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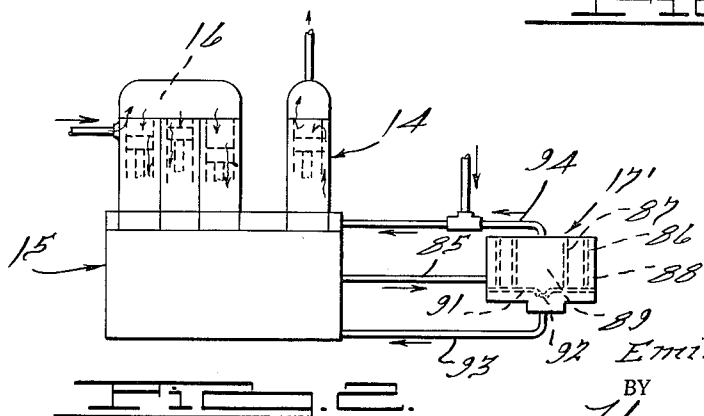
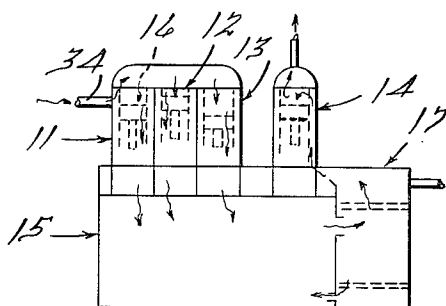
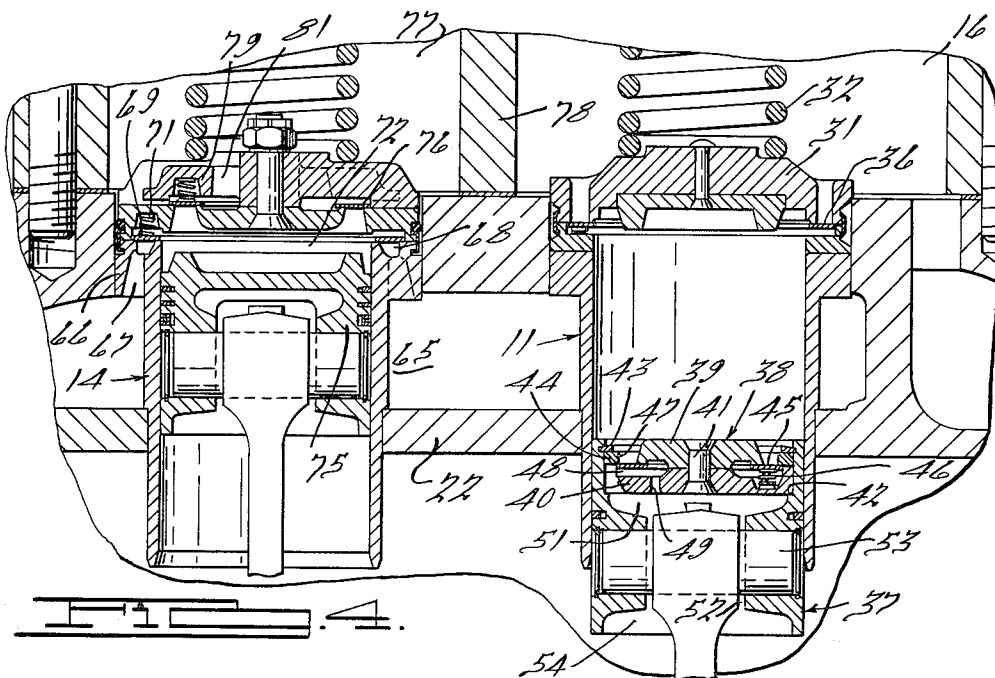
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TWO-STAGE REFRIGERANT COMPRESSOR

Filed Feb. 6, 1964

2 Sheets-Sheet 1



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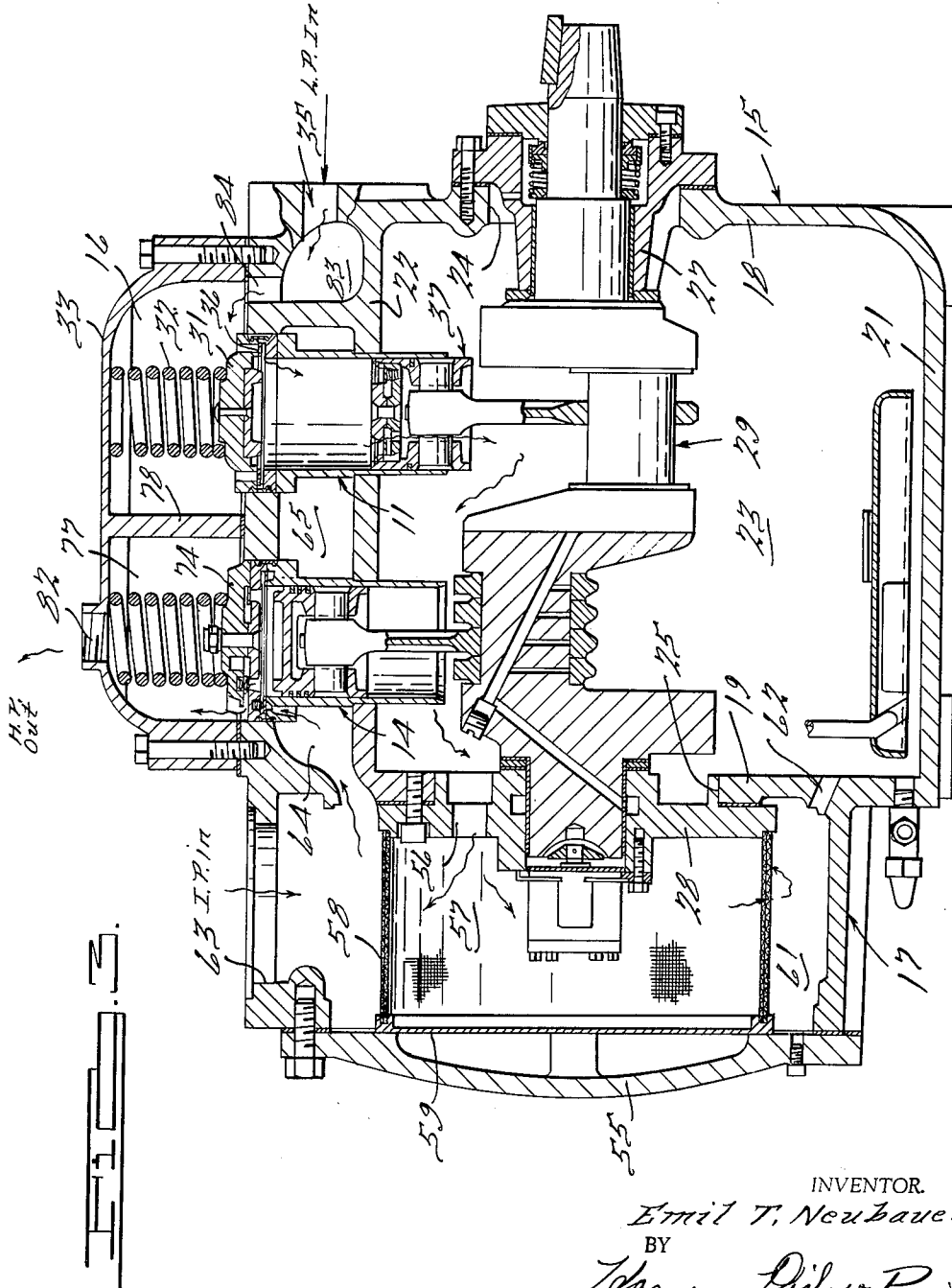
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2 Sheets-Sheet 2



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3,204,865
TWO-STAGE REFRIGERANT COMPRESSOR
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4 Claims. (Cl. 230-206)

This invention relates to refrigerant compressors, and more particularly to multiple stage piston-and-cylinder compressors in which the intermediate stage gases are delivered to the crankcase which contains lubricating oil.

It is an object of the present invention to provide a novel and improved refrigerant compressor of this type which affords a simple and compact compressor layout while at the same time avoiding entraining of lubricant from the crankcase in the refrigerant gases, which might remove excessive amounts of lubricant, especially during start-up times when the oil has a high foaming tendency, and which would adversely affect system operation by loading it up with lubricant.

It is another object to provide an improved two-stage refrigerant compressor of this type which permits multiple cylinder single-stage compressors of known types to be adapted for two-stage operation with a minimum of cost and additional parts.

Other objects, features and advantages of the present invention will become apparent from the subsequent description, taken in conjunction with the accompanying drawings.

In the drawings:

FIGURE 1 is a schematic view showing the principles of operation of the invention, in which the bypass from the intermediate to the high pressure stage is incorporated with the compressor housing;

FIGURE 2 is a view similar to FIGURE 1 but showing a modified form of the invention in which the bypass is exterior to the compressor housing;

FIGURE 3 is a cross-sectional view in elevation showing a suitable construction incorporating the principles of the invention shown in FIGURE 1; and

FIGURE 4 is an enlarged fragmentary view of that portion of FIGURE 3 showing the pistons, cylinders and associated valves.

Briefly, each illustrated embodiment of the invention comprises a four-cylinder two-stage refrigerant compressor in which three cylinders, generally indicated at 11, 12 and 13, are used for the low stage and a fourth cylinder generally indicated at 14 in FIGURES 1 and 2 for the high stage. The pistons for these cylinders are connected to a common crankshaft within a crankcase generally indicated at 15 in FIGURES 1 and 2, and the suction or inlet gases are delivered to a cylinder head chamber 16 for the three low stage cylinders and are compressed thereby. The initially compressed gases pass from the low stage cylinders through their own pistons to the interior of crankcase 15, the latter of course having lubricating oil therein.

The invention contemplates the use of a bypass which leads the refrigerant gases from the crankcase, in which they have a pressure intermediate that of the low and high stages, to the high stage cylinder. This bypass is indicated generally at 17 in FIGURE 1 and at 17' in FIGURE 2. In each case, the bypass receives the refrigerant gases and any lubricating oil entrained therein, passes the gases through a filter while changing their direction and increasing their volume so as to facilitate entrapment and removal of the entrained lubricant, and delivers them to the second stage cylinder through a pressure-responsive inlet valve. The gases compressed in the second stage by the piston, which is of a standard type without any valves, is delivered through another

cylinder head chamber to the system. The result is a compact two-stage compressor construction using mostly standard parts which nevertheless avoids the entrainment of lubricating oil in the refrigerant gases delivered to the high-pressure stage and to the system itself.

Referring more particularly to FIGURES 3 and 4 of the drawings, crankcase 15 has side walls 18 and 19, a floor 21, and an upper portion 22 forming a crankcase chamber 23. Walls 18 and 19 have aligned apertures 24 and 25 respectively, in which are mounted bearing supporting members 27 and 28, these members carrying bearing assemblies which support opposite ends of a crankshaft generally indicated at 29.

Upper portion 22 of housing 15 supports low stage cylinders 11, 12 and 13, one cylinder 11 being shown in FIGURES 3 and 4. The cylinder has a suction valve assembly 31 supported by a conventional spring 32 within chamber 16 of a cylinder head 33.

An inlet 34, seen in FIGURE 1, leads to chamber 16 within cylinder head 33 by means of an L-shaped passage generally indicated at 35 in portion 22 of housing 15, as seen in FIGURE 3. Low pressure suction valve assembly 31 is provided with an ordinary inlet valve 36 leading to the chamber of cylinder 11. The piston generally indicated at 37 which is slidably mounted in cylinder 11 is provided with means for transferring the gases compressed within cylinder 11 to crankcase chamber 23. This means is best seen in FIGURE 4 and includes a valve supporting subassembly generally indicated at 38 mounted in the upper recessed portion of cylinder piston 37. Subassembly 38 comprises two circular members 39 and 40 which are secured together by a rivet 41 and are held against a shoulder 42 by a removable snap ring 43 and a ring 44. An annular discharge valve member 45 is disposed between members 39 and 40, and in particular is adapted to seat against the undersides of member 39 and ring 44, as urged by a plurality of circumferentially spaced helical coil compression springs, one of which is shown at 46. An annular passage 47 is formed between member 39 and ring 44, valve member 45 closing this passage when it engages member 39 and ring 44. When member 45 is pushed downwardly away from its engagement with member 39 and ring 44, against the urging of springs 46, passage 47 will be connected with an annular space 48 in member 40 which is connected with a plurality of circumferentially spaced passages 49 in this member. Passages 49 lead downwardly into a space 51 formed in piston 37, this chamber leading to an annular space 52 which passes the wrist pin 53 and opens into a chamber 54 which opens downwardly into crankcase chamber 23.

As mentioned previously, bypass section 17 in the embodiment of FIGURES 1, 3 and 4 is integrally connected to crankcase 15, as seen in FIGURE 3, being formed as a lateral extension of the crankcase outwardly of wall 19, with a cover 55. A passage 56 is provided in the upper portion of bearing supporting member 28 which connects chamber 23 with a chamber 57 inside an annular filter 58. This filter is coaxial with crankshaft 29 and is supported along one edge by member 28 and along its other edge by a circular member 59 inside cover 55. The arrangement is such that filter 58 will entrap and separate from the refrigerant gases lubricant particles entrained therein, permitting the lubricant to drain to the bottom of a chamber 61 which surrounds filter 59 and return to the crankcase chamber by a drain passage 62. The upper end of extension 17 is provided with a connection 63 for the delivery of flash gases or refrigerant liquid at intermediate pressure which comes from another portion of the refrigerating system (not shown) in a conventional manner for the purpose of cooling the compressor. Another passage 64 leads from chamber 61 to an enlarged

chamber 65 surrounding the cylinders. Cylinder 14 is mounted in portion 22 of crankcase 15 alongside cylinder 11, as seen in FIGURE 3, and its upper end is adjacent chamber 65.

Cylinder 14 has an enlarged portion 66 surrounding its upper end through which pass a plurality of circumferentially spaced axially extending passages 67 leading to an annular chamber 68. An annular intake valve 69 is urged by springs 71 against the upper surface of cylinder portion 66, and when this valve is lifted by pressure differential forces, the gases will flow into cylinder chamber 72, as seen in FIGURE 4. The piston 75 in cylinder 14 is of a standard solid type, that is, it does not have any ports or valves. Annular discharge valve 76 leads from chamber 72 to a chamber 77 within cylinder head 33, chambers 16 and 77 being separated by a partition 78. A resiliently mounted discharge valve assembly 79 having ports 81 leading to chamber 77 is provided for cylinder 14. A high-pressure outlet port 82 leads from chamber 78 through cylinder head 33, as seen in FIGURE 3.

It may be mentioned at this point that the basic arrangement shown in FIGURES 3 and 4, with the exception of the inlet 34, passage 35, valve-carrying low-pressure pistons 37, refrigerant passage 56, and oil drain passage 62, is similar to that found in a known make of two-stage compressor, passage 63 in the known compressor being used as the main refrigerant inlet with no refrigerant being carried through the crankcase. In other words, FIGURES 3 and 4 show a method of conveniently adapting a standard compressor to achieve the purposes of the invention, namely, two-stage, by substituting discharge valve-carrying low-pressure pistons for the standard solid pistons, altering the shape of a few parts, and creating an entirely different flow pattern.

In operation, refrigerant gases from the system evaporator (now shown) entering through low-pressure inlet 34 and passage 35, which comprises a chamber 83 and a port 84, as seen in FIGURE 3, will flow into chamber 16, and from there will flow through inlet valves 36 into cylinders 11, 12 and 13. This downward flow will be induced by the downward motion or suction strokes of pistons 37 within their respective cylinders 11, 12 and 13. During the upward or compression strokes of the pistons 37, the gases in their respective cylinders will be compressed to a pressure slightly above the intermediate pressure in crankcase chamber 23. At this point, the discharge valve 45 of each piston 37 will be opened by the pressure differential existing across it, thereby permitting the compressed gases to flow into crankcase chamber 23 at the intermediate pressure.

The gases will then flow through port 56 into chamber 57 within filter 58. These gases will carry with them entrained lubricant particles, especially during startup time when the oil has a high foaming tendency. As the mixture flows outwardly through filter 58, the lubricant particles will be trapped by the filter and condensed by the enlarged nature of chambers 57 and 61, and will run downwardly to the bottom of annular chamber 61, draining through passage 62 to the crankcase. A check valve (not shown) could be placed in passage 62 to prevent backflow of lubricant.

The refrigerant gases will flow upwardly in chamber 61 through passage 64 to chamber 65, the enlarged nature of the latter further serving to condense entrained lubricant particles which will run back through passage 64 to chamber 61. From there the gases will flow through passages 67 and inlet valve 69 to chamber 72 of cylinder 14, this flow being induced by the downward movement of piston 75. Upon upward or compressive movement of piston 75, the gases will be compressed to their high pressure and flow out through discharge valve 76, passages 81 and chamber 77 to discharge port 82, flowing from there to the condenser (not shown) of the refrigerating system.

The embodiment of FIGURE 2 will operate in the same way as that of FIGURES 1, 3 and 4, except for the fact that piping will be provided connecting connecting crankcase 15 with bypass unit 17'. This modification could be used in cases where it is desired to convert a standard compressor which does not have passages or extensions integral with the crankcase which are usable as the bypass unit. More particularly, a conduit 85 leading from reservoir 15 to unit 17' will correspond to passage 56 shown in FIGURE 3, this conduit delivering the mixture of gases and entrained lubricant at intermediate pressure to unit 17'. The unit may be provided with two concentric annular filters 86 and 87, conduit 85 leading to an outer chamber 88 so that the gases will flow radially inwardly through the filters to an inner chamber 89. A floor 91 is provided which will collect the lubricant trapped by the filters and bypass chambers, this lubricant flowing through a central port 92 in floor 91 to a drain conduit 93 which will return the lubricant to the crankcase 15. Conduit 94 leading from chamber 89 corresponds to passage 64, seen in FIGURE 3, and will deliver the intermediate pressure gases to the high-pressure cylinder 14.

It will thus be seen that a novel and improved two-stage refrigerant compressor is provided which, while enabling a compact arrangement of chambers for the low, intermediate and high pressure gases, nevertheless prevents any excess entrained lubricant from being discharged from the high-pressure cylinder into the system.

While it will be apparent that the preferred embodiment of the invention disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. A multi-stage compressor having a low-pressure stage comprising at least one cylinder and piston assembly, a high-pressure stage comprising at least one cylinder and piston assembly, a lubricant contained in a crankcase, a crankshaft in said crankcase operatively connected to the pistons of both said low-pressure and said high-pressure stages, means for delivering low-pressure refrigerant gases to the inlet of said low-pressure stage, means including pressure operated valve means associated with said low-pressure stage for delivering refrigerant gases compressed in said low-pressure stage at an intermediate pressure to said crankcase, a bypass extending from said crankcase around said high-pressure stage to the inlet of the latter for delivering partially compressed refrigerant from the crankcase to the inlet of said high-pressure stage, said bypass including passage-way means requiring all the refrigerant which flows from said crankcase to said high-pressure stage inlet port to pass through the bypass means in the path of all fluid flowing through said bypass for returning to said crankcase lubricant entrained in the refrigerant gases traversing said bypass, and means including pressure operated valve means for delivering refrigerant compressed in said high-pressure stage from the said compressor.

2. In a multi-stage compressor of the type having a low-pressure cylinder, a high-pressure cylinder, pistons in said cylinders connected to a crankshaft, and a lubricant-containing crankcase enclosing said crankshaft, a low-pressure inlet chamber adjacent said low-pressure cylinder, an inlet valve between said chamber and low-pressure cylinder responsive to suction movement of the piston to permit gases to be induced into the low-pressure cylinder, a discharge valve carried by said low-pressure piston and responsive to the attainment of a predetermined pressure in the low-pressure cylinder upon compressive movement of the piston to connect the low-pressure cylinder with the crankcase, thereby permitting gases to flow into the crankcase at an intermediate pressure, a bypass leading from the side of said crankcase,

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a bypass chamber having walls and connected to the exit of said bypass, said bypass including passageway means requiring all the refrigerant which flows from said crankcase to said high-pressure stage inlet port to pass through the bypass means in said bypass chamber and in the path of all fluid flowing through said bypass chamber adapted to separate entrained lubricant from said gases, means for permitting said separated lubricant to return to said crankcase, an inlet valve for said high-pressure cylinder separate from said high-pressure piston, a passageway connecting said bypass chamber with the last-mentioned inlet valve, and a discharge valve for said high-pressure cylinder, the high-pressure inlet and discharge valves being responsive to suction and compression strokes respectively of said high-pressure piston to permit flow therethrough.

3. In a multi-stage refrigerant compressor, a housing having a crankcase formed at the lower portion thereof, high-and-low-pressure pistons and cylinders supported at the upper end thereof, a crankshaft rotatably supported by bearings carried by the side walls and connected to said pistons, an inlet passage in one of said side walls, an inlet chamber surrounding the suction valve assembly of said low-pressure cylinder and connected to said inlet passage, an inlet valve connecting said inlet chamber to said low-pressure cylinder and responsive to each suction stroke of said low-pressure piston to admit refrigerant gases to said low-pressure cylinder, a discharge valve in said low-pressure piston, passages in said low-pressure piston connecting said low-pressure cylinder with said crankcase, said passages being controlled by said discharge valve, the discharge valve being responsive to the attainment of a predetermined pressure in said low-pressure cylinder upon each compression stroke of the low-pressure piston to admit gases at intermediate pressure to said crankcase, a lateral passage in the other side wall of said crankcase, an extension on said crankcase forming a chamber, a filter in said chamber adapted to separate entrained lubricant particles from refrigerant gases, a drain passage in the bottom of said other side wall leading back from said extension to said crankcase, a passage leading back through said other side wall to an enlarged chamber surrounding said high-pressure cylinder, an inlet valve leading from said last-mentioned chamber to said high-pressure cylinder and responsive to each suction stroke of said high-pressure piston to admit gases into said high-pressure cylinder, said last-mentioned inlet valve being separate from said high-pressure piston, and a discharge valve leading from said high-pressure piston and responsive to each compression

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stroke thereof to permit high-pressure gases to leave the high-pressure cylinder.

4. In a multi-stage refrigerant compressor, a housing having a crankcase formed at the lower portion thereof, high-and-low pressure pistons and cylinders supported at the upper end thereof, a crankshaft rotatably supported by bearings carried by the side walls and connected to said pistons, an inlet passage in one of said side walls, an inlet chamber surrounding the suction valve assembly of said low-pressure cylinder and connected to said inlet passage, an inlet valve connecting said inlet chamber to said low-pressure cylinder and responsive to each suction stroke of said low-pressure piston to admit refrigerant gases to said low-pressure cylinder, a discharge valve in said low-pressure piston, passages in said low-pressure piston connecting said low-pressure cylinder with said crankcase, said passages being controlled by said discharge valve, the discharge valve being responsive to the attainment of a predetermined pressure in said low-pressure cylinder upon each compression stroke of the low-pressure piston to admit gases at intermediate pressure to said crankcase, a lateral passage in the other side wall of said crankcase, an extension on said crankcase forming a chamber, a filter in said chamber adapted to separate entrained lubricant particles from refrigerant gases, a drain passage in the bottom of said other side wall leading back from said extension to said crankcase, a passage leading back through said other side wall to an enlarged chamber surrounding said high-pressure cylinder, an enlarged portion surrounding the end of said high-pressure cylinder, an inlet valve in said last-mentioned portion with passages connecting said last-mentioned chamber with said high-pressure cylinder through said last-mentioned inlet valve, the inlet valve being responsive to each suction stroke of said high-pressure piston to admit gases into said high-pressure cylinder, said last-mentioned inlet valve being separate from said high-pressure piston, and a discharge valve leading from said high-pressure piston and responsive to each compression stroke thereof to permit high-pressure gases to leave the high-pressure cylinder.

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