

Dec. 17, 1935.

R. G. WYLD

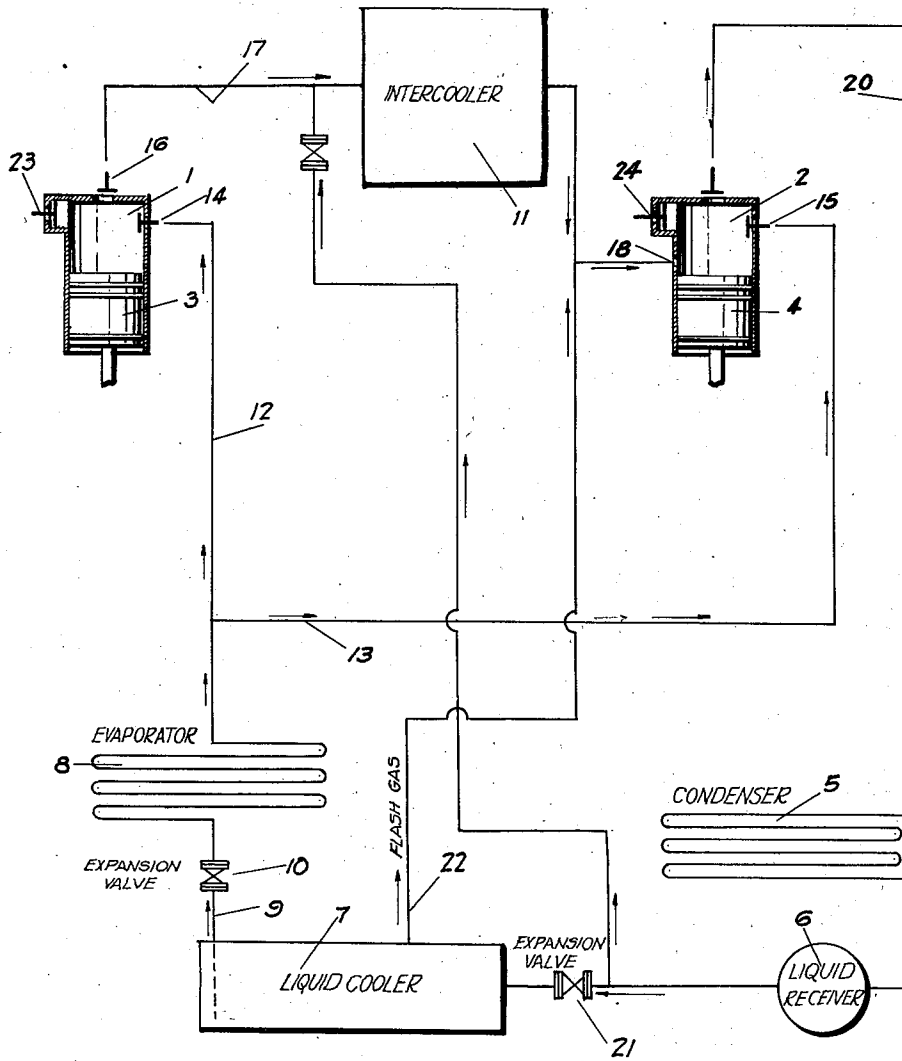
2,024,323

APPARATUS FOR COMPRESSING GASEOUS FLUIDS

Filed July 1, 1932

2 Sheets-Sheet 1

Fig. 1



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2 Sheets-Sheet 2

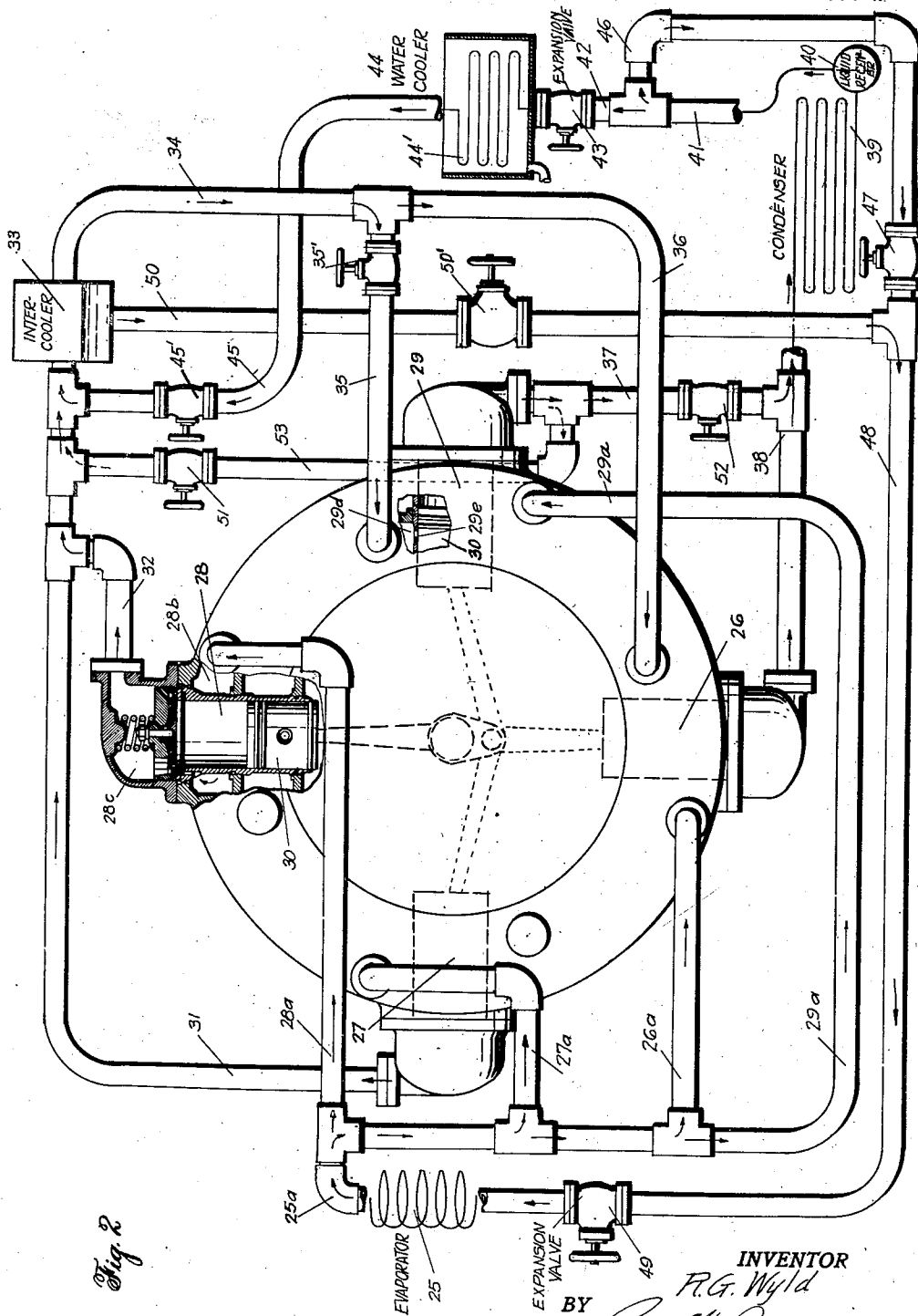


Fig. 2

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2,024,323

APPARATUS FOR COMPRESSING GASEOUS FLUIDS

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Application July 1, 1932, Serial No. 620,313

13 Claims. (Cl. 62—115)

This invention relates generally to an improved method and apparatus for producing refrigeration and more particularly for obtaining the advantages of compound compression in a simple and relatively inexpensive manner as by using two or more compressor cylinders of preferably the same size and the pistons of which are operated preferably at substantially the same speed.

It is desirable especially in the manufacture of a refrigeration apparatus, although it is also applicable to compressors for other work, to standardize the equipment as far as possible consistent with maintaining or improving the efficiency, thereby obtaining a lower cost of manufacture due to quantity production and also reducing inventory. In addition to accomplishing these results it is desirable to have the standardized equipment sufficiently flexible so that it may be used in a wide range of applications.

Heretofore improved efficiency has been obtained in one phase of refrigeration work by the use of compound compressors involving a relatively large low pressure cylinder and a relatively small high pressure cylinder, thereby necessitating the manufacture and carrying in stock of two different sizes of cylinders for a given capacity.

While my improved refrigeration system employs cylinders preferably of the same size such as would serve ordinarily only as single stage compressors, and while herein they not only initially function in the manner of single stage compressors as by having low pressure gas drawn in all cylinders on the suction strokes, yet the cylinders are brought into such cooperating relation by a novel arrangement employing multiple-effect ports in certain of the cylinders that the advantages of compound compression are obtained without the necessity of usual high and low pressure cylinders of different sizes.

It is therefore one of the specific objects of my invention to obtain the advantages of compound compression by an improved arrangement and combination of elements, and in one specific aspect of the invention this is accomplished by using cylinders all of the same size, certain of which are provided with multiple-effect ports. A further object is to provide an improved combination having a mode of cooperation between the various elements of a refrigeration system whereby different ratios of compounding may be obtained without changing the size of the cylinders used.

Specifically, I employ preferably two or more cylinders of the same size or piston displacement, each cylinder being provided with usual intake

and discharge valves. Each cylinder is supplied through its intake valve with relatively low pressure gaseous refrigerant supplied from an evaporator into which the liquid refrigerant was expanded to effect the necessary cooling of a storage room, brine, etc. To effect the compound compression one of the cylinders, termed a high pressure cylinder, is provided with multiple effect ports which are connected to the discharge of the other cylinder which is herein termed a low pressure cylinder. The result is that after the high pressure cylinder has drawn in gas, through its intake valve, of low pressure gas from the evaporator, this gas is supplemented at the end of the suction stroke through the multiple-effect ports by the higher pressure gas from the low pressure cylinder. If desired one high pressure and two low pressure cylinders may be employed connected in the same manner as just described or three or more cylinders can serve as low pressure cylinders all supplying one or more high pressure cylinders, all of these cylinders being of the same size and the multiple-effect ports of each cylinder being opened or closed depending upon whether the particular cylinders are high or low pressure cylinders. It is thus seen that any desired ratio of compression may be effectively obtained preferably with cylinders of the same size although under certain conditions it may be advantageous to use cylinders of different sizes such as may be found in existing plants.

Other objects have to do with providing an improved refrigeration system involving an inter-cooler, condenser and liquid cooler all of which are arranged in an improved manner so as to efficiently utilize the refrigerant whether in the gaseous or liquid state.

Other objects and advantages will be more apparent to those skilled in the art from the following description of the accompanying drawings 40 in which:

Fig. 1 is a diagrammatic layout of my system employing two compressor cylinders, and

Fig. 2 is a diagrammatic layout of the invention employing four cylinders interconnected so as to obtain the improved compounding, this modification being particularly adapted for manufacture of ice and simultaneously maintaining other cooling systems at one or more different temperatures, such as storage rooms, 50 water coolers, etc.

In the simplified diagram of Fig. 1 disclosing one specific embodiment of the invention, there is shown low and high pressure compressor cylinders 1 and 2 respectively, each of the recipro- 55

cating piston type. These cylinders are preferably of the same size and their pistons 3 and 4 are operated at the same speed and with the same length stroke. The compressors may be separately or commonly driven units. There is also a condenser 5, receiver 6, liquid cooler 7, liquid evaporator 8 and intercooler 11. The interconnections between the foregoing elements will be more easily understood from a description of the operation.

In operation, liquid refrigerant such as ammonia or carbon dioxide, etc. is supplied from liquid cooler 7, through pipe 9, expansion valve 10 and evaporator 8 from which refrigerant gas, assumed for purposes of illustration to be ten pounds pressure per square inch, is divided and conducted through pipes 12 and 13 to the regular compressor intake valves 14 and 15 so as to be drawn into the cylinders during the suction strokes. Low pressure piston 3 compresses and discharges its gas through discharge valves 16 and pipe 17 to the multiple effect port 18 of high pressure cylinder 2. For purposes of illustration the pressure of the gas discharged from the low pressure cylinder is assumed to be forty pounds per square inch. Ports 18 are controlled by piston 4 so that the low pressure cylinder gas is admitted to high pressure cylinder 2 at the end of its stroke thus supplementing the initial charge of gas taken in through valve 15. The total weight of refrigerant and pressure thereof in cylinder 2 is therefore materially increased at the beginning of the compression stroke of piston 4 than would be the case without the supply from low pressure cylinder 1. Hence the pressure of gas compressed and discharged from cylinder 2 through discharge valve 19 is, for purposes of illustration, in the neighborhood of 200 pounds per square inch.

The compressed refrigerant is conducted through pipe 20 to condenser 5 which liquefies the gas. The condensed liquid discharges into receiver 6 from which it passes through an expansion valve 21 into the liquid cooler 7 to thereupon repeat the cycle above described.

An additional feature of this system is the efficient recompression of the flash gas created in liquid cooler 7. When the liquid refrigerant enters liquid cooler 7 through expansion valve 21 a certain percentage of the refrigerant is immediately transformed into gas called flash gas, this acting to cool the remaining liquid ammonia. The flash gas is then conducted through a pipe 22 for admission to multiple-effect port 18 simultaneously with the gas from low pressure cylinder 1.

To obtain maximum flexibility in operation of the machines so as to efficiently or properly take care of various conditions of operation or capacity I propose that, if desired, adjustable clearance pockets diagrammatically shown at 23 and 24 may be employed. These pockets may be of any usual type although preferably they are of the type shown in my copending application Serial No. 451,787, filed May 12, 1930. If only one clearance device is used it is preferable that the same be applied to the high pressure multiple-effect port cylinder. Whether one or all cylinders are thus provided it is seen that adjustment will control the pressure and temperature conditions and capacity thus effecting the proper operating relations best suited for any particular circumstances.

In order to use cylinders herein of standard construction for both high and low pressures, the

cylinder sleeve of the high pressure cylinder is drilled to provide multiple-effect or center ports whereas the sleeve of the other cylinder is undrilled although its cylinder casting would be formed the same as the high pressure cylinder thus making the low pressure cylinder readily adaptable for high pressure connection if such were desired. The cylinders can therefore be considered as interchangeable in that a drilled sleeve could be changed for an undrilled sleeve or vice versa.

To operate with a wide range of flexibility or capacity I have shown in Fig. 2 a system which may operate under four or more pressures, this system being particularly applicable to ice making. It will therefore be assumed for purposes of illustration that the main load comes from a freezing tank (not shown) having an evaporator coil 25 from which evaporated gaseous refrigerant at say twenty pounds pressure is conducted through a pipe 25a and thence through branch pipes 26a—29a to each of the main suction valves of all compressor cylinders 26—29. The intake valve for each of the cylinders is of the same general type as shown in the application of H. C. Heller, Serial No. 605,059, filed April 13, 1932, wherein the fluid from the intake passage is admitted to a chamber 28b surrounding the upper half of the cylinder, fluid from the intake chamber being drawn past an annular plate type of valve into the cylinder. Fluid is discharged through a preferable annular plate type of valve into a discharge chamber 28c, the details of construction of this valve mechanism not being further described here as it does not per se form a part of my present invention, as it will be understood that any suitable type of valve mechanisms may be employed.

For the purpose of precooling the water which is to be made into ice, before it enters the freezing tank, it would be advantageous to have a water cooler 43 provided with cooling coils 44 in which the refrigerant would operate at forty pounds pressure. The compressor as shown is of the radial cylinder type having a common single throw crankshaft although it will of course be understood that any other suitable type of compressor may be employed, it being further understood that the particular type of compressor herein shown does not per se constitute a part of my invention.

During operation of the compressor, fluid will be drawn in on the suction stroke of each of the pistons 30 and upon the compression in cylinders 27 and 28 fluid is discharged through pipes 31 and 32 to intercooler 33 from which the cooled gases are conducted through a pipe 34 and branch pipes 35 and 36 to a suitable chamber 29d and a corresponding chamber of cylinder 26. From these chambers fluid is admitted to cylinders 26 and 29 through the so-called multiple-effect or center ports such for example as 29e.

The fluid admitted through center ports 29e, etc. will increase the weight and pressure of the refrigerant in cylinders 26 and 29 so that upon the compression stroke, fluid will be discharged at a relatively high pressure, say 185 pounds per square inch, through pipes 37 and 38 into condenser 39 from which condensed liquid is conducted to a liquid receiver 40. The liquid refrigerant is then conducted through pipe 41 which has a branch 42 provided with a suitably adjusted expansion valve 43 for operating at say forty pounds pressure in cooling coils 44 for precooling water before it enters the freezing tank, 75

the evaporated refrigerant from the cooler coils being discharged through a pipe 45, past a suitable normally open stop valve 45' and into intercooler 33.

The greater portion of the condensed refrigerant in liquid receiver 40 is conducted through pipe 46 past a normally open stop valve 47 to pipe 48 and is expanded through a suitable expansion valve 49 to evaporator 25 thus completing the cycle.

To facilitate cooling of low pressure gas from cylinders 27 and 28, a certain amount of excess liquid refrigerant may be passed through pipe 45 to the intercooler. A portion of this refrigerant will evaporate to cool the gas from the low pressure cylinders, the evaporated refrigerant together with the low pressure cylinder gas passing from the intercooler through pipe 34 to the multiple-effect ports of cylinders 26 and 29, thus obtaining efficient recompression of this gas.

If desired, the entire amount of liquid refrigerant from receiver 40 may be passed through coils 44' and pipe 45 to intercooler 33, in which event the excess amount of liquid refrigerant not required for intercooling purposes would accumulate in the bottom of the intercooler and drain through a pipe 50 past a stop valve 50' to pipe 48 to complete the cycle by passing through expansion valve 49. In this mode of operation stop valve 47 is closed.

It is seen that the foregoing arrangement utilizes two cylinders 27 and 28 as low pressure cylinders and cylinders 26 and 29 as high pressure cylinders although if desired three cylinders such as 27, 28 and 29 may each be used as low pressure cylinders pumping into the remaining single cylinder 26 acting as the high pressure cylinder. To accomplish this a normally closed stop valve 51 is opened while normally open stop valves 52 and 35' are closed in which event it is seen that cylinder 29 can no longer receive through its multiple-effect port 29e low pressure gas from intercooler 33 but will receive gas only through its regular suction valve from evaporator 25 through pipe 29a. Upon the compression stroke in this cylinder the compressed gases will now flow through a pipe 53 to the intercooler along with the compressed gases from cylinders 27 and 28. The compressed gases in the intercooler, now supplied from the three cylinders 27, 28 and 29, will pass through pipes 34 and 36 to the multiple-effect port of cylinder 26 to be compressed therein under high pressure and discharged through pipe 38 to condenser 39 to complete the cycle as described with the two low and two high pressure cylinders.

If desired clearance devices could be used with the Fig. 2 form and it is equally apparent from the principles of operation just described that three low pressure cylinders could pump into two high pressure cylinders, or in a four cylinder compressor as shown in Fig. 2 two low pressure cylinders could pump into one high pressure cylinder while the fourth cylinder could be used only for the water cooler. In case the fourth cylinder is used solely for the water cooler, then the intercooler would operate say at sixty pounds per square inch pressure while the other portions of the system could operate at pressures such as might be desired or might be most efficient for any particular set of operating conditions. In connection with the low pressure cylinders it will be understood that the center port may be used to give multiple effect, not for compound operation as above described with other modifications, but rather for obtaining a pressure in a third

evaporator which is at a pressure between that in the low and high pressure cylinders, thus giving as many as five different pressures in the system with two or more cylinders.

It is thus seen that my improved arrangement permits the use of the same size cylinders in obtaining the benefits of compound compression, and this is accomplished in an economical and efficient manner while at the same time allowing a choice in the range of compression ratios without necessitating the manufacture or keeping in stock of cylinders of different sizes. While I have shown in Fig. 2 a compressor whose various pistons are of the same diameter, actuated from a common crankshaft and therefore at the same speed and stroke, it will be clear from the disclosure herein that separate compressors, if used, may be operated at either the same or different speeds or with cylinders of different sizes, all of which would be used in accordance with the principles outlined herein. It will also be understood that if it is desired to use multiple-effect in conjunction with the low pressure cylinders this may be done simultaneously with my improved system.

All of the foregoing desirable results are obtained in addition to obtaining efficient liquid cooling in the intercooler. While the compound compression and liquid cooling is rendered possible in one specific aspect of my invention by initially charging the high and low pressure cylinders with low pressure gas from the evaporator and then conducting the gas from an intercooler to the multiple-effect ports of the high pressure cylinder, it will of course be understood that various changes in the construction and arrangement of elements may be made by those skilled in the art without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. A compressor system comprising, in combination, a compressor having a plurality of cylinders each provided with intake valve mechanism, means for supplying each cylinder with low pressure gas through said intake valve mechanism, and means for supplementing the low pressure gas in certain of said cylinders with gas compressed in other of said cylinders.

2. A compressor system comprising, in combination, a compressor having a plurality of cylinders having pistons therein of substantially identical displacement, each cylinder being provided with intake valve mechanism, means for supplying each cylinder with low pressure gas through said intake valve mechanism, and means for supplementing the low pressure gas in certain of said cylinders with gas compressed in other of said cylinders.

3. A refrigeration system comprising, in combination, a compressor having a plurality of pistons and cylinders of substantially identical bore and stroke each provided with intake valve mechanism, means for supplying each cylinder with low pressure gas through said intake valve mechanism, and means for supplementing the low pressure gas in certain of said cylinders with gas compressed in other of said cylinders.

4. A refrigeration system comprising, in combination, a compressor having high and low pressure pistons and cylinders, intake and discharge valve mechanism for each cylinder, said high pressure cylinder having multiple-effect ports, and means whereby refrigerant gas compressed in the low pressure cylinder is discharged

into the high pressure cylinder through the multiple-effect ports thereof.

5 5. A compressor system comprising, in combination, a compressor having high and low pressure pistons and cylinders actuated from a common crankshaft, means for supplying each cylinder with fluid at substantially the same pressure including intake valve mechanism, and means for supplying to the high pressure cylinder at substantially near the end of its stroke fluid which is compressed from the low pressure cylinder.

10 6. A refrigeration system comprising, in combination, a compressor having high and low pressure cylinders, said high pressure cylinder being provided with multiple-effect ports, intake and discharge valves for each of said cylinders, means for supplying low pressure gas to all of said cylinders through their intake valves, an intercooler, means for discharging compressed gaseous fluid from the low pressure cylinder into said intercooler and for conducting the gas from said intercooler into said high pressure cylinder through the multiple-effect ports thereof.

15 7. A refrigeration system comprising, in combination, a compressor having high and low pressure cylinders, said high pressure cylinder being provided with multiple-effect ports, intake and discharge valves for said cylinders, means for supplying low pressure gas to all of said cylinders through their intake valves, an intercooler, means for discharging compressed gaseous fluid from the low pressure cylinder into said intercooler and for conducting the gas from said intercooler into said high pressure cylinder through the multiple-effect ports thereof, a condenser for receiving compressed gaseous fluid from the high pressure cylinder, and means for conducting at least a part of the condensed liquid refrigerant to said intercooler for cooling the compressed fluid from said low pressure cylinder.

20 8. A refrigeration system comprising, in combination, a compressor having high and low pressure cylinders, said high pressure cylinder being provided with multiple-effect ports, intake and discharge valves for said cylinders, means for supplying low pressure gas to all of said cylinders through their intake valves, an intercooler, means for discharging compressed gaseous fluid from the low pressure cylinder into said intercooler and for conducting the gas from said intercooler into said high pressure cylinder through the multiple-effect ports thereof, a condenser for receiving compressed gaseous fluid from the high pressure cylinder, means for conducting at least a part of the condensed liquid refrigerant to said intercooler for cooling the compressed fluid from said low pressure cylinder, a cooler, and means for conducting condensed liquid to and expending the same in said cooler.

25 9. A refrigeration system comprising, in combination, a compressor having high and low pressure cylinders, said high pressure cylinder being provided with multiple-effect ports, intake and discharge valves for said cylinders, means for

supplying low pressure gas to all of said cylinders through their intake valves, an intercooler, means for discharging compressed gaseous fluid from the low pressure cylinder into said intercooler and for conducting the gas from said intercooler into said high pressure cylinder through the multiple-effect ports thereof, a condenser for receiving compressed gaseous fluid from the high pressure cylinder, and means for conducting at least a part of the condensed liquid refrigerant to said intercooler for cooling the compressed liquid from said low pressure cylinder, said means which conducts the cooling liquid to said intercooler being provided with an expansion valve and connected into said intercooler so that the gas formed upon evaporation of the liquid will thereafter pass into the high pressure cylinder or cylinders.

10 10. A refrigeration system comprising, in combination, a compressor having high and low pressure cylinders, an intercooler, means for discharging compressed gas from said low pressure cylinder into said intercooler and from there into said high pressure cylinder, a condenser receiving compressed gas from the high pressure cylinder for condensing the same to liquid, means for passing the liquid refrigerant from said condenser into said intercooler through an expansion valve for effecting cooling of the low pressure gases, a liquid cooler in which flash gas is formed, and means for recirculating the flash gas and intercooling gas through the high pressure cycle.

15 11. A refrigeration system comprising, in combination, a compressor having a plurality of cylinders each provided with an intake valve, means for supplying each cylinder with low pressure gas through its intake valve, means for supplementing the low pressure gas in certain of said cylinders with gas compressed in other of said cylinders, and adjustable clearance means associated with certain of said cylinders.

20 12. A compressor system comprising, in combination, a compressor having a plurality of cylinders each provided with an intake valve, means for supplying each cylinder with low pressure gas through its intake valve, means for supplementing the low pressure gas in certain of said cylinders with gas compressed in other of said cylinders, and adjustable clearance means associated with the cylinder or cylinders which are supplied with gas from other of the cylinders.

25 13. A refrigeration system comprising, in combination, a compressor having a plurality of cylinders each provided with an intake valve, means for supplying each cylinder with low pressure gas through its intake valve, means for supplementing the low pressure gas in certain of said cylinders with gas compressed in other of said cylinders, and adjustable cylinder clearance means associated with a cylinder or cylinders to which the supplemental gas is supplied while the cylinders from which the supplemental gas is supplied remain invariable in their cylinder clearance.

REGINALD G. WYLD.

CERTIFICATE OF CORRECTION.

Patent No. 2,024,323.

December 17, 1935.

REGINALD G. WYLD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 60, claim 8, for the word "expending" read expanding; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of September, A. D. 1936.

Seal)

Leslie Frazer
Acting Commissioner of Patents.