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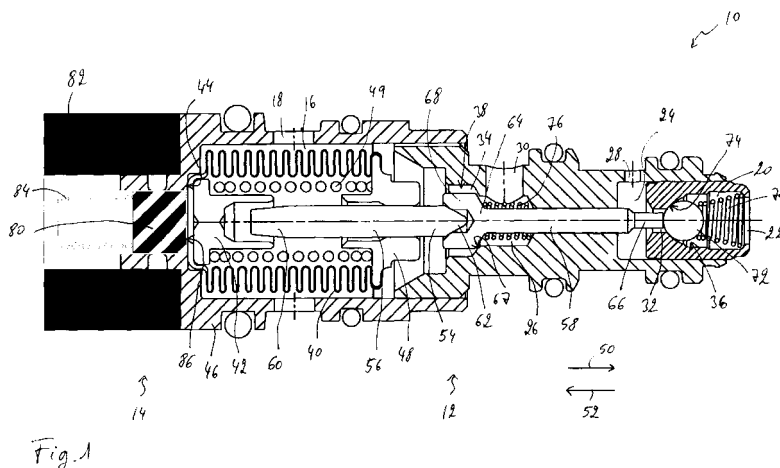
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(54) **Device for controlling a compressor**

(57) A device for controlling a compressor (10), in particular of an air conditioning system of an automotive vehicle, comprising a variable displacement compressor having a crankcase, a suction area and a discharge area, wherein at least one piston is arranged in the crankcase and has a stroke depending on a pressure difference between refrigerant in the crankcase and refrigerant in the suction area, and a mechanical control valve (12) for controlling the capacity of the compressor. The mechanical control valve (12) has a discharge chamber (20) fluidly connected to the discharge area of the compressor; a first crankcase chamber (24) fluidly connected to the crankcase of the compressor; a first fluid communication passage (32) between the dis-

charge chamber (20) and the first crankcase chamber (24), a first internal valve (36) being arranged in the first fluid communication passage (32); and an axially moveable shaft (54) for operating the first internal valve (36) so as to open or close the first fluid communication passage (32). According to an important aspect of the invention, the device further comprises switching means (14) for switching the mechanical control valve (12) between a first operating mode, in which the axially moveable shaft (54) is allowed to move so as to open or close the first fluid communication passage (32); and a second operating mode, in which the axially moveable shaft (54) is maintained in a position wherein the first fluid communication passage (32) is open.



Description

Introduction

[0001] The present invention generally relates to a device for controlling a compressor, in particular of an air conditioning system of an automotive vehicle.

[0002] Automotive air conditioning compressors typically have an electromagnetic clutch interposed between the drive pulley and the drive shaft of the compressor. The clutch allows the compressor to be entirely disconnected when air conditioning demand is absent or very low. This obviously saves energy and, more importantly, prevents evaporator icing that would otherwise occur when cooling demand was low and the compressor continued to pump. With fixed capacity compressors, the clutch is also used to achieve the desired cooling demand by regulating the intervals at which the compressor is switched between full and zero capacity. The frequent clutching and declutching of the compressor has negative effects on the driveability and comfort, as each clutching or declutching changes the torque of the engine.

[0003] Variable capacity compressors have been introduced to vary the capacity of the compressor according to the cooling demand. Frequent clutching and declutching of the compressor can be avoided by using such compressors. The latter reduce or increase the compressor capacity by changing the piston stroke length, which, in turn, is achieved by changing the slant angle of the piston driving plate, such as e.g. a wobble plate or a swash plate, relative to the rotating drive shaft. A greater slant increases stroke length, while a smaller slant minimises stroke length. Changing the slant angle, in turn, is typically accomplished indirectly by changing the net pressure force balance seen between the front and back of the piston as the piston is pulling back within its bore. The net pressure balance seen by the piston is the difference between the suction pressure, which acts on the front of the piston, and the crankcase pressure, which acts on the back of the piston. When the crankcase pressure is relatively greater than suction pressure, the piston stroke length is further limited. This pressure balance can be controlled by a control valve that admits some of the discharge pressure into the crankcase or vents therefrom.

[0004] The control valve can be a mechanical control valve comprising a suction chamber connected to a suction area of the compressor via a suction port, a first crankcase chamber connected to the crankcase via a first crankcase port, a discharge chamber connected to a discharge area of the compressor via a discharge port and a second crankcase chamber connected to the crankcase via a second crankcase port. The suction chamber and the first crankcase chamber, resp. the discharge chamber and the second crankcase chamber, are connected to each other within the mechanical control valve by means of communication passages. Inter-

nal valves, which are arranged in the communication passages, are opened or closed through movement of a central shaft within the mechanical control valve, whereby the communication passages between the respective chambers can be opened or closed. The central shaft is connected at one end thereof to a bellows arranged in the suction chamber. In response to pressure changes within the suction chamber, the bellows expands or contracts, thereby moving the central shaft and opening or closing respective communication passages. The pressure in the crankcase and hence the capacity of the compressor can be controlled in response to suction pressure, which is a function of cooling demand.

[0005] If the cooling demand increases, the suction pressure increases, whereby the bellows contracts and pulls the central shaft into a position in which the communication passage between the suction chamber and the first crankcase chamber is open and the communication passage between the discharge chamber and the second crankcase chamber is reduced. Refrigerant can now flow from the crankcase to the suction area, thereby reducing the pressure of the refrigerant in the crankcase with respect to the refrigerant in the suction area. The stroke of the piston, and thereby also the cooling capacity of the compressor, is increased.

[0006] On the other hand, if the cooling demand decreases, the suction pressure decreases, whereby the bellows expands and pushes the central shaft into a position in which the communication passage between the suction chamber and the first crankcase chamber is reduced and the communication passage between the discharge chamber and the second crankcase chamber is open. Refrigerant can now flow from the discharge area to the crankcase, thereby increasing the pressure of the refrigerant in the crankcase with respect to the refrigerant in the suction area. The stroke of the piston, and thereby also the cooling capacity of the compressor, is decreased.

[0007] It has also been proposed to use an electronic control valve, such as e.g. a solenoid actuated control valve, wherein the shaft is connected to a plunger associated with a solenoid coil. Movement of the central stem, and hence opening or closing of the respective communication passages is controlled by regulating the current flowing through the solenoid coil. By regulating the current flowing through the solenoid coil, the position of the central shaft and the degree of opening of the communication passages can be controlled. By further opening the communication passage between the discharge pressure and the second crankcase chamber, more refrigerant can flow into the crankcase. If enough refrigerant is allowed to flow into the crankcase, the piston driving plate of the compressor can be brought into an almost perpendicular position with respect to the drive shaft. The stroke length of the piston is thereby kept to a minimum, such that no refrigerant is compressed. With the use of an electronic control valve,

there is hence a potential to eliminate the clutch, which is a fairly heavy and expensive component, and use the electronic control valve to activate and deactivate the compressor.

[0008] Such electronic control valves, which are generally used for automatic climate control, are however expensive and need a complicated control system involving a rather complicated algorithm for proper operation.

Object of the invention

[0009] The object of the present invention is to provide an improved device for controlling a compressor. This object is achieved by the device of claim 1.

General description of the invention

[0010] In order to overcome the abovementioned problems, the present invention proposes a device for controlling a compressor, in particular of an air conditioning system of an automotive vehicle, comprising a variable displacement compressor having a crankcase, a suction area and a discharge area, wherein at least one piston is arranged in the crankcase and has a stroke depending on a pressure difference between refrigerant in the crankcase and refrigerant in the suction area, and a mechanical control valve (MCV) for controlling the capacity of the compressor. The mechanical control valve has a discharge chamber fluidly connected to the discharge area of the compressor; a first crankcase chamber fluidly connected to the crankcase of the compressor; a first fluid communication passage between the discharge chamber and the first crankcase chamber, a first internal valve being arranged in the first fluid communication passage; and an axially moveable shaft for operating the first internal valve so as to open or close the first fluid communication passage. According to an important aspect of the invention, the device further comprises switching means for switching the mechanical control valve between a first operating mode, in which the axially moveable shaft is allowed to move so as to open or close the first fluid communication passage; and a second operating mode, in which the axially moveable shaft is maintained in a position wherein the first fluid communication passage is open.

[0011] In the first operating mode, the mechanical control valve is free to control the opening of the first communication passage between the discharge chamber and the first crankcase chamber. The stroke of the piston and hence the capacity of the compressor can thus be controlled according to cooling demand.

[0012] In the second operating mode, the first internal valve is prevented from closing the first communication passage between the discharge chamber and the first crankcase chamber. More high pressure refrigerant flows from the discharge area to the crankcase and increases the pressure difference between the refrigerant

in the crankcase and the refrigerant in the suction area. Due to the higher pressure difference, the stroke of the piston is minimized so that the compressor cannot pump anymore refrigerant through the system. Although the drive shaft of the compressor is still driven by the drive pulley, the compressor is not pumping anymore, thus no cooling capacity is generated.

[0013] The compressor can be activated and deactivated by activating or deactivating the switching means. The fairly heavy and expensive electromagnetic clutch, generally used to activate and deactivate the compressor, can hence be dispensed with. By using a mechanical control valve, there is no need to provide a control means or an algorithm to operate the control valve. Furthermore, it has to be noted that the mechanical control valve is, compared to an electronic control valve, a very cheap component. The present device for controlling a compressor hence comprises considerable cost savings, by dispensing with the expensive electromagnetic clutch and by using a cheap mechanical control valve instead of an expensive electronic control valve.

[0014] Preferably, the axially moveable shaft of the mechanical control valve comprises a bellows, the bellows contracting and expanding in response to refrigerant pressure changes within a surrounding chamber, the surrounding chamber being in fluid communication with the suction area of the compressor. The bellows expands and contracts in response to refrigerant pressure in the suction area, which is a function of cooling demand. The expanding or contracting bellows moves the axially moveable shaft so as to further open or close the first fluid communication passage. The flow of refrigerant from the discharge area to the crankcase, and thereby the capacity of the compressor, is hence automatically controlled.

[0015] As refrigerant pressure in the suction area decreases, the bellows expands and moves the axially movable shaft in a direction wherein the first fluid communication passage is opened. High-pressure refrigerant from the discharge area is allowed to flow into the crankcase. This increases the pressure difference between the front and the back of the piston, which in turn reduces the stroke of the piston and the capacity of the compressor.

[0016] On the other hand, as refrigerant pressure in the suction area increases, the bellows contracts and moves the axially movable shaft in a direction wherein the first fluid communication passage is closed. High-pressure refrigerant from the discharge area is not allowed to flow into the crankcase. A decrease in the pressure difference between the front and the back of the piston increases the stroke of the piston and the capacity of the compressor.

[0017] Preferably, the mechanical control valve further comprises a suction chamber fluidly connected to the suction area of the compressor; a second crankcase chamber fluidly connected to the crankcase of the compressor; and a second fluid communication passage be-

tween the suction chamber and the second crankcase chamber, a second internal valve being arranged in the second fluid communication passage; the axially moveable shaft operating the second internal valve so as to open or close the second fluid communication passage.

[0018] When the compressor capacity is to be decreased and the axially moveable shaft is moved so as to open the first fluid communication passage, the second fluid communication passage is closed. High-pressure refrigerant entering the crankcase from the discharge area is thereby prevented from escaping the crankcase to the suction area.

[0019] On the other hand, when the compressor capacity is to be increased and the axially moveable shaft is moved so as to close the first fluid communication passage, the second fluid communication passage between the crankcase and the suction area can be opened. By opening the second communication passage, refrigerant is allowed to flow from the crankcase to the suction area, thereby achieving a decrease in pressure in the crankcase. The pressure in the crankcase can be reduced rapidly by opening the second fluid communication passage.

[0020] The switching means is preferably electrically controlled. An "on/off" switch on the dashboard can e.g. be used to control the switching means.

[0021] In the "on" position of the switch, the switching means is operated so as to bring the mechanical control valve into its first operating mode, wherein the axially moveable shaft is allowed to move so as to open or close the first fluid communication passage, i.e. wherein the mechanical control valve is allowed to adjust the capacity of the compressor.

[0022] In the "off" position of the switch, the switching means is operated so as to bring the mechanical control valve into its second operating mode, wherein the axially moveable shaft is prevented from closing the first fluid communication passage, i.e. wherein the mechanical control valve is forced to maintain the compressor at minimum capacity.

[0023] Preferably, the switching means comprises a plunger in axial alignment with the axially moveable shaft of the mechanical control valves a coil, e.g. a solenoid coil, for axially moving the plunger in a first direction when the coil is energised, and a spring for axially moving the plunger in a second direction, opposite to the first directions when the coil is not energised. By energizing and de-energizing the coil, the plunger can act on the axially moveable shaft and easily switch the mechanical control valve between its first and second operating modes. Instead of using a solenoid coil, it is also possible to use e.g. a permanent magnet.

[0024] Advantageously, the switching means is arranged such that, when the coil is not energised, the mechanical control valve is in its second operating mode. When no current is fed to the coil, the communication passage between the discharge area and the crankcase is always open, so that the compressor is inactive, i.e.

so that the compressor is not compressing any refrigerant. This ensures that no refrigerant is pumped from the compressor to the evaporator, thereby preventing evaporator icing. Also, this arrangement minimizes energy consumption of the switching means, by only consuming energy when the air conditioning system is actually activated. Furthermore, in case of a power failure of the switching means, the latter automatically brings the mechanical control valve into its second operating mode wherein evaporator icing is prevented.

[0025] According to a preferred embodiment of the invention, the switching means comprises a plunger arranged at a first end of the axially moveable shaft in axial alignment therewith, the plunger being moveable between a first and a second position, wherein, in the first position, the plunger allows free movement of the axially moveable shaft within the mechanical control valve, and in the second position, the plunger penetrates into the mechanical control valve and limits the movement of the axially moveable shaft so that the first fluid communication passage cannot be closed. In the first position of the plunger, a first end of the bellows rests on the valve body, whereas in the second position of the plunger, the latter protrudes into the valve and the bellows is lifted from the valve body. The first end of the bellows now rests on the plunger protruding into valve. The movement of the bellows and hence of the axially moveable shaft is thereby restricted.

[0026] The first internal valve can e.g. be a ball valve comprising a valve seat, a ball and a spring for pushing the ball onto the valve seat, wherein the axially moveable shaft contacts the ball for pushing the latter into a valve open position.

Detailed description with respect to the figures

[0027] The present invention will be more apparent from the following description of a not limiting embodiment with reference to the attached drawings, wherein

Fig.1 shows a cut through a device for controlling a compressor according to the invention in a first operating mode;

Fig.2 shows a cut through the device of Fig.1 in a second operating mode; and

Fig.3 shows a cut through a compressor wherein a device for controlling the compressor according to the invention is mounted.

[0028] Fig. 1 and 2 show a device 10 for controlling a compressor (shown in Fig.3); the device 10 comprises a mechanical control valve 12 and a switching means 14.

[0029] In Fig. 1, the mechanical control valve 12 is shown in a first operating mode, an operating mode in which the mechanical control valve opens or closes a

fluid communication passage between a crankcase and a discharge area of the compressor and a fluid communication passage between a crankcase and a suction area of the compressor.

[0030] The mechanical control valve 12 has a suction chamber 16 in fluid communication with a suction area (not shown) of the compressor via a suction port 18 and a discharge chamber 20 in fluid communication with a discharge area (not shown) of the compressor via a discharge port 22. The control valve 12 further comprises first and second crankcase chambers 24, 26 in fluid communication with a crankcase (not shown) of the compressor via first and second crankcase ports 28, 30. The first and second crankcase ports 28, 30 are also often referred to as crankcase charge and bleed ports, wherein the crankcase charge port is used to charge the crankcase with high pressure refrigerant and the crankcase bleed port is used to bleed refrigerant from the crankcase. First and second communication passages 32, 34 are arranged between the discharge chamber 20 and the first crankcase chamber 24, respectively the suction chamber 16 and the second crankcase chamber 26. The communication passages 32, 34 are provided with first and second internal valves 36, 38 for opening or closing the respective communication passages 32, 34.

[0031] The mechanical control valve 12 shown in the figures comprises a preferably evacuated bellows 40 arranged in the suction chamber 16. A first end 42 of the bellows 40 rests on an inner wall portion 44 of the valve body 46, whereas a second end 48 of the bellows 40 is axially moveable within the suction chamber 16. A bellows spring 49 is arranged in the bellows 40 between the first and second ends 42, 48 and normally maintains the bellows in an expanded position. The position of the second end 48 of the bellows 40 within the suction chamber 16 depends on the refrigerant pressure in the suction chamber 16. If the pressure in the suction chamber 16 is lowered, the bellows 40 expands and the second end 48 is moved in a direction away from the first end 42, as indicated by arrow 50. On the other hand, if the pressure in the suction chamber 16 is raised, the bellows 40 contracts and the second end 48 is moved in a direction towards the first end 42, as indicated by arrow 52.

[0032] An axially movable shaft 54 is centrally arranged in the mechanical control valve 12 and has a first shaft portion 56 and a second shaft portion 58. The first shaft portion 56 is connected to the second end 48 of the bellows 40 so that it can be axially moved within the mechanical control valve 12 as the bellows 40 expands or contracts. A first end 60 of the first shaft portion 56 extends into the bellows 40 and a second end 62 of the first shaft portion 56 comes into contact with a first end 64 of the second shaft portion 58. The second shaft portion 58 extends from the first shaft portion 56 to the first internal valve 36. A second end 66 of the second shaft portion 58 comes into contact with the first internal valve

36.

[0033] The second internal valve 38 is formed by a stepped profile of the second communication passage 34 and a corresponding stepped profile of the first end 64 of the second shaft portion 58, which is located in the second communication passage 34. The stepped profile of said second communication passage 34 forms a valve seat 67 in the second communication passage 34. The first end 64 of the second shaft portion 58 has a radially protruding portion 68 which can be pushed against the valve seat 67, thereby closing the second communication passage 34.

[0034] In the first operating mode of the mechanical control valve 12, the first end 42 of the bellows 40 rests on the inner wall portion 44 of the valve body 46. As the bellows 40 expands, the first shaft portion 56 is moved in direction of arrow 50. The first shaft portion 56 then pushes the second shaft portion 58 in the same direction. The radially protruding portion 68 of the first end 64 of the second shaft portion 58 is pushed against the valve seat 67 of the second internal valve 38 when the second shaft portion 58 is moved in direction 50, thereby reducing, or even closing, the second communication passage 34. As the second shaft portion 58 is moved in direction 50, its second end 66 comes into contact with the first internal valve 36, pushing against a valve ball 72 and lifting the latter from its valve seat 74, thereby opening the first communication passage 32.

[0035] On the other hand, as the bellows 40 contracts, the first shaft portion 56 is moved in direction of arrow 52. The second shaft portion 58 is pushed in the same direction by means of a spring 76 arranged in the second crankcase chamber 26, thereby lifting the radially protruding portion 68 from the valve seat 67 and opening the second communication passage 34. As the second shaft portion 58 is moved in direction 52, its second end 66 allows the valve ball 72 to be pushed onto its valve seat 74 by means of a spring 78 arranged in the discharge chamber 20, thereby reducing, or even closing, the first communication passage 32.

[0036] As described above, in the first operating mode of the mechanical control valve, the first and second communication passages 32, 34 are opened or closed by the expanding or contracting bellows 40, in response to pressure changes within the suction chamber 16.

[0037] According to the invention, the mechanical control valve 12 has a second operating mode, in which the first communication passage 32 is maintained open whatever the pressure in the suction chamber 16. Fig. 2 shows the mechanical control valve 12 in its second operating mode.

[0038] A switching means 14 is provided to switch the mechanical control valve 12 between the first operating mode and the second operating mode. The switching means 14 is preferably arranged at the end of the mechanical control valve 12 closest to the suction chamber 16. According to a preferred embodiment of the invention, the switching means 14 comprises a plunger 80

associated with a solenoid coil 82 placed around the plunger 80. When the solenoid coil 82 is energized, the plunger 80 is pulled further into the solenoid coil 82, in the direction of arrow 52. A spring 84 is associated with the plunger 80 for pushing the latter out of the solenoid coil 82.

[0039] In Fig.1, the solenoid coil 82 is energized and the plunger 80 has moved into the coil 82, thereby compressing the spring 84. In this first position of the plunger 80, a first surface 86 of the plunger 80 is flush with - or in retreat with respect to - the inner wall portion 44 of the valve body 46, so that the first end 42 of the bellows 40 can rest on the inner wall portion 44.

[0040] In Fig.2, the solenoid coil 82 is de-energized and the plunger 80 is pushed into the suction chamber 16 of the control valve 12 by the spring 84. The first end 42 of the bellows 40 now rests on the first surface 86 of the plunger 80, which protrudes into the suction chamber 16. As the first end 42 of the bellows 40 is pushed in direction of arrow 50, it comes into contact with the first end 60 of the first shaft portion 56, thereby pushing the first and second shaft portions 56, 58 in direction 50. As long as the solenoid coil 82 is de-energized, the first communication passage 32 remains open and high-pressure refrigerant can flow from the discharge area to the crankcase of the compressor thereby reducing the stroke of the pistons so as to minimize the capacity of the compressor.

[0041] In summary, when the solenoid coil 82 is energized, the plunger 80 is retracted from the suction chamber 16 and the mechanical control valve 12 is able to open and close the first and second communication passages 32, 34 in response to the suction pressure of the refrigerant in the suction chamber 16. When, on the other hand, the solenoid coil 82 is de-energized, the plunger 80 protrudes into the suction chamber 16 and limits the movement of the shaft 54 so that the first communication passage 32 is always open. When the solenoid coil 82 is de-energized, the stroke of the pistons of the compressor is minimized and the latter is unable to pump refrigerant through the refrigeration system, thereby avoiding evaporator icing is when there is no cooling demand.

[0042] It will be appreciated that, although in the above description the switching means is arranged at the end of the mechanical control valve closest to the suction chamber, the switching means can also be arranged elsewhere. The switching means can e.g. also be arranged within the mechanical control valve.

[0043] Fig.3 shows a cut through a variable displacement compressor 110 comprising a housing having a front housing member 112, a central housing member 114 and a rear housing member 116. Between the front housing member 112 and the central housing member 114, a crankcase 118 is formed. A rotary shaft 120 passes through the crankcase 118 and is coupled to an engine (not shown) via a drive belt (not shown) received on a drive belt support 124. When the engine runs the

rotary shaft 120 is rotated. A piston driving plate 126 is supported by the rotary shaft 120 and is generally inclined with respect to the latter. A plurality of cylinder bores 128 (only two are shown in Fig.3) are formed in the central housing member 114. A piston 130 is retained in each cylinder bore 128. Each piston 130 is attached to the periphery of the piston driving plate 126 via a shoe 132 and reciprocates forward and backward in the cylinder bore 128 as the piston driving plate 126 moves with the rotary shaft 120. The length of the stroke of the piston 130 depends on the angle of tilt of the piston driving plate 126. The more tilted the piston driving plate 126, the longer the stroke of the piston 130 and hence the higher the capacity of the compressor 110. The angle of tilt of the piston driving plate 126, in turn, depends on the pressure of the refrigerant in the crankcase 118 and the pressure of the refrigerant in a suction chamber 134.

[0044] The suction chamber 134, which forms a suction pressure area, and a discharge chamber 136, which forms a discharge pressure area, are arranged in the rear housing member 116. A suction port 138 and a discharge port 140 are formed between the suction and discharge chambers 134, 136 and the cylinder bore 128. As the piston 130 moves from the top dead center to the bottom dead center, refrigerant from the suction chamber 134 is drawn into the cylinder bore 128 via the suction port 138. As the piston 130 moves from the bottom dead center to the top dead center, the refrigerant in the cylinder bore 128 is compressed to a predetermined pressure and is discharged to the discharge chamber 136 via the discharge port 140. The suction chamber 134 and the discharge chamber 136 are connected to an external refrigeration circuit (not shown), at least comprising a condenser, an expansion device and an evaporator. In order to control the discharge capacity of the compressor 110, the latter is provided with a mechanical control valve 10 (in Fig.3, the mechanical control valve 10 is represented schematically). The rear housing member 116 of the compressor 110 comprises a first passage 142 in connection with the suction chamber 134 for connecting the latter to the suction chamber 16 of the mechanical control valve 10 via the suction port 18. The rear housing member 116 of the compressor 110 also comprises a second passage 144 in connection with the discharge chamber 136 for connecting the latter to the discharge chamber 20 of the mechanical control valve 10 via the discharge port 22. Finally, the rear housing member 116 of the compressor 110 comprises a third and fourth passages 146 (only one of which is shown) in connection with the crankcase 118 for connecting the latter to the first and second crankcase chambers 24, 26 of the mechanical control valve 10 via the first and second crankcase ports 28, 30.

[0045] The discharge capacity of the compressor 110 depends on the required air conditioning system load. For instance, if a lot of cooling is required, the flow volume discharged from the compressor 110 has to be in-

creased. The stroke or displacement of the piston 130 must be increased to increase the flow volume. In order to increase the displacement of the piston 130, the pressure in the crankcase 118 is reduced with respect to the pressure in the suction chamber 134. Similarly, if only a little of cooling is required, the flow volume discharged from the compressor 110 has to be reduced. The stroke or displacement of the piston 130 must be decreased to reduce the flow volume. In order to decrease the displacement of the piston 130, the pressure in the crankcase 118 is increased with respect to the pressure in the suction chamber 134. The increase and decrease of the refrigerant pressure in the crankcase 118 is regulated by means of the mechanical control valve 10.

[0046] When the switching means 14 of the mechanical control valve 10 is in its second operating mode, the communication between the discharge chamber 136 and the crankcase 118 is maintained in an open position, so that the pressure in the crankcase 118 is considerably increased with respect to pressure in the suction chamber 134. Due to the pressure difference between crankcase pressure and suction pressure, the piston driving plate 126 is brought into an almost perpendicular position with respect to the rotary shaft 120 as shown in Fig.3. The stroke length of the piston 130 is thereby reduced to a minimum, so that the discharge capacity of the compressor 110 is reduced to a minimum, thus no cooling capacity is generated.

Reference Numerals

[0047]

10 device for controlling compressor
12 mechanical control valve
14 switching means
16 suction chamber
18 suction port
20 discharge chamber
22 discharge port
24 first crankcase chamber
26 second crankcase chamber
28 first crankcase port
30 second crankcase port
32 first communication passage
34 second communication passage

36 first internal valve
38 second internal valve
5 40 bellows
42 first end of bellows
44 inner wall portion
10 46 valve body
48 second end of bellows
15 49 bellows spring
50 arrow
52 arrow
20 54 axially movable shaft
56 first shaft portion
25 58 second shaft portion
60 first end of first shaft portion
62 second end of first shaft portion
30 64 first end of second shaft portion
66 second end of second shaft portion
35 67 valve seat
68 radially protruding portion
72 valve ball
40 74 valve seat
76 spring
45 78 spring
80 plunger
82 solenoid coil
50 84 spring
86 first surface
55 110 compressor
112 front housing member

114	central housing member		tween said discharge chamber and said first crankcase chamber, a first internal valve being arranged in said first fluid communication passage; and
116	rear housing member		
118	crankcase	5	
120	rotary shaft		- an axially moveable shaft for operating said first internal valve so as to open or close said first fluid communication passage
124	drive belt support		
126	piston driving plate	10	
128	cylinder bores		characterised by switching means for switching said mechanical control valve between
130	piston	15	- a first operating mode, in which said axially moveable shaft is allowed to move so as to open or close said first fluid communication passage; and
132	shoe		
134	suction chamber		
136	discharge chamber	20	- a second operating mode, in which said axially moveable shaft is maintained in a position wherein said first fluid communication passage is open.
138	suction port		
140	discharge port	25	
142	first passage		
144	second passage		
146	third and fourth passages	30	

Claims

1. Device for controlling a compressor, in particular of an air conditioning system of an automotive vehicle, comprising:

a variable displacement compressor having a crankcase, a suction area and a discharge area, wherein at least one piston is arranged in said crankcase and has a stroke depending on a pressure difference between refrigerant in said crankcase and refrigerant in said suction area; and

a mechanical control valve for controlling the capacity of said compressor, said mechanical control valve having:

- a discharge chamber fluidly connected to said discharge area of said compressor;
- a first crankcase chamber fluidly connected to said crankcase of said compressor;
- a first fluid communication passage be-

3. Device according to any one of the previous claims, wherein said mechanical control valve further includes:

- a suction chamber fluidly connected to said suction area of said compressor;
- a second crankcase chamber fluidly connected to said crankcase of said compressor; and
- a second fluid communication passage between said suction chamber and said second crankcase chamber, a second internal valve being arranged in said second fluid communication passage;

said axially moveable shaft operating said second internal valve so as to open or close said second fluid communication passage.

4. Device according to any one of the previous claims, wherein said switching means is electrically controlled.

5. Device according to claim 4, wherein said switching means comprises:

a plunger in axial alignment with said axially moveable shaft of said mechanical control valve,

a coil for axially moving said plunger in a first direction when said coil is energised, and 5

a spring for axially moving said plunger in a second direction, opposite to said first direction, when said coil is not energised. 10

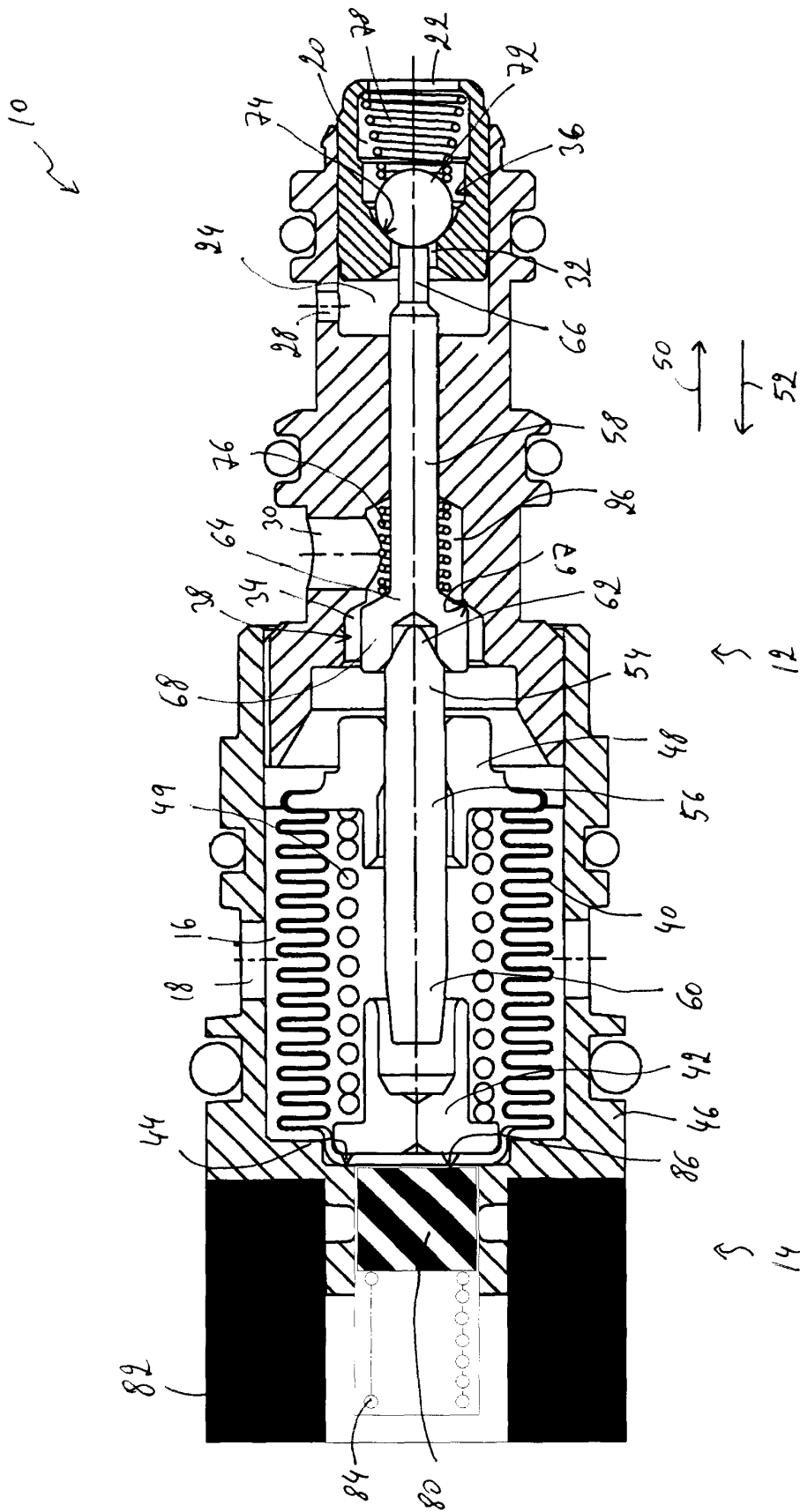
6. Device according to claim 5, wherein said coil is a solenoid coil.

7. Device according to claim 5 or 6, wherein said switching means is arranged such that, when said coil is not energised, said mechanical control valve is in its second operating mode. 15

8. Device according to any one of the previous claims, wherein said switching means comprises a plunger arranged at a first end of said axially movable shaft in axial alignment therewith, said plunger being moveable between a first and a second position, wherein: 20 25

- in said first position, said plunger allows free movement of said axially movable shaft within said mechanical control valve; and 30
- in said second position, said plunger penetrates into said mechanical control valve and limits the movement of said axially moveable shaft so that said first fluid communication passage cannot be closed. 35

9. Device according to any one of the previous claims, wherein said first internal valve is a ball valve comprising a valve seat, a ball and a spring for pushing said ball onto said valve seat, wherein said axially movable shaft contacts said ball for pushing said ball into a valve open position. 40 45 50 55



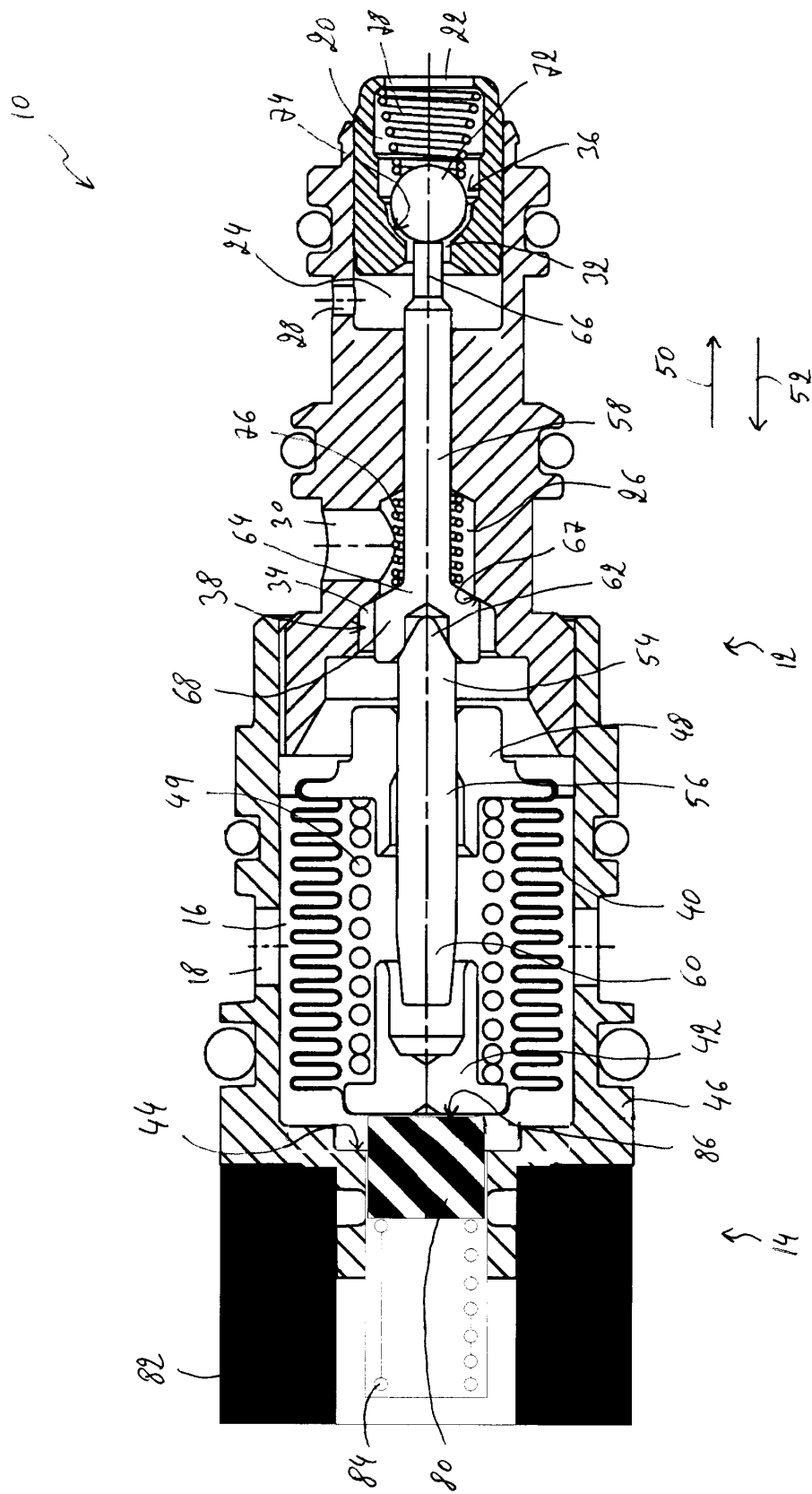
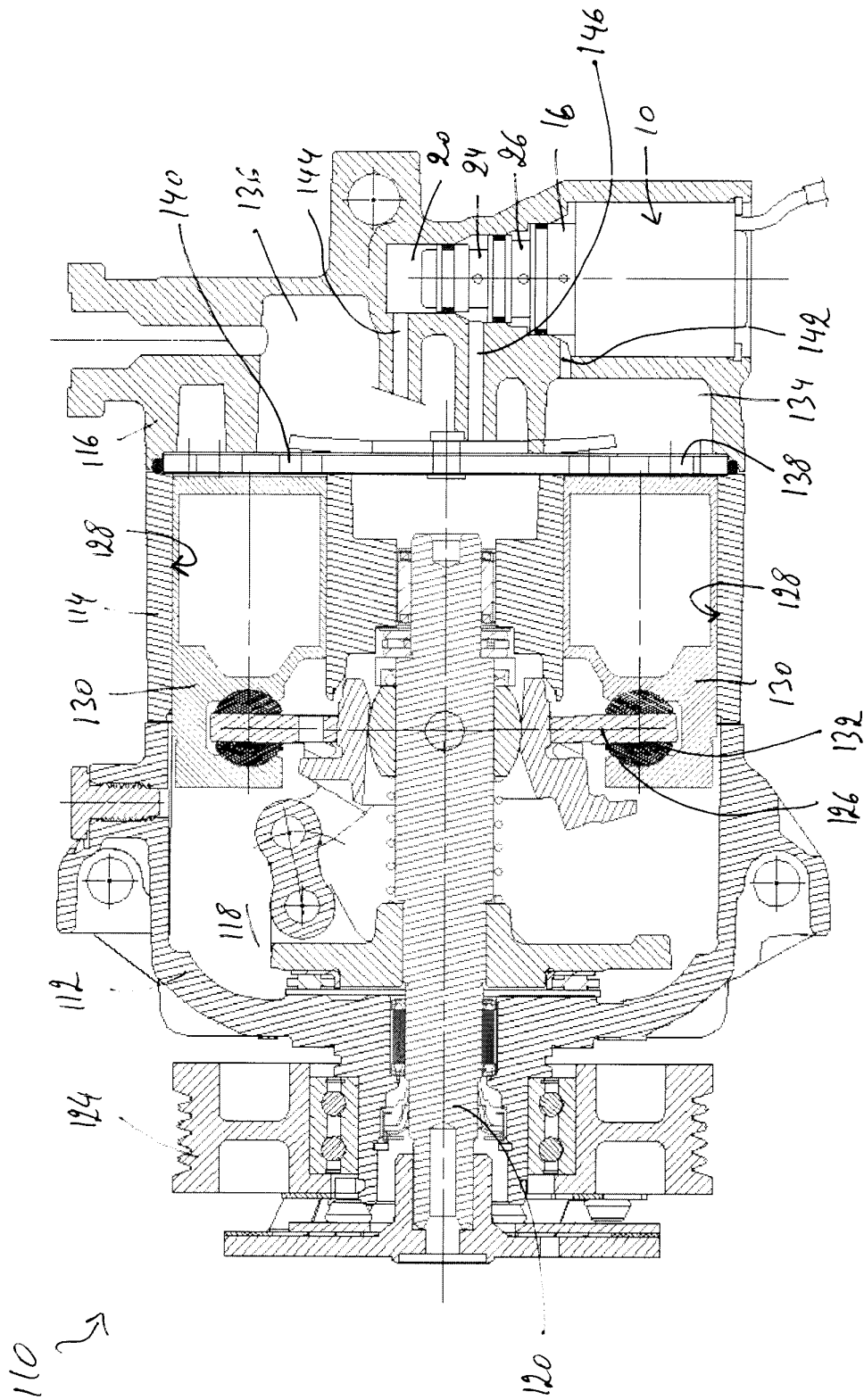


Fig. 2





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 10 1833

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Place of search MUNICH		Date of completion of the search 22 September 2003	Examiner Hillebrand, S
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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