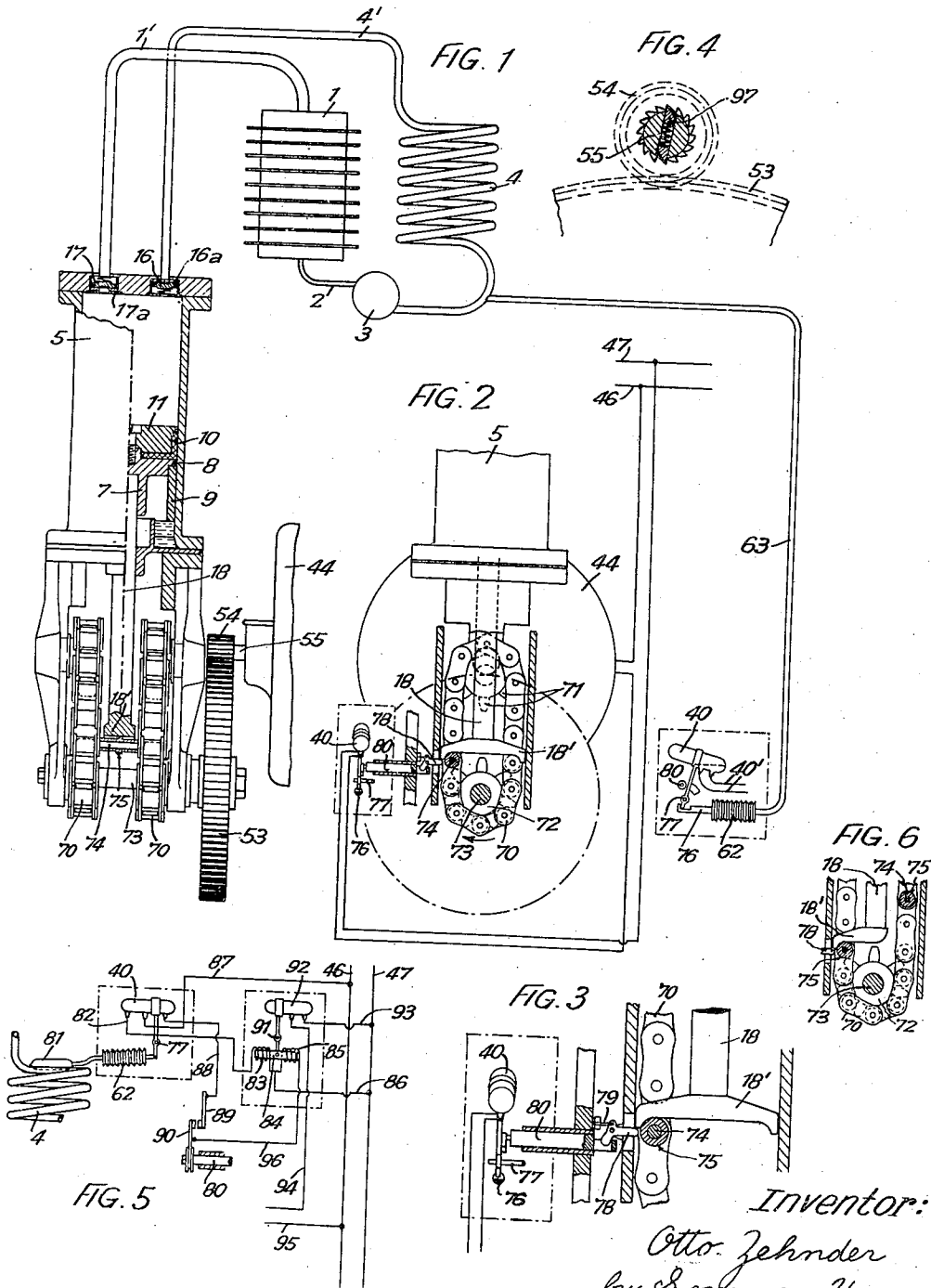


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REFRIGERATING SYSTEM

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REFRIGERATING SYSTEM

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This invention relates to compression refrigerating systems comprising piston operated compressors, the suction stroke of the compressor being effected by the pressure of the refrigerant vapor passing into the compressor and the compression stroke of the compressor being effected by a source of electric power, which is automatically connected.

According to the invention, the suction stroke of the compressor piston is effected by refrigerant vapor passing into the compressor when the pressure of the refrigerant vapor present in the suction conduit surpasses a certain value, in consequence of which the piston actuates an endless conveying device which drives an electric motor. The energizing circuit of the motor is closed by a thermostatic device, the piston of the compressor then being actuated for performing its compression stroke by means of the electric motor and at the end of the compression stroke the piston influences a control member which interrupts the energizing circuit of the motor.

By this means it is possible to operate the system by an unusually small number of piston strokes. The compressor cylinder is comparatively large and, with a relatively large evaporating surface in the evaporator, the evaporator pressure drop will be very little, approximating, for instance, no more than 0.5 atm. during the suction stroke of the piston. In this way the energy inherent in the refrigerant vapor can be utilized for reducing or completely overcoming the no-load-, ventilating- and friction-losses of the electric motor. Moreover, provision can be made for the electric motor to start at no-load during the time elapsing between compression strokes that is in the course of each succeeding suction stroke which occur under the influence of the refrigerant returning to the compressor from the evaporator.

Examples of the compression refrigerating system according to the invention are illustratively exemplified in the accompanying drawing, in which

Fig. 1 shows an elevation partly in section of the compressor and associated accessories of a first example of a refrigerating system according to the invention including an injection evaporator;

Fig. 2 shows a side elevation of Fig. 1;

Fig. 3 is a sectional view of a detail of Fig. 2 on a larger scale;

Fig. 4 is a view of a modification of the drive

between a conveying device and the driving motor;

Fig. 5 is a schematic view of an example of a refrigerating system according to the invention including a flooded evaporator, and

Fig. 6 is a view of a modified detail.

In the first example of refrigerating system, the condenser in which the compressed ammonia vapors are condensed by withdrawing heat therefrom, is designated by 1 in Fig. 1. A lower conduit 2 leads from the condenser 1 to a nozzle throttling arrangement 3 being in the form of a temperature regulating device with which the evaporator 4 is connected. The liquid ammonia supplied to the evaporator evaporates therein by absorbing heat. The condenser 1 and the evaporator 4 are connected through conduits 1', 4' respectively with the upper space of a cylinder 5 guiding a reciprocatory compressor piston 7 which moves upwardly or downwardly dependent on certain conditions of operation. At the points of connection of the two conduits 4', 1' spring-pressed valve discs 16, 17 respectively, are arranged in the head of the cylinder 5, each valve disc normally closing its associated valve opening through the intermediary of resilient valve seats 16a, 17a respectively, both of which are made of a rubber material providing perfect sealing.

The piston 7 is provided with a rim 8 and a liner 9 which is made of hygroscopic material, for example felt, and serves for lubricating the cylinder wall. Above the rim 8, serving as an oil wiping member, the piston 7 is provided with a cuff 10 which is made of a material impervious to oil, for example a special rubber material, and within which a headpiece 11 connected to the piston is arranged. The piston 7 cooperates with two parallelly disposed conveyer chains 70 each of which passes over two chain wheels 71, 72, the latter wheels being united into a double chain wheel to the axle 73 to which a gear wheel 53 is fixed which intermeshes with a pinion 54 which is in turn secured on the rotor shaft 55 of an electric driving motor 44. The two conveyer chains 70 are interconnected by a transverse driving pin 74 carrying a roller 75.

Referring to Figs. 1 to 3, the piston 7 is assumed to be moved downwardly under the influence of the pressure of the refrigerant vapor passing from the evaporator 4 through conduit 4' into the cylinder 5, so that the piston rod 18 rests against the driving pin 74 through a cross-piece 18', thereby moving said pin along with it and moving the pair of chains 70 in the corresponding direction and turning the pair of wheels

53, 54 accordingly. This has the result that during the suction stroke of the piston 7, then taking place, the conveyer chains 70 have the tendency to drive the electric motor 44 at a higher than synchronous speed, so that a wattmeter (not shown) connected in circuit is stopped, and does not register any current consumed, although the electric motor 44 is not disconnected from the network 46, 47. The suction stroke of the piston 7 comes to an end by the crosspiece 18' arranged on the piston rod 18 hitting the chain wheel axle 73. When the piston 7 arrives in the respective position, the cross pin 74 provided with the roller 75 keeps on moving together with the pair of chains 70, thereby circulating about the chain wheel axle 73, whereupon the cross pin 74 moves upwardly in order to hit the crosspiece 18' and consequently move the piston 7 upwardly which thus performs its compression stroke.

When sufficient refrigerant has been expanded into the evaporator 4 to cause the pressure therein to rise sufficiently, an expansible tube 62 connected with the evaporator via a conduit 63 and having an arm 76 for controlling a mercury tumbler switch 40 is extended. The tumbler switch 40 which is included in the energizing circuit of the electric driving motor 44 by a wire loop 40' and pivoted at 77 engages by means of its carrier arm into a notch provided in the control arm 76 (Fig. 2). In consequence of the expansible tube 62 being extended the control arm 76 is moved to the left hand side with reference to the drawing, whereby the tumbler switch 40 is rocked about its pivot axis 77 into the connecting position as shown in this figure, so that the energizing circuit of the motor is closed and thus the electric motor 44 is driven electrically instead of mechanically as before. After the piston 7 has traveled through a certain length of suction stroke a bell crank lever 78 is rocked by the crosspiece 18' against the influence of a spring 79, so that the bell crank lever 78 displaces a control bolt 80 toward the right in the drawing by means of its shorter depending arm. The bell crank lever 78 engages in a slot which is formed in the control bolt 80 so as to allow the bell crank lever 78 to perform a rocking movement in the direction opposite to the movement described above without influencing the control bolt 80, so that this bolt remains in position without being disturbed in the course of the suction stroke of the piston 7. In the course of the compression stroke of the piston 7 the control bolt 80 is however axially displaced in the guide in which it is arranged and is thus retracted from the path of rocking movement of the tumbler switch 40.

As the pressure in the evaporator 4 decreases the expansible tube 62 contracts in consequence of which the control arm 76 having been pulled to the left with reference to the drawing tends to swing the tumbler switch 40 toward the left into disconnecting position. This rocking movement of the tumbler switch 40 into disconnecting position is, however, possible only if the control bolt 80 is retracted from its locking position by the piston 7 which takes place at a certain time moment, namely after the piston 7 has passed through a predetermined length of travel in the course of the compression stroke.

As the tumbler switch 40 is rocked into disconnecting position, whereby the electric motor 44 is set at rest, the piston 7 then being loaded imparts a driving impulse to the pair of conveyer chains 70 and thus to the electric motor 44 just sufficient for returning the driving pin 74

into initial position which corresponds to the position of the crosspiece 18', carried by the piston rod 18, at the end of the suction stroke of the piston 7.

When the electric motor 44 is connected again, the motor is given time for starting completely unloaded until the driving bolt 74 has moved round the underside of the chain wheel axle 73. The electric motor 44 is, therefore, adapted to start unloaded each time after the performance of a compression stroke during the suction stroke for the reason that during the suction stroke of the piston 7 the pair of chains 70 is driven from the piston 7 and during the compression stroke of the piston 7 from the electric motor 44. By means of the control bolt 80 which is automatically actuated by the piston 7 and is associated with the mercury tumbler switch 40 included in the energizing circuit of the motor this tumbler switch is prevented from changing over at an improper time, so that disconnecting of the system is impossible, when the driving pin 74 hits the crosspiece 18' on the piston rod 18 in the course of the upward movement of this pin, in order to adapt the piston 7 subsequently to perform its suction stroke.

In the arrangement of Fig. 4 it is assumed that between the wheel 54 and the motor shaft 55 a unidirectional coupling 97 is arranged to which end the wheel 54 is provided with interior ratchet teeth. The coupling 97 may consist of a pair of outwardly spring pressed teeth located in a transverse bore in shaft 55, and which have inclined outer faces adapted to cooperate with correspondingly shaped teeth formed within wheel 54.

Due to the fact that this coupling is inoperative during the suction stroke the suction period can be shortened by giving the compressor piston a lead on the motor. During the suction stroke the compressor piston travels so fast that the space in the cylinder increases faster than gas is supplied thereto. Without the presence of this coupling the piston would require an equal amount of time for effecting the suction stroke as for effecting the compression stroke. The reason for this is that by action of the pressure in the evaporator there exists a tendency to drive the motor at a high speed than synchronism from the conveying device after the piston has reached its top dead centre in the course of the compression stroke, and that this tendency toward higher speed is opposed in induction motors by means of a resistance for each corresponding increase in speed. By virtue of the above-mentioned coupling the detrimental friction influences from the cylinder wall, which at low suction speeds of the piston affect the degree of efficiency to a great extent, can be considerably reduced, especially if the cylinder is in hot condition, due to the reduction in time obtained for the filling of the cylinder. The wattmeter connected in circuit with the motor records the energy losses of the motor while running at no-load. Due to the detrimental influence of the cylinder wall being decreased, the increase of degree of efficiency is considerably greater than the no-load losses which moreover are set up only during a very short time period the length of which corresponds to that of the duration of the suction stroke of the piston.

In the arrangement shown in Fig. 5, a capillary tube 81 is soldered onto the evaporator 4, the liquid contained therein, which is sensitive to

heat, acts on the expansion tube 62 of a thermostatic device. The throttling device (not shown) connected with the evaporator 4 in advance thereof is constructed as a float valve by which the supply conduit 2 can be wholly closed dependent on requirements. The expansion tube 62 cooperates with the mercury tumbler switch 40 which is connected through a conducting wire 82 with a winding 83 which surrounds a core member 84 which is further surrounded by a winding 85. The two windings 83, 85 are connected through a connecting wire 86 with a line wire 47 of the network from the line wire 46 of which a conducting wire 87 leads to the tumbler switch 40. A conducting wire 88 leads from the tumbler switch 40 to a fixed contact arm 89 with which a contact arm 90 is associated which is arranged in the control bolt 80 and which in the operation of the system is influenced, as explained in the preceding example, by the crosspiece 18' carried by the piston rod 18. The common core member of the two windings 83, 85 is connected to a carrier arm pivotally mounted at 91, of a mercury tumbler switch 92 which is connected with the line wire 47 of the network through a branch wire 93, whereas the tumbler switch 92 is connected with the electric motor via a conducting wire 94 which is further connected through a branch wire 95 with the line wire 46 of the network. A connecting wire 96 leads from the winding 85 to a displaceable contact member 90.

As the temperature and thus also the pressure of the refrigerant vapor in the evaporator 4 rises, as explained in connection with the first example, the piston 7 of cylinder 5 moves downward and the electric motor is driven by the pair of conveyer chains 70. On the other hand the expansion tube 62 is extended by action of said pressure rise, so that the tumbler switch 40 is moved to the left hand side with reference to the drawing, whereby a circuit 87, 82, 83, 86 bridging the line wires is closed, and thus the winding 83 is energized. Consequently the core member 84 is shifted from right to left with reference to the drawing so that the tumbler switch 92 rocks to the right and the energizing circuit through the motor is closed via the wires 94, 95, whereby the electric motor is thus driven electrically.

After the room temperature has dropped sufficiently for causing the expansion tube 62 to contract, so that the tumbler switch 40 rocks to the right, a circuit 87, 88, 96, 85, 86 is prepared for being closed. The closing of this circuit is initiated by the control bolt 80 being correspondingly displaced by the crosspiece 18' carried by the piston rod 18 in the course of the compression stroke of the piston, as explained in connection with the first example. The winding 85 is then energized and the tumbler switch 92 disconnected by the core member 84 shifting accordingly.

The minimum pressure required to move piston 7 is, for example, about 0.2 atmosphere.

In this example, the motor is thus connected and disconnected, as the room temperature decreases, by a relay including the windings 83, 85 and the tumbler switch 92, by means of a thermostatic device provided by the expansion tube 62 and the tumbler switch 40. For determining the correct time moment for disconnecting the system the contact arm 90 is accordingly operated from the compressor piston by means of the control bolt 80.

Instead of providing a unidirectional coupling

97 between the shaft 55 of the electric motor 44 and the auxiliary wheel 54, as shown in Fig. 4, for the same purpose the pair of endless chains 70 may be provided with two driving studs 74 which subdivide the chain length accordingly (Fig. 6). In this arrangement the crosspiece 18' of the piston rod 18 extends only to one side. The suction stroke of the piston 7 effected by action of refrigerant vapor pressure takes place during the time while one of the two driving studs 74 moves through the free zone below the apex of the chain wheel axle 73 and then hits the crosspiece 18' for moving the piston 7 along with it during the compression stroke. Otherwise the system operates on the same principle as previously explained.

What I claim is:

1. In a compression refrigerating system comprising piston operated compression means for compressing the refrigerant, an evaporator and a condenser for producing and condensing refrigerant vapor respectively, a piston operated compressor communicating with said evaporator and said condenser through valved suction and pressure conduits respectively, an endless power transmitting device operatively connected with said compressor piston, a pressure switching arrangement associated with said evaporator, a member controllable by said piston for mechanically controlling said switching arrangement, and an electric driving motor, a circuit for said motor connecting it conductively with said switching arrangement and operatively connected with said transmitting device for being driven by said device while said piston performs its suction stroke, by the effect of a rise of pressure in said suction conduit above a predetermined value, and for driving said piston for performing its compression stroke until said piston controls said control member for releasing said switching arrangement for disconnecting said motor.

2. In a compression refrigerating system comprising piston operated compression means for compressing the refrigerant, as claimed in claim 1, wherein the endless portion of said transmitting device is provided with a driving pin for cooperation with said piston rod which rests against said pin during said suction stroke, whereupon said pin keeps on moving for the purpose of engaging with said piston rod for actuating said piston for effecting said compression stroke of said piston after having changed its direction of movement.

3. In a compression refrigerating system comprising piston operated compression means for compressing the refrigerant, as claimed in claim 1, wherein in the course of said compression stroke of said piston said control member is temporarily retracted from the locking position thereof by said piston rod, whereby a tumbler switch which is influenced by said pressure arrangement is adapted to interrupt said energizing circuit of said motor.

4. A compression refrigerating system as claimed in claim 1, and in which a relay having an electric circuit is provided, and wherein in the course of said compression stroke of said piston said control member is displaced by said piston rod so that, for the purpose of interrupting said electric circuit of said motor, the circuit through said relay is closed.

5. In a compression refrigerating system comprising piston operated compression means for compressing the refrigerant, as claimed in claim 1, wherein in the driving connection between said

endless transmitting device and said motor a unidirectional coupling is arranged which is ineffective during said suction stroke of said piston.

6. Refrigerating machine according to claim 1 and in which the endless rotating power transmitting device is provided with a plurality of driving pins for cooperation with said piston, so

that the suction stroke of the piston will always end at the time that one of said pins passes through the zone beneath the axle of the transmitting device, so as thereafter to act on the piston to produce the compression stroke.

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