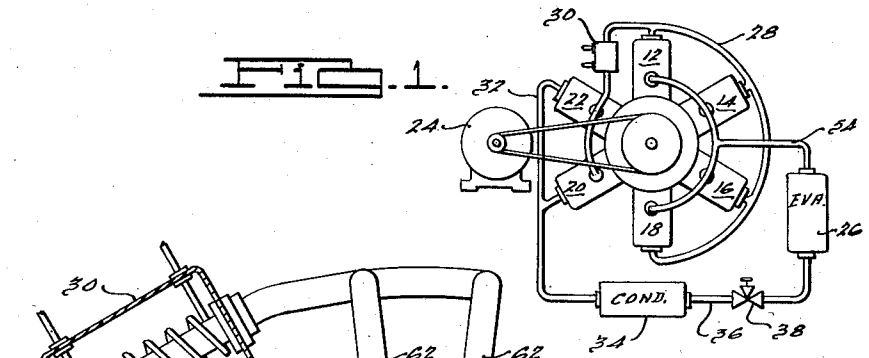
Dec. 11, 1951 A. B. NEWTON 2,578,146

COMPRESSOR

Filed Aug. 26, 1947 2 SHEETS—SHEET 1

FIG. 1.



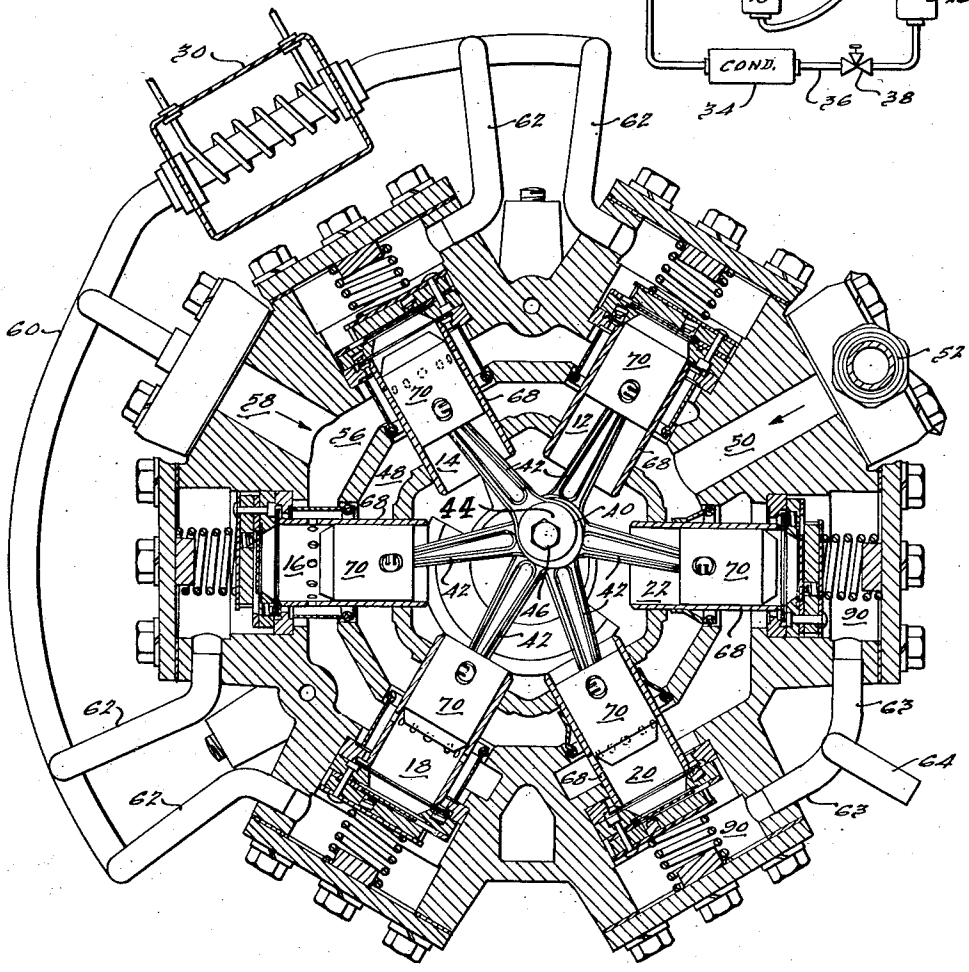


FIG. 2.

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COMPRESSOR

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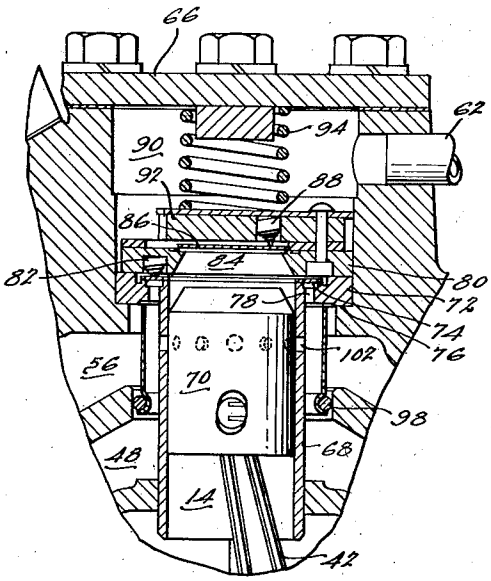


FIG. 3.

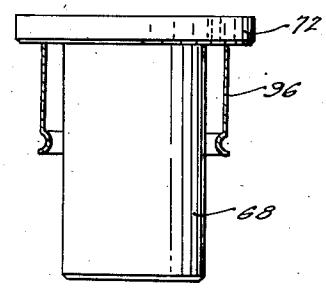


FIG. 4.

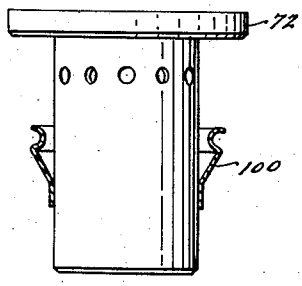


FIG. 5.

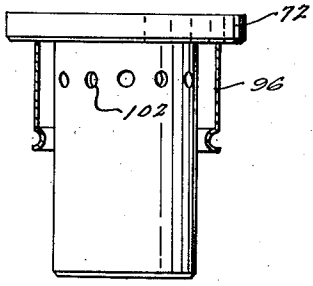


FIG. 6.

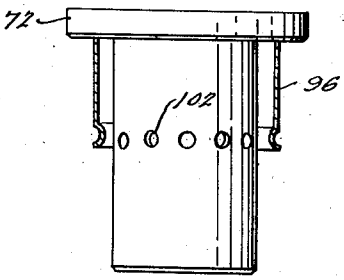


FIG. 5.

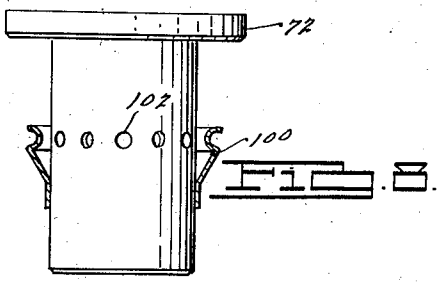


FIG. 8.

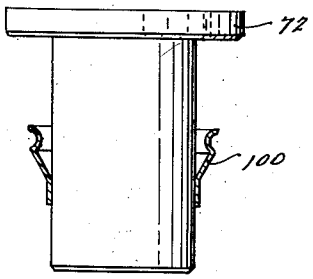


FIG. 7.

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2,578,146

UNITED STATES PATENT OFFICE

2,578,146

COMPRESSOR

Alwin B. Newton, Dayton, Ohio, assignor to Chrysler Corporation, Highland Park, Mich., a corporation of Delaware

Application August 26, 1947, Serial No. 770,641

8 Claims. (Cl. 230—46)

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This invention relates to low temperature refrigeration systems, and more particularly to means for adapting a compressor to a multi-stage low temperature refrigeration apparatus.

Similar apparatus associated with a multiple effect refrigeration system has been described in copending application, Serial No. 746,062, filed May 5, 1947, by R. L. Jones, Jr.

It is a principal object of this invention to predetermine the operating pressures in a multi-stage system by the selection of particular liners for association with individual pistons in a compressor adapted to handle both stages of the compression.

An additional important object of the invention is to provide means associated with replaceable liners for preselecting the operative relation of individual cylinders of a multi-stage compressor with the respective stages of compression.

The substitution of liners in a multi-cylinder compressor is utilized to vary the effective compression stroke of the piston in individual cylinders thereof and to vary the operative relationship of individual cylinders relative to the compression stages of a multi-stage system. Thus, one compressor may be adapted for use in conjunction with various multi-stage refrigeration systems by adapting individual cylinders to accommodate different volumes of gas and by connecting individual cylinders with different compression stages in a multi-stage system. The preselection which is offered by the proper combination of liners in the compressor permits one motor compressor set to be adapted to various multi-stage systems.

Further objects and advantages of my invention reside in the combination and arrangement of parts hereinafter described and claimed, reference being had to the accompanying drawings in which:

Fig. 1 is a diagrammatic showing of a multi-stage refrigerating system with which the combination of compressor and liners may be associated;

Fig. 2 is a cross section taken through the compressor so as to pass through the center line of each cylinder;

Fig. 3 is an enlargement of one cylinder and its valve mechanism as shown in Fig. 2; and

Figs. 4 through 9 are elevations of various liners adapted to be inserted in the compressor shown in Fig. 2.

One type of low temperature refrigeration is known as multi-staging. In multi-stage apparatus gas from the evaporator is passed first

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through a low stage compressor which is usually a lightly powered large displacement compressor, and then through a high stage compressor to a condenser. Liquid then passes on back to the evaporator through an expansion valve. Considerable efficiency can be gained by the use of an intercooler between stages of compression. Multi-stage refrigeration apparatus is used where it is desired that one evaporator produce an extremely low temperature. This necessitates an extremely great differential in pressure between the intake and exhaust sides of the system. Performing the compression in two stages offers two advantages, first, the stroke of the compressor piston and the compressor design are mechanically simplified and secondly the refrigerant may be precooled between stages.

In Fig. 1 a multi-stage refrigeration system is diagrammatically illustrated. A refrigerant compressor 10 is provided with a plurality of cylinders 12, 14, 16, 18, 20 and 22. A motor 24 drives the compressor. An evaporator 26 is connected to inlet ports in cylinders 12, 14, 16 and 18. These cylinders exhaust into a ring 28 which passes through an intercooler 30. The intercooler is adapted to lower the temperature of the refrigerant by passing a medium such as cold water in heat exchange relation therewith. The ring 28 is connected to intake ports in cylinders 20 and 22. These cylinders exhaust to a line 32 which is operatively connected to a condenser 34. A line 36 connects the condenser 34 and the evaporator 26 and has an expansion valve 38 positioned therein. Cylinders 12, 14, 16 and 18 form the low stage compression means. Cylinders 20 and 22 form the high stage compression means.

In Fig. 2 a sectional view of a compressor adapted to provide both low and high stages is shown. The compressor illustrated is of the radial six cylinder type. A cast housing has radial portions which are each adapted to have associated therewith cylindrical liners and pistons and valve mechanism to form the cylinders designated in Fig. 1 by the numerals 12, 14, 16, 18, 20 and 22. Fig. 3 illustrates the construction of one radial portion in greater detail. A crankshaft 40 is rotatably mounted in the cast housing and adapted to be driven by a motor means such as an induction type electric motor (not shown). A plurality of piston rods 42 are rotatably mounted on the eccentric portion of the crankshaft 40 and are retained on this eccentric portion by a cap 44 and a lock nut 46. An annulus 48 is integrally cast in the housing and operatively connected by passage 50 to an orifice 52 which may

be operatively connected to the evaporator by line 54. The annulus 48 forms the low pressure annulus of the compressor. A high pressure annulus 56 is integrally cast in the housing in concentric relation to the annulus 48. The high pressure annulus 56 is operatively connected by a passage 58 to a ring 60. The ring 60 and passage 58 serve as an inlet means for refrigerant entering the high pressure annulus 56. Ring 60 is provided with a plurality of branches 62 each of which connects the ring 60 to the exhaust side of one of the low stage cylinders 12, 14, 16 and 18. The high stage cylinders 20 and 22 are operatively connected to lines 63 and 64 which lead to condenser 34 and were designated by the numeral 32 in the diagrammatic showing of Fig. 1. Ring 60 corresponds to the ring 28 diagrammatically illustrated in Fig. 1.

It should be understood that although the compressor shown in Fig. 2 is illustrated as being used in a two stage system, the plurality of cylinders therein could be grouped to accommodate a three or more stage system. For simplicity the discussion will describe a two stage system. Referring to Fig. 3 the construction of a typical radial portion of the cast housing is illustrated. The cylinder 14 has been arbitrarily chosen for this description although the construction of each cylinder is similar with the exception that different liners may be substituted in the housing to form the cylinder therein. A removable cap 66 is secured to a radial portion of the cast housing. The cap has been illustrated as secured to the housing by bolts. A removable cylindrical liner 68 may be inserted into the radial portion of the housing by removal of the cap 66. Aligned openings are provided in the radial portion of the housing and the walls forming the low pressure annulus and the high pressure annulus. The aligned openings are adapted to receive the liner 68. A piston 70 is operatively associated with the outer end of each piston rod 42. The pistons 70 are each adapted for reciprocation in one of the liners 68. The liner is formed with a tubular portion having a flange 72 adjacent one end thereof. An intake valve 74 in the form of a flexible annular ring is positioned concentrically of the outer portion of the flange 72 of the liner 68. A flange 72 of the liner rests upon the annular shoulder 76 provided within the radial portion of the cast housing. The flange 72 is provided with a plurality of passages 78 extending therethrough. The intake valve 74 is adapted to restrict the passage of refrigerant through the openings 78. The intake valve 74 rests upon the liner flange 72 which is recessed for its reception so that the valve ring 74 may move axially. A ring 80 rests upon the flange 72 of liner 68 and suitable springs 82 are provided in ring 80 to yieldably urge suction valve ring 74 into position to restrict passage 78. The ring 80 is provided with a central opening 84 which is aligned with the interior of the liner 68. A discharge valve plate 86 is positioned across the opening 84 and seated on the ring 80. Springs 88 urge it to its closed position. Valve 86 is adapted to move off its seat on ring 80 to expose the opening 84 to a chamber 90 in the radial portion of the cast compressor housing. Chamber 90 is operatively connected to discharge pipe 62 and ring 60.

On the suction stroke of the piston 70 which is illustrated in Fig. 3 expanded refrigerant gas from the low pressure annulus 48 enters the orifice 78 and passes through the suction valve 74 which is lifted from its seat against the force of springs 82 when a pressure differential is created by the retraction of piston 70. On the compression stroke the greater internal pressure with the aid of springs 82 seats valve 74 thus closing off passages 78. Discharge valve 86 is raised from its seat against the force of springs 88 and the compressed gas flows from the opening 84 to chamber 90. The compressed gas leaves chamber 90 through discharge pipe 62 and ring 60 and is admitted by passage 58 to the high pressure annulus 56. As soon as the piston 70 commences to retract the differential in pressure between chamber 90 and the exterior of the cylinder aided by springs 88 causes valve 86 to be seated and suction to be reestablished through passages 78.

In order that any entrained globules of liquid refrigerant or oil may be dispersed a mechanical relief valve is provided. A member 92 is bolted to the ring 80. The springs 88 previously referred to are positioned in recesses in the member 92. The assembly comprising member 92 and ring 80 is urged against the flange 72 by a spring 94 bearing against this assembly and against cap 66. The spring 94 is of sufficient strength to keep the valve assembly seated but is designed to permit relief against accidental overpressure.

The description of the operation of cylinder 14 which was made with reference to Fig. 3 herein is typical of the operation of cylinders 12, 14, 16 and 18. These cylinders possess the common feature that the inlet openings are operatively connected with the low pressure annulus 48 which is connected in fluid flow relationship with the evaporator. These cylinders discharge compressed gas into the high pressure annulus of the compressor. Because of the requirement that these cylinders take gas from the low pressure annulus and discharge it to the high pressure annulus they are provided with liners which will hereinafter be described as the first type of liner. The cylinders 20 and 22 of the compressor have mechanical valving that is similar to that described with reference to Fig. 3 but the liners 68 associated therewith are of a different type which will hereinafter be referred to as the second type of liner. This second type of liner is so designed that it operatively connects the intake ports of cylinders 20 and 22 with the high pressure annulus 56 of the compressor. The chambers 90 associated with the cylinders 20 and 22 are connected by lines 63 and 64 to the condenser of the refrigerating system. The cylinders illustrated in Fig. 2 are therefore divided into the low stage cylinders 12, 14, 16 and 18 which receive gas from the evaporator and discharge the gas to high pressure cylinders 20 and 22 which in turn discharge the gas to the condenser of the refrigerating system.

Figs. 4, 5 and 6 illustrate liners which are adapted to be assembled in the compressor. These liners are of the type which was previously referred to herein as the first type of liner. Each of these liners 68 is provided with a flange 72. However, a cylindrical skirt 96 having a greater diameter than the body portion of the liner 68 is provided. Each skirt 96 is secured to and depends from flange 72. It will thus be apparent that a path for gas is provided between the skirt 96 and the body portion of the liner 68. When liners of this type are assembled in the cylinders a gasket 98 is used to seal the lower portion of the skirt 96 against the partition

separating the high pressure annulus of the compressor from the low pressure annulus. The passages previously referred to herein which lead to the suction ports of the cylinder are aligned with the space between the skirt and the body portion of the liners so that gas may pass from the low pressure annulus up between the skirt and the body portion of the liner and into passages 78.

Figs. 7, 8 and 9 illustrate the second type of liner. Each of these liners is provided with a skirt 100. The skirt 100 is of frusto-conical shape having the smaller end thereof secured to the liner as by welding. The widest portion of the skirt is provided with a groove adapted to receive a gasket similar to the gasket 93 referred to above. The skirt 100 is assembled with the liners in inverted relationship so that the small portion of the skirt is welded to that portion of the liner which is remote from the flange 72. By referring to Fig. 2 it will become evident that the skirts 100 serve to seal the intake ports of the compressor cylinders from the low pressure annulus 43 and to provide a fluid flow connection between the high pressure annulus 56 and the passages 78 in the liner flange 72.

The body portion of the liner of either type may be provided with ports 102. Figs. 4, 5 and 6 illustrate isolated liners of the first type which are similar with the exception that the presence and spacing of ports 102 is varied. In Fig. 4 the ports 102 have been omitted. In Fig. 5 the ports have been located so that they are not uncovered until the piston is near the end of its suction stroke. In Fig. 6 the ports have been located so that they are uncovered when part of the suction stroke has been completed. By removing the cap 66 and substituting a different liner which has the ports 102 positioned at a different location the volumetric capacity of an individual cylinder may be radically changed. The ports 102 permit gas to bypass the suction valve 74 when they are uncovered by the piston 70. No compression will be effected until the ports 102 are closed by being covered by the piston. The particular axial location of the ports 102 will determine the volume of refrigerant to be compressed within the cylinder. A minimum volume of refrigerant is compressed when the liner of Fig. 6 is used. A maximum volume of refrigerant may be compressed by using the liner of Fig. 4 which permits the entire stroke of the piston to be used to compress gas. An intermediate volume of refrigerant may be compressed by using the liner of Fig. 5.

The axial spacing of openings 102 is similarly varied in liners of the second type which are illustrated in Figs. 7, 8 and 9. The volumetric capacity of the cylinders 20 and 22 may also be predetermined by the selection of porting in the liners.

The same compressor housing crankshaft and piston components may be used with different liners to produce a compressor having stages therein of radically different capacity. The capacity is determined by the selection of liners and may be altered to adapt the same compressor to the requirements of different multi-stage refrigerating systems. When the operating requirements of pressure and temperature in a given installation change or where it is desired to use one compressor in a different installation a conversion of the capacity of the compressor relative to each stage of the multi-stage refrigerating system may be effected by interchanging liners in the compressor housing. Thus, the combination of interchangeable liners with a compressor housing adapted to receive them and the proper selection of ports, skirts for the liners and external connections on the compressor housing provides a means for preselecting the number of cylinders operating in each stage and the displacement of each cylinder. The pressures to which the refrigerant will be compressed and the volume to be compressed in each stage of the refrigeration system may thus be predetermined with an accuracy not heretofore obtainable.

I claim:

1. A refrigerant compressor apparatus comprising a housing, a plurality of pistons, driving means to reciprocate said pistons, a plurality of cylindrical liners assembled in said housing, one of said liners being assembled in operative relationship with each of said pistons and receiving said piston for reciprocation therein, first means forming a refrigerant inlet passage in said housing, second means associated with said housing and forming a refrigerant discharge passage, a third means forming an intermediate fluid flow passage in said housing, a first valve means to control the admission of refrigerant to each of said liners, a second valve means to control the discharge of refrigerant from each of said liners, a skirt associated with each of a first group of said liners and adapted to cooperate with said housing to provide a fluid flow connection between the first valve means of said first group of liners and said inlet passage, a skirt associated with each of a second group of said liners and adapted to cooperate with said housing to provide a fluid flow connection between the first valve means of said second group of liners and said intermediate passage, means associated with said compressor and adapted to provide a fluid flow communication between the second valve means of said first group of liners and said intermediate passage and means associated with said compressor and adapted to provide a fluid flow communication between the second valve means of said second group of liners and said discharge passage.

2. The combination of a refrigerant compressor adapted for use in a multi-stage refrigeration system and a plurality of interchangeable liners, said liners being adapted to be assembled in said compressor to form a plurality of cylinders therein for cooperation with pistons of said compressor, means forming a plurality of passages for refrigerant in said compressor, intake and exhaust valves associated with said cylinders, a first type of skirt carried by some of said liners and adapted to operatively connect the intake valves of cylinders formed by these liners with one of said passages, a second type of skirt carried by other of said liners and adapted to operatively connect the intake valves of cylinders formed by said other liners with another of said passages and means forming a fluid flow connection between the exhaust valves of some of said cylinders with one of said passages.

3. A refrigerant compressor apparatus comprising a housing, a plurality of pistons, driving means to reciprocate said pistons, a plurality of cylindrical liners assembled in said housing, one of said liners being assembled in operative relationship with each of said pistons and receiving said piston for reciprocation therein, means associated with said housing and forming first, second and third refrigerant passages, said first

and second passages being formed in said housing, a first valve means to control the admission of refrigerant to each of said liners, a second valve means to control the discharge of refrigerant from each of said liners, means connecting the discharge valve means of some of said liners with said second passage, means connecting the discharge valve means of other of said liners with said third passage, attachments carried by some of said liners and adapted to form a refrigerant flow connection between some of said first valve means and said first passage and attachments carried by other of said liners and adapted to form a refrigerant flow connection between other of said first valve means and said second passage, at least some of said liners having an opening in the wall thereof to expose the interior of said some liners to said first passage during a portion of the stroke of the pistons reciprocating in these liners and other liners having an opening in the wall thereof exposing the interior of said other liners to said second passage.

4. A refrigerant compressor apparatus comprising a housing, a plurality of pistons, driving means to reciprocate said pistons, a plurality of cylindrical liners assembled in said housing, one of said liners being assembled in operative relatonship with each of said pistons and receiving said piston for reciprocation therein, means associated with said housing and forming first, second and third refrigerant passages, each of said liners having a port means to control the admission of refrigerant thereto, a valve means to control the discharge of refrigerant from each of said liners, means connecting the discharge valve means of some of said liners with said second passage, means connecting the discharge valve means of other of said liners with said third passage, attachments carried by some of said liners and adapted to form a refrigerant flow connection between the associated port means and said first passage, attachments carried by other of said liners and adapted to form a refrigerant flow connection between their associated port means and said second passage, said port means being so located in said liners that at a predetermined position in the compression stroke of the associated piston, said piston covers the associated port and the effective length of the compression stroke is predetermined by the location of the port relative to the limits of the mechanical movement of said piston so that deviations in the locations of the ports in different liners determines the effective length of the compression strokes of the individual pistons associated with each of the liners.

5. A refrigerant compressor apparatus comprising a housing, a plurality of pistons, driving means to reciprocate said pistons, a plurality of cylindrical liners assembled in said housing, one of said liners being assembled in operative relationship with each of said pistons and receiving said piston for reciprocation therein, means associated with said housing and forming first, second and third refrigerant passages, a first valve means to control the admission of refrigerant to each of said liners, a second valve means to control the discharge of refrigerant from each of said liners, means connecting the discharge valve means of some of said liners with said second passage, means connecting the discharge valve means of other of said liners with said third passage, an attachment carried by a first one of said liners and adapted to form a refrigerant flow connection between said first valve means and said first passage, an attachment carried by a second one of said liners and adapted to form a refrigerant flow connection between its first valve means and said second passage, said first liner having a port therein forming the first valve means thereof so that at a predetermined position in the compression stroke of the associated piston, the piston covers the port and the effective length of the compression stroke is predetermined by the location of said port relative to the limits of the mechanical movement of said piston and said second liner having ports at other locations to form the first valve means thereof whereby different effective compression strokes are obtained by the pistons associated with said first and said second liners and the porting of said liners is operatively connected to different passages by said attachments.

6. A refrigerant compressor apparatus comprising a housing, a plurality of pistons, driving means to reciprocate said pistons, a plurality of cylindrical liners assembled in said housing, one of said liners being assembled in operative relationship with each of said pistons and receiving said piston for reciprocation therein, means associated with said housing and forming first, second and third refrigerant passages, a first valve means to control the admission of refrigerant to each of said liners, a second valve means to control the discharge of refrigerant from each of said liners, means connecting the discharge valve means of some of said liners with said second passage, means connecting the discharge valve means of other of said liners with said third passage, attachments carried by some of said liners and adapted to form a refrigerant flow connection between some of said first valve means and said first passage, attachments carried by other of said liners and adapted to form a refrigerant flow connection between other of said first valve means and said second passage, at least some of said plurality of liners having ports therein, the arrangement of ports being varied between some of said liners whereby varied effective compression strokes are obtained by pistons having the same mechanical movement, said attachments carried by said some liners being adapted to direct the flow of refrigerant from said first passage to the ports associated with said some liners, and said attachments carried by said other liners being adapted to direct the flow of refrigerant from said second passage to the ports of said other liners.

7. A fluid compressor comprising a housing, a plurality of reciprocable pistons in the housing, a cylinder for each of said pistons having an inlet opening, means forming a plurality of fluid passageways in said housing, a skirt for each of said cylinders, the skirt for a first one of said cylinders limiting fluid flow from one of said passageways to the inlet opening of said first cylinder and the skirt for a second one of said cylinders limiting fluid flow from the other of said passageways to the inlet opening of said second cylinder, means forming a discharge passage for discharging fluid from said first cylinder into said second passageway and means forming a discharge passage for discharging fluid from said second cylinder to the exterior of said compressor.

8. A refrigerant compressor apparatus comprising a housing, a plurality of pistons, driving means to reciprocate said pistons, a plurality of cylindrical liners assembled in said housing, one of said liners being assembled in operative rela-

tionship with each of said pistons and receiving said piston for reciprocation therein, means associated with said housing and forming first, second and third refrigerant passages, said first and second passages being formed in said housing, a first valve means to control the admission of refrigerant to each of said liners, a second valve means to control the discharge of refrigerant from each of said liners, means connecting the discharge valve means of some of said liners with said second passage, means connecting the discharge valve means of other of said liners with said third passage, attachments carried by some of said liners and adapted to form a refrigerant flow connection between some of said first valve means and said first passage and attachments

carried by other of said liners and adapted to form a refrigerant flow connection between other of said first valve means and said second passage.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,329,348	Copeland	Jan. 27, 1920
1,535,856	Rix	Apr. 28, 1925
1,634,633	Thompson	July 5, 1927
1,694,218	Hazard	Dec. 4, 1928
2,186,492	Paget	Jan. 9, 1940