United States Patent

Gannaway

[15] **3,695,786**

[45] **Oct. 3, 1972**

[54] **COMPRESSOR AND METHOD OF LUBRICATION**

[72] Inventor: **Edwin L. Gannaway**, Sidney, Ohio

[73] Assignee: **Copeland Refrigeration Corporation**

[22] Filed: **Jan. 27, 1970**

[21] Appl. No.: **6,158**

[52] **U.S. Cl.**.....**417/437**, 184/6

[51] **Int. Cl.**.....**F16n 13/00**

[58] **Field of Search**.....417/437, 521; 418/85–88; 184/6 L

[56] **References Cited**

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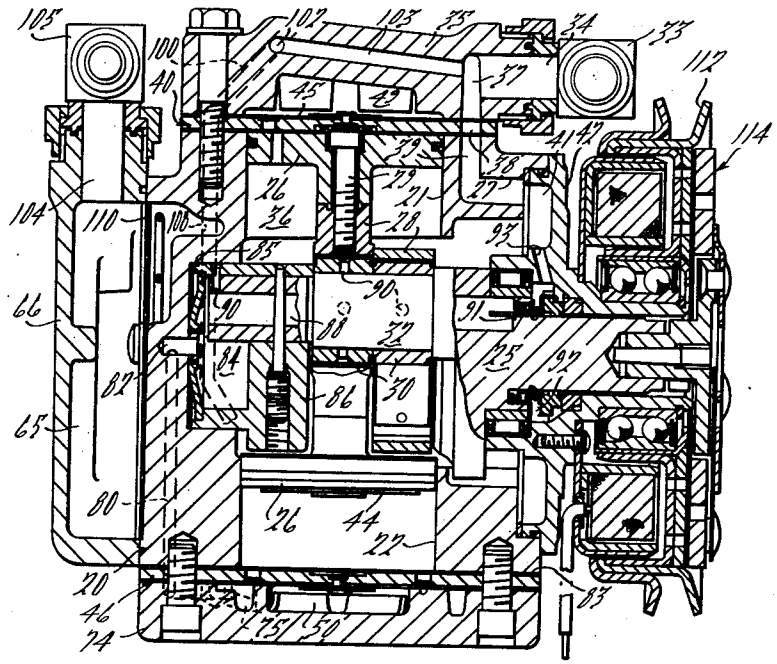
Primary Examiner—William L. Freeh

Attorney—Harness, Dickey & Pierce

[57] **ABSTRACT**

A Scotch yoke refrigeration compressor of the four cylinder X-type has a rear discharge chamber containing a high pressure oil sump from which oil is led through a capillary tube to a cavity in the body containing a low pressure oil sump from which the oil is led to the parts to be lubricated. The pressure of oil in the low pressure sump is materially reduced but somewhat higher than the pressure in the areas of the lubricated parts. A high point of the low pressure sump is vented to a compressor inlet passage area having a pressure slightly below that in the low pressure sump and slightly above that in the areas of the lubricated parts.

7 Claims, 28 Drawing Figures



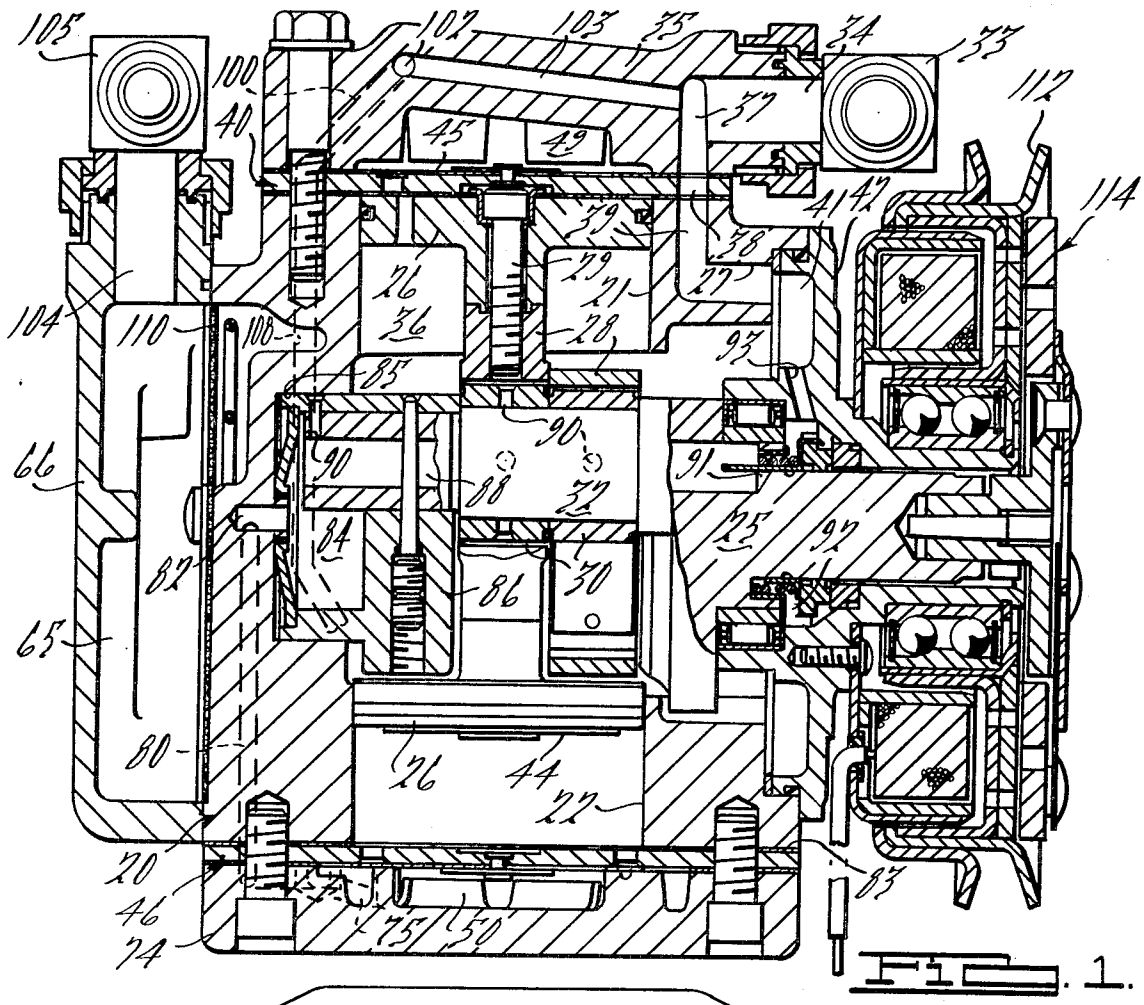


FIG. 1.

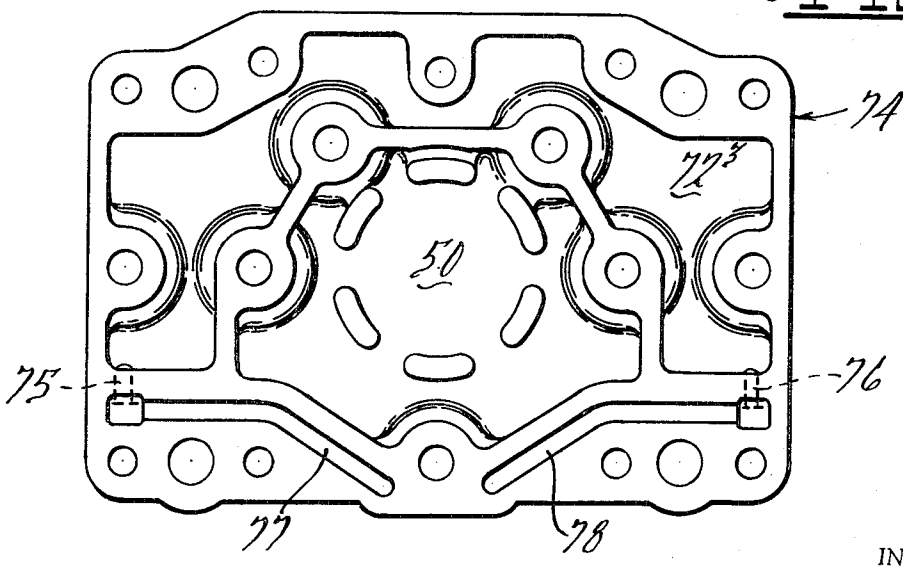


FIG. 4.

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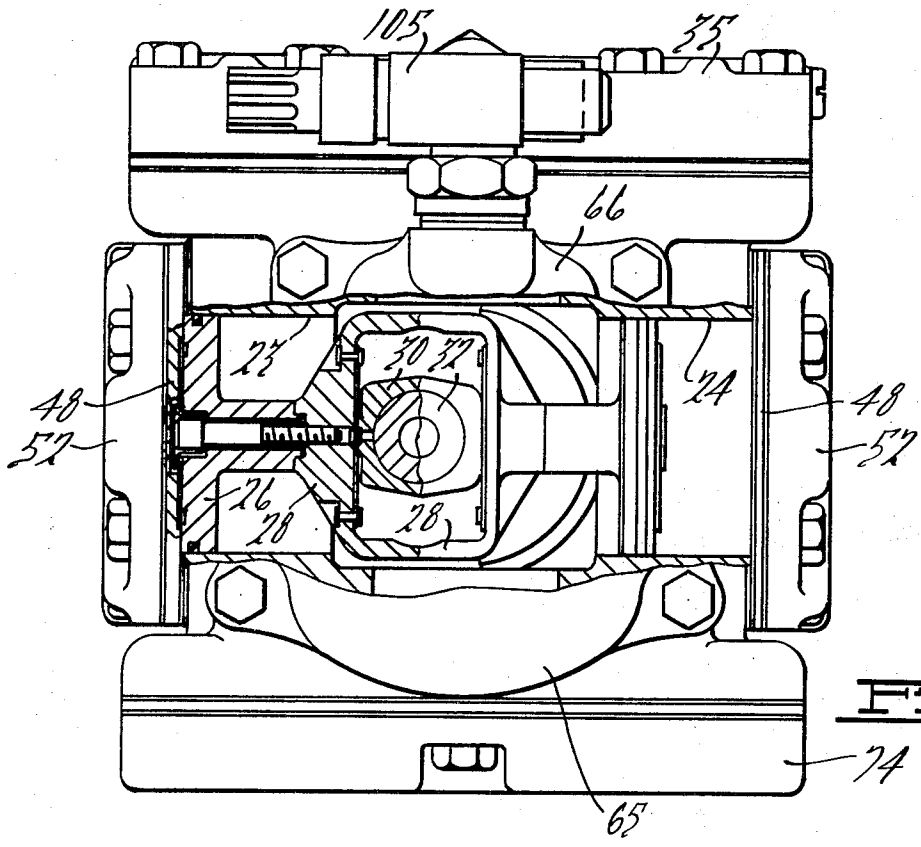


FIG. 2

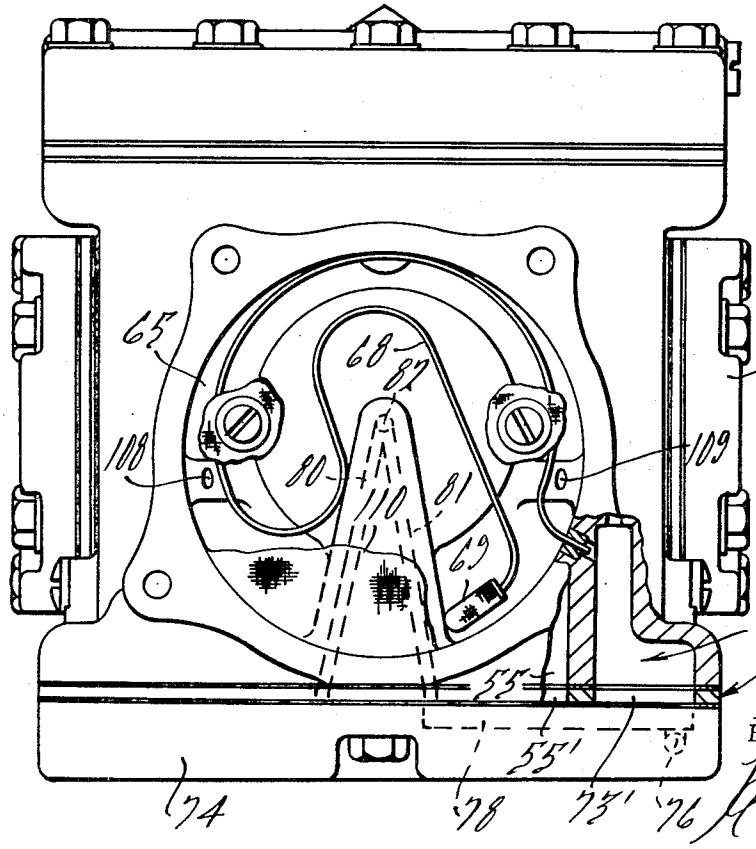


FIG. 3

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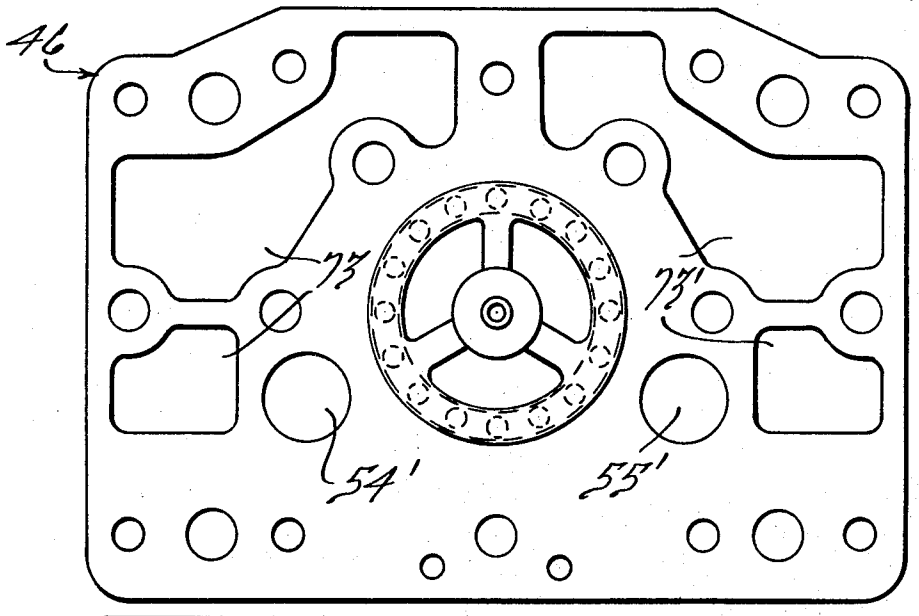


FIG. 5.

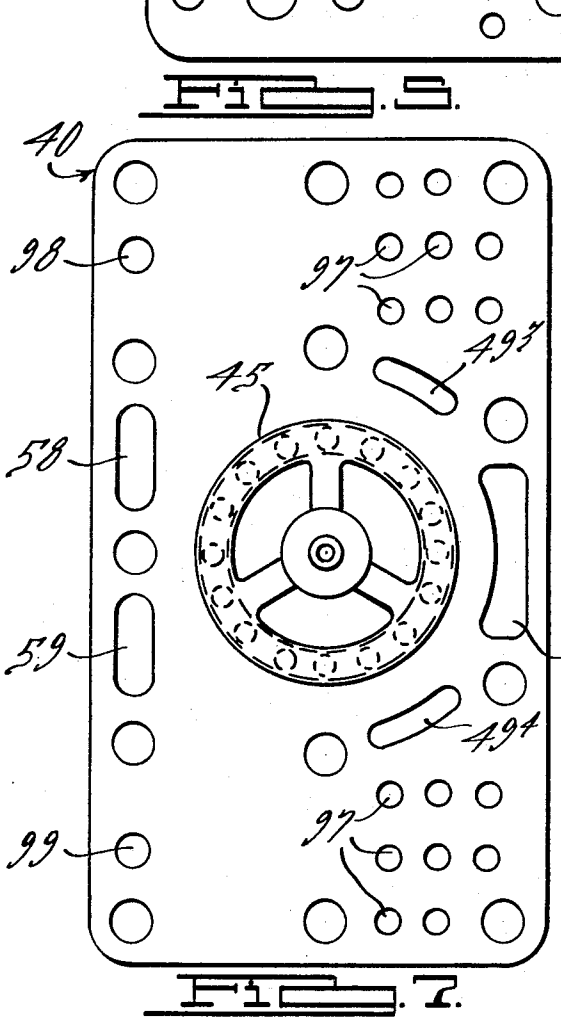


FIG. 7.

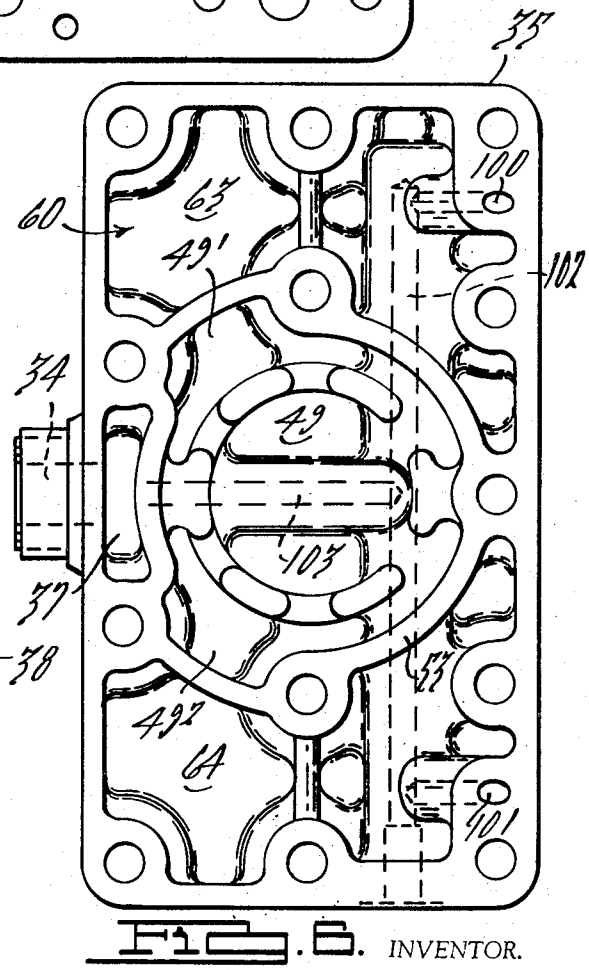


FIG. 6.

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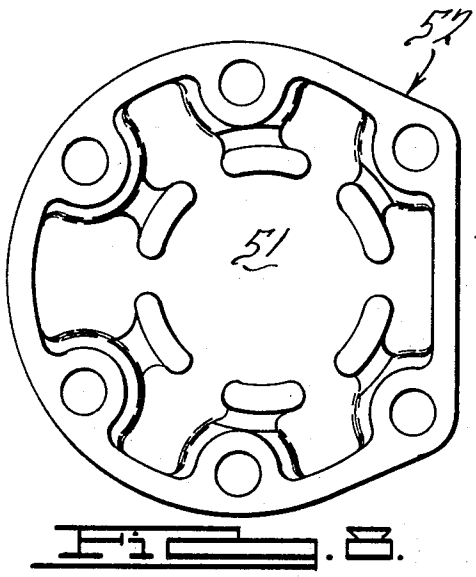


Fig. 8.

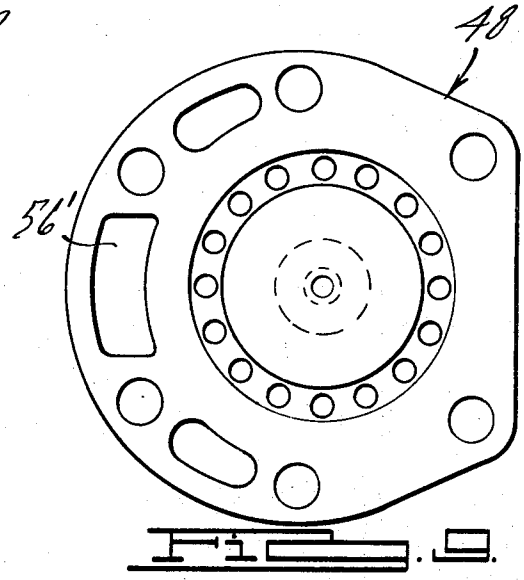


Fig. 9.

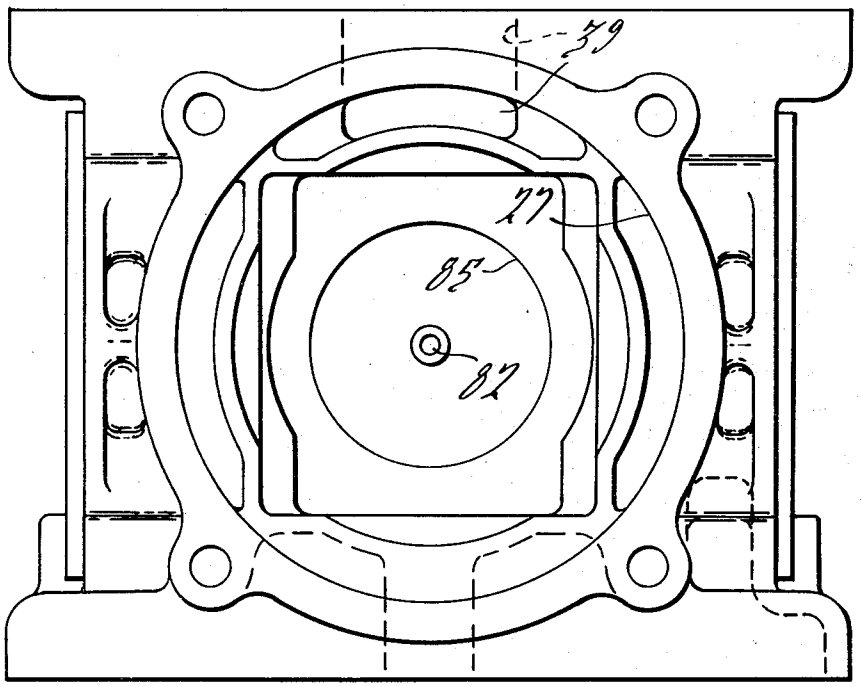


Fig. 10.

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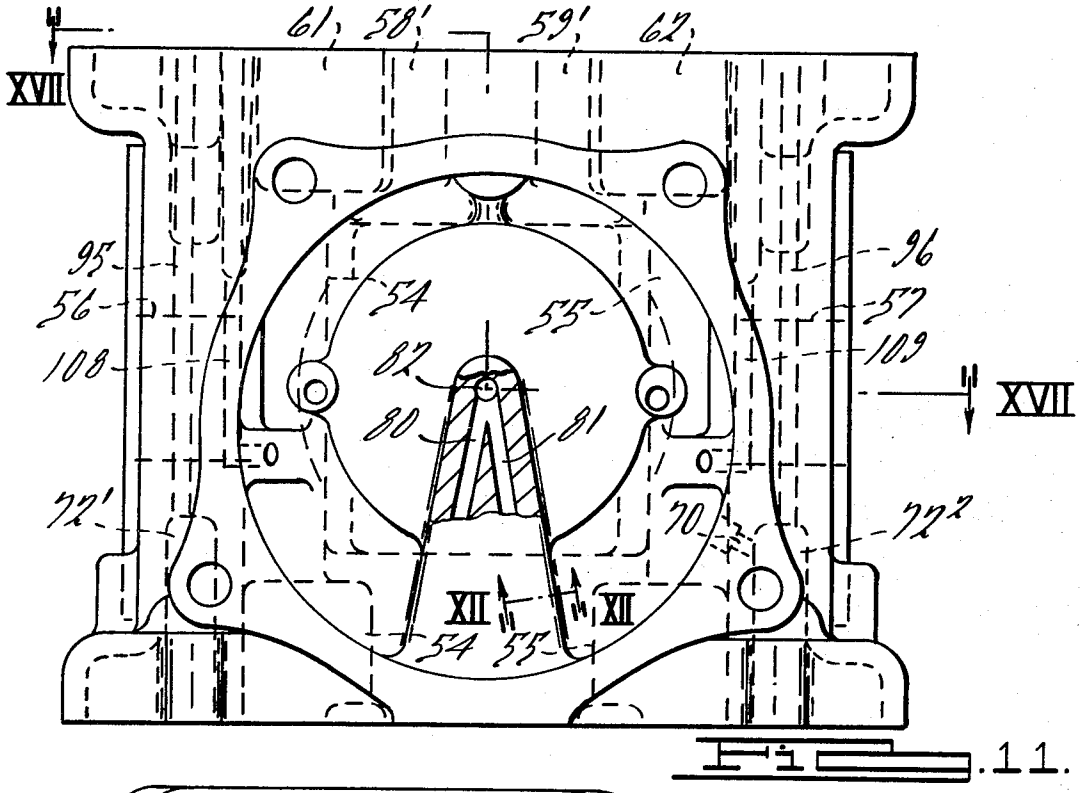
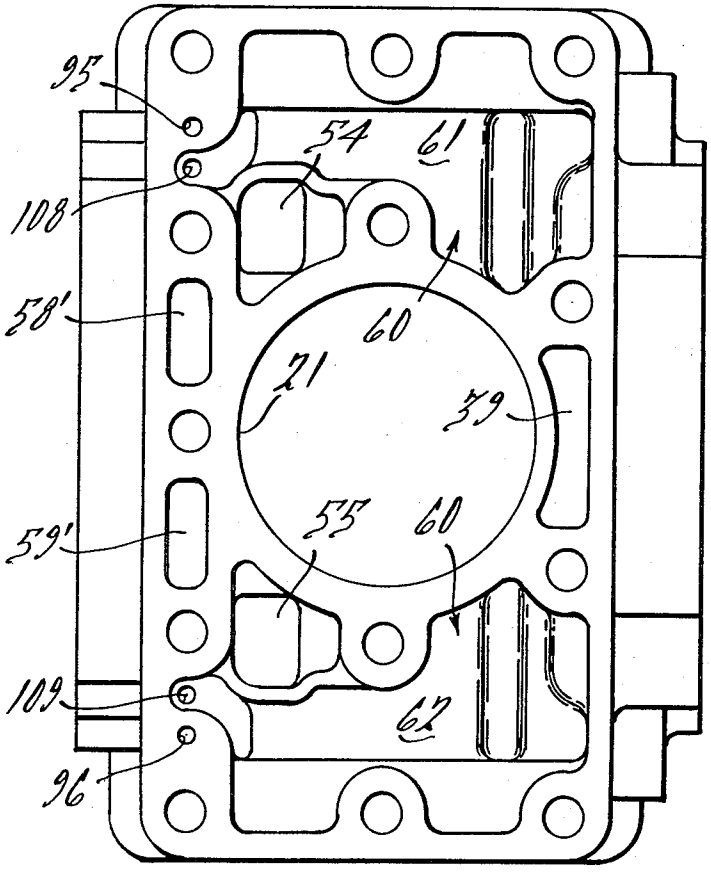


Fig. 11.



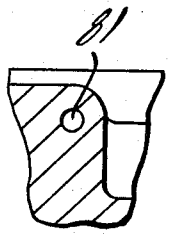


Fig. 12.

Fig. 13.

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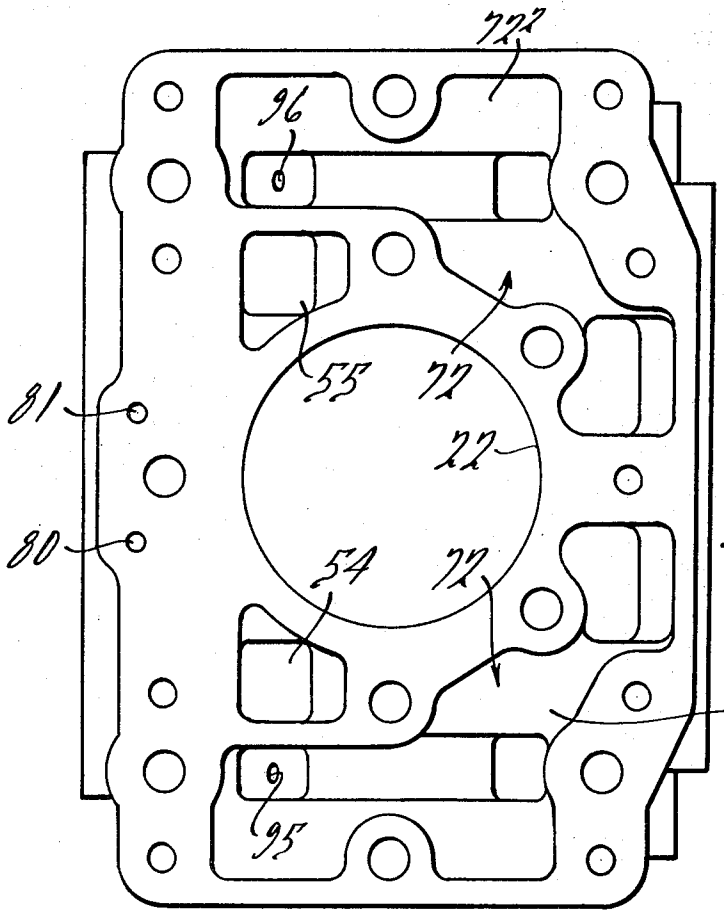


Fig. 14.

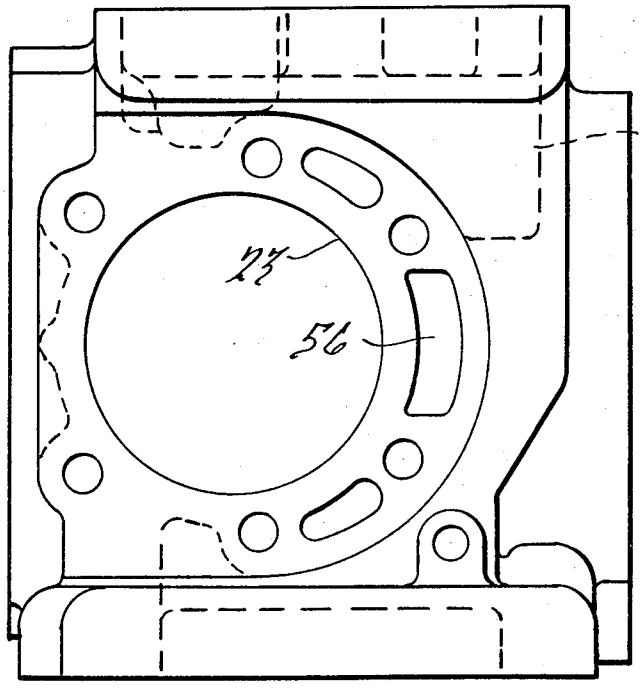


Fig. 15.

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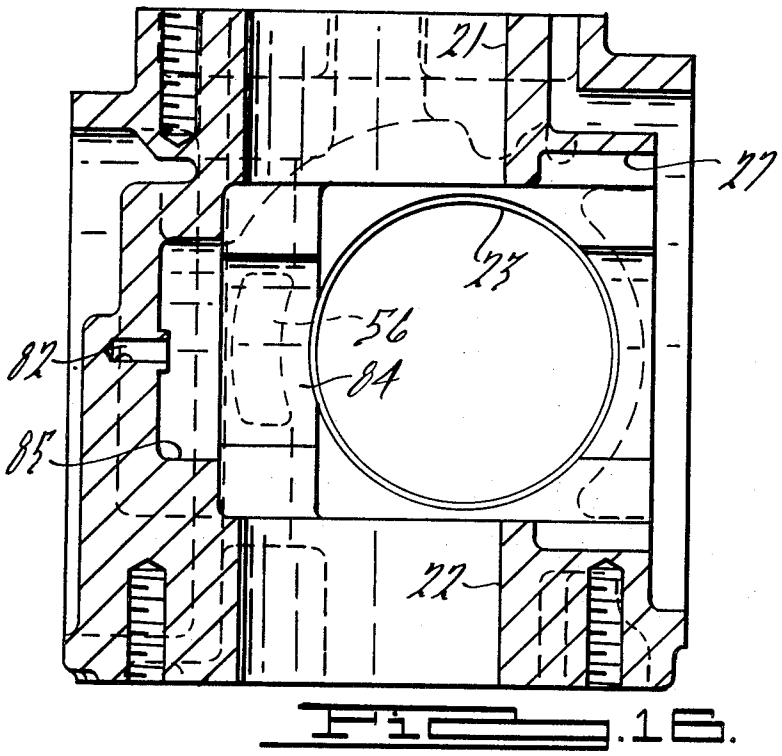


Fig. 16.

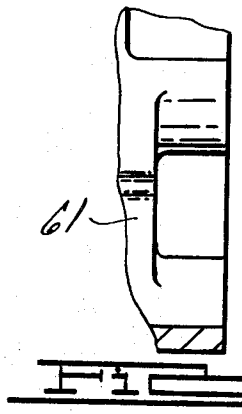


Fig. 18.

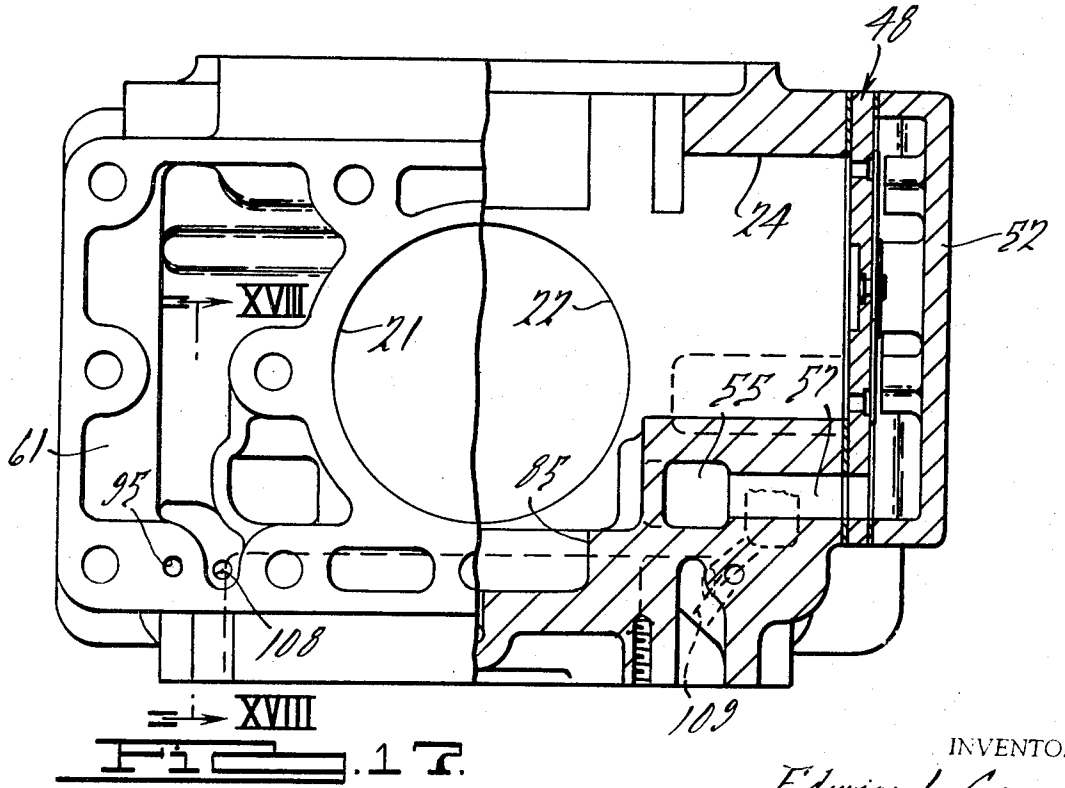


Fig. 17.

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COMPRESSOR AND METHOD OF LUBRICATION

BACKGROUND OF THE INVENTION

The present invention is an improvement upon the lubrication systems disclosed in the copending applications of Edwin L. Gannaway and Robert M. Draper, Ser. No. 747,920 filed July 26, 1968 and Ser. No. 767,030 filed Sept. 9, 1968, now U.S. Pat. No. 3,560,120, granted Feb. 2, 1971, and has as its overall objective the provision of an improved means and method for lubricating the components of refrigeration compressors by a forced feed system powered entirely by discharge pressure, which effectively prevents flooding of the cylinders of the compressor with lubricant during off cycles, and which effectively separates the oil and refrigerant.

Other objects and advantages will be come apparent upon consideration of the present disclosure in its entirety.

BRIEF DESCRIPTION OF THE FIGURES OF DRAWING

FIG. 1 is a central longitudinal sectional view, with parts in elevation, of a compressor incorporating the present invention;

FIG. 2 is a rear elevational view with parts broken away and in section;

FIG. 3 is a rear elevational view with the rear cover removed and a screen assembly partly broken away;

FIG. 4 is a top plan view of the bottom head;

FIG. 5 is a bottom plan view of the bottom valve plate;

FIG. 6 is a bottom plan view of the top head;

FIG. 7 is a top plan view of the top valve plate;

FIG. 8 is a plan view of the inner face of one of the side heads;

FIG. 9 is a plan view of the outer face of one of the side valve plates;

FIG. 10 is a front elevational view of the body;

FIG. 11 is a rear elevational view of the body, partly broken away;

FIG. 12 is a detailed sectional elevational view taken substantially on the line XII—XII of FIG. 11 and looking in the direction of the arrows;

FIG. 13 is a top plan view of the body;

FIG. 14 is a bottom plan view of the body;

FIG. 15 is a side elevational view of the body;

FIG. 16 is a central vertical sectional elevational view of the body;

FIG. 17 is a sectional elevational view taken substantially on the line XVII—XVII of FIG. 11 and looking in the direction of the arrows, showing one of the side heads in section;

FIG. 18 is a detailed sectional elevational view taken substantially on the line XVIII—XVIII of FIG. 17 and looking in the direction of the arrows and

FIGS. 19–28 inclusive are diagrammatic views corresponding generally to FIGS. 1, 3, 4, 5, 6, 7, 9, 13, 14 and 17 respectively, in which outlines of passages, chambers and ports are shown with coded hatchings designating relative pressure conditions.

DETAILED DESCRIPTION OF PREFERRED FORM OF THE INVENTION

The principal moving parts of my preferred compressor construction are similar to those disclosed in the aforementioned patent application Ser. No. 747,920, and many of these will not require detailed description herein, the present invention being carried out mainly by altered arrangement and configuration of walls, ports passages and chambering of the block or body, heads, valve plates, covers, etc.

The cast aluminum block, **20**, contains four cylinders, **21–24** inclusive, arranged at 90° to each other and perpendicular to the longitudinal axis of rotation of the crankshaft **25**. The coaxial vertical pair of opposed cylinders **21,22** is offset rearwardly from the horizontal coaxial pair of opposed cylinders **23, 24**. A rigid dual piston assembly is contained in each pair of cylinders, the pistons **26** of each pair being united by a centrally positioned Scotch yoke **28** actuatable by a slide **30** driven by a throw **32** of the crankshaft.

The inlet process valve **33** delivers suction gas to an entrance chamber **34** in top head **35** which communicates with the central low pressure crankcase area **36** centered in the block **20**. Suction gas entering chamber **34** flows downwardly therefrom through passages **37, 38, 39** in the head **35**, top valve plate **40**, and block **20** respectively. The lower end of passage **39** opens forwardly into a chamber **41**, the forward portion of which is defined by the front bearing support plate **42**. Chamber **41** opens rearwardly into the crankcase area **36** beneath the pistons, which are ported and provided with intake valves **44** on their head surfaces in known manner. Also in known manner, the valve plates for the individual cylinders are provided on their outer surfaces with exhaust valves **45**. The bottom valve plate is designated **46** and the side valve plates are designated **48**. The compressed gas is conducted from the outer ends of the cylinders via centrally positioned outlet chambers **49, 50** in the top and bottom heads, respectively, and **51** in the side heads **52**. (The side heads are alike) Chambers **49, 50, 51** communicate via cored passages in the block, identified by reference numbers **54–57** inclusive with a high pressure chamber generally designated **60** and formed partly of two sections, **61, 62** in the upper portion of the block and partly of sections **63, 64** located in top head **35** on either side of outlet chamber **49**. The high pressure chamber **60** communicates via passages **58, 59** in the top valve plate, and connected downflow passages **58', 59'** cored in the rear wall of the block, with a combined discharge chamber and oil sump **65** of substantially annular form formed partly in the rear wall of the block and partly in the rear cover **66**.

The front of the block has an opening **27** of large cross section which is closed and sealed by the front closure **42** and through which the crankshaft and all attached internal parts are installed with the exception of the pistons, which are installed through the open outer ends of the cylinders and secured to the yokes by axial screws **29**. The suction gas enters the compressor crankcase area through the front, as indicated.

The fact that the horizontal cylinders are positioned forwardly of the vertical cylinders and the rear crankshaft parts are of lesser diameter permits the vertical high pressure passages **54, 55** and connecting

horizontal passages **56, 57** for the outlet gas from the several cylinders, as well as drain holes **108, 109**, to be accommodated in the block areas on either side of the wall bounding the bearing bore **85** and behind the horizontal cylinders.

The inner ends of the horizontal outlet gas passages **56, 57** intersect the risers **54, 55**. The bottom ends of the risers **54, 55** and the outer ends of the connecting passages **56, 57** open at the bottom and side surfaces of the block for connection with the outlet head chambers **50** and **51** respectively through connecting openings **54', 55', 56'**, in the valve plates, to receive discharge gas from the bottom and side cylinders and conduct it to the high pressure chamber sections **61, 62** at the top of the block. The top head discharge chamber **49** has extension portions **49', 49^2** extending angularly laterally and forwardly to overlie sections **61, 62** providing free communication between discharge chamber **49** of the top cylinder and high pressure chamber **60** through openings **49^3, 49^4** in top valve plate **40**. The wall **53** bounding the discharge chamber **49** and extensions **49', 49^2** therefore acts in compression to support and stiffen the head, and assists in isolating the suction downflow passage **37**, but does not isolate from each other the chamber portions **49, 61, 62, 63, 64**. Additional holes **97** are formed in the top valve plate to provide a larger cross sectional area of communication for flow of discharge gas from the lower three cylinders and the block sections **61, 62** of the first discharge chamber **60** to the head sections **63, 64**, from which it is led via holes and passages **58, 58', 59, 59'** to the main discharge chamber **65**.

Oil which collects in the bottom of chamber **65** is forced by the discharge pressure through a capillary tube **68** having a screened inlet end in the bottom sump portion of the chamber **65**, thence through a drilled passage **70** into a relatively large low pressure oil sump chamber **72** formed partly in the bottom area of the block (in two sections, **72', 72^2** on either side) and partly in the bottom head **74**, wherein the chambered section is designated **72^3** and extends around the front and sides of outlet chamber **50**. Suitable openings **73, 73'** in the bottom valve plate **46** coact in forming portions of the low pressure sump **72** by connecting the portions of the latter which are formed in the block and bottom head **74** respectively.

From opposite side corner portions near the bottom of the bottom head section **72^3** of sump chamber **72** out flow passages **75, 76** extend angularly upwardly and rearwardly to connect with channels **77, 78** in the top surface of bottom head **74** and which extend horizontally inwardly toward the vertical center plane of the compressor for communication with one of the riser passages **80, 81** which extend upwardly to communicate with an axial passage **82** which extends forwardly to communicate with a chamber **84** in the rear crankshaft bearing opening **85** formed in the rear wall of the block.

The disclosed compressor construction is particularly suitable for automotive air conditioning systems and is normally installed with the crankshaft positioned lengthwise of the vehicle. In order to insure that oil is taken from the low point of the high pressure sump, the compressor may be installed slightly tilted toward the right or left, the riser **80** or **81** on the high side being blocked off by the gasket **83** between the valve plate **46** and bottom head, the gasket being orificed only in registry with the lower of the two feed passage systems **77–80** and **78–81**.

The chamber **84** is formed partly by a hollowed out portion of a combined counterweight and rear male bearing portion **86** secured to the rear end of the crankshaft. The rear end of oil passage **88** in the crankshaft opens into chamber **84** to conduct oil therefrom to areas to be lubricated and which are fed from passage **88** via distribution ports as **90, 91**. Port **91** delivers oil to the seal chamber **92**, which is vented to inlet chamber **41** by a passage **93**.

From the upper portions of the low pressure sump sections **72', 72^2** in each side of the block, riser passages **95, 96** extend upwardly and communicate through openings **98, 99** in the top valve plate **40** and connecting passages **100, 101, 102** in top head **35** with a passage **103** which extends forwardly through head **35** and opens into the inlet chamber **34** in alignment with the inlet opening thereinto from the process valve **33**.

Oil which is pumped with the refrigerant through the compressor and which is discharged into the outlet chamber **65** is projected downwardly into the latter chamber through the passages **58', 59'**, while the gas must reverse its flow in order to pass upwardly through outlet passage **104** to the discharge valve **105**. Due to such change of direction, the oil is effectively separated from the gas and retained in the sump space at the bottom of chamber **65**. Oil which is separated in the high pressure chamber areas in the upper head and block portions drains from the latter to sump chamber **65** through drilled drain passages **108, 109** in the block. Agglomeration and separation of the oil from the gas is also assisted by a multiple screen assembly, generally designated **110** secured to the rear of the block and segregating the portion of chamber **65** in the block from the portion in the rear cover **66**. The inlet screen **69** for the capillary tube **68** is located on the block side of the screen assembly **110**.

In operation, when the compressor is driven by a suitable source of power (not shown) applied to the pulley portion **112** of the magnetic clutch assembly **114** which drives the crankshaft, oil in the high pressure sump space in chamber **65** is driven by outlet pressure through the capillary tube **68** to the low pressure oil sump **72**. The capillary tube feeds oil at a desired rate to the low pressure oil sump **72**. The pressure in sump **72** is slightly higher than that in the crankcase area **36**. For example, if the discharge pressure in chamber **65** is of the order of 250 psi, the pressure in sump **72** might be 40 psi, while crankcase pressure might be of the order of 38 psi. The pressure at the mouth of passage **103** in inlet chamber **34** will be slightly below the pressure in chamber **72**, but slightly above crankcase pressure. Thus the sump **72** is actually at an intermediate pressure. In the preferred construction shown, the ramming effect of the inflowing gas which is directed against the mouth of passage **103** assists in maintaining the pressure at the chamber end of the passage **103** slightly higher than the pressure in the crankcase area, yet low enough so that gas which separates from the refrigerant in sump **72** and which has entered the latter with the oil is vented via passage **103** to the intake.

Normally only gas passes to the intake via passage **103**. A slight pressure drop of course also occurs in the passages **37**, **41**, etc., leading to the crankcase area **36** which contains the parts to be lubricated, so that the pressure differential between sump **72** and the crankcase area is sufficient to insure positive lubrication. Thus failure of lubrication due to refrigerant vapor in the oil passages and flooding of the cylinders with oil during off cycles of the compressor, are effectively prevented. The capacity of the sump **72** is sufficient to accommodate the full quantity of lubricant, and the pressure in sump **72** and in the crankcase space immediately equalizes when the compressor stops.

This Detailed Description of Preferred Form of the Invention, and the accompanying drawings, have been furnished in compliance with the statutory requirement to set forth the best mode contemplated by the inventor of carrying out the invention. The prior portions consisting of the "Abstract of the Disclosure" and the "-Background of the Invention" are furnished without prejudice in an effort to comply with administrative requirements of the Patent Office.

What is claimed is:

1. A refrigeration compressor having an inlet area, a discharge chamber, a low pressure region containing parts to be lubricated, a high pressure oil sump pressurized by said discharge chamber, a second chamber defining a low pressure oil sump, pressure reducing oil-conducting means connecting said high pressure oil sump to said second chamber and tending to maintain said second chamber at a pressure somewhat above that in said low pressure region but substantially below that in high pressure sump, and conduit portions connecting a lower portion of said low pressure oil sump to said parts to be lubricated, the capacity of the low pressure oil sump being sufficient to accommodate the entire oil supply of the compressor.

2. A compressor as defined in claim **1** wherein said low pressure region is at a pressure somewhat below that in said inlet area when the compressor is running, and vent means connecting said second chamber to said inlet area.

3. A compressor as defined in claim **2** including a body having said second chamber in a lower portion thereof and said last mentioned low pressure area in an upper portion thereof

4. In a compressor as defined in claim **2**, a body having said low pressure oil sump chamber located near the bottom and said low pressure area in an upper portion thereof.

5. A refrigeration compressor as defined in claim **2** including a body, a crankshaft journaled therein and drivable from one end, a plurality of radial cylinders perpendicular to the axis of the crankshaft, said discharge chamber and high pressure oil sump being combined in a single chamber located at a part of the body appurtenant to the other end of the crankshaft, the second chamber being located in a lower portion of the body, said means connecting the low pressure oil sump to the parts to be lubricated being connected to a bottom area of said second chamber and leading to an end of said crankshaft opposite the drivable end, and said vent means being connected to an upper area of said second chamber.

6. The method of lubricating a refrigeration compressor having a low pressure suction area containing parts to be lubricated, a high pressure discharge area, and a charge of lubricant, which comprises collecting lubricant form the compressor discharge in a high pressure sump and pressurizing it by pressure from the discharge area, conducting lubricant from said high pressure sump to an intermediate pressure sump having a capacity sufficient to accommodate the entire charge, while reducing its pressure to a value lower than that in the discharge area but higher than that in said suction area, and conducting lubricant from said intermediate pressure sump to the parts to be lubricated.

7. A method as defined in claim **6** for use with a compressor having an inlet area wherein the operating pressure is below that in the intermediate pressure sump but above that in said suction area, and wherein gas is liberated from the lubricant in the intermediate pressure sump, comprising the further step of conducting gas from an upper portion of the intermediate pressure sump to said inlet area.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,695,786 Dated October 3, 1972

Inventor(s) Edwin L. Gannaway

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the heading of Sheet 1 of the drawing, change "Sheet 1 of 7" to read --Sheet 1 of 11--.
On the heading of Sheet 2 of the drawing, change "Sheet 2 of 7" to read --Sheet 2 of 11--.
On the heading of Sheet 3 of the drawing, change "Sheet 3 of 7" to read --Sheet 3 of 11--.
On the heading of Sheet 4 of the drawing, change "Sheet 4 of 7" to read --Sheet 4 of 11--.
On the heading of Sheet 5 of the drawing, change "Sheet 5 of 7" to read --Sheet 5 of 11--.
On the heading of Sheet 6 of the drawing, change "Sheet 6 of 7" to read --Sheet 6 of 11--.
On the heading of Sheet 7 of the drawing, change "Sheet 7 of 7" to read --Sheet 7 of 11--.
Add sheets 8 to 11 inclusive of the drawing, as attached hereto.

Signed and sealed this 12th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334

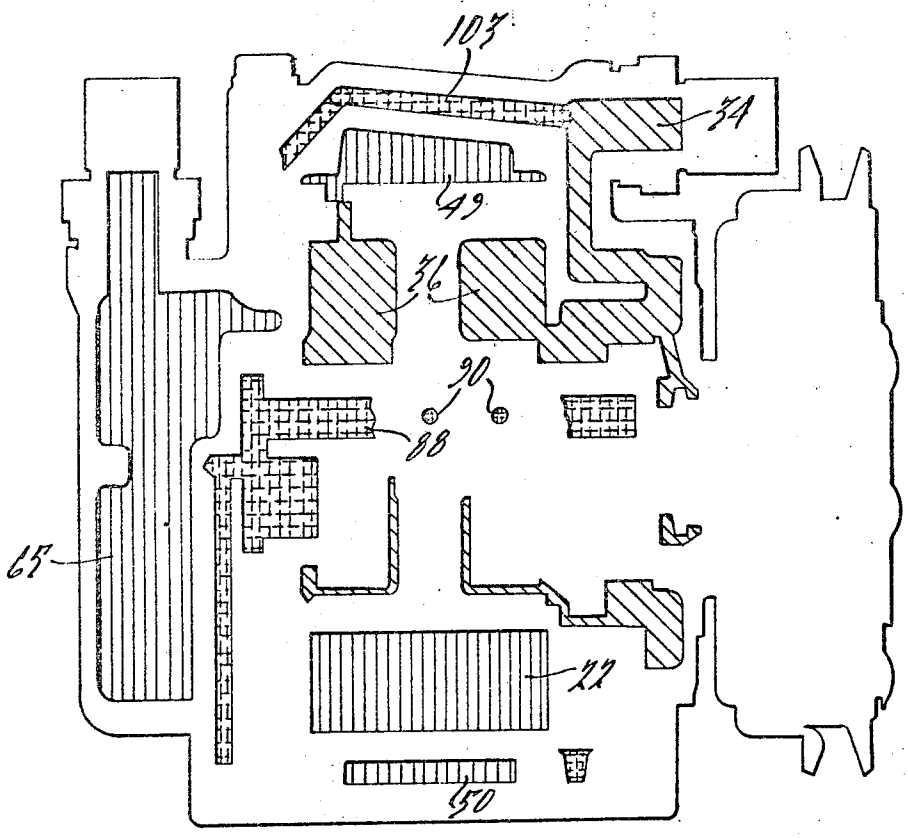
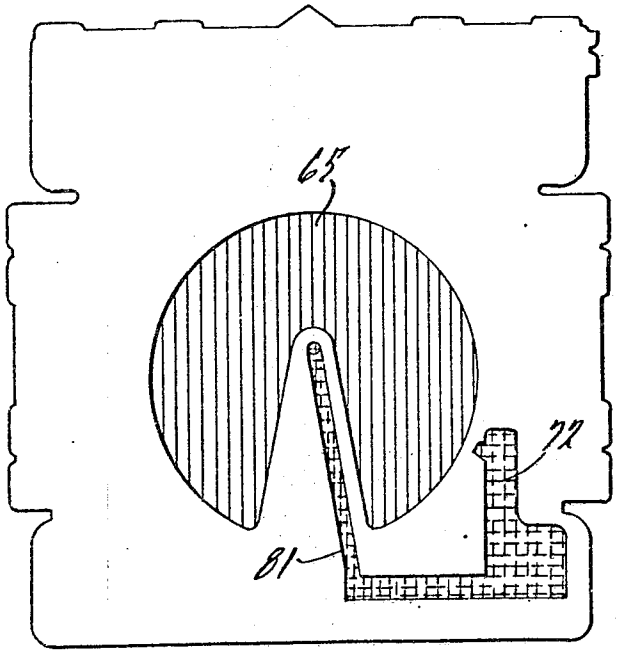


Fig. 19.

Discharge Pressure (High)

Lubrication Pressure (Intermediate)

Suction (Inlet) Pressure (Low)



Rear

Fig. 20.

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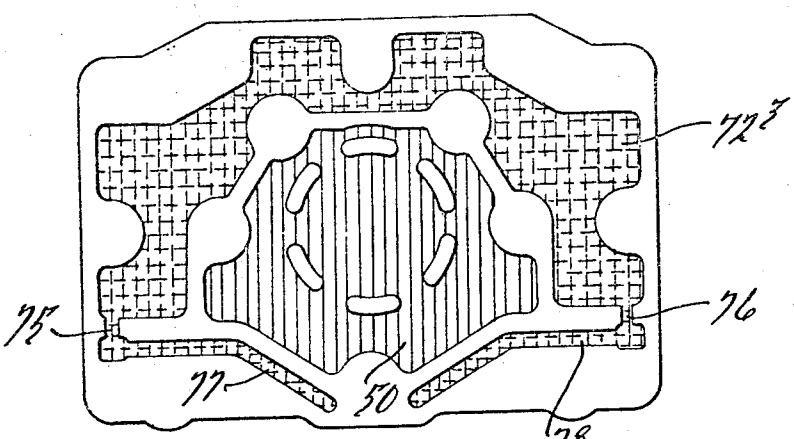
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PATENTED OCT 3 1972

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SHEET 09 OF 11

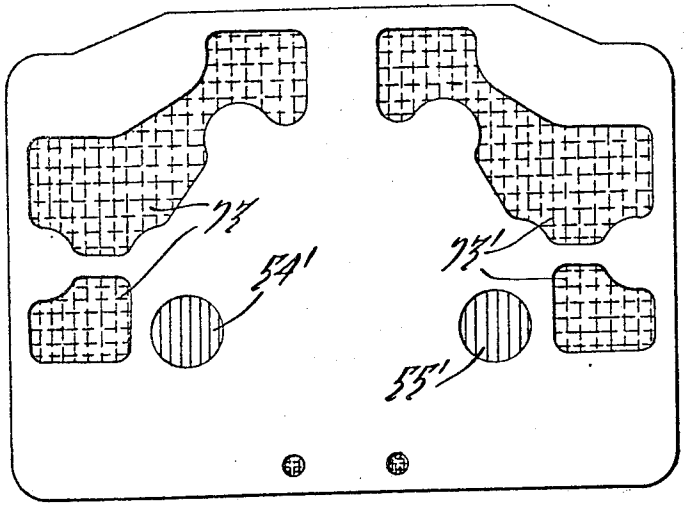


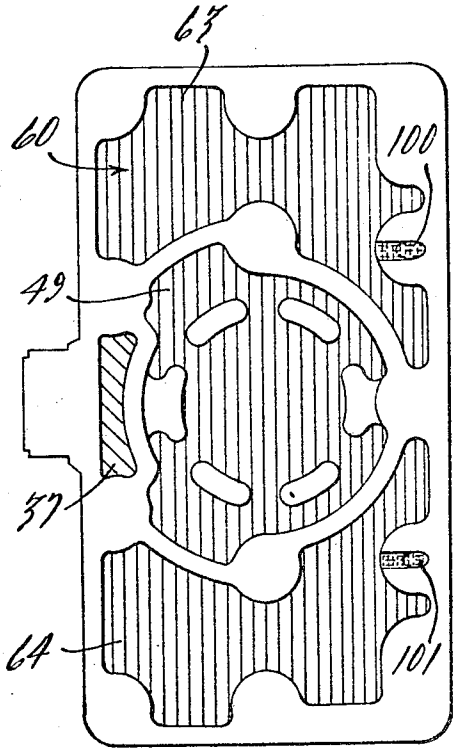
Bottom Head, Top Plan

FIG. 21.

FIG. 22.

Bottom Valve Plate, Bottom Plan

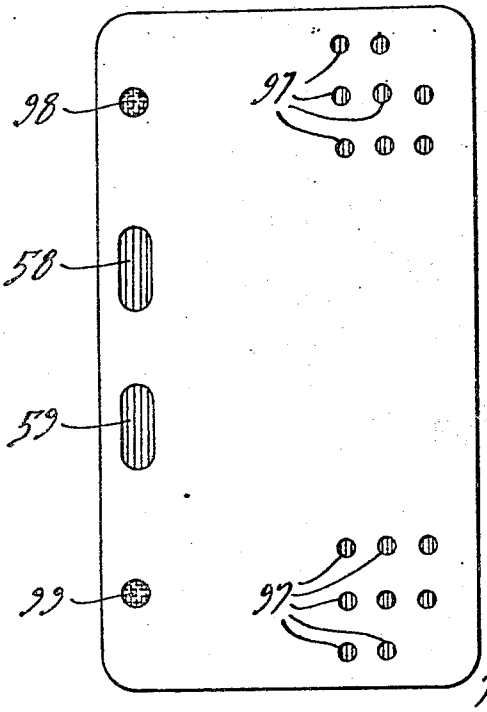




Top Head, Bottom Plan

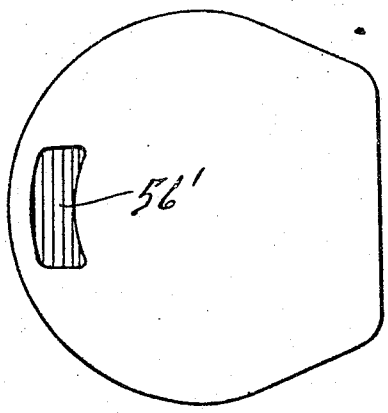
FIG. 23.

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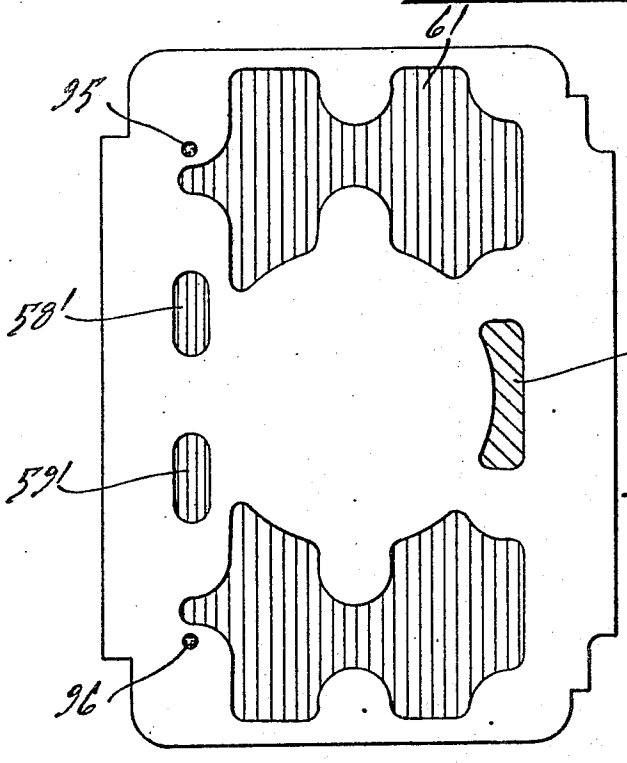
Top Valve Plate, Top Plan

FIG. 24.



Side Valve Plate, Outer Face

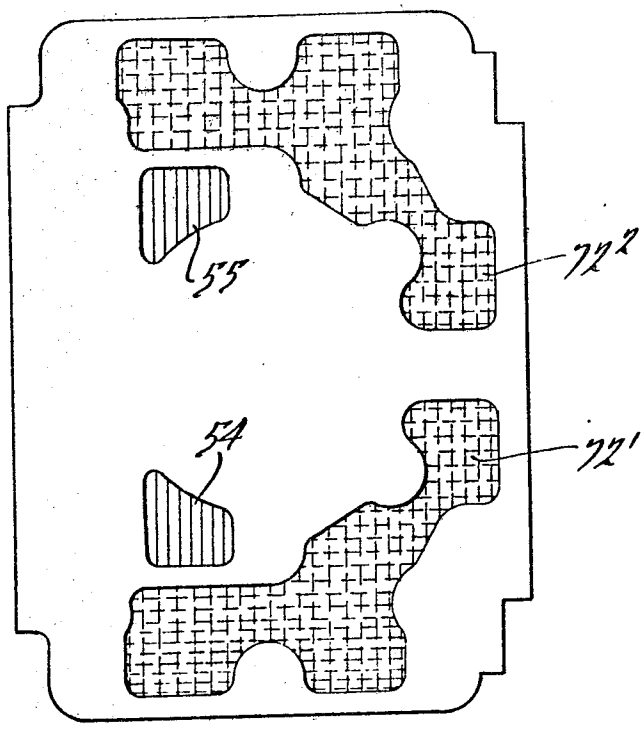
FIG. 25.



Block, Plan

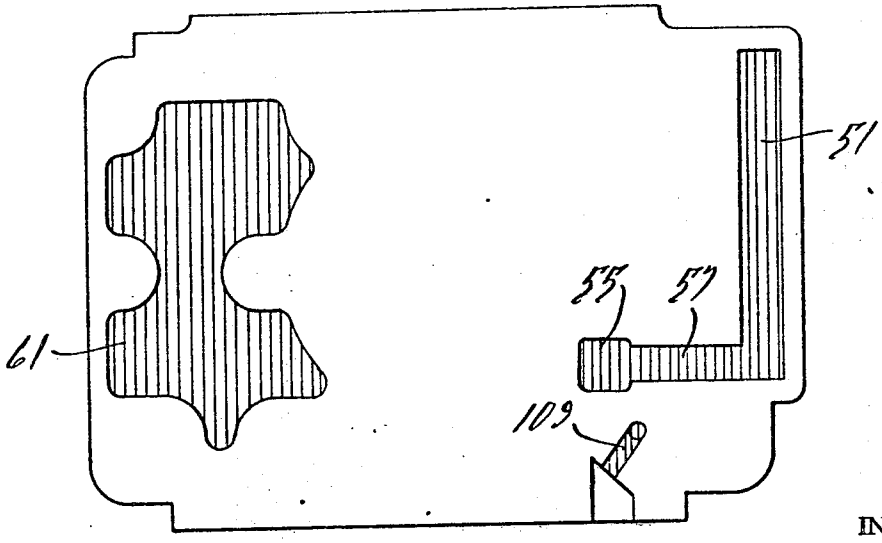
FIG. 26.

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Block, Bottom Plan

FIG. 27.



Horizontal Section On Fig. 11

FIG. 28.

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