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MULTI-STAGE COMPRESSOR WITH ANNULAR RING VALVE SERVICE

Original Filed Oct. 17, 1960

4 Sheets-Sheet 1

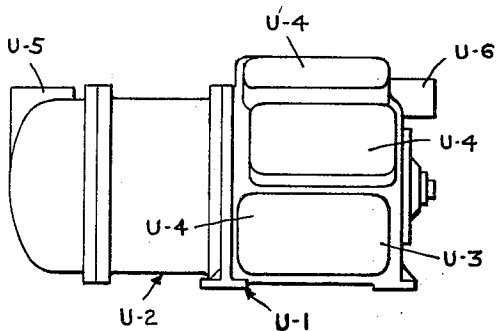


FIG. 1

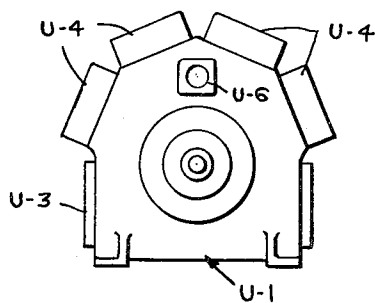


FIG. 2

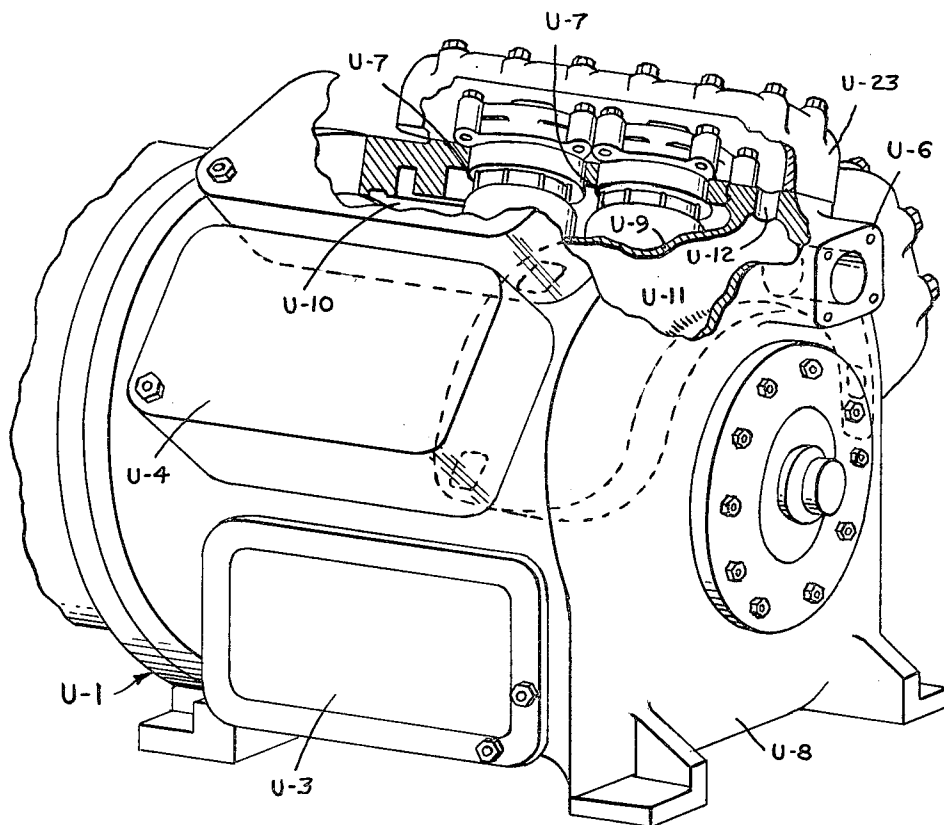


FIG. 3

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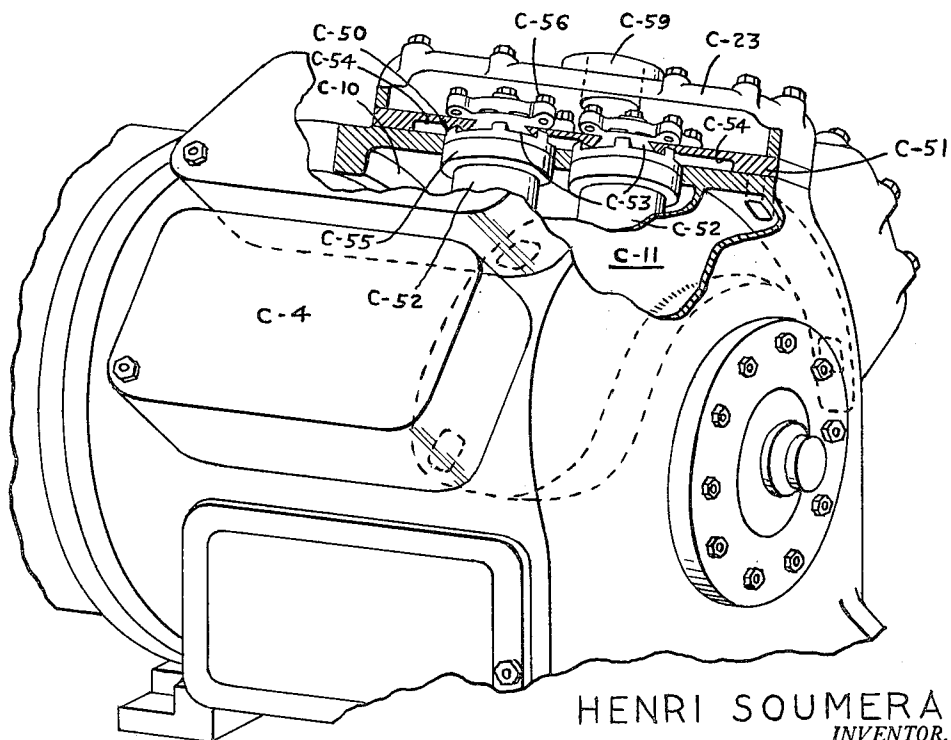
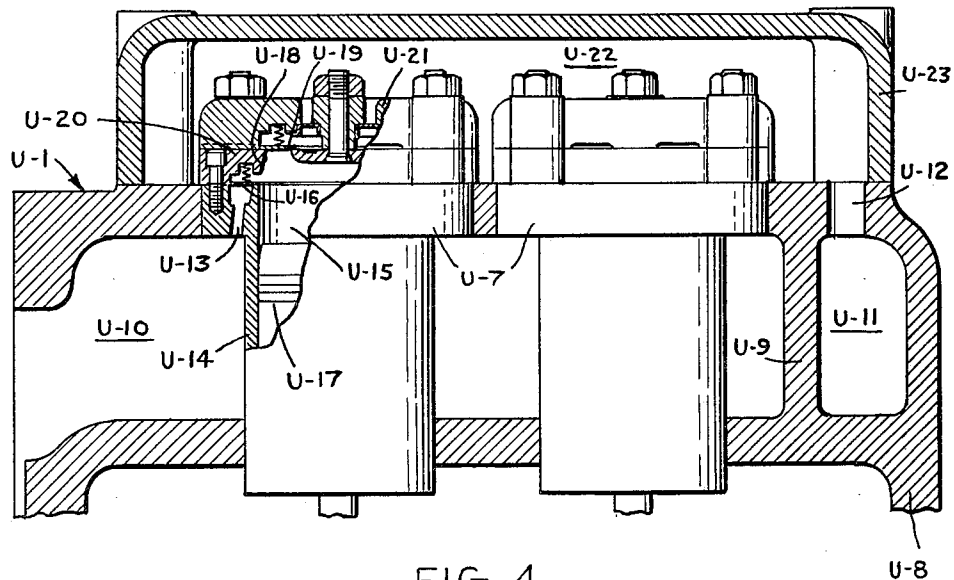
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4 Sheets-Sheet 2



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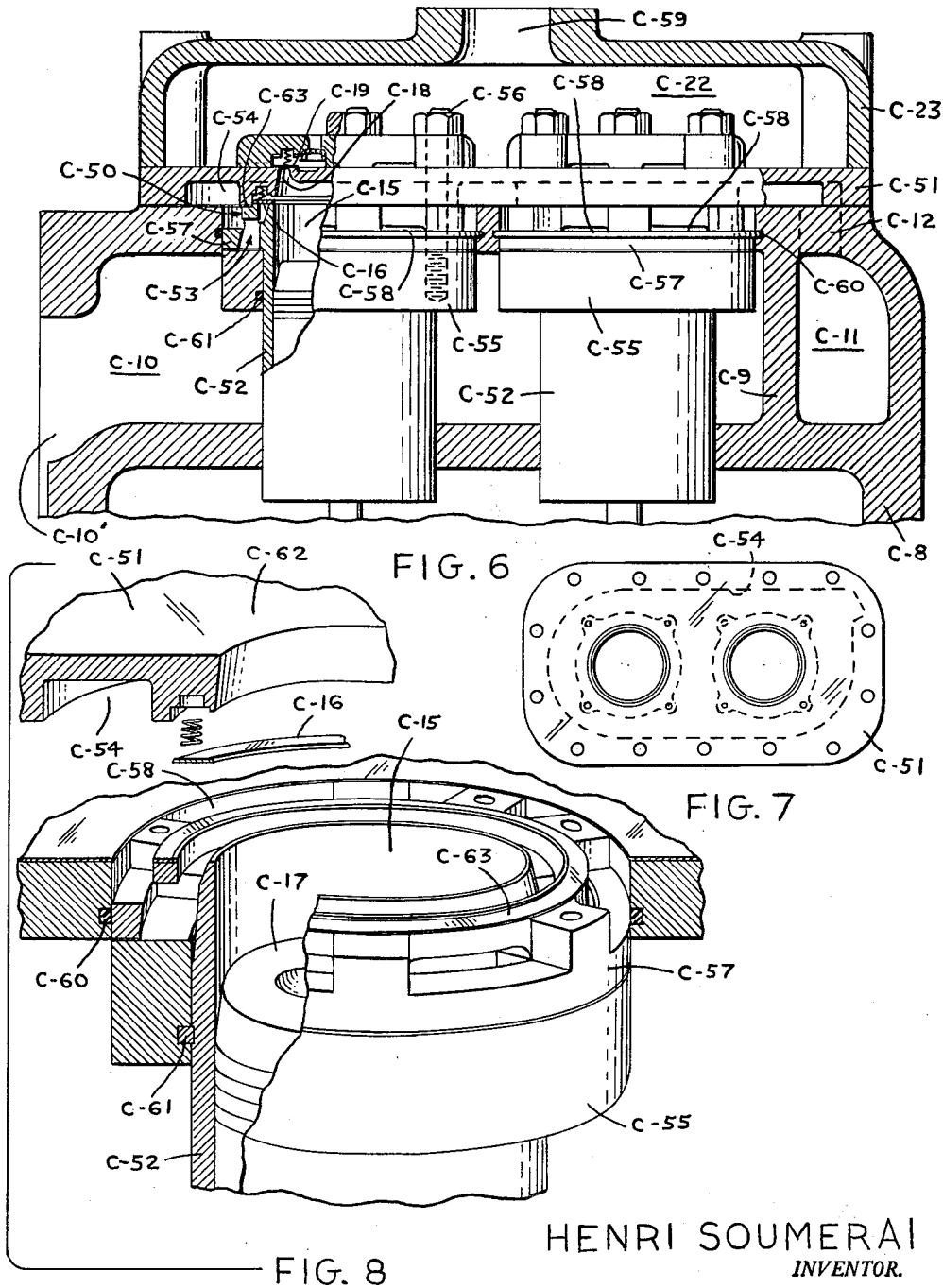
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MULTI-STAGE COMPRESSOR WITH ANNULAR RING VALVE SERVICE

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4 Sheets-Sheet 4

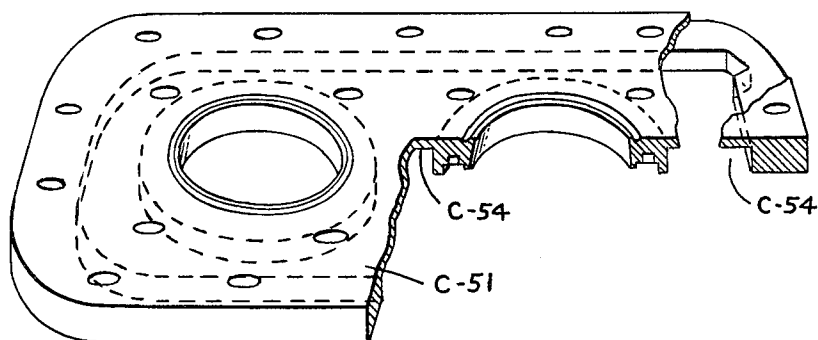


FIG. 9

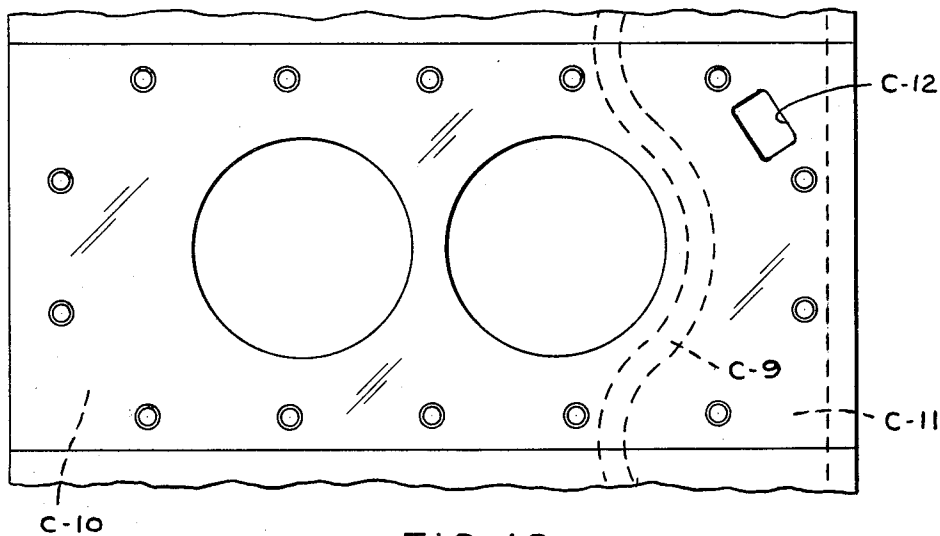


FIG. 10

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MULTI-STAGE COMPRESSOR WITH ANNULAR RING VALVE SERVICE

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Continuation of application Ser. No. 63,045, Oct. 17, 1960. This application Apr. 11, 1962, Ser. No. 192,019
11 Claims. (Cl. 230-40)

This invention is a continuation of my copending application Serial No. 63,045 filed October 17, 1960 and relates to multi-stage refrigeration compressors and more particularly to means for converting a multi-cylinder refrigeration compressor including annular ring valve service to multi-stage operation.

The circulating implement or compressor of certain types of refrigeration systems must provide refrigerant to the high side at above normal operating pressures. In other types of systems there is such a differential between the low and high side of the system that the usual compressor cannot provide refrigerant of the required condition.

To this end designers call for compressors which act on the refrigerant in stages to thereby increase the pressure thereof to that demanded by the system. These prior type multi-stage machines are usually ramifications of known multi-cylinder compressors; however, from a practical standpoint they embody components, such as external manifolding, which add to the cost of manufacture and detract from the simplicity of the unit.

Accordingly, it is an object of this invention to provide means for converting a multi-cylinder compressor to multi-stage operation which entails providing a minimum of modified components for the multi-cylinder unit.

It is a further object of this invention to provide an improved multi-stage compressor which is simple in construction.

It is another object of this invention to convert a multi-cylinder compressor to multi-stage operation without costly redesign.

With the foregoing objects in view, and others as may appear in the accompanying specification, the invention consists of various features of construction and combination of parts which will be first described in connection with the accompanying drawings, showing a multi-cylinder compressor embodying the novel means for converting same to multi-stage operation.

In the drawings:

FIGURE 1 is a side view of an unconverted compressor.

FIGURE 2 is an end view of an unconverted compressor.

FIGURE 3 is a perspective view of an unconverted compressor with a cylinder head partly broken away.

FIGURE 4 is a vertical section through a cylinder head of an unconverted compressor.

FIGURE 5 is a perspective view of a converted compressor with a cylinder head partly broken away and showing the conversion means.

FIGURE 6 is a vertical section through the converted cylinder head of the compressor shown in FIGURE 5.

FIGURE 7 is a top plan view showing the plate portion of the conversion kit.

FIGURE 8 is an enlarged exploded view partly in sec-

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tion and partly in perspective of the liner portion of the conversion kit.

FIGURE 9 is an enlarged perspective view of the plate portion of the conversion kit.

FIGURE 10 is a top view of a cylinder bank.

Unconverted Multi-Cylinder Compressor

Referring to the drawings, FIGURES 1 through 4 show the unconverted multi-cylinder refrigeration compressor generally designated U-1 contemplated for conversion to a multi-stage unit as will be described in detail hereinafter. For purposes of clarity and in order to facilitate the comprehension of the concepts of the advance described herein, parts having generally the same construction and purpose will be given the same reference characters.

However, in order to distinguish the units reference characters applied to the unconverted unit will be preceded by a U and those applied to a converted unit will be preceded by a C.

Continuing with the presentation of the construction of compressor U-1: the unit comprises a driving portion U-2 (which may be any known prime mover such as an electric motor) and a compression portion U-3 shown as including a plurality of compression means U-4 which compress fluid passed to the suction opening U-5 from the low side of a refrigeration installation and discharge this fluid out discharge opening U-6 to the high side of a refrigeration installation.

While the plurality of compression means U-4 are shown as comprising four banks each including two cylinders designated U-7, it is not intended to limit the scope of this invention to this arrangement as any number of banks within the realm of reasonableness may be provided. It will also be understood by those skilled in the art that the conversion means, to be hereinafter described, for embodiment in the multi-cylinder type of compressor to convert same to multi-stage operation may be adapted to a multi-cylinder compressor including single cylinders without departing from the scope of the improvement contemplated herein.

Referring to FIGURES 3 and 4 the compression portion U-4 of the unit includes a casing U-8 which is divided by a partition U-9 to provide first and second compartments U-10 and U-11. In actual construction compartments U-10 and U-11 are cast as separate portions of the casing to provide chambers which are respectively connected to the low and high side of the system.

More particularly compartment U-10 is in communication with suction opening U-5 which is in turn connected to the low side of the refrigeration system.

Compartment U-11 receives compressed fluid from the compression means U-4 through passage or opening U-12 and passes this pressurized fluid to the high side of the system through discharge opening U-6.

As is customary in this type of unit, the compression means U-4 all take suction from the first compartment U-10, and as will be understood by those skilled in this art fluid passes through a port U-13 formed in liner U-14 into cylinder U-15. The usual suction valve of the annular ring type U-16 is disposed over port U-13 to regulate flow into cylinder U-15. Piston U-17 driven through usual crankshafts by driving means U-2 compresses the fluid and forces same through the discharge port U-18 by discharge valve of the annular ring type U-19, all of

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which are disposed in valve plate U-20 and valve guard U-21, into discharge chamber U-22.

Discharge chamber U-22 is shown as formed by disposing head U-23 on a portion of casing U-8 and communicating with the second compartment U-11 through opening U-12. Fluid passed to compartment U-11 is discharged through discharge opening U-6 to the high side of the system.

It will be obvious that the head U-23 in the form of compressor described hereinabove closes over the casing U-8 and is connected thereto to form a closed discharge chamber U-22. Discharge chamber U-22 in turn communicates with second compartment U-11. Second compartment has connected thereto discharge opening U-6 which communicates with the high side of the refrigeration system.

While only one bank is described it will be evident to one skilled in the art that the remaining banks of the unconverted compressor U-1 are of similar construction and function in the manner described above.

The compressor U-1 generally described above can readily be adapted to multi-stage operation should a particular refrigeration system require same. Thusly the above described unit may be converted to multi-stage operation as hereinafter described without the need for complicated and costly redesign.

Conversion Means

The desired conversion to multi-stage operation is accomplished by associating conversion means generally designated C-50 with at least one bank of the multi-cylinder compressor described above.

Accordingly in this manner the remaining unconverted stages will act as a low pressure stage and provide the initial increase in pressure to the fluid which is then raised to the final or output pressure by the converted or high pressure stage as will be evident from the description that follows.

With more particularly the conversion means C-50 comprises a plate means C-51 mounted in association with cylinder liners C-52 having generally the same shape and configuration of the liners U-14 of the unconverted unit except that passageways C-53 are provided which communicate the cylinder C-15 with the inner passages C-54 of the plate C-51. Seal members taking the form of annular rings C-55 are disposed about the liner C-52 to prevent entry of fluid passed to compartment C-10 into cylinder C-15. All of the foregoing elements are held in operating position by any well known means such as bolt members C-56.

The usual annular ring type suction valve C-16 is disposed over the portion of passageway C-53 to regulate the flow into cylinder C-15 and discharge valve C-19 is disposed over port C-18 to regulate flow out of the high pressure stage.

Referring to FIGURES 7, 8, 9 and 10 the plate means C-51 including passageways C-54 is disposed over the casing and communicates second compartment C-11 through passage C-12 with the cylinder C-15 through the passageways C-53 formed in a flange C-57 of liner C-52. The passageways comprise a plurality of slots C-58 milled in the flange forming an entrance opening to pass fluid from the second compartment C-11 to the cylinder C-15. It is preferred that the slots C-58 be equidistantly distributed about flange C-57 to thereby provide for efficient ingress of fluid to the cylinder C-15 through the portion thereof.

While the seal means C-55 are shown as annular rings and the slots C-58 as milled it will be obvious that these components can be cast as integral parts of the liner, that is, the slots formed as cored passageways in an oversized flange cast on the liner.

Fluid compressed by the high pressure stage is passed to discharge chamber C-22 which is formed over the casing and the annular ring type valving arrangement and

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includes a discharge outlet C-59 which is connected to the high pressure side of the refrigeration system.

To accomplish operation as a multi-stage unit, as will be evident to one skilled in the art, a suitable plug means is disposed in discharge opening of U-6 and accordingly fluid compressed in the first stage which is passed to the second compartment C-11 is forced to pass to the cored passageway C-54 to the cylinder C-15.

The sealing effect of seal means C-57 is amplified by providing the usual O-rings C-60 and C-61 and seal rings C-62 and C-63. Thusly fluid entering compartment C-10 is prevented from entering the high pressure stage while at the same time permitted to pass to the low pressure stages.

Operation of the Converted Compressor

In operation of the multi-stage unit low pressure gas from the system enters the first compartment C-10 through the opening C-10' in the casing C-8. Gas from the first compartment passes through the inlets of the low pressure banks for compression by the usual pistons. Sealing means C-55 prevents the passage of gas from compartment C-10 to the high pressure bank.

The gas compressed by the low pressure banks is discharged through the usual valving into discharge compartment U-22 and flows through ports U-12 to the second compartment U-11 as is clearly shown in FIGURES 3 and 4.

Gas in the second compartment C-11 passes through port C-12 in the casing into the cored passageways C-54 of the valve plate C-51 associated with the cylinders through the passageways C-53 in the cylinder liner of the high pressure stage as is clearly shown in FIGURES 5, 6 and 7.

The refrigerant is then compressed to desired pressure and passed to the system through the discharge valve arrangement C-19 into discharge compartment C-22 out through outlet C-59 in high pressure head C-23 to the high side of the system.

As was mentioned above the unit shown and described above comprises a 2-stage compressor including plural cylinders in each stage. It will be obvious that the multi-stage compressor can be furnished in other forms by merely adding the valve plate and sealing arrangements to a low stage thereof. Furthermore, a multi-cylinder unit comprising stages including one cylinder can be converted to multi-stage operation in accordance with the concepts discussed herein.

The foregoing concept may be realized without departing from the scope of this invention as defined by the following claims.

What is claimed is:

1. In combination a compressor including a casing, partition means dividing the casing into a first and second compartment, a first and second compression means in the casing and a portion of each of said first and second compression means disposed in the first compartment, each of said first and second compression means including means forming a cylinder, an inlet and an outlet disposed in communication with the cylinders of each of said first and second compression means, said inlets of each of the compression means communicating with the first compartment and the outlets of each of the compression means connected to the second compartment; with means for converting said compressor to multi-stage operation wherein the means forming said cylinder of said second compression means comprises a liner having a passage means communicating said cylinder with the inlet of said second compression means, means mounted on said second compression means to preclude communication between the inlet of said second compression means and the first compartment, conversion means mounted to said casing relative the inlet of said second compression means and connecting the inlet thereof with the second compartment, said second compression means forming a high pres-

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sure stage, means forming a discharge compartment connected to said second compression means, and said outlet of the compression means forming said high pressure stage communicating with said discharge compartment.

2. The apparatus claimed in claim 1 wherein the conversion means comprises a valve plate mounted on the cylinder of said second compression means and disposed in fluid tight relationship with said cylinder liner, and said valve plate includes valved passageways communicating the second compartment with the inlet of said cylinder.

3. The apparatus claimed in claim 2 wherein the means mounted on said second compression means to preclude communication between the inlet of said second compression means and the first compartment comprises an annular ring disposed about the liner and in abutment with the casing of the second compression means, gasket means between the annular ring and the casing and O-rings between the annular ring and the liner forming the cylinder, and gasket means between the plate means and the cylinder.

4. A multi-stage compressor including a unitary casing, partition means dividing said unitary casing into a first compartment and a second compartment, a plurality of compression means in said unitary casing, and said compression means including means forming a cylinder, said plurality of compression means divided in banks including at least two compression means in each bank, an inlet and an outlet disposed in communication with the cylinders of each of the compression means, one of said banks of said compression means forming a low pressure stage, said low pressure stage having its inlet in communication with the first compartment and its outlet in communication with the second compartment, the other bank of compression means in said unitary casing forming a high pressure stage and having its inlet in communication with the second compartment, means forming a discharge compartment connected to said other bank of compression means forming said high pressure stage, and said outlet of the bank of compression means forming said high pressure stage communicating with said discharge compartment.

5. A multi-stage compressor including a casing, partition means dividing said casing into a first compartment and a second compartment, a plurality of compression means in said casing including means forming a cylinder, said plurality of compression means divided into banks including at least two compression means in each bank, an inlet and an outlet disposed in communication with the cylinder of each of the compression means, and annular ring valve service disposed relative each of the inlets of the respective cylinders, one of said banks of compression means forming a low pressure stage, said low pressure stage having its inlet in communication with the first compartment and its outlet in communication with the second compartment, the other bank of compression means in said casing forming a high pressure stage and having its inlet in communication with the second compartment, means forming a discharge compartment connected to said other bank of compression means forming said high pressure stage, and said outlet of the bank of compression means forming said high pressure stage communicating with said discharge compartment.

6. In combination a compressor including a casing, partition means dividing the casing into a first and second compartment, a plurality of compression means in the casing and a portion of said plurality of compression means disposed in the first compartment, each of said compression means including means forming a cylinder, said plurality of compression means disposed in banks including at least two compression means in each bank, an inlet and an outlet disposed in communication with the cylinders of each of the compression means, said inlets of each of the banks of compression means communicating with the first compartment and the outlets of each of the banks of compression means connected to the

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second compartment; with means for converting said compressor to multi-stage operation comprising means mounted on one of said banks of compression means to preclude communication between the inlet of said last mentioned bank of compression means and the first compartment, said last mentioned compression means bank forming a high pressure stage, means in said casing communicating the inlet of said bank of compression means forming said high pressure stage with said second compartment, means forming a discharge compartment connected to said bank of compression means forming said high pressure stage, and said outlet of the bank of compression means forming said high pressure stage communicating with said discharge compartment.

7. The apparatus claimed in claim 6 wherein the means in said casing communicating the inlet of the bank of compression means forming said high pressure stage with said second compartment comprises a plate connected to the bank of compression means forming said high pressure stage, said plate having valve means formed therein being operable to regulate the flow of fluid from the second compartment to the second compression means bank.

8. In combination with a compressor including a casing, a partition means dividing the casing into a first and second compartment, a plurality of compression means in the casing and a portion of said plurality of compression means disposed in the first compartment defining a low pressure stage, each of said first compression means including means forming a cylinder, an inlet and an outlet disposed in communication with the cylinder of each of the first compression means, said inlets of each of the first compression means communicating with the first compartment, and the outlets of each of the first compression means connected to the second compartment, of means for converting said compressor to multi-stage operation comprising:

- (a) second compression means mounted in the casing forming a high pressure stage and being cooperative with said first compartment to preclude communication between said first compartment and the high pressure stage,
- (b) said second compression means including a cylinder having an inlet and an outlet communicating therewith,
- (c) conversion means carried on the casing and cooperative with said second compression means and forming a passage communicating the second compartment with the second compression means inlet,
- (d) means in said conversion means forming a discharge compartment connected to the second compression means forming the high pressure stage,
- (e) and the outlet of said second compression means communicating with said discharge compartment.

9. In the combination defined in claim 8 wherein the conversion means carried on the casing includes:

- (a) a plate having means forming a passage therein communicating the second compartment with the second compression means inlet,
- (b) and means forming a passage communicating the second compression means outlet with the discharge compartment.

10. In the combination defined in claim 8 wherein said conversion means carried on the casing includes:

- (a) a valve passage formed therein communicating the second compartment with the second compression means inlet,
- (b) said valve passage being operable to permit a unidirectional flow of compressed fluid from said second compartment to the second compression means inlet.

11. In the combination substantially as defined in claim 8 wherein the conversion means carried on the casing includes:

- (a) means forming an annular groove communicating with the second compression means inlet,

(b) valve means carried in said annular groove and being operable to pass fluid from said second compartment into the second compression means.

References Cited in the file of this patent

UNITED STATES PATENTS

460,696	Windhausen	Oct. 6, 1891
706,979	Martin	Aug. 12, 1902
740,133	Hildebrand	Sept. 29, 1903
1,580,973	Rembold	Apr. 23, 1926
2,168,036	Maniscalco	Aug. 1, 1939

5

2,178,662
2,454,600
2,576,876
2,763,425
2,856,121
2,955,750
2,955,751
2,965,036

10

940,779

Hanson	Nov. 7, 1939
Fischer	Nov. 23, 1948
Gamble	Nov. 27, 1951
Sahle	Sept. 18, 1956
Buehler	Oct. 14, 1958
Phelps	Oct. 11, 1960
Hackbart et al.	Oct. 11, 1960
Wood	Dec. 20, 1960

FOREIGN PATENTS

Germany	Mar. 29, 1956
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