July 3, 1962 D. G. HARTER ET AL 3,041,847

COMPRESSOR CAPACITY CONTROLLERS

Filed March 21, 1960 3 Sheets-Sheet 1

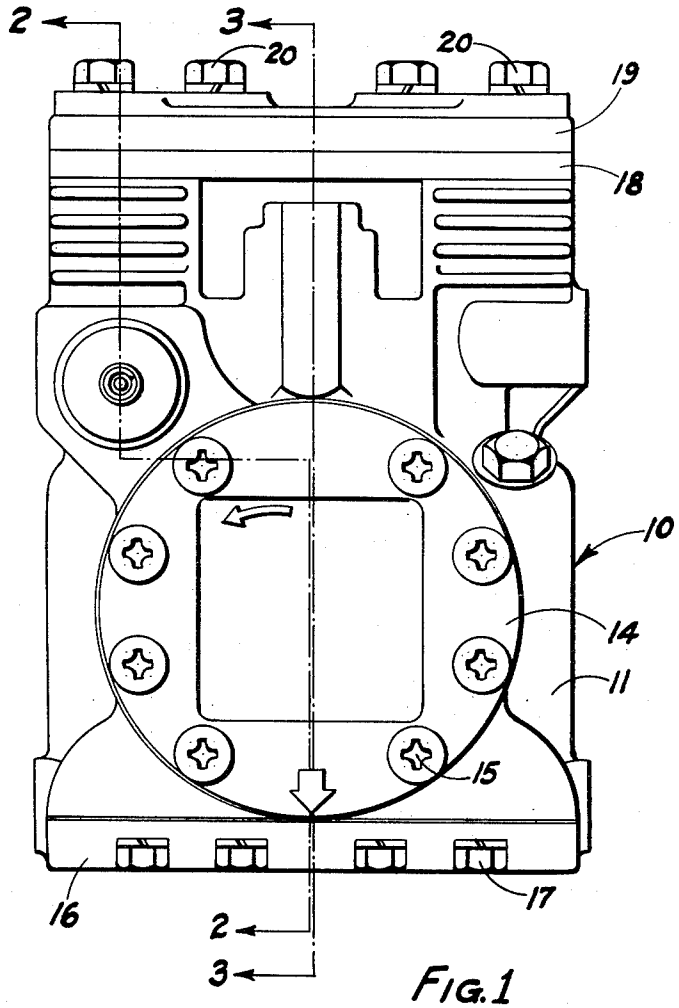


FIG. 1

INVENTORS
DONALD G. HARTER,
WILLIAM J. HALEY,
ANDREW P. BOEHMER
BY AND BOUBENE M. JAREMUS.
Sidney N. Rosenfeld
ATTORNEY

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Filed March 21, 1960 3 Sheets-Sheet 2

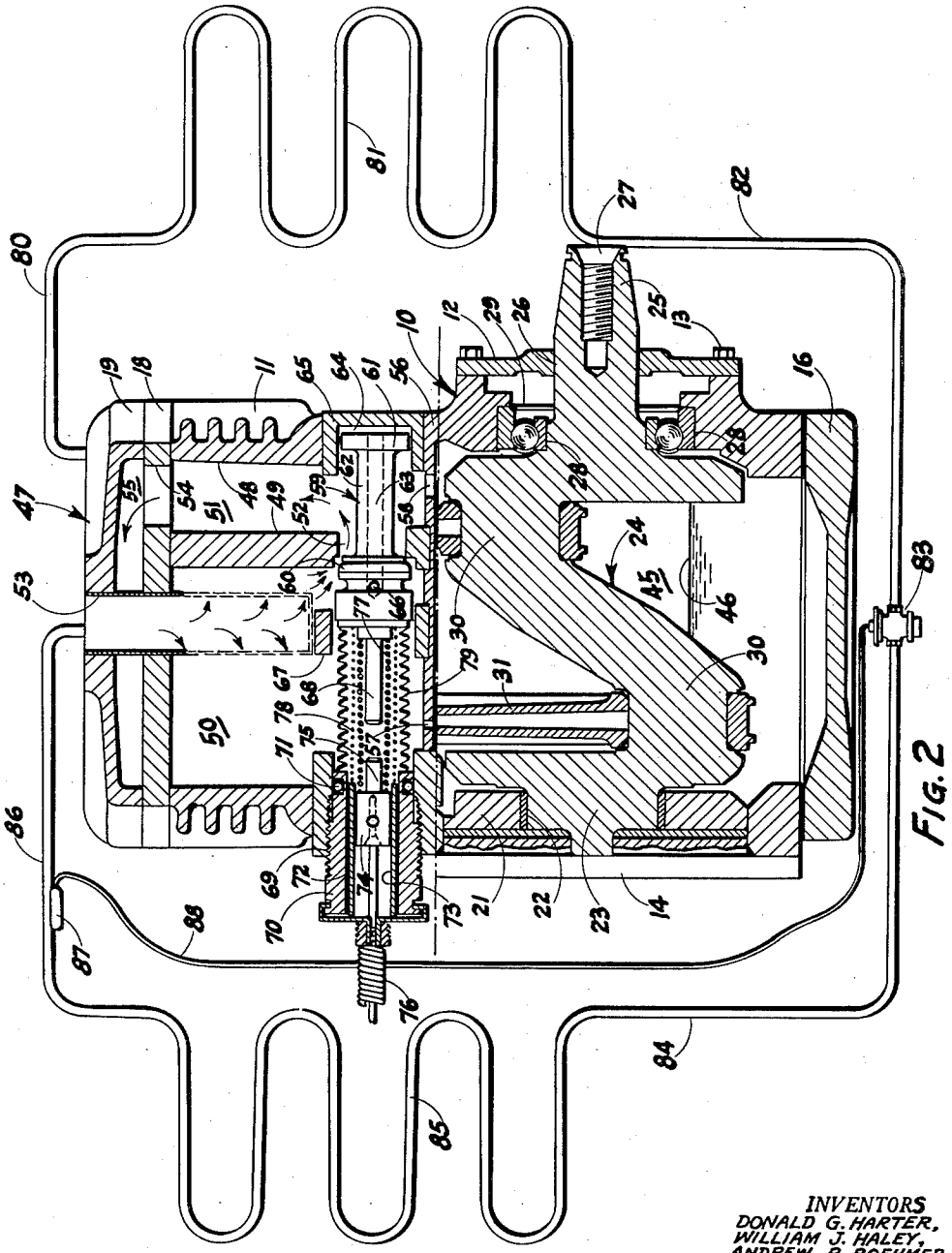


FIG. 2

INVENTORS
DONALD G. HARTER,
WILLIAM J. HALEY,
ANDREW P. BOEHMER
BY AND BOUBENE M. JAREMUS.

Sidney V. Bowman
ATTORNEY

July 3, 1962 D. G. HARTER ET AL 3,041,847

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Filed March 21, 1960 3 Sheets-Sheet 3

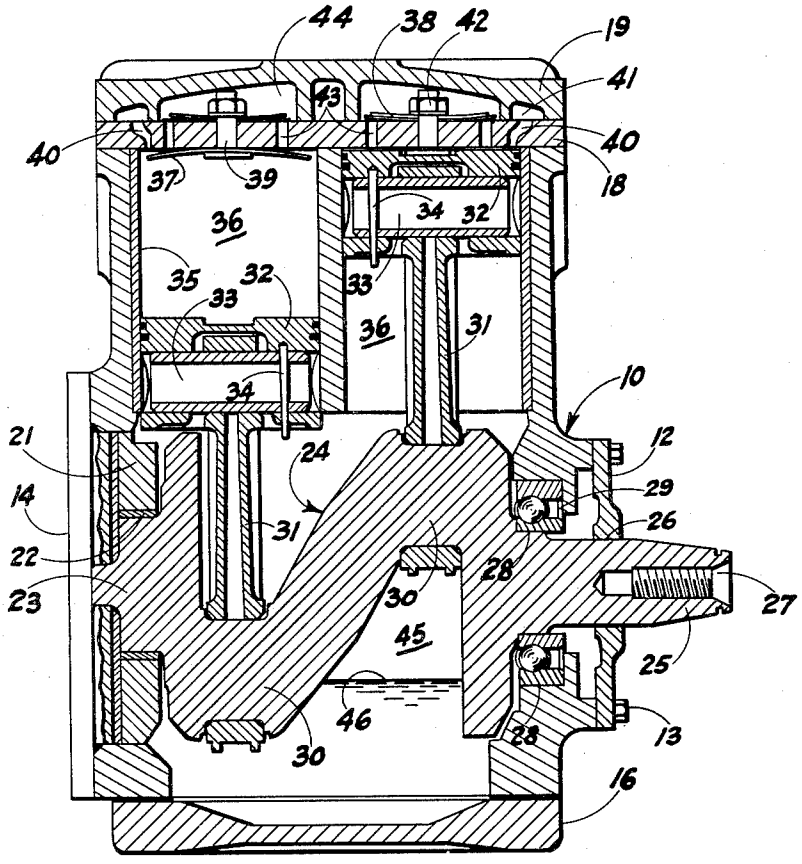


FIG. 3

INVENTORS
DONALD G. HARTER,
WILLIAM J. HALEY,
ANDREW P. BOEHMER
BY AND BOUBENE M. JAREMUS.

ATTORNEY

United States Patent Office 3,041,847 Patented July 3, 1962

3,041,847

COMPRESSOR CAPACITY CONTROLLERS

Donald G. Harter and William J. Haley, Decatur, Andrew P. Boehmer, Des Plaines, and Boubene M. Jaremus, Barrington, Ill., assignors to Borg-Warner Corporation, Chicago, Ill., a corporation of Illinois

Filed Mar. 21, 1960, Ser. No. 16,554
9 Claims. (Cl. 62—193)

This invention relates to automotive compressors and, more particularly, to a capacity control device for the same.

In automotive compressors, the compressor drive is arranged such that adequate capacity is delivered by the compressor at idling speeds or low engine speeds of the particular vehicular engine driving the compressor. It will be apparent that at high engine speeds, the compressor has a far greater capacity than is necessary.

In addition, the compressor is so designed that the pumping capacity of the compressor is regulated such that a vehicle can be cooled down quickly after starting. It will also be apparent that this capacity is no longer needed to maintain the vehicle cool after it has been quickly cooled down.

For these reasons, it has been thought necessary to provide automotive compressors with clutches between the compressor and the vehicle engine in order to provide the variable capacity needed.

Prior art patents have included devices for maintaining the suction pressure of the automotive compressor substantially constant, which has the effect of maintaining a substantially constant capacity over a variable driving range. However, because these prior art devices have been unwieldy and inefficient in operation, and were designed to be a separate component to be installed in the particular system with all the consequent difficulties, they have not been adopted. In addition, they have further suffered from the fact that no positive means of insuring the flow of lubricant from the device to the crank case of the compressor has been provided.

It is an object of the invention therefore to provide an automotive compressor having a capacity control device integral therewith. It is a further object of the invention to provide a capacity control device for an automotive compressor having a chamber in which lubricant collects and where means are provided for maintaining the crank case of the compressor at a lower pressure than the abovementioned chamber, thereby insuring flow of lubricant from the chamber into the compressor.

Yet another object of the invention is to provide an automotive compressor, including a capacity control device for maintaining suction pressure substantially constant, said device being capable of regulation by an operator to change the control point at which the device operates. A still further object is to provide a capacity control device of the type just abovementioned, which is inexpensive and fool-proof and efficient in operation.

The invention consists of the novel constructions, arrangements and devices to be hereinafter described and claimed for carrying out the above-stated objects and such other objects as will appear from the following description of preferred embodiments of the invention described with reference to the accompanying drawings, in which:

FIG. 1 is a rear elevation of a compressor embodying the capacity control device of the invention;

FIG. 2 is a section taken on line 2—2 of FIG. 1, and showing diagrammatically the basic components of a refrigerating system; and

FIG. 3 is a section taken on the line 3—3 of FIG. 1.

Like numerals refer to like parts throughout the several views.

Turning now to FIGS. 2 and 3, a compressor **10** is

shown embodying the capacity control device of the instant invention. Compressor **10** comprises a main housing **11**, which encloses the operative parts of the compressor and the capacity control device. Housing **11** is provided with a front cover plate **12**, which is maintained on housing member **11** by a plurality of bolts **13**. A back cover plate **14** is also provided and is maintained in assembled relation with respect to housing **11** by way of a plurality of bolts **15** (see FIG. 1). A bottom closure plate **16** is maintained in assembled relation with respect to housing **11** by way of a plurality of bolts **17** (see FIG. 1). A valve plate **18** and a compressor head **19** are together maintained in assembled relationship with housing **11** by ways of bolts **20** (see FIG. 1).

Details of the compressor, such as lubricating pump, lubricating passages, seals, etc., have been omitted for clarity since they form no part of the invention per se.

Housing **11** is provided on the interior thereof with a bearing support **21** attached to the housing **11** by any suitable means, and having seated therein a bearing **22**. Bearing **22** receives one end **23** of a crank shaft **24**. The other end of the crank shaft terminates in a driving connection **25**, which protrudes through an aperture **26** provided in front cover plate **12**. A threaded passage **27** is provided in crank shaft end **23** for the purpose of receiving attaching means for driving the compressor **10**. A ball bearing **28**, seated in a recess **29** provided for that purpose in housing **11**, serves to support driving connection **25** of crank shaft **24**. Crank shaft **24** is provided with a pair of crank throws **30**, each having attached thereto a connecting rod **31** for reciprocating a pair of pistons **32**. A wrist pin **33** is provided for each piston **32** for maintaining the piston and respective connecting rod in assembled relation. A pin **34** serves to maintain wrist pin **33** in proper relation to piston **32**.

The pistons **32** reciprocate within cylinders **35**, which constitute working spaces **36** of the compressor. Customary inlet valves **37** and outlet valves **38** are provided for the proper operation of the compressor. A bolt **39** maintains each inlet valve **37** in proper position beneath valve plate **18**. A pair of annular passages **40** communicate the compressor working spaces **36** with a suction chamber **41** provided in the compressor head **19**. A bolt **42** maintains each outlet valve **38** in position over valve plate **18**. A pair of annular passages **43** are provided through valve plate **18**, communicating the compressor working spaces **36** with a discharge chamber **44** provided in the compressor head **19**. A lower portion of housing **11**, in combination with the bottom closure plate **16**, constitutes a lubricant containing sump **45** having lubricant therein to a level **46**.

Compressor **10** is provided with a capacity control apparatus **47** for maintaining the suction pressure of the compressor substantially constant. Capacity control device **47** comprises a compartment **48**, including a wall **49** therein, dividing the compartment into inlet chamber **50** and outlet chamber **51**. Wall **49** has an aperture **52** therein, providing communication between the inlet chamber **50** and outlet chamber **51**. A suction inlet line **53** is provided for receiving suction gas and terminates in inlet chamber **50**. Valve plate **18** extends over the entire compartment **48** and has an aperture **54** therein, communicating outlet chamber **51** with a suction chamber **55** provided in the compressor head **19**, and which communicates with suction chamber **41**. A second wall **56** separates the compartment **48** from the crankcase of the compressor. Wall **56** is provided with a first aperture **57**, providing communication between inlet chamber **50** and the crank case. A second aperture **58** provides communication between the outlet chamber **51** and the crankcase.

A valve assembly **59** is provided for controlling the

passage of refrigerant gas from inlet chamber 50 into outlet chamber 51 by way of aperture 52 in wall 49. Valve assembly 59 comprises a valve 60 and regulating spool 61 connected together by a regulating spool stem 62. A pressure transmitting passage 63 is provided in regulating spool stem 62, and communicates at one end thereof with a pressure chamber 64, formed by a regulating spool bearing 65. The other end of passage 63 is provided with a transverse port 66 for communicating pressure in inlet chamber 50 to pressure chamber 64. The area of the regulating spool 61, which is exposed to the reduced pressure in outlet chamber 51, is exactly equal to the opposing area of valve 60. Thus, this portion of the valve is completely balanced. A valve guide bearing 67 is provided within which valve 60 is received. A valve stem 68 is provided and forms an integral part of valve 60.

Housing 11 is provided with a threaded opening 69 therein leading into inlet chamber 50. A plug member 70 is threadedly received in opening 69 and has an O ring 71 seated in a slot provided therein for sealing opening 69. Plug 70 has a passage 72 formed therein, which receives a bearing 73. A spring tensioning member 74 is slidably received within bearing 73, and has attached thereto a guide stem 75. A Bowden wire 76 is attached to spring tensioning member 74 for positioning the same. A first spring 77 is seated at one end on member 74, encompassing guide stem 75, and on its other end on valve 60, encompassing valve stem 68. Spring 77 acts to force the valve 60 in a closed direction, and it will be apparent that the force of the spring can be varied by adjusting the position of spring tensioning member 74. A second spring 78 is provided and seats on one end against bearing 73, and on its other end against valve 60, providing a constant force, tending to close valve 60. Springs 77 and 78 are encompassed by a bellows 79, the internal effective area of the bellows being exposed to atmospheric pressure. The bellows thus provide an additional valve closing force. The opening force on regulating spool 61, due to the pressure in chamber 64, is thus opposed only by the combined spring and bellows force and atmospheric pressure acting on the inside of the bellows, the force on the opposing area of valve 60 being completely balanced, as was set out hereinabove. The entire device is so calibrated that the valve is wide open at the suction pressure it is desired to maintain within the evaporator of the refrigerating system.

A hot gas line 80 communicates discharge chamber 44 with a condenser 81. A hot liquid line 82 leads to a pressure reducing device, such as an expansion valve 83. From expansion valve 83, a cold liquid line 84 leads to an evaporator 85. A cold gas line 86 communicates evaporator 85 with suction inlet line 53. The customary thermal bulb 87 is situated on cold gas line 86, and is connected to expansion valve 83 by way of capillary 88.

Operation

In operation, gas within working space 36 is compressed to a high pressure and corresponding temperature, and flows through hot gas line 80 into condenser 81, wherein it is condensed to a liquid. The hot liquid flows through line 82 and through expansion valve 83. In its passage through expansion valve 83, the pressure and corresponding temperature of the liquid is reduced. The now cold liquid flows through liquid line 84 to evaporator 85, wherein it takes up heat from the heat-exchange fluid flowing thereover. The heat taken up by the cold refrigerant serves to evaporate it, and the cold gas then flows through line 86 back to the compressor to complete the cycle.

If the capacity of the compressor is more than desired, it is apparent that the gas will be removed from evaporator 85 more quickly than it is liberated, thereby serving to reduce the suction pressure. This reduced pressure is communicated to pressure chamber 64. The reduced pressure within chamber 64 allows springs 77 and 78 to force valve 60 in a valve closing direction until the pressure exerted to close the valve is balanced by the pressure within pressure chamber 64, thereby maintaining the suction pressure substantially constant. Conversely, an increase in the suction pressure, indicating insufficient capacity, is also communicated to pressure chamber 64 acting to open valve 60 until the pressures across the valve equalize with the same effect on the suction pressure.

At any time that the valve 60 is partially throttling, it will be apparent that the pressure within inlet chamber 50 will be somewhat higher than the pressure within outlet chamber 51. The lower pressure in chamber 51 is communicated to the crank case of the compressor via aperture 58. Since the crank case pressure is below that of inlet chamber 50, a positive flow of lubricant is assured from inlet chamber 50 into the crank case of the compressor. This lubricant flows through aperture 57. It will be noted that aperture 58 is of larger size than lubricant return aperture 57 to insure that the pressure in the crank case of the compressor is lower than that obtaining in inlet chamber 50. In actual practice, the pressure within the crank case will be at some intermediate pressure between that obtaining in inlet chamber 50 and outlet chamber 51.

Should the operator desire to change the pressure at which the valve 60 balances (at which no throttling occurs), he need only push or pull on Bowden wire 76 to change the tension on spring 77. If the tension on spring 77 is increased by pushing on Bowden wire 76, then the pressure within pressure chamber 64 will have to be correspondingly higher to maintain the valve 60 in its open position. This serves to maintain pressure in evaporator 85 slightly higher with a correspondingly slightly higher temperature. Conversely, reducing the tension on spring 77 reduces the pressure within chamber 64 necessary to maintain the valve in an open position, thereby reducing the pressure and corresponding temperature of evaporator 85.

We wish it to be understood that our invention is not to be limited to the specific constructions and arrangements shown and described, except only insofar as the claims may be so limited, as it will be apparent to those skilled in the art that changes may be made without departing from the principles of the invention.

What is claimed is:

1. In a refrigerating system including an evaporator and a compressor having working space for a piston and a crankcase having a lubricant filled sump therein, the combination of means for varying the gas flow from said evaporator to the working space of said compressor and for returning lubricant to said sump comprising a compartment including an inlet chamber operatively connected to said evaporator and an outlet chamber operatively connected to the working space of said compressor, valve means for regulating flow between said chambers, means for modulating said valve between an open and closed position dependent on the pressure in said evaporator, means communicating said inlet chamber with the crankcase of said compressor for returning lubricant thereto, and means communicating said outlet chamber with said crankcase for providing positive lubricant flow between said inlet chamber and said crankcase.

2. In a refrigerating system including an evaporator and a compressor having working space for a piston and a crankcase having a lubricant filled sump therein, the combination of means for varying the gas flow from said evaporator to the working space of said compressor and for returning lubricant to said sump comprising a compartment including an inlet chamber operatively connected to said evaporator and an outlet chamber operatively connected to the working space of said compressor, valve means for regulating flow between said chambers, means for modulating said valve between an open and

closed position dependent on the pressure in said evaporator, means for varying the pressure at which said valve starts to modulate, means communicating said inlet chamber with the crankcase of said compressor for returning lubricant thereto, and means communicating said outlet chamber with said crankcase for providing positive lubricant flow between said inlet chamber and said crankcase.

3. In a compressor having a working space for a piston, the combination of a compartment, including an inlet chamber and an outlet chamber, wall means including an aperture therein separating said chambers, a modulating valve seated in said aperture for regulating flow between said chambers, manually adjustable spring means operatively connected to said valve for urging said valve in a closed direction, means for applying a valve opening force to said valve proportional to the pressure in said inlet chamber, a suction line for communicating said inlet chamber with an evaporator of a refrigerating system, and an outlet communicating said outlet chamber with the working space of the compressor.

4. In a compressor having a working space for a piston and including a crankcase having a lubricant filled sump therein, the combination of a compartment, including an inlet chamber and an outlet chamber, wall means including an aperture therein separating said chambers, a modulating valve seated in said aperture for regulating flow between said chambers, spring means operatively connected to said valve for urging said valve in a closed direction, means for applying a valve opening force to said valve proportional to the pressure in said inlet chamber, a second wall means separating said compartment from said crankcase and including an oil return orifice, a suction line for communicating said inlet chamber with an evaporator of a refrigerating system, and an outlet communicating said outlet chamber with the working space of the compressor.

5. In a compressor having a working space for a piston and including a crankcase having a lubricant filled sump therein, the combination of a compartment, including an inlet chamber and an outlet chamber, wall means including an aperture therein separating said chambers, modulating valve means seated in said aperture for regulating flow between said chambers, a second wall means separating said compartment from said crankcase and including an oil return orifice communicating said inlet chamber with said crankcase, a suction inlet for communicating said inlet chamber with an evaporator of a refrigerating system, and an outlet communicating said outlet chamber with the working space of the compressor.

6. In a compressor having a working space for a piston and including a crankcase having a lubricant filled sump herein, the combination of a compartment, including an inlet chamber and an outlet chamber, wall means including an aperture therein separating said chambers, modulating valve means seated in said aperture for regulating flow between said chambers, a second wall means separating said compartment from said crankcase and including an oil return orifice communicating said inlet chamber with said crankcase and a pressure equalizing orifice communicating said outlet chamber with said crankcase, a suction inlet for communicating said inlet chamber with an evaporator of a refrigerating system, and an outlet communicating said outlet chamber with the working space of the compressor.

7. In a compressor having a working space for a piston and including a crankcase having a lubricant filled sump therein, the combination of a compartment, including an inlet chamber and an outlet chamber, wall means including an aperture therein separating said chambers, a modulating valve seated in said aperture for regulating flow between said chambers, spring means operatively attached to said valve for urging said valve in a closed direction, means for applying a valve opening force to said valve proportional to the pressure in said inlet chamber, a second wall means separating said compartment from said crankcase and including an oil return orifice communicating said inlet chamber with said crankcase and a pressure equalizing orifice communicating said outlet chamber with said crankcase, a suction inlet for communicating said inlet chamber with an evaporator of a refrigerating system, and an outlet communicating said outlet chamber with the working space of the compressor.

8. In a compressor having a working space for a piston and including a crankcase having a lubricant filled sump therein, the combination of a compartment, including an inlet chamber and an outlet chamber, wall means including an aperture therein separating said chambers, a modulating valve seated in said aperture for regulating flow between said chambers, a first spring operatively connected to said valve urging said valve in a closed direction, a second manually adjustable spring operatively connected to said valve for further urging said valve in a closed direction, a second wall separating said compartment from said crankcase and including an oil return orifice communicating said inlet chamber with said crankcase, a suction inlet for communicating said inlet chamber with an evaporator of a refrigerating system and an outlet communicating said outlet chamber with the working space of the compressor.

9. In a compressor having a working space for a piston and including a crankcase having a lubricant filled sump therein, the combination of a compartment, including an inlet chamber and an outlet chamber, wall means including an aperture therein separating said chambers, a modulating valve seated in said aperture for regulating flow between said chambers, a first spring operatively connected to said valve urging said valve in a closed direction, a second manually adjustable spring operatively connected to said valve for further urging said valve in a closed direction, a second wall means separating said compartment from said crankcase and including an oil return orifice communicating said inlet chamber with said crankcase and a pressure equalizing orifice communicating said outlet chamber with said crankcase, a suction inlet for communicating said inlet chamber with an evaporator of a refrigerating system and an outlet communicating said outlet chamber with the working space of the compressor.

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