

Oct. 16, 1945.

L. BUEHLER, JR
REFRIGERATION SYSTEM
Filed March 24, 1941

2,387,117

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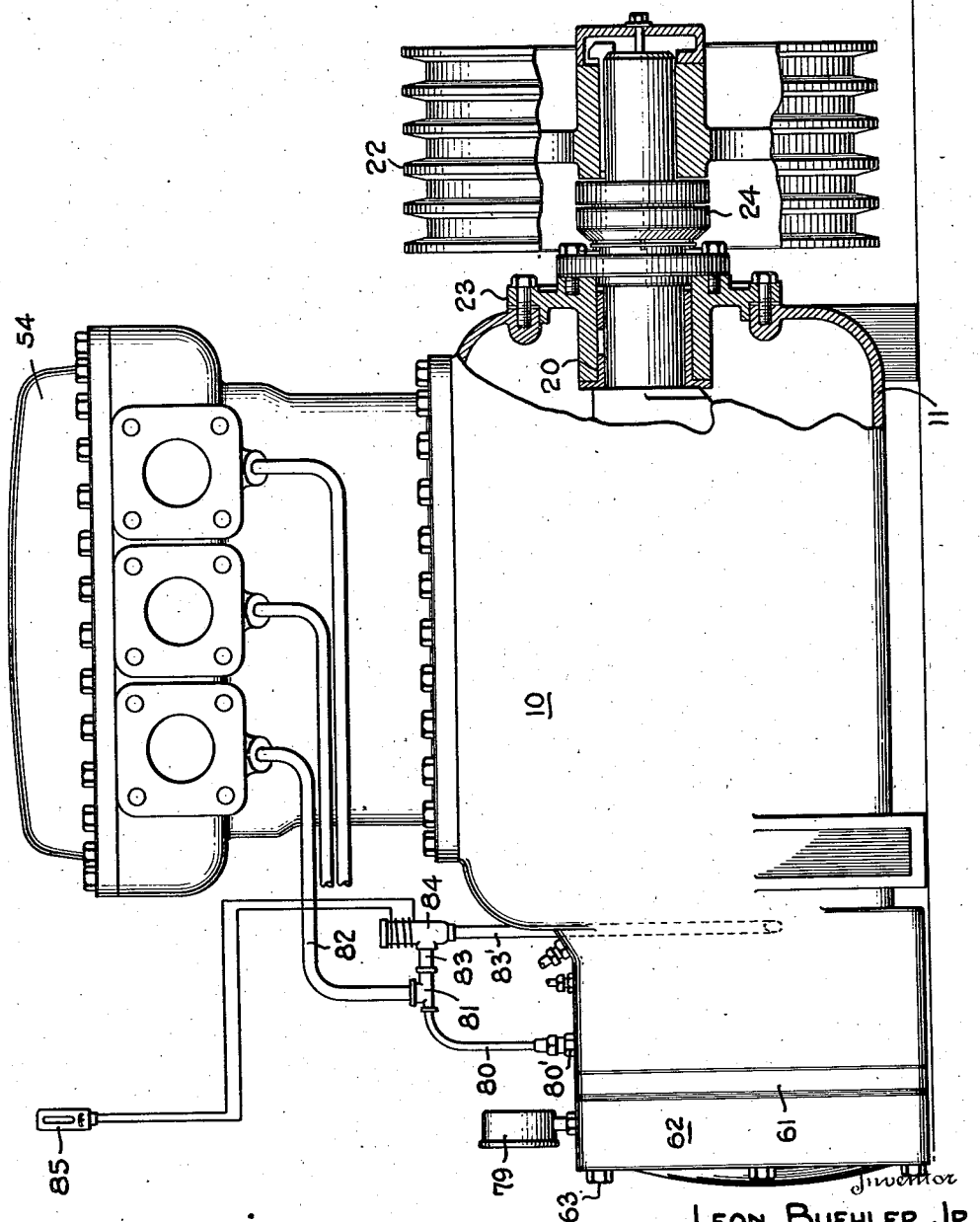


Fig. 1.

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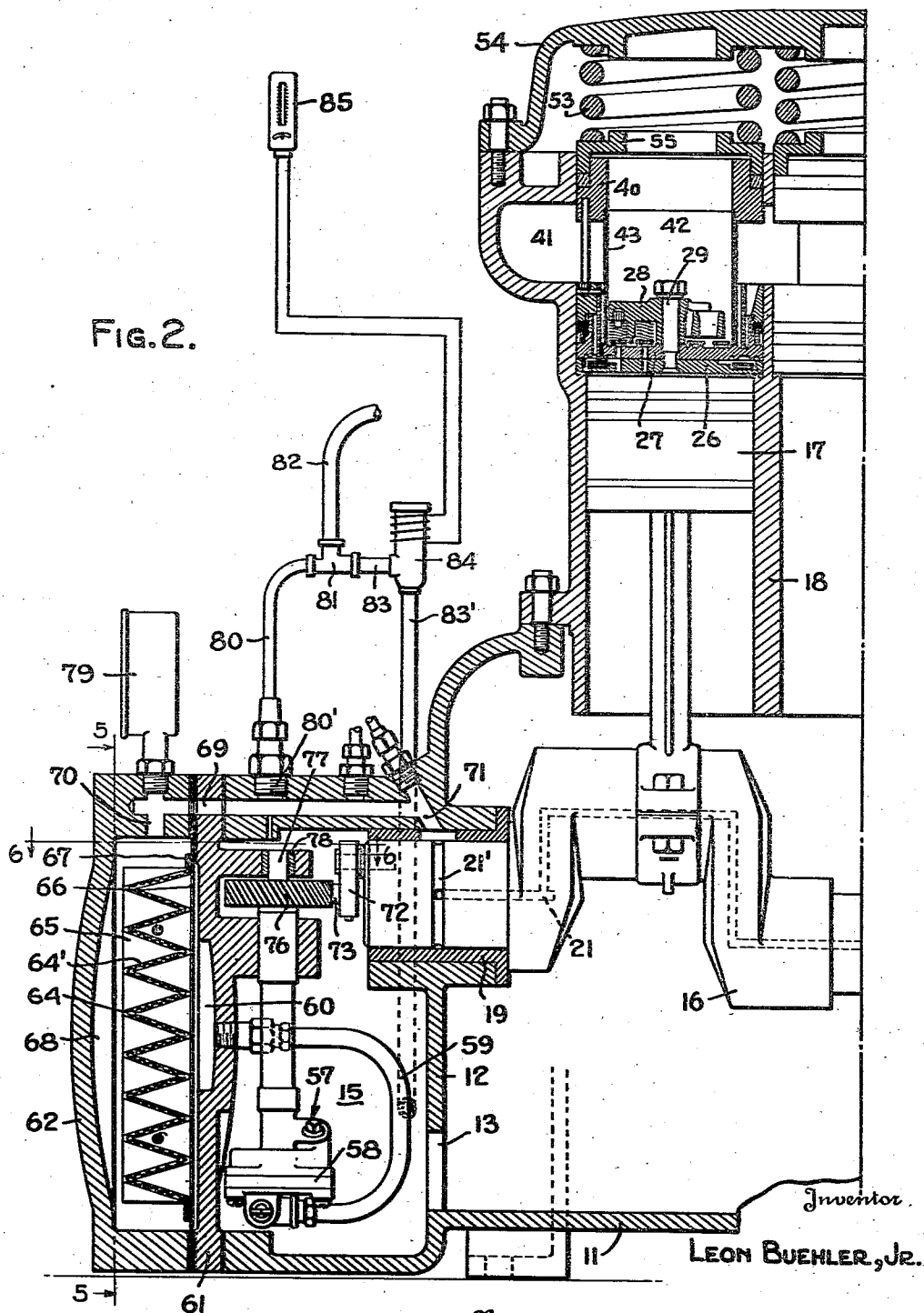
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FIG. 2.



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FIG. 3.

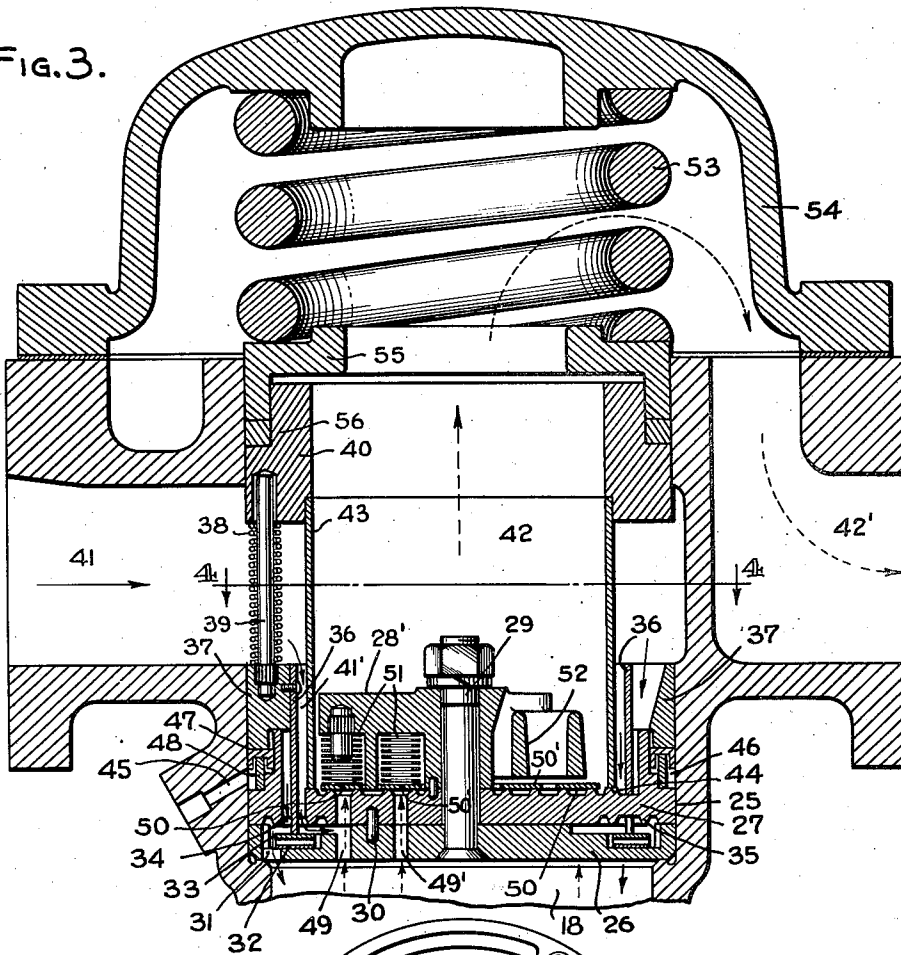
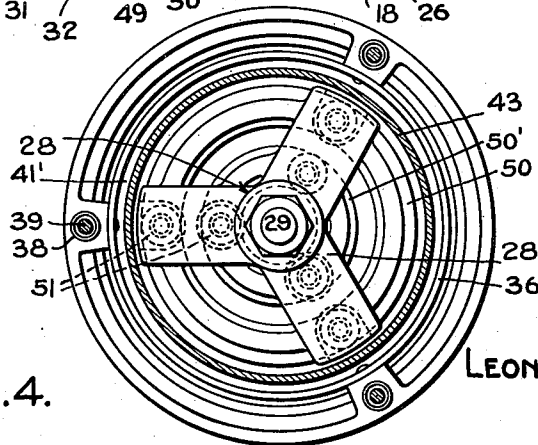


FIG. 4.



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FIG. 6.

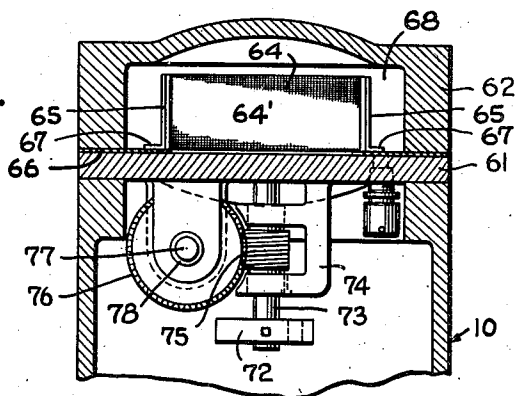
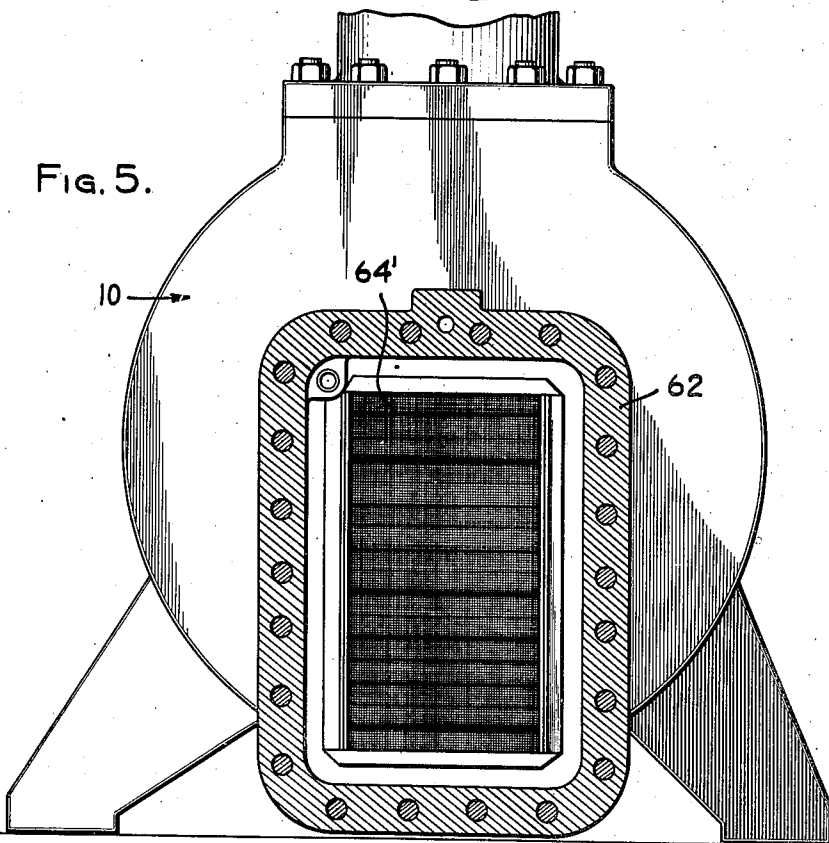


FIG. 5.



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REFRIGERATION SYSTEM

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14 Claims. (Cl. 230—30)

This invention relates to refrigeration systems and particularly to compressors for use in such systems.

An object of the invention is to provide a compressor incorporating improved means functioning to unload the compressor in accordance with load requirements.

The unloading means as herein disclosed is preferably of that type operating through pressure generated in the lubricating system for the compressor, and the head of the compressor cylinder is of the spring mounted safety type and carries as part of its assembly a suction valve also functioning as an unloader valve normally urged towards open or unloading position by spring pressure, the oil pressure of the lubricating system being applied through a control device operating in accordance with load requirements to move the suction valve to a position where it will operate in its normal capacity as a suction valve. Thus the action of the capacity control is not directly dependent upon the operation of the compressor yet at the same time the unloading pressure is applied through the lubricating system for the compressor. This construction provides a remarkably flexible unloading system for the compressor and at the same time prevents damage in the event a slug of liquid or other substantially non-compressible body is interposed between the top of the piston and the cylinder head.

Another object of the invention therefore, is to provide a compressor for refrigeration systems embodying unloading means of a flexible nature and a safety head for the compressor cylinder or cylinders carrying as part of its assembly a combined unloading and suction valve forming part of the unloading system.

Other objects include improvements directed generally to systems of the type under consideration, and which will become apparent in view of the following description taken in conjunction with the drawings, wherein:

Fig. 1 is a view in elevation, partly broken away, of a three-cylinder compressor embodying the features of the invention;

Fig. 2 is a substantially central vertical section through part of Fig. 1 reading from left to right of said figure;

Fig. 3 is an enlarged sectional view of one of the compressor cylinder heads particularly illustrating the spring mounted safety construction of the latter;

Fig. 4 is a sectional plan view taken on the line 4—4, Fig. 3;

Figs. 5 and 6 are sections taken substantially on the lines 5—5 and 6—6, Fig. 2.

Referring to the drawings in detail, a refrigeration compressor is generally indicated at 10 and has a crankcase 11 which at one end is provided with a partition wall 12, note Fig. 2, formed with a port 13, leading into a chamber 15 housing an oil pump and coating assembly which will subsequently be described. Within the crankcase is mounted a crankshaft 16 having connected thereto pistons 17 operating in cylinders 18. Crankshaft 16 is journaled in main bearings 19 and 20 supplied with oil under pressure through force feed lubrication, the oil entering shaft bore 21 through ports 21' and passing through the bore and lubricating the connecting rod bearings as well as the main bearing 20 and then returning to the crankcase for recirculation.

The crankshaft may be driven from any suitable source of power connected to pulley 22, note Fig. 1, which is mounted on the end of the crankshaft beyond end plate 23, said shaft at this point being provided with a seal assembly generally indicated at 24, for preventing the escape of refrigerant.

The head of each cylinder 18 carries a spring mounting assembly, one of which is shown in detail in Figs. 3 and 4. The cylinder 18 at its upper extremity is formed with a counterbore 25 which forms a seat for cylinder head 26 and valve case 27. A cage member 28 is disposed on the case 27 and is formed with a series of radial webs 28'. The head 26, case 27 and cage 28 are connected as a unit by center bolt 29 and pins or studs 30. An annular recess 31 in the head 26 provides a seat for valve spring 32, over which lies suction valve 33, the latter being in the form of an annular disc of suitable material. The valve case 27 is provided with inlet port 34 for admitting the gas to be compressed into cylinder 18. A valve seat 35 is formed on case 27 against which the valve 33 is adapted to seat on the compression stroke of piston 17 when the cylinder 18 is delivering at full load capacity.

In effecting unloading of the cylinder 18, the suction valve 33 is displaced from its seat 34 by control means including abutment sleeve 36 connected to capacity control lift piston or plunger 37 slidable in the lower extremity of counterbore 25 and normally under spring pressure by means of springs 38 mounted on pins 39, the latter at their lower ends each being connected to the plunger 37 and at their upper ends projecting into ring member 40 slidable in the upper extremity of the said counterbore.

The main suction inlet space or port is generally indicated at 41 and the main exhaust space or port at 42, these ports being separated by the ring member 40 and sleeve 43 which at its upper end is pressed into the member 40 and at its lower end engages a seat 44 formed on the top of the valve case 27. Port 41 communicates with port 34 through port or space 41'.

An inlet port 45 for pressure fluid is formed in the wall above the cylinder and leads into annular space 46 which is sealed by gasket 47 held in position by annular member 48.

It will be seen that as long as the pressure in annular space 46 is sufficiently low to permit the springs 38 to overcome valve spring 32, suction valve 33 will be displaced from its seat 34, thereby permitting gas to surge back and forth in the said space when the piston 17 is reciprocated, but when pressure is built up in the space 46 to a point where it overcomes the spring 38, the sleeve 36 will be moved upwardly free of the suction valve 33, permitting the latter to seat and function in its normal manner.

The cylinder head 26 and valve case 27 are formed with communicating exhaust or discharge ports 49 and 49' which are spaced radially from one another and are controlled by annular disc valves 50 and 50' normally urged to seated position by springs 51 housed by the webs 28', movement of the valves 50 and 50' away from their seats being definitely limited by stops 52.

The entire cylinder head assembly just described is mounted under the pressure of main head spring 53 which is interposed between cap 54 and member 55, the latter being imposed on the member 40 with a sealing gasket or packing 56 therebetween.

The sleeve 43 constitutes a rigid abutment for the valve cage or plate 27 and transmits thrust from the cylinder head 26 and said cage to the members 40 and 55 and thence through the main head spring 53 to the cap 54.

In the position shown in Fig. 3, the suction valve 33 is in unloading position, the pressure in the space or chamber 46 being insufficient to offset the pressure of the springs 38. When pressure builds up in this space, the plunger or piston 37 is driven upwardly, compressing springs 38 and moving the abutment sleeve 36 clear of the suction valve 33, permitting the latter to seat, whereupon the compressor piston can operate normally to draw in refrigerant vapor through intake ports 41, 41' past the suction valve 33 and through port 34 into the cylinder on the down stroke of the piston, the suction valve being seated on the up stroke of the piston and the compressed refrigerant being discharged through ports 49 and 49' outwardly through exhaust or discharge passage 42 and port 42'. Should a slug of liquid or other substantially incompressible body be encountered by the upwardly moving piston, it will cause the head 26 to unseat against the resistance of spring 53. This yielding movement of the safety head will allow a longer period of time to get rid of the liquid; viz, until the end of the stroke of the piston 17.

Referring now to the unloader pressure system, this is best shown in Fig. 2. An oil pump 57 is mounted in the chamber 18 and is provided with an impeller chamber 58 having connected thereto the intake end of a tube or conduit 59 which discharges oil into a chamber 60 defined by plate 61 and cap 62, note also Fig. 6. The cap 62 and plate 61 are bolted to the crank case by stud bolts 63.

Within the chamber defined by the plate 61 and cap 62 is a screen assembly comprising a screen 64 which is of a particular construction to obtain maximum screening or filtration efficiency. This screen is doubled upon itself or corrugated as indicated at 64' and compressed between plates 65 attached to base plate 66 at 67. Oil coming into the inlet chamber 60 flows into the screen and diverges, going both ways and filling the outer chamber 68, from which it passes into pressure chamber 69 through port or passage 70. Oil under pressure in the chamber 69 feeds through port 71 to the bore 21 in the crankshaft and connecting rod and crankshaft bearings and then back into the sump or well of the crankcase, to be recirculated. It will be understood that the oil for lubrication is not only carried through the bore 21 of the crankshaft 16, but is also carried to the various bearings of the compressor by drillings in the connecting rods and by other conventional means, not shown in detail. It will be noted that by doubling the screen 64 upon itself not only results in a large screening area within a restricted space but also stiffens and reinforces the screen.

The oil pump 57 is preferably driven from the crankshaft 16 by means of eccentric 72 which turns stud shaft or pin 73 mounted in bearing yolk 74 and having secured thereon spiral pinion 75 which drives gear 76 secured on the upper end of impeller shaft 77, note particularly Fig. 6, the said shaft being mounted at its upper end in bearing 78, note also Fig. 2.

The wall above the pressure chamber 69 is tapped at a number of points to provide for mounting an oil pressure gauge 79 and to accommodate suitable pipe connections for the unloading system. It is preferred to control the unloading or capacity of the compressor in steps or stages, that is, where one-fourth to one-half capacity reduction is desired, one stage of the control may take care of one-fourth of the reduction and another stage the other fourth. Preferably each cylinder of the compressor is provided with a separate control and unloader mechanism. Hence, in the present instance there are three connections to the pressure chamber 69, one for each piston. However, since the control in each instance is the same, the description of one will suffice for all.

A tube or pipe line 80 is tapped into the pressure chamber 69 at the point 80', such tube being of relatively small size and defining a restrictor flow passage or conduit. The conduit 80 connects into a T coupling 81 which has the one end of conduit 82 connected thereto and discharging into the port 45, note Fig. 3 in conjunction with Fig. 2. The line 82 is of greater flow capacity or greater diameter than the line 80. Leading from the coupling 81 is a return conduit 83, 83' having a capacity control valve 84 therein and which may be of the type shown in my Patent 2,140,415. The valve 84 may be magnetically operated so that its opening and closing can be controlled from a thermostat, pressure switch or the like indicated at 85 and influenced by suction gas pressure, temperature of the material being cooled, or temperature corresponding with suction temperature. In certain instances actuation of the unloading valve may be manual. In other words, the actuation of the capacity control is preferably regulated in accordance with load requirements and is not dependent upon any timed relation of the operation of the compressor.

The machine operates as follows:

When the machine is idle, the pump 57 is also idle and the pressure in the chamber 69 will be at the crankcase pressure or suction pressure. Therefore, there will be no pressure in the annular space or chamber 46 beneath the plunger or capacity control lift piston 37, and hence the springs 38 will force the plunger downwardly, thereby causing the suction valve control sleeve 36 to hold the suction valve 33 clear of its seat 35 against the pressure of valve spring 32. The compressor cylinder will, therefore, start unloaded, thereby reducing the starting torque.

When the valve 84 is open, very little excess pressure can build up in the pressure space or chamber 46 even though the compressor is running, due to the fact that the line 80 acts as a restrictor and allows only a small amount of liquid to pass, and the line 83—83' being of ample size permits practically all the liquid or oil that may pass through the restrictor line 80 to drain back into the crankcase. Therefore, when the valve 80 is open, the springs 38 will bear downwardly on the plunger 37 and sleeve 36 and overcome the opposed pressure of the valve spring 32 so that the suction valve 33 will be held off its seat and will not function as a suction valve. However, when the valve 84 is closed, liquid or oil passes through the restrictor line 80 and line 82 into the pressure chamber 46, allowing the suction valve to close, whereupon the cylinder 18 will function normally to compress and pump gas.

While the unloading system herein disclosed is particularly adapted for control by steps or stages by means of an independent valve 84 and coacting connections for each cylinder, it will be understood that one or a group of cylinders could be provided with a graduated control over any desired range by utilizing a control valve which would gradually close to thereby vary the pressure in chamber 46 to partially or completely unload the compressor cylinder or cylinders in accordance with adjustment of the valve.

The operation of the valve 84 may be controlled by a pressure switch actuated by suction pressure to the compressor so as to open the valve and reduce the capacity when the pressure drops and to close the valve and increase the capacity when the suction pressure increases, or a thermostat actuated by liquid refrigerant temperature, air temperature, chilled water temperature, etc., could be employed so as to reduce the capacity on falling temperature and increase the capacity on rising temperature. Also, instead of an electric valve, a direct pressure actuated valve connected to the suction line could be employed, or even a direct temperature actuated valve controlled by the expansion and contraction of the fluid in a thermostatic bulb.

It will thus be seen that the present unloader system readily lends itself to a variety of capacity controls, either automatic or manual, so as to regulate the unloading action in accordance with load requirements.

The entire safety head assembly including the suction valve 33 is free to slide vertically in the counterbore 25, but is normally held in seated position by spring 53. Should a slug of liquid enter the cylinder, the piston on its compression stroke will lift the safety head against pressure of the spring 53. At this time, the discharge valves 50, 50' will be open and some of the liquid may escape through these valves. The yielding safety head allows a longer period of time to get

rid of the liquid and at the same time relieves the strain from the cylinder head connections.

It will be understood that certain limited changes in construction and design of the various parts of the compressor and unloading system as herein disclosed may be made without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. In a refrigeration system having a closed refrigerant circuit, a compressor having a cylinder with a piston therein and a crankcase provided with a force feed lubricating system, said cylinder being provided with spring-pressed suction and discharge valves, a control member adapted to engage the suction valve and having coacting spring return means of greater strength than the suction valve spring and whereby the suction valve is displaced from its seat to unload the cylinder, means operatively connected with the lubricating system of the compressors for applying fluid pressure to said control member to overcome the tension of its return spring and move the member clear of the suction valve and permit unrestricted normal operation of the latter, and means operating in accordance with load requirements of the refrigeration system for controlling the admission of fluid pressure from the lubricating system to said control member.

2. In a refrigeration system having a closed refrigerant circuit, a compressor having a cylinder with a reciprocating piston therein and a crankcase provided with a force feed lubrication system, a head for said cylinder provided with suction and discharge ports, suction and discharge valves controlling said ports and valve springs tending to normally urge said valves to seated position, a reciprocating control member adapted to engage the suction valve and having coacting spring means of greater strength than the suction valve spring and whereby the latter valve is normally urged from its seat to unload the cylinder, the cylinder head being provided with a pressure chamber in communication with said control member, conduit means communicating said chamber with the lubricating system of the compressor and whereby a lubricating fluid under pressure may be admitted to said chamber to move said control member clear of the suction valve and permit the latter to function normally to load the cylinder, and means operable in accordance with load requirements of the refrigeration system for controlling the pressure of fluid in said chamber.

3. In a refrigeration system, a compressor having a cylinder with a reciprocating piston therein and a crankcase provided with a force feed lubrication system, said cylinder being provided with a head formed with suction and discharge ports and having suction and discharge valves controlling said ports, valve springs tending to normally urge said valves to seated position, a spring pressed reciprocating control member having a part adapted to engage said discharge valve and move it from its seat against the resistance of its valve spring, said head being provided with a pressure chamber within the region of said control member, means for conducting lubricating fluid under pressure to said chamber to retract said member clear of the suction valve and permit the latter to function normally as a suction valve, and means for selectively controlling the application of pressure to said chamber.

4. In a refrigeration system having a closed refrigerant circuit, a compressor having a cylinder

with a reciprocating piston therein and a crankcase provided with a force feed lubrication system, said cylinder being provided with suction and discharge ports and spring pressed suction and discharge valves controlling said ports, spring pressed control means adapted to engage the suction valve and move it from its seat against the pressure of its valve spring to unload the cylinder, conduit means connected into the lubrication system and leading to said control means and whereby fluid pressure may be applied thereto to release the suction valve and permit the latter to move to seated position, said conduit means including a restricted conduit connected into the lubrication system and a conduit of greater flow capacity connected to the restricted conduit and leading to the control means, and valve means controllable in accordance with load requirements of the refrigeration system for regulating the passage of fluid from said restricted conduit to its enlarged connecting conduit.

5. In a refrigeration system, a compressor having a cylinder with a reciprocating piston therein and a crankcase provided with a force feed lubrication system, said cylinder being provided with suction and discharge ports and spring pressed valves controlling said ports, a spring pressed control member adapted to engage the suction valve and overcome its coacting spring and move the suction valve clear of its seat to unloading position, the compressor being provided with a pressure chamber within the region of said control member, conduit means connected into the lubricating system for conducting fluid under pressure to said pressure chamber, said conduit means including a conduit of restricted flow capacity tapped into the system and conduits connecting with said restricted conduit one of which leads to said pressure chamber and is of greater flow capacity than the restricted conduit and the other of which constitutes a return conduit and leads back to the lubricating system, and a control valve in said latter conduit operable to control the flow of oil therethrough to thereby also control the pressure built up in the pressure chamber.

6. In a refrigeration system, a compressor having a cylinder with a piston therein, a head for said cylinder having suction and discharge ports, spring pressed suction and discharge valves for said ports, a main suction space and a main discharge space communicating with said suction and discharge ports, a cylindrical member mounted in said head and separating said main suction and discharge ports, a reciprocating control member adjacent said cylindrical member and adapted to engage the suction valve and move it from its seat to unloading position, spring means tending to normally urge the said control member into engagement with said suction valve to hold the latter in unloading position, said head being provided with a fluid pressure chamber within the region of said control member, and means for applying controlled pressure to said chamber to displace the control member from said suction valve and permit the latter to function normally as a suction valve.

7. In a refrigeration system, a cylinder with a piston therein, a head for said cylinder, said head being provided with suction and discharge ports, spring pressed suction and discharge valve for said ports, a reciprocating control member mounted in said head and adapted to engage said suction valve, spring means for normally urging said control member against the suction valve to

move the latter to unloading position, fluid pressure means for retracting said reciprocating member against the tension of said spring means to relieve pressure from the suction valve and permit the latter to function normally as a suction valve, and means resiliently mounting the cylinder head.

8. In a refrigeration system, a compressor having a cylinder with a reciprocating piston therein, a cylinder head for said cylinder and a valve case overlying said cylinder head, said head and valve case being provided with suction and discharge ports, spring pressed suction and discharge valves for said ports, a spring pressed control member mounted for vertical reciprocation in said head and having a part adapted to engage the suction valve, spring means normally urging said control member downwardly to hold the suction valve clear of its seat in unloading position, said head being provided with a fluid pressure chamber within the region of said plunger, means for admitting fluid under pressure to said chamber to counteract said spring means and permit the suction valve to seat, and means resiliently mounting said head and valve case together with said control member permitting the entire assembly to become displaced as a unit in the event an incompressible body becomes interposed between the piston and said head.

9. In a refrigeration system, a compressor having a cylinder with a reciprocating piston therein, a cylinder head for said cylinder and a valve case overlying said cylinder head, said head and valve case being provided with suction and discharge ports, spring pressed suction and discharge valves for said ports, a reciprocating capacity control member having a part adapted to engage the suction valve, spring means normally urging said capacity control member to a position where it displaces the suction valve from its seat to unloading position, means to overcome the unloader spring means so that the compressor can operate normally and means resiliently mounting the cylinder head, valve cage and capacity control member for movement as a unit in the cylinder wall in the event an incompressible body becomes interposed between the piston and cylinder head.

10. In a refrigeration system, a compressor having a cylinder with a reciprocating piston therein, the wall of the cylinder being counterbored at the upper extremity of the cylinder, a head mounted in said counterbore and provided with suction and discharge ports and suction and discharge valves overlying said ports, a capacity control member also mounted for reciprocation in said counterbore and having a part adapted to abut said suction valve, spring means normally urging said capacity control member into position where it moves the suction valve clear of its seat to unload the cylinder, means to overcome the unloader spring means so that the compressor can operate normally and means resiliently mounting the cylinder head, capacity control member and valve assembly for movement as a unit in the event an incompressible body becomes interposed between the piston and cylinder head.

11. In a refrigeration system having a closed refrigerant circuit, a compressor having a cylinder with a reciprocating piston therein and a crankcase provided with a force feed lubricating system and a pressure chamber, said lubricating system including a pump mounted within the crankcase and discharging oil under pressure into

the pressure chamber, an unloading device for said cylinder including a fluid-operated capacity control member, a conduit tapped into said chamber for conducting fluid under pressure to said capacity control member, and valve means operating in accordance with load requirements for controlling the flow of fluid through said conduit.

12. A compressor having a cylinder with a reciprocating piston therein, a resiliently mounted safety head for the compressor, suction and discharge valves in said head, and a capacity control member co-active with said suction valve to displace the latter from its seat to unload the cylinder and means to restore the compressor to normal operation.

13. In a refrigeration system, a compressor having a cylinder with a reciprocating piston therein, a head for said cylinder having suction and discharge ports, spring-pressed suction and discharge valves for said ports, a cylindrical member mounted on said head and separating the area thereabove into a main suction space and a main discharge space, a reciprocating control member in the form of a cylindrical sleeve surrounding said cylindrical member and arranged at its lower end to engage the suction valve, a spring operatively connected to said control sleeve and normally exerting a downward thrust thereon with sufficient force to urge said sleeve into engagement with the suction valve and hold the latter in unloading position, said head being

formed with a fluid pressure chamber, and means for communicating fluid pressure to said chamber to raise the control sleeve clear of the suction valve and permit the latter to function normally as a suction valve.

14. In a refrigeration system having a closed refrigerant circuit, a compressor having a cylinder with a reciprocating piston therein and a crank case provided with a force-feed lubricating system, said cylinder being provided with suction and discharge ports and spring pressed suction and discharge valves for controlling said ports, control means adapted to engage the suction valve and move it from its seat against the pressure of its valve spring to unload the cylinder, a pressure chamber in communication with said control means, means defining a series of interconnected flow passages communicating the lubricating system with said pressure chamber and whereby fluid pressure may be applied to the control means to effect release of the suction valve and permit the latter to move to seated position, said flow passages including a conduit of restricted flow capacity connected into the lubricating system and arranged to discharge into a conduit of greater flow capacity leading to the pressure chamber and to also discharge into a return conduit leading back to the lubrication system, and valve means controllable in accordance with the load requirements for regulating the flow of fluid through said return conduit.

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