assembly accurately in position in the crankcase.

A cylinder sleeve and valve assembly as more particularly described and claimed in my copending application Ser. No. 587,006 filed Oct. 17, 1966, and indicated generally at 68 together with associated piston and connecting rod may then be inserted radially into each of the valve casings 52 as shown in FIG. 1. Each cylinder sleeve and valve assembly comprises a cylinder 69 having a stepped outer surface at one end to fit within one of the sleeves 61 and having an outwardly-extending flange 71

at its other end to fit within the small diameter portion 55 of the valve casing. A piston 72 is slidable in each of the cylinders and is connected through a wrist pin 73 to a connecting rod 74 which extends generally radially into the crankcase. At its inner end each connecting rod is formed with a circular bearing portion 75 adapted to engage with an eccentric portion on the crankshaft.

A valve assembly indicated generally at 76 is secured to the flange 71 of the cylinder and carries various valve parts as described more fully in my copending application referred to above. After the valve assembly and cylinder and piston have been inserted into the valve casing 52, they are retained in place by a snap ring or similar fastener 77 fitting into the annular groove 57 in the valve casing.

A crankshaft 78 extends through the bearings 33*a* and into the bearing 63*a* and is provided intermediate its ends with an eccentric crank portion 79 and closely adjacent thereto with a counter-weight portion 81. The crankshaft is formed with a lower bearing portion 82 fitting into the lower bearing 63*a*, with an intermediate bearing portion 83 fitting into the bearing 33*a*, and with an upper shaft portion 84 extending upwardly through the motor supporting sleeve 47. With the several cylinder sleeve and valve assemblies and associated pistons in place, the crankshaft may be inserted from the bottom of the crankcase (with the lower bearing housing 63 removed) by passing the shaft portion 84 and crankshaft bearing portion 83 through the connecting rod bearings 75 and then through the upper bearing housing 33 until the crankshaft is in the position shown in FIG. 1. Thereafter, the lower bearing housing 63 may be inserted over the bearing portion 82 at the lower end of the crankshaft and can be secured in place by inserting the snap ring 67.

As is more particularly disclosed and claimed in my Patent No. 3,253,776, the crankshaft is provided with a plurality of vertically-disposed passageways which are offset from the axis of rotation of the shaft and which communicate with the opening 64 in the lower bearing housing 63 by a transversely-disposed passage 86. As shown, the passage 86 is open at its opposite ends to lubricate the bearing 63*a*. The crank or eccentric 79 of the crankshaft is provided with passages 87 communicating with vertically-disposed passages (not shown). The passages 87 open at the surface of the crank portion 79 to provide relatively high pressure and relatively low pressure lubrication of the several connecting rod bearings 75. Passages are provided in the crankshaft communicating with the upright passage 85 and opening at the exterior of the bearing portion 83 for lubricating the upper bearing 33*a*. A refrigerant vapor vent passage 89 may be provided at the upper end of the crankshaft bearing portion 83 to vent any vapor which gets into the passage 85.

The crankshaft 78 is driven by a motor which comprises an annular stator structure 91 of an external diameter to fit closely within the corrugations 49 and with its lower edge engaging the tongues 51 to limit movement of the stator into the sleeve 47 and to position the stator accurately. An annular rotor 92 is rotatable within the stator and fits over the shaft portion 84. The rotor may be secured to the shaft 84 by keying or in any other suitable manner. After the stator and rotor are installed, a motor shroud or cover 93 may be placed over the motor with its lower edges telescoping over and secured to the upper end of the sleeve 47. The cover 93 is formed in its top with a central opening 94 through which the incoming suction gas may flow to flow over the motor and assist in cooling it and to then flow through the openings 28 to the valve assembly.

After the motor and compressor parts have been assembled with the crankcase structure as described above, the entire assembly may be inserted in the lower shell 11 to be supported on the springs 16. Resilient rubber bumpers 95 are inserted in openings in the flange 29 of plate 27 and bear against the sides of the lower shell 11 resiliently to position and support the crankcase assembly. The assembly is then completed by adding the top cover part or shell 10 and making the necessary wiring connections. Annular stop ring 98 in the shell 10 abuts flange 29 to limit upward movement of the compression mechanism within the outer housing.

The modified crankcase assembly of FIGS. 5 and 6 is much like that shown in FIGS. 1–3 and accordingly, like numerals are used to designate like elements. Major changes are found in the construction of the upper and lower plate members and the valve housing. For added strength and to facilitate fabrication, the upper and lower plate members each include relatively thick plates 27′ and 96, respectively, having annular recesses 27*a*, *b* and *c* and 96*a*, *b* and *c*, respectively, therein for receiving the upper and lower ends of sleeves 23, 24 and 25. The extended surface of the recesses cooperates with the exterior of the sleeves 23, 24, and 25 to insure better sealing of the abutting surfaces. The recesses also function to accurately locate and space the sleeves from one another.

Bearing housing 33 is supported in the central openings in plates 26 and 27′. Bearing liners 33*a* are provided in bearing housing 33 for journaling the crankshaft.

The annular valve housings 53′ are preferably formed from sheet metal inserted into openings in sleeves 23 and 24 and expanded into snug engagement with the wall means defining the openings in the sleeves. The valve housing 53′ are then brazed or otherwise bonded to the sleeves to provide a fluid-tight seal therebetween.

The motor support is defined by annular sleeve 47′ secured to the top of plate 26′. Annular recess 26*a* is provided in the plate 26′ for locating the sleeve 47′ on the plate 26′ and for increasing the surface contact at the bonded joint to enhance the seal between sleeve 47′ and plate 26′. The ribs 49′ for supporting the motor stator are formed from generally U-shaped or V-shaped members secured to the interior of sleeve 47′. Tongues or projections 51′ are struck from the ribs 49′ or otherwise formed on the ribs 49′. The lower edge of the motor stator abuts the tongues 51′ to accurately position the motor stator within the crankcase.

The rivets 99 or like fastening means are used to join the plates 26′ and 27′ during initial assembly. Subsequently plates 26′ and 27′ are joined by brazing or chemical adhesive.

Secured to the bottom of plate 96 are a plurality of lower retaining members 101 formed from a plurality of plate segments connected to one another by fastenings 102. As shown, the retaining members are spaced 120° apart. Defined within each retaining member is a recess 103 for receiving a retaining ring to hold the lower bearing assembly in place in the crankcase.

While presently preferred embodiments of the invention have been shown and described in detail, it will be understood that this is for the purpose of illustration only and is not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. In a refrigerant reciprocating compressor, a crankcase comprising outer, intermediate and inner coaxial sheet metal sleeves of different diameters to define annular spaces between adjacent sleeves, annular top and bottom plate means joined to the opposite ends of the sleeves and securing them rigidly together, the sleeves being formed with radially aligned openings therethrough, a tubular valve housing secured in the openings in the outer and intermediate sleeves, the valve housing and the opening in the inner sleeve adapted to receive and support a cylinder sleeve, the annular space between the inner and intermediate sleeves defining a suction gas inlet chamber and the valve housing having an opening therein communicating with the space between the intermediate and

outer sleeves whereby said space serves as a discharge gas chamber.

2. The construction of claim 1 including a generally sinuous perforated baffle in the discharge gas chamber extending axially of the adjacent sleeves to muffle the discharge gas.

3. The construction of claim 1 in which the top and bottom plate means have locater means formed on their inner faces against which the ends of the intermediate and inner sleeves seat accurately to position the sleeves.

4. The construction of claim 3 in which the locater means comprise recesses in the inner faces of the top and bottom plate means.

5. The construction of claim 1 in which the bottom plate means is formed of at least two annular plates spaced at their inner edges to define an annular recess adjacent to the innermost plate to receive a bearing supporting plate and an annular groove adjacent to the outermost plate to receive a snap ring.

6. The construction of claim 1 in which the bottom plate means is formed of at least four annular plates secured together face-to-face, the second plate from the outer end of the crankcase having a larger internal opening than the immediately adjacent plates to define therewith an internally opening annular groove and the innermost plate having a smaller internal opening than the plate immediately adjacent thereto, a bearing and an annular bearing supporting plate secured to the bearing and fitting face-to-face against the inner edge of the innermost plate and fitting within the plate next adjacent thereto, and a snap ring fitting in said groove to secure the bearing supporting plate in place.

7. The construction of claim 6 in which the bearing supporting plate comprises two annular plates secured together face-to-face with their inner edges flared in opposite directions, and the bearing fits in the central openings in the plates and is secured to the flared inner edges thereof.

8. The construction of claim 1 in which the top plate means comprises two annular plates secured together in face-to-face relationship, the inner edge of at least one of said plates being flared, and a tubular bearing fitting in the central openings in the plates and secured to the flared inner edge.

9. The construction of claim 1 including sleeve means secured to the top plate means and projecting outward therefrom and adapted to receive and support the stator of a motor.

10. The construction of claim 8 in which the last named sleeve means is formed with a series of inwardly projecting axially extending ribs closely to receive the stator and having stop means thereon to limit movement of the stator into the sleeve means.

11. The construction of claim 9 including a plurality of ribs formed from a single corrugated member, the ribs having stop means thereon for accurately positioning a motor stator within the sleeve means.

12. The construction of claim 1 including an annular sleeve member in the opening in the inner sleeve, the annular sleeve member being coaxial with an associated valve housing, the sleeve member and the valve housing cooperating to receive a cylinder sleeve and valve assembly therein.

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ROBERT M. WALKER, *Primary Examiner.*