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Description

The invention relates to a capacity control valve for a compressor comprising a suction chamber and a delivery chamber having therebetween a connection adapted to be blocked by a valve, said delivery chamber being coupled to a pressure pipe. Such a control is generally known and is used in piston compressors commercially available from applicant.

Piston compressors are used frequently in a cooling installation for compressing refrigerant, in particular gas or vapour. If the compressor or part of the compressor is in compressing condition, by one or a set of piston(s) the gas is brought from the suction chamber to the delivery chamber and delivered therefrom through the pressure pipe. However, if the compressor or part of the compressor is out of operation, the valve is activated for opening the connection between delivery chamber and suction chamber. In this so-called recirculation condition the refrigerant is recirculated by the pistons from the suction chamber to the delivery chamber and therefrom to the suction chamber again. However in said recirculation condition, the delivery chamber and the pressure pipe should be separated for preventing a back flow of the refrigerant from the pressure pipe. Said separation is implemented in known way by a nonreturn valve connected in the refrigerant path from delivery chamber to pressure pipe.

Thus, the known control has the disadvantage that a non-return valve should be applied, representing in the compressing condition a throttling path resulting in an undesired pressure drop.

From Fr A-2 419 447 a control valve is known that consists of a slide provided axially slidable in a closed valve chamber, in which in a plane extending substantially perpendicular to the direction of sliding of the slide, the wall of the valve chamber is provided with a number of ports for the connection between the internal space of the valve chamber and the delivery chamber. This control valve, however, is a mixing valve for cold and hot water. This three-way valve is balanced as the pressures of cold and hot water are usually equal. Would one use this known valve in opposite flow direction as a capacity control valve for a compressor the valve is not balanced anymore because of different pressures in pressing and suction sides respectively.

The invention has the object to provide a capacity control valve of the above mentioned type, in which the above mentioned disadvantage and problems are obviated.

According to the invention this object is achieved in that the control valve consists of a slide provided axially slidable in an closed valve chamber, that in a plane extending substantially perpendicular to the sliding direction of the slide the wall of the valve chamber is provided with a number of ports for the connection between the internal space of the valve chamber and the delivery chamber and that the spaces of the valve

chamber have at both sides of the number of ports a connector for connections to the suction chamber und pressure pipe respectively, in which in both of the end positions of the slide a first sealing face thereof engaging the valve chamber wall releases the number of ports at least partly, in which further the slide has a second sealing face engaging the valve chamber wall and connected to the first sealing face, with between the sealing faces a recess lying opposite of the connector for the connection to the suction chamber in any position of the slide and in which the faces facing to each other of the recess have substantially an equal area and between the end faces of the slide a continuous passage is provided.

By applying this capacity control valve a non-return valve between delivery chamber and pressure pipe is not necessary anymore, because in the recirculation condition of the compressor said control valve disconnect automatically the connection between the pressure pipe and the delivery chamber.

The recess between the sealing faces is always in communication with the suction chamber so that the pressures on the faces facing to each other are equal. As the space in front of the slide is in communication with the space behind the slide, the pressures on the faces facing from each other are equal. Thereby the control valve is completely balanced in any condition without having an external connection and can be activated with low energy.

In a preferred embodiment the axial size of the sealing face of the slide is smaller than the corresponding size of the ports.

Thereby the advantage is obtained that upon blocking of the slide in an intermediate position, the number of ports is never completely closed, so that in the delivery chamber not a too high pressure would be built up, by which otherwise the delivery chamber would be blown up.

In an embodiment at the end face of the slide facing from the valve chamber space communicating with the pressure pipe, the magnetizable armature is attached coaxially, cooperating with an electric coil arranged coaxially.

Preferably a bias spring is provided biasing the slide in the direction from the valve chamber space communicating with the pressure pipe. The space in which the electric coil is arranged, is adjacent to the delivery chamber.

In this embodiment the control valve is energized in the recirculation condition of the compressor. Thereby the advantage is obtained that in the energized condition of the coil, this is cooled by the refrigerant in the delivery chamber and has a relatively low temperature during the recirculation.

Hereafter the invention will be elucidated by reference to the drawing in which a preferred embodiment of the invention is shown.

In the drawing a piston compressor is illustrat-

ed, however it is clear that the capacity control valve according to the invention may be applied also in other compressor types. Such piston compressors are frequently applied in cooling installations, in which as refrigerant freon or ammonia gas is used. The capacity control valve according to the invention seems to be suitable also for other applications.

The compressor consists of a suction chamber 1 and a delivery chamber 2 in the head of the compressor. The control valve is mounted on the head and is directly adjacent to the delivery chamber 3. Said control valve consists of a cylindrical valve chamber 3, 4, 5 and 6 and a slide axially slidable therein. The right hand side 3 of the valve chamber communicates with the space 8 to which a pressure pipe not shown in the drawing may be connected.

In the valve chamber wall a number of ports 9 are provided connecting the valve chamber to the delivery chamber 2. The portion of the valve chamber in which the ports 9 are provided is formed by a cylinder lining 10 pressed in the valve chamber and in the wall of which apertures are bored. The ports 9 are surrounded by a ring-shaped space 11 which may be considered as an extension of the delivery chamber 2. By using the detachable cylinder lining 10 the ports 9 may be provided in a simple way.

The cylindrical slide 7 has two ring-shaped sealing faces 12, 13. The first sealing face 12 engages the inner wall of the cylinder lining 10, whereas the second sealing face 13 engages a cylindrical wall of the valve chamber portion 4. For the effective sealing any known sealing means may be applied.

The slide 7 is slidable form the shown position at the left hand side of the ports to the right and reversely.

Between the said sealing faces 12, 13 a recess 14 is provided, in which a space 4 is closed by the recess face and the valve chamber wall. To said space a connecting conduct 15 is connected at a location so that in each position of the slide 7 the connecting conduct 15 debouches always into the space 4 defined by the recess 14. Said connecting conduct 15 extends to the suction chamber 1. The connection between the said space 4 and the suction chamber 1 may be established also through passages in the head and the compressor housing.

The control valve is shown in the compressing condition. The pistons 16 and 17 suck refrigerant from the suction chamber 1 and carry it to the delivery chamber 2. Piston compressors are generally known and consequently it is not necessary to go further into this. The refrigerant is pressed from the delivery chamber 2 through the ports 9 and the space 8 into the pressure pipe not illustrated in the drawing.

When the compressor is put into the recirculation condition by activating the control valve, the slide 7 is shifted from the left to the right, until the first sealing face 12 lies beyond the ports 9. In this recirculation condition a refrigerant path is

established extending from the suction chamber 1 through the delivery chamber 2, the ports 9, the space 4 defined by the recess 14, the connecting conduct 15 and again to the suction chamber. In this condition the refrigerant is recirculated by the pistons 16, 17, whereas no refrigerant is transported to the space 8.

However, the possibility exists that the slide 7 is blocked in some way and sticks. When in the blocked condition the sealing face 12 is at the right hand side of the ports 9, problems do not arise because the compressor remains in its undangerous recirculation condition. Also, when the sealing face 12 sticks at the left hand side of the ports 9 no problem will arise because a vessel connected to the pressure pipe and not shown in the drawing should be provided with an overpressure protection according to regulations. However, a blocked intermediate position gives a problem because the ports 9 may be completely closed by the sealing face 12. When in the blocked intermediate position the ports 9 are closed by the first sealing face the compressor may be blown up by the pressure built up in the delivery chamber 2. Said problems are removed in that the size of the first sealing face 12 is smaller in the direction of sliding than the size of the ports 9 measured in the same direction. Thereby not a single position of the slide 7 is possible in which the ports are closed. Thus, in the intermediate position always a passage remains open to the suction chamber 1 or the space 8 or both.

It is noted that balanced valves are known per se. By the construction of the slide 7 having said recess 14, while the connecting conduct 15 always debouches into the space 4 defined by recess 14, the slide is always balanced with respect to the pressure established in the suction chamber 1 and transferred through the connecting conduct 15 onto the slide 7. The balancing of the slide is optimal when the opposite faces 18, 19 of the recess 14 extending upto the sealings 12 and 13 transversely to the axes of the slide 7 have equal cross section area within the sealing.

The balancing regarding the pressure in the space 8 acting on the right hand face 20 of the slide 7 is obtained by a continuous passage extending from the right hand end face 20 to the left hand end face 21 of the slide 7. In the shown embodiment said passage is defined by the clearance between operating rod 22 and the bore 23 of the slide 7. In order to produce said balancing the operating rod 22 may be hollow also and may be provided with a transverse aperture at the location of the space 5. The latter solution is not shown because this is already sufficiently clear in itself. By said passage the pressures onto the left hand and right hand end faces 21 and 20 respectively of the slide 7 are equal and by their equal areas of the cross section within the sealing, the slide 7 is substantially balanced as to the pressure. A disturbance is caused by the area of the cross section of the rod.

The sliding of the slide 7 may be controlled in

any way, for example pneumatically. Preferably, in the shown embodiment the slide is operated electromagnetically resulting in the advantage of complete balance of the slide.

The electromagnetic control device consist of a coil 24 which may be energized through electrical conductors 25. Said coil 24 is arranged in the left hand part 6 of the control valve chamber and enclosed between the bush 26 and the cover 27. By means of O-rings 28 and bush 35 the space of the coil is separated from the spaces 30, 36, 5. In the internal space of the electrical coil 24 an armature 29 from magnetizable material is accommodated partly and axially slidable therein. The armature 29 is screwed onto the operating rod 22 of the slide 7. The armature 29 is supported slidable as an alternative in the recess 30 of the cover 27. Supporting may be at the bore 31. The sliding of the armature 29 is effected by energizing the coil 24.

Only a small portion 31 of the bore of the bush 26 has a relatively small diameter. The remaining portion 32 of the bore of the bush 26 has a larger diameter for accommodating one end of the bias spring 33. The other end of the spring 33 is supported on the right hand face of the armature 29. For balancing, between the portion 31 of the bore of the bush 26 and the operating rod 22 a space may be provided. In order to obtain the complete balance of the armature, the armature is also accommodated in its guiding recess 30 by a small clearance. I.e. in the spaces 5, 8, 36 and 30 equal pressures occur so that the slide is completely balanced.

As seen from the drawing the valve chamber is located adjacent to the delivery chamber 2, while the slide 7 is biased in the direction of its compressing position. Thereby the advantage is obtained that when the coil 24 is energized and thus heated, it is cooled by the refrigerant in the delivery chamber 2 through the wall 34 of the head of the compressor, said refrigerant having a lower temperature than the coil because with energized coil the compressor is in its recirculation condition. For in this condition, the relatively cooled refrigerant coming from the suction chamber 1 flows through the delivery chamber 2.

Claims

1. Capacity control valve for a compressor comprising a suction chamber (1), a delivery chamber (2) and therebetween a connection (15) controlled by the control valve, said delivery chamber (2) being coupled to a pressure pipe, characterized in that the control valve consists of a slide (7) provided axially slidable in a closed valve chamber (3, 4, 5, 6), that in a plane extending substantially perpendicular to the direction of sliding of the slide (7), the wall of the valve chamber is provided with a number of ports (9) for the connection between the internal space (3, 4) of the valve chamber and the delivery chamber (2), that at both sides of the number of ports

(9) the spaces (4, 3) of the valve chamber have a connector for connections to the suction chamber (1) and pressure pipe respectively, in which in both of the end positions of the slide (7), a first sealing face (12) thereof engaging the valve chamber wall releases the number of ports (9) at least partly, that the slide (7) has a second sealing face (13) engaging the valve chamber wall and connected to the first sealing face (12), with between the sealing faces (12, 13) a recess (14) lying opposite of the connector for the connection (15) to the suction chamber (1) in any position of the slide (7), in which the faces (18, 19) facing to each other of the recess (14) have substantially an equal area and that between the end faces (20, 21) of the slide (7) a continuous passage is provided.

2. Capacity control valve according to claim 1, characterized in that the axial size of the first sealing face (12) of the slide (7) is smaller than the corresponding size of the ports (9).

3. Capacity control valve according to one of the claims 1—2, characterized in that at the end face of the slide (7) facing from the valve chamber space (3) connected to the pressure pipe, a magnetizable armature (29) is attached coaxially, cooperating with an electrical coil (24) arranged coaxially.

4. Capacity control valve according to claim 3, characterized in that a bias spring (33) is provided biasing the slide (7) in the direction from the valve chamber (3) communicating with the pressure pipe and that the space in which the electrical coil (24) is provided is adjacent to the delivery chamber (2).

Patentansprüche

1. Mengenstevensventil für einen Kompressor, mit einer Saugkammer (1), einer Druckkammer (2) und einer dazwischen angeordneten, von dem Mengenstevensventil gesteuerten Verbindung (15), wobei die Druckkammer (2) an eine Druckleitung angeschlossen ist, dadurch gekennzeichnet, daß das Stevensventil einen Schieber (7) aufweist, der axial gleitbar in einer geschlossenen Ventilkammer (3, 4, 5, 6) angeordnet ist, daß in einer sich im wesentlichen senkrecht zur der Gleitrichtung des Schiebers (7) erstreckenden Ebene die Wandung der Ventilkammer mit einer Anzahl von Durchgangsöffnungen (9) versehen ist, um den Innenraum (3, 4) der Ventilkammer mit der Druckkammer (2) zu verbinden, daß beiderseits der Anzahl von Durchgangsöffnungen (9) die Räume (4, 3) der Ventilkammer ein Verbindungsglied für Verbindungen zu der Saugkammer (1) bzw. zu der Druckleitung haben, wobei in beiden Endlagen des Schiebers (7) dessen erste Dichtfläche (12), die an der Wandung der Ventilkammer anliegt, die Anzahl von Durchgangsöffnungen (9) zumindest teilweise freigibt, daß der Schieber (7) eine zweite Dichtfläche (13) hat, die an der Wandung der Ventilkammer anliegt und mit der ersten Dichtfläche

(12) verbunden ist, mit einer Ausnehmung (14) zwischen den Dichtflächen (12, 13), die in jeder Lage des Schiebers (7) dem Verbindungsglied für die Verbindung (15) zu der Saugkammer (1) gegenüberliegt, wobei die einander gegenüberliegenden Flächen (18, 19) der Ausnehmung (14) im wesentlichen einen gleichen Flächeninhalt haben und zwischen den Endflächen (20, 21) des Schiebers (7) ein ununterbrochener Durchgang vorgesehen ist.

2. Mengensteuerventil nach Anspruch 1, dadurch gekennzeichnet, daß die axiale Abmessung der ersten Dichtfläche (12) des Schiebers (7) kleiner ist als die axiale Abmessung der Durchgangsöffnungen 9.

3. Mengensteuerventil nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß an die Endfläche (20) des Schiebers (7), die dem mit der Druckleitung verbundenen Ventilkammer-Raum (3) gegenüberliegt, eine magnetisierbare Armatur (29) koaxial angeschlossen ist, die mit einer koaxial angeordneten elektrischen Spule (24) zusammenwirkt.

4. Mengensteuerventil nach Anspruch 3, dadurch gekennzeichnet, daß eine vorgespannte Feder (33) vorgesehen ist, die den Schieber (7) in die Richtung von der mit der Druckleitung kommunizierenden Ventilkammer (3) weg zu bewegen sucht, und daß der Zwischenraum, in dem die elektrische Spalte (24) angeordnet ist, der Druckkammer (2) benachbart ist.

19), en regard l'une de l'autre du creux (14) ayant sensiblement la même surface, et qu'entre les faces d'extrémité (20, 21) du tiroir (7) est prévu un passage continu.

2. Vanne de commande de débit selon la revendication 1, caractérisée par le fait que la dimension axiale de la première face de jonction étanche (12) du tiroir (7) est plus petite que la dimension correspondante des lumières (9).

3. Vanne de commande de débit selon l'une des revendications 1 et 2, caractérisée par le fait qu'à la face d'extrémité du tiroir (7) opposée à l'espace (3) de la chambre de vanne relié au tuyau de refoulement est fixée coaxialement une armature aimantable (29) qui coopère avec un enroulement électrique (24) disposé coaxialement.

4. Vanne de commande de débit selon la revendication 3, caractérisée par le fait qu'il est prévu un ressort de rappel (33) qui rappelle le tiroir (7) dans la direction opposée à la chambre (3) de vanne qui communique avec le tuyau de refoulement, et que l'espace dans lequel est placé l'enroulement électrique (24) est contigu à la chambre de refoulement (2).

Revendications

1. Vanne de commande de débit pour un compresseur comprenant une chambre d'aspiration (1), une chambre de refoulement (2) et, entre les deux, une liaison (15) commandée par la vanne, la chambre de refoulement (2) étant accouplée à un tuyau de refoulement, caractérisée par le fait qu'elle est constituée d'un tiroir (7) monté axialement coulissant dans une chambre de vanne fermée (3, 4, 5, 6), que dans un plan sensiblement perpendiculaire à la direction de coulissement du tiroir (7), la paroi de la chambre de vanne est pourvue d'un certain nombre de lumières (9) pour la communication entre l'espace intérieur (3, 4) de la chambre de vanne et la chambre de refoulement (2), que des deux côtés des lumières (9), les espaces (4, 3) de la chambre de vanne ont un raccord pour le raccordement respectivement à la chambre d'aspiration (1) et au tuyau de refoulement, une première face de jonction étanche (12) du tiroir (7) en contact avec la paroi de la chambre de vanne dégageant au moins partiellement les lumières (9) dans les deux positions extrêmes du tiroir (7), que le tiroir (7) a une deuxième face de jonction étanche (13) en contact avec la paroi de la chambre de vanne et reliée à la première face de jonction étanche (12), entre les faces de jonction étanche (12, 13) se trouvant un creux (14) qui, dans toute position du tiroir (7), est en face du raccord de la liaison (15) à la chambre d'aspiration (1), les faces (18,

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