Nov. 4, 1969 T. W. RUNDELL ETAL 3,476,308

COMPRESSOR CONSTRUCTION

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FIG. 1

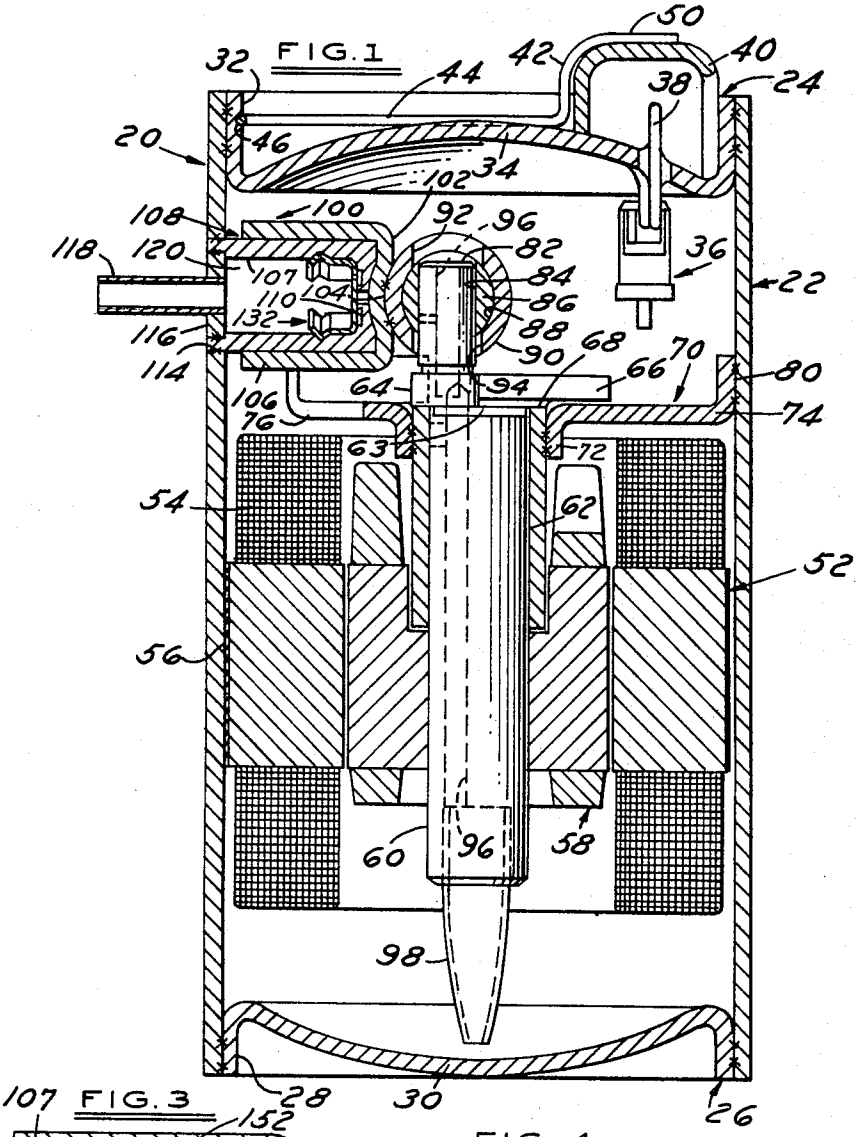


FIG. 3

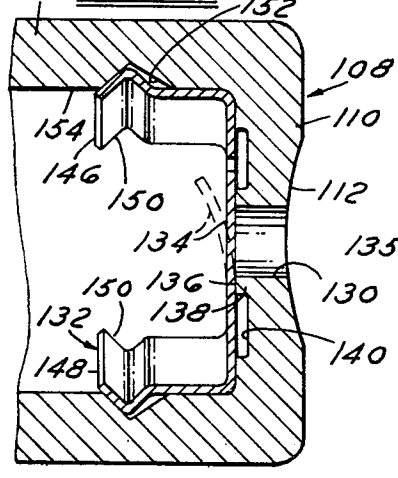
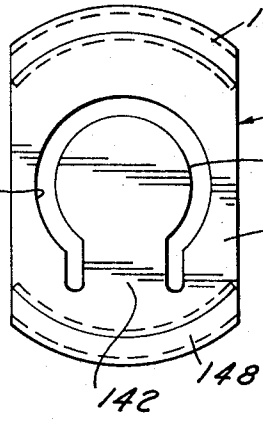


FIG. 4



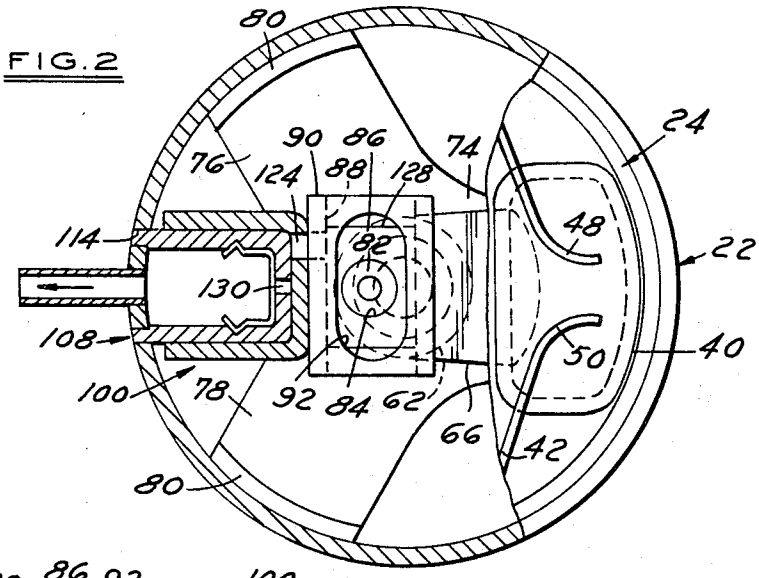
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COMPRESSOR CONSTRUCTION

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FIG. 2



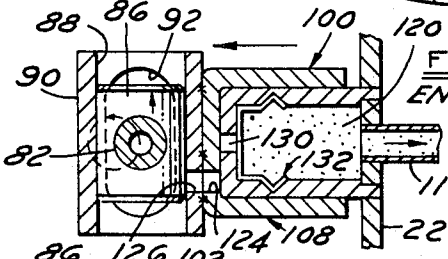


FIG. 5

END OF COMPRESSION
START OF SUCTION

FIG. 9

DISCHARGE 180°

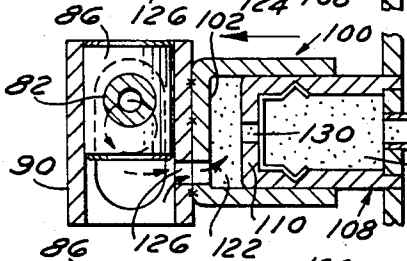
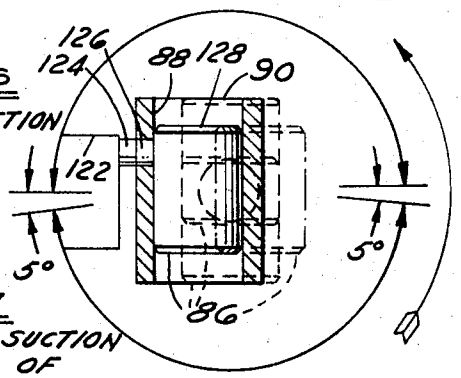


FIG. 6

SUCTION



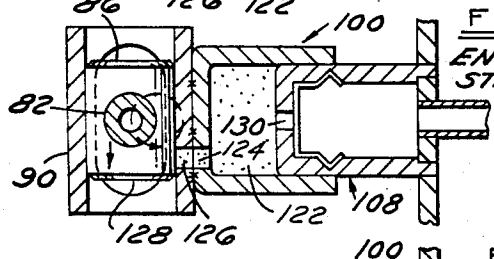


FIG. 7

END OF SUCTION
START OF COMPRESSION

SUCTION 170°

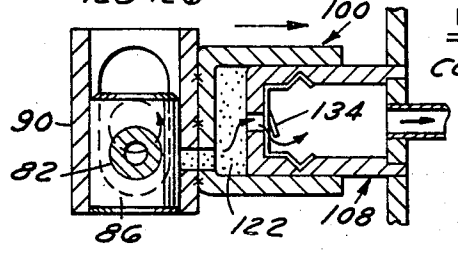


FIG. 8

COMPRESSION

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COMPRESSOR CONSTRUCTION

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FIG. 10

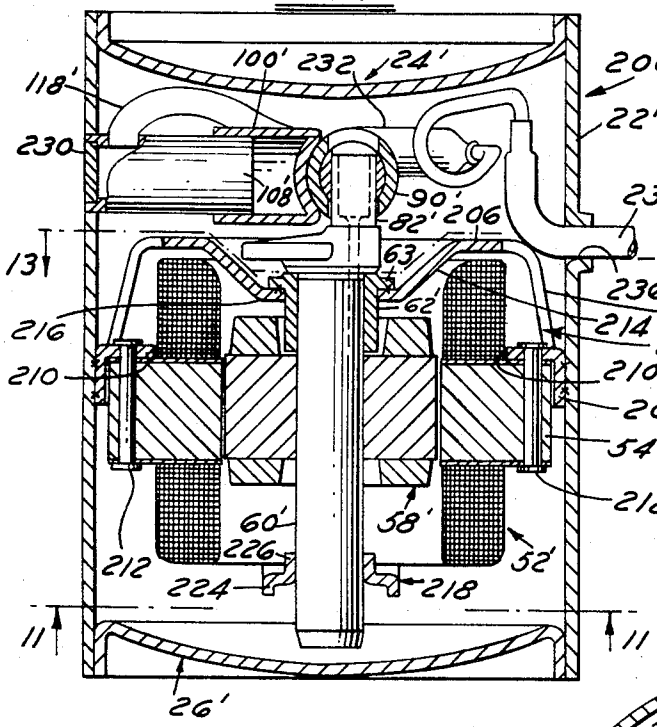


FIG. 12

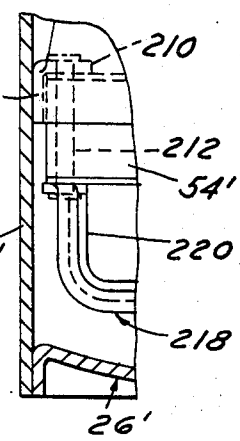


FIG. 13

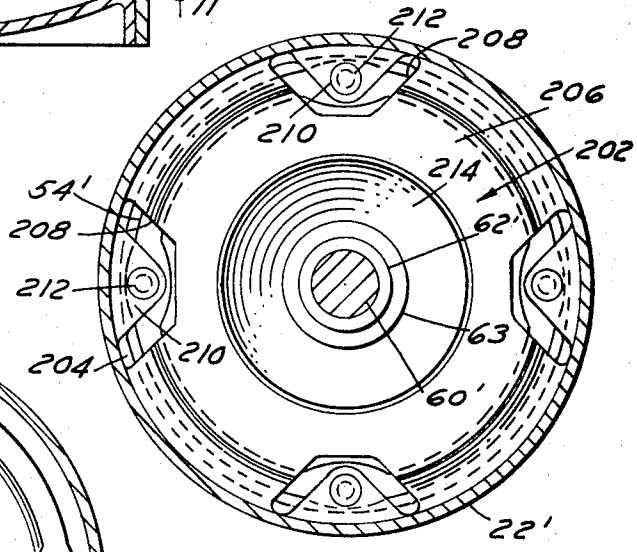
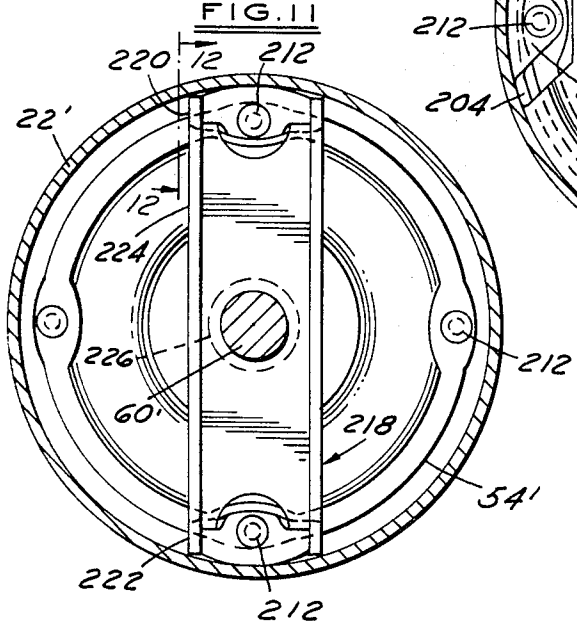


FIG. 11



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3,476,308

COMPRESSOR CONSTRUCTION

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Int. Cl. F04b 35/04, 29/00
U.S. Cl. 230—58 10 Claims

ABSTRACT OF THE DISCLOSURE

A hermetic motor-compressor unit constructed primarily of sheet metal components and having a scotch yoke mechanism drivingly connecting the motor with the pump of the unit. The compressor pump comprises a stationary piston and moving cylinder which are both cup-like members arranged with the cylinder guided on the exterior of the piston and reciprocated by the scotch yoke mechanism which also serves as an intake valve to the pump chamber.

An object of the present invention is to provide an improved compressor construction, preferably of the hermetic type, in which as many parts as possible may be economically mass produced by stamping and/or drawing equipment, and which eliminates the need for the usual reed-type inlet valve in the compressor pump.

Other objects, features and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a vertical center section through a hermetic motor-compressor unit constructed in accordance with the present invention.

FIG. 2 is a top plan view of the unit of FIG. 1 with a portion broken away and taken in horizontal center section through the pump of the unit.

FIG. 3 is a fragmentary view of the stationary piston and outlet valve of the compressor pump taken in section as in FIG. 1 but on an enlarged scale.

FIG. 4 is a plan view of the outlet valve shown by itself.

FIGS. 5–8 inclusive are fragmentary center sectional views of the scotch yoke and pump structure of the compressor illustrating in sequence a cycle of operation thereof.

FIG. 9 is a diagrammatic view illustrating the cycle of operation of the scotch yoke-inlet valve mechanism of the unit.

FIG. 10 is a vertical center sectional view illustrating a modified motor-compressor unit also constructed in accordance with the present invention.

FIG. 11 is a horizontal sectional view taken on the line 11—11 of FIG. 10.

FIG. 12 is a fragmentary vertical sectional view taken on the line 12—12 of FIG. 11.

FIG. 13 is a horizontal sectional view on the line 13—13 of FIG. 10.

Referring in more detail to the accompanying drawings, FIGS. 1 and 2 illustrate a motor-compressor unit 20 constructed in accordance with the present invention in which the majority of parts are adapted to be fabricated from sheet metal stock by high-volume production equipment, such as stamping and metal drawing presses, to provide a lightweight, small capacity hermetic compressor at a relatively low cost. The hermetically sealed casing of unit 20 comprises a cylindrical tube 22 closed at each of its opposite ends by top and bottom covers 24 and 26 respectively. Bottom cover 26 has an axially circular extending rim 28 welded to the bottom of tube 22, and a

domed center portion 30 disposed with its convex surface facing downwardly. Top cover 24 likewise has an axially extending rim 32 inserted with a close fit within the upper end of tube 22 and secured thereto by welding, and a domed central portion 34 disposed with its convex surface facing upwardly. Cover 24 also has a conventional electrical connector 36 with leads 38 extending in sealed relation through the cover. The exterior terminals of leads 38 are protected by a small cover 40 removably retained on cover 24 by a spring clip 42 (FIGS. 1 and 2) having a circular bite portion 44 which resiliently expands into a groove 46 provided in rim 32. By squeezing together the ends 48 and 50 of clip 42 bite 44 may be contracted to remove clip 42 from cover 24 and thereby free cover 40. Cover 40 may also house suitable thermal overload protection devices of known construction.

Unit 20 includes a conventional electric motor 52 with stator windings 54 mounted on an annular core 56 which in turn is suitably fixed to the inner wall of tube 22. A rotor 58 of motor 52 is mounted on a crankshaft 60 for rotation therewith, shaft 60 in turn being journalled within a tubular bushing 62 which is stationarily mounted concentric with core 56 and tube 22. Shaft 60 has a thrust bearing surface 63 formed as part of the underface of a crank throw 64 and counterweight 66 which are fixed to the upper end of crankshaft 60, surface 63 riding on the upper end surface 68 of bushing 62. Bushing 62 in turn is stationarily supported by a sheet metal spider frame 70 (FIGS. 1 and 2) having a central hub 72 in which bushing 62 is received and welded, and three radially outwardly extending arms 74, 76 and 78 each having an upturned end 80 secured as by welding to the inner wall of tube 22 at 120° intervals.

The scotch yoke mechanism of unit 20 includes a cylindrical crank pin 82 fixed on crank throw 64 eccentrically of crankshaft 60 so as to revolve around the axis of shaft 60 as shaft 60 rotates. Pin 82 is rotatably received in a crossbore 84 of a cylindrical slider 86 which slides axially in the throughbore 88 of a cylindrical crosshead 90. Crosshead 90 has a pair of diametrically opposed, axially extending slots 92 and 94 in its upper and lower sides respectively. Lower slot 94 receives pin 82 therethrough and permits lateral travel of the pin axially of crosshead 90 as seen in FIGS. 5–8, whereas upper slot 92 provides a vent hole for oil discharged from the upper end of an oil passage 96 which extends axially through pin 82 and shaft 60 to a centrifugal impeller tube 98 fixed to the lower end of shaft 60.

Crosshead 90 is fixed at one side thereof to a cup-like cylinder 100 which constitutes the moving part of the compressor pump of unit 20. As best seen in FIG. 1, cylinder 100 has an end wall 102 with a transverse concavity 104 which receives the side of crosshead 90, cylinder 100 being welded to crosshead 90 at this juncture so to be oriented with its axis perpendicular to the axes of crosshead 90 and crankshaft 60. The cylindrical skirt 106 of cylinder 100 has a close sliding fit on the cylindrical skirt 107 of a stationary cup-like piston 108 which constitutes the stationary part of the compressor pump. Piston 108 has a transverse end wall 110 with a transverse groove 112 (FIG. 3) adapted to nest with the transverse convexity of wall 102 to provide essentially zero clearance at the end of the compression stroke of the pump when cylinder 100 is fully telescoped onto piston 108 as shown in FIGS. 1, 2 and 5. Piston 108 is inserted through a circular opening 114 in the side wall of tube 22 and welded to the rim of this opening. The outer end of piston 108 is closed by a plug 116 having an outlet tube 118 mounted therein for communication with a muffler chamber 120 formed by the hollow interior of piston 108.

As best seen in FIGS. 6, 7 and 8 the space between the

end walls **102** and **110** of the cylinder and piston forms a variable volume pump chamber **122** which is expanded and contracted by reciprocation of cylinder **100** on piston **108**. The inlet pasage to chamber **122** comprises a portion **124** which extends through wall **102** adjacent skirt **106** and which registers with a port **126** which extends through the adjacent side of crosshead **90**. The inlet passage is alternately positively opened and closed in synchronism with reciprocation of cylinder **100** by slider **86** as it reciprocates in crosshead **90**. As best seen in the sequence of FIGS. 6, 7 and 8 one end wall **128** of the slider moves past port **126** so that the side wall of the slider completely covers port **126** just as cylinder **100** reaches bottom dead center position (FIG. 7). Port **126** remains covered and closed by slider **86** as cylinder **100** moves toward piston **108** on its compression stroke (i.e., the discharge stroke of the pump) and until shortly after the cylinder has bottomed on the piston at the end of the compression stroke. As shown in the diagrammatic illustration of FIG. 9, slider **86** preferably is designed to open the inlet passage for 170° of crankshaft rotation and to close the inlet passage for 180° of crankshaft rotation, the uncovering and covering tolerances being accommodated by the 5° angular increments taken from the suction half of the pump cycle. When port **126** is uncovered by slider **86**, communication is established between chamber **122** and the interior of the compressor casing via the adjacent open end of bore **88** and slots **92** and **94** in crosshead **90**.

The outlet passage from pump chamber **122** comprises a port **130** extending centrally through end wall **110** of piston **108** to chamber **120**. As best seen in FIGS. 3 and 4, port **130** is controlled by an outlet check valve **132** which comprises a thin one-piece stamping of spring steel having a flexible reed valve portion **134** adapted to seat in closed position on a rim **138** formed by machining an annular groove **140** in the inner surface of wall **110** around port **130**. Reed **134** is formed by blanking out a keyhole-shaped slot **135** (FIG. 4) from the flat bottom **144** of valve member **132**, leaving a connecting stem or hinge **142** so that reed **134** can flex between the closed and open positions thereof indicated in solid and broken lines respectively in FIG. 3. Valve member **132** also includes a pair of spring fingers **146** and **148** integrally joined to the opposite ends of bottom **144** and each having an outwardly crimped V-shaped detent portion **150** biased by the resilience of the finger so as to snap outwardly into engagement with an annular V-shaped groove **152** (FIG. 3) in the inner wall **154** of piston **108** upon member **132** being slideably inserted endwise through the open end of the piston to thereby securely but removably retain valve member **132** in operative position (FIG. 3).

In operation, motor-compressor unit **20** is energized from a conventional power source through electrical connections (not shown) from connector **36** to rotatably drive crankshaft **60** and this rotational motion is converted by the scotch yoke mechanism into reciprocating motion of cylinder **100** on stationary piston **108** so as to alternately expand chamber **122** to its maximum volume (FIG. 7) and contract it to almost zero volume (FIG. 5). During the suction stroke of the pump (FIGS. 5, 6 and 7) the pressure differential created between chambers **120** and **122** maintains reed **134** closed, while the pump inlet passage **124**, **126** is opened by the spool valve action of slider **86** in crosshead **90**. This causes refrigerant gas to be drawn into chamber **122** from the interior space defined by tube **22** and covers **24** and **26** of the compressor casing. The interior space of the casing in turn communicates via suitable connections (not shown) with the "low side" of the refrigeration or other system with which it is to be used. As cylinder **100** travels toward top dead center on its compression stroke (FIGS. 7, 8 and 5), the inlet passage is closed by slider **86**, and, when the pressure of the compressed gas in pump chamber **122** exceeds that of the gas in muffler chamber **120** and discharge tube **119**, reed **134** opens and the compressed gas is expelled from chamber **122** into chamber **120**.

From the foregoing description, it will now be apparent that a motor-compressor unit constructed in accordance with the present invention lends itself to high volume low unit cost mass production fabrication equipment and techniques. Except for motor **52** and crankshaft **60**, the majority of components are simple in configuration and may be stamped and/or drawn from sheet metal stock. By having the cylinder **100** arranged externally of the piston and serving as the moving part of the compressor pump, the intake valve of the pump may be formed by the scotch yoke crosshead and slider parts, thereby eliminating one of the two leaf valves hitherto required.

Referring to FIGS. 10–13 inclusive, a second embodiment **200** of a motor-compressor unit of the invention is illustrated which is similar in most respects to unit **20**, corresponding parts being given like reference numerals with a prime (“′”) suffix. Unit **200** differs from units **20** primarily in the supporting frame for motor **52** and crankshaft **60**. Thus, in place of the three-legged spider **70**, a cup-like frame member **202** is provided for supporting stator **54′** of motor **52′** in fixed position in casing **22′** and for supporting the crankshaft bushing **62′** adjacent the upper end of crankshaft **60′**. Frame **202** has a cylindrical rim **204** which has a close fit against the inner wall of tube **22′** and is welded thereto. The side wall of frame **202** is generally conically shaped so as to taper inwardly and upwardly from rim **204** up to the top end wall **206** of the frame. Four openings **208** are struck out at 90° intervals around the side wall of frame **202** (FIG. 13), and four tabs **210** are bent down from the material taken from the side wall in forming these openings so as to extend inwardly at right angles to tube **22′** to provide hangers to which stator **54′** is secured by fasteners **212**.

The central portion of top wall **206** is depressed downwardly to form a frusto-conical wall **214** and a radial flange **216** the inner margin of which defines a central opening through which bushing **62′** is inserted so that a flange **63** thereof rests on and is fixed to flange **216**.

The supporting framework for the motor and crankshaft of unit **200** also includes a U-shaped strut **218** (FIGS. 10, 11 and 12) with a pair of arms **220** and **222** bent up one from each of the opposite ends of a straight central portion **224** which extends horizontally and diametrically across the lower end of casing **22′**. Each arm **220** and **222** is secured by a fastener **212** to the underside of stator **54′**. As best shown in FIGS. 10 and 11, the lower end of crankshaft **60′** extends through a bushing **226** which serves as an outboard bearing for the crankshaft spaced remote from the inboard bearing **62′**. Bushing **226** is formed integrally from the central portion **224′** of the strut by a suitable piercing and drawing operation.

The compressor pump of unit **200** differs from that of unit **20** in that outboard end of the stationary piston **108′** is completely closed by a plug **230** (FIG. 10), the discharge tube **118′** being connected through the skirt of piston **108′** and extending therefrom internally of the casing to an auxiliary muffler **232** which in turn is connected to an outlet opening **236** in the side wall of casing tube **22′**.

Unit **200**, like unit **20**, thus has a majority of its components fabricated from stamped and/or drawn sheet metal parts for economy of manufacture, and the compressor pump thereof requires only one reed valve **132**.

It is to be understood that the above described motor compressor units of the invention may be disposed for operation with the axis of rotation of the crankshaft of the unit orientated horizontally rather than vertically as illustrated by way of example herein. The only modification required for horizontal operation is the substitution of a suitable oil pump for the previously described pick-up tube **98**, and for this purpose, well-known positive displacement type gear rotor or rotary vane oil pumps or the like may be used in conjunction with a suitable dip

tube for conducting oil from the oil sump to the pump inlet, as in the manner indicated in United States Patents 1,967,035; 2,185,473 and/or 2,283,024.

We claim:

1. In a motor-compressor unit, the combination comprising a casing, a support frame connected to said casing, a motor mounted in said casing, a crankshaft supported by said frame and rotatably driven by said motor, a compressor pump disposed in said casing including a piston connected in a fixed relation to said support frame, a cylinder externally slidably received on said piston and defining with said piston a pump chamber, drive means operably connecting said crankshaft with said cylinder for reciprocating said cylinder on said piston in response to rotation of said crankshaft and means forming intake and discharge passages and valves for said pump chamber, said drive means comprising a scotch yoke mechanism including a crank pin eccentrically mounted on said cranckshaft, a slider carried on said crank pin and a crosshead slidably connected with said slider and connected in fixed relation to said cylinder, said crosshead having a surface along which said slider travels, said intake passage means comprising a passage extending through said cylinder and said crosshead between said pump chamber and said surface of said crosshead, said intake valve means comprising said slider alternately closing and opening said intake passage during reciprocation of said slider on said crosshead in response to rotation of said crankshaft.

2. The combination set forth in claim 1 wherein said discharge valve means comprises a discharge passage connecting said pump chamber with the interior of said piston and a thin metallic generally U-shaped valve member having a flat central portion containing a reed valve and further having a pair of spring arms with detent portions, said piston having means in engagement with said detent portions to thereby removably retain said valve member in operative position in said piston with said reed valve thereof acting as a discharge check valve controlling said discharge passage.

3. In a motor-compressor unit, the combination comprising a casing, a support frame connected to said casing, a motor mounted in said casing, a crankshaft supported by said frame and rotatably driven by said motor, a compressor pump disposed in said casing including a piston connected in a fixed relation to said support frame, a cylinder externally slidably received on said piston and defining with said piston a pump chamber, drive means operably connecting said crankshaft with said cylinder for reciprocating said cylinder on said piston in response to rotation of said crankshaft and means forming intake and discharge passages and valves for said pump chamber, said crankshaft being journalled in a bushing adjacent one end of said crankshaft, and wherein said frame comprises a sheet metal frame disposed transversely of said casing and having a central hub portion receiving said bushing therethrough, said frame being fixedly secured to said bushing and extending radially outwardly from said hub portion to fixed connections with said casing.

4. The combination set forth in claim 3 wherein said frame comprises a generally flat central portion surrounding said hub portion and a plurality of angularly spaced arms connected at their inner ends to said central portion and each having a mounting portion bent at right angles to the outer end of the arm and welded to said casing.

5. The combination set forth in claim 3 wherein said frame comprises a generally cup-like member having a circular rim portion secured to said casing, a side wall of generally frusto-conical configuration and an end wall joined to said side wall, said hub portion comprising said end wall receiving said bushing therethrough and providing the support therefor to form an inboard bearing for said crankshaft, and further including an outboard bearing for said crankshaft comprising a generally U-shaped strut having a central portion extending diametrically of said crankshaft and having a hub portion journalling said crankshaft near the end thereof remote from said one end, said strut having a pair of arms one at each opposite end thereof fixedly connected to said cup-like member.

6. The combination set forth in claim 5 wherein said cup-shaped frame member has a plurality of circumferentially spaced openings in said side wall thereof and a tab bent inwardly in each of said openings, and wherein said motor has an annular stator secured to said tabs of said frame member.

7. The combination set forth in claim 6 wherein said crankshaft is oriented with its axis upright and said hub portion of said end wall of said cup-like frame member has a downwardly depressed portion in the center thereof whereby said inboard bearing is supported at an elevation below the uppermost portion of said end wall so that oil collecting on said end wall drains toward said inboard bearing.

8. The combination set forth in claim 3 wherein said casing comprises a cylindrical tube with a circular end plate inserted at each of the opposite ends thereof and hermetically closing said opposite ends.

9. In a motor-compressor unit, the combination comprising a casing, a support frame connected to said casing, a motor mounted in said casing, a crankshaft supported by said frame and rotatably driven by said motor, a compressor pump disposed in said casing including a piston connected in a fixed relation to said support frame, a cylinder externally slidably received on said piston and defining with said piston a pump chamber, drive means operably connecting said crankshaft with said cylinder for reciprocating said cylinder on said piston in response to rotation of said crankshaft and means forming intake and discharge passages and valves for said pump chamber, said piston comprising a cup-shaped member closed at one end by an integral end wall and having its other end secured in an opening of said casing, said cylinder also comprising a cup-shaped member closed at one end by an integral end wall and receiving said piston with a sliding seal fit through the other open end of said cylinder member, said discharge passage extending through said integral end wall at said one end of said piston to the interior of said piston.

10. The combination set forth in claim 9 wherein said piston is closed at said other end thereof by a plug member and said outlet valve is disposed within said piston adjacent said end wall thereof so that the interior of said piston forms a muffler chamber adjacent said discharge valve means.

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U.S. Cl. X.R.

230—174