March 9, 1954 V. J. GRUMBLATT 2,671,605

UNLOADER AND OVERLOAD PROTECTOR FOR ROTARY COMPRESSORS

Filed Aug. 27, 1949

Fig. 4.

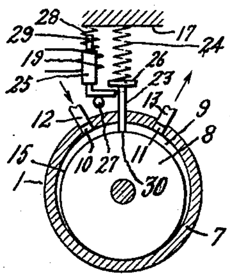


Fig. 5.

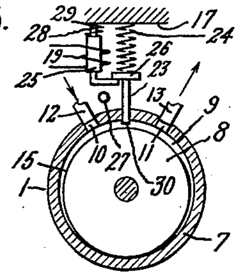


Fig. 6.

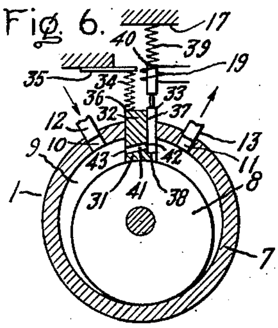


Fig. 7.

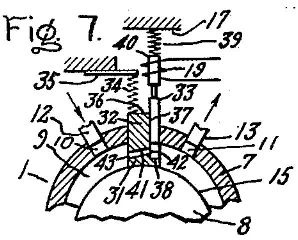


Fig. 1.

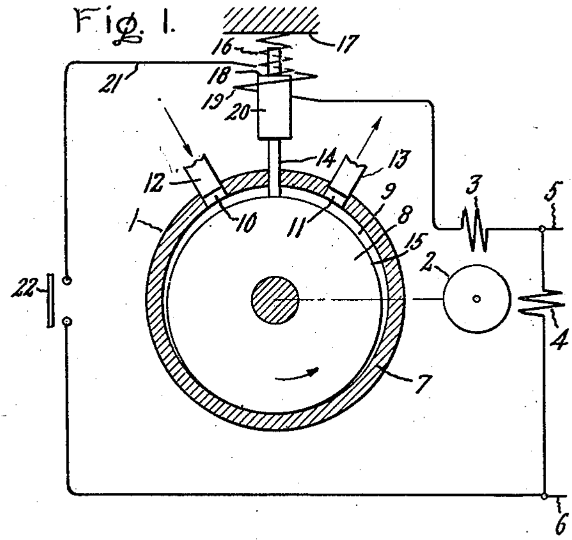


Fig. 3.

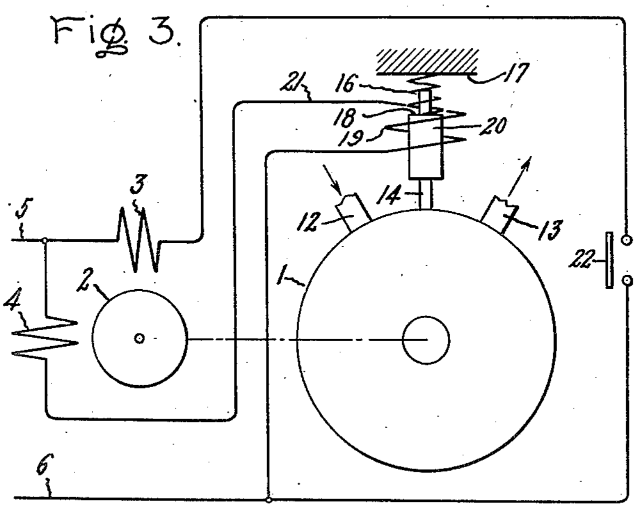
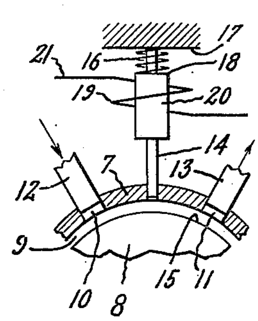


Fig. 2.



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Patented Mar. 9, 1954 2,671,605

UNITED STATES PATENT OFFICE

2,671,605

UNLOADER AND OVERLOAD PROTECTOR FOR ROTARY COMPRESSORS

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Application August 27, 1949, Serial No. 112,787

12 Claims. (Cl. 230—138)

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My invention relates to compressors and more particularly to rotary compressors.

In the operation of compressors it is frequently desirable to make provision for unloading, particularly during the starting operation in order to reduce the load on the motor used for driving the compressor. Such unloading may be accomplished, for example, by providing free communication between the inlet and discharge ports of the compressor. Similarly, it may be desirable to provide such communication during the subsequent operation of the compressor in the event an overload should occur for any reason. By my invention I have provided a simple arrangement which facilitates unloading of a compressor and also protects the motor against undesirable overloads.

It is an object of my invention to provide an improved unloading arrangement for a rotary compressor.

It is another object of my invention to provide an improved overload protector for a rotary compressor.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In carrying out the objects of my invention, I provide an arrangement for automatically moving the blade of the rotary compressor out of engagement with the rotor during all or a portion of each revolution of the rotor in response to the load on the driving motor. Alternatively, only one part of a multi-part blade may be moved to reduce the load. More specifically, the position of the blade or the movable part of the blade is controlled by a solenoid whose energization is dependent on the load on the motor.

For a better understanding of my invention reference may be had to the accompanying drawing in which Fig. 1 is a schematic diagram illustrating an embodiment of my invention; Fig. 2 is a view of a portion of the apparatus of Fig. 1 under different conditions; Fig. 3 is a schematic diagram illustrating a modified form of my invention; Fig. 4 shows another modified form of my invention; Fig. 5 is a view similar to Fig. 4 illustrating the position of the parts under different conditions; Fig. 6 shows another modified form of my invention; and Fig. 7 is a view similar to Fig. 6 illustrating the position of the parts under different conditions.

Referring to Fig. 1, there is shown a rotary compressor 1 which is driven by an electric motor 2. The electric motor includes a starting winding 3 and a running winding 4. Power is supplied to these windings from any suitable power source through lines 5, 6.

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The rotary compressor includes a housing 7 within which a rotor 8 is eccentrically mounted and is driven by the motor 2. The rotor 8 rotates within a chamber 9 provided within the housing 7 of the compressor. The compressor includes an inlet port 10 and a discharge port 11 both of which are in communication with the chamber 9. Fluid pumped by the compressor is supplied to the inlet port 10 through a conduit 12 and is discharged from the discharge port 11 through a conduit 13.

In order to block communication between the inlet and discharge ports 10 and 11 during the normal operation of the compressor a conventional blade 14 is slidably received within the housing 7 and engages the periphery 15 of the rotor. The blade 14 is biased into engagement with the periphery 15 of the rotor by a compression spring 16, one end of which bears against a stationary stop 17 and the other end of which bears against a shoulder 18 of the blade 14.

The arrangement thus far described involves a conventional rotary compressor structure in which, as the rotor 8 is rotated in the direction indicated by the arrow, fluid is taken in through the inlet port 10, is moved through the chamber 9, and is discharged through the discharge port 11. However, when compressors are employed, for example, in refrigerating systems there may be a substantial difference in pressure between the low, or inlet side, and the high or discharge side, particularly during the starting operation, and this imposes a heavy load on the driving motor 2. In order to reduce this load until the motor has had an opportunity to come up to speed and is able to assume the load, I have provided an arrangement for automatically withdrawing the blade 14 from engagement with the periphery 15 of the rotor 8. It can be seen that moving the blade out of engagement with the rotor permits free communication between the inlet port and the discharge port through the chamber 9 and hence substantially eliminates the pumping load on the motor 2. To accomplish this purpose a solenoid 19 is provided about a portion 20 of the blade 14. The solenoid 19 is connected in a circuit 21 in series with the starting winding 3. In a conventional arrangement a switch is arranged in series with the starting winding, the switch being arranged to interrupt the starting winding circuit after the motor has come up to speed. The operation of the switch may be based on the speed of the motor, the current through the starting winding, etc. Such a switch has been shown at 22 in this figure but it will become apparent that, insofar as the operation of the solenoid 19 is concerned, the switch 22 could be omitted and a closed circuit utilized.

During normal operation the current through the winding 3 and the solenoid 19, even should the switch 22 be omitted, is sufficiently low that any biasing force exerted by the solenoid 19 is exceeded by the opposing bias of the spring 16, and the blade 14 is maintained in engagement with the periphery 15 of the rotor 8. However, during the starting operation a much heavier current flows through the windings of the motor 2 and hence through the solenoid 19, which is arranged in series with the starting winding 3 of the motor. Under these circumstances the force exerted by the solenoid 19 on the armature portion 20 of the blade 14 exceeds the force exerted by the spring and the blade is moved out of engagement with the rotor to the position shown in Fig. 2, wherein the upper end of the blade 14 engages the stop 17 and the lower end of the blade 14 is moved out of the chamber 9 and is positioned within the housing 7. This allows communication through the chamber 9 between the ports 10 and 11 and hence effects an unloading of the compressor. As the motor comes up to speed the current through the windings decreases and hence the current through the solenoid 19 correspondingly decreases, and the blade 14 is again moved into engagement with the rotor 8 by the spring 16, instituting normal operation of the compressor. The motor, having come up to speed, is readily able to assume the necessary pumping load.

The operation of the device in the case of an overload occurring during the regular operation of the compressor is the same as that involved in the unloading operation just described. Should an overload occur for any reason the resultant increase in current through the motor windings is reflected in the energization of the solenoid 19 and the movement of the blade 14 out of engagement with the rotor. This substantially reduces the pumping load on the motor and minimizes the danger of overload damage to the motor.

The modified form shown in Fig. 3 differs from that described above only in that the solenoid 19 is arranged in series with the running winding 4 in lieu of the starting winding 3. The same numerals have been used to designate corresponding parts. During the starting operation there is a heavier current through the running winding 4 than during the normal operation of the compressor and hence a larger energizing current through the solenoid 19. The resultant energization of the solenoid 19 is effective through the armature 20 to move the blade 14 out of engagement with the periphery 15 of the rotor, unloading the compressor in the same manner as previously described. Similarly, should an overload occur, the increased current through the winding 4 is also reflected in increased current through the solenoid 19 and the blade 14 is moved out of engagement with the rotor 8 by the solenoid 19.

In Figs. 4 and 5 there is illustrated a modified form of my invention in which the blade is only partially withdrawn from the chamber 9 so as to remain out of engagement with the rotor during only a portion of each revolution. The same numerals have been used to designate corresponding parts in Figs. 1, 2, and 3 and in Figs. 4 and 5. Referring to Figs. 4 and 5 there is shown the rotary compressor 1 including the housing 7 providing the chamber 9 within which the eccentrically-mounted rotor 8 rotates. Inlet and discharge ports 10 and 11, respectively, are illustrated. A blade 23 extends through the housing 7 and is biased toward engagement with the periphery 15 of the rotor 8 by a spring 24. During normal operation of the compressor the blade is compressed into engagement with the periphery 15 of the rotor during the entire revolution of the rotor. In order to provide for shifting the blade under certain conditions, for example, to unload the compressor, a solenoid 19 is utilized, this solenoid being connected in series with the starting winding 3 or running winding 4 as illustrated in Figs. 1 and 3. The solenoid 19 controls the position of an armature 25 which is arranged to engage a portion 26 of the blade 23. In the position shown in Fig. 4, which corresponds to the normal operating condition of the compressor, the armature 25 is biased downwardly against a stop 27 by a spring 28 and the engaging portion of the armature is spaced slightly below the portion 26 of the blade 23 so as not to interfere with the movement of the blade under the influence of the rotor 8 and the spring 24. During starting of the motor or during overload conditions the current through the starting or running winding and hence through the solenoid 19 increases substantially. Under these conditions the solenoid 19 moves the armature 25 to the position shown in Fig. 5 wherein a portion 29 of the armature engages the stop 17 and the armature engages the portion 26 of the blade 23 and moves the blade upwardly to the position shown in Fig. 5. The stop 17 and the spacing between the stop and the portion 29 of the armature 25 during normal operating conditions are arranged so that the maximum travel of the armature moves the tip or end 30 of the blade 23 only partially out of the chamber 9 of the compressor. Thus, in the position of the rotor 8 shown in Fig. 5 the blade 23 is held out of engagement with the rotor. However, it can be seen that during a portion of each revolution of the rotor the periphery 15 of the rotor will engage the tip 30 of the blade 23 and during this portion of each revolution refrigerant is pumped by the compressor in the normal manner. When the motor has come up to speed during the starting operation or when an overload occurring for any other reason has passed, the energization of the solenoid 19 is reduced and the armature 25 returns to the position shown in Fig. 4, allowing normal movement of the blade 23 and normal operation of the compressor.

In Figs. 6 and 7 there is shown another modified form of my invention which employs a two-part blade in which one part of the blade remains in engagement with the rotor at all times. The same numerals have been used to designate corresponding parts in Figs. 6 and 7 and in the preceding figures. Referring to Fig. 6 wherein the position of the parts is illustrated for normal operation of the compressor there is shown a blade 31 extending through the housing 7 between the inlet port 10 and the discharge port 11. The blade 31 is made of two relatively movable parts 32 and 33. The part 32 is pressed into engagement with the periphery of the rotor 8 by a spring 34 in a conventional manner. One end of the spring 34 engages a stop 35 and the other end presses against an end 36 of the blade part 32. A recess 37 is provided in one side of the part 32 of the blade and the part 32 of the blade is arranged to slide within this recess. The position of the blade part 33 is controlled by the solenoid 19 which is arranged in series with the starting winding or the running winding of the motor as illustrated in Figs. 1 and 3. The blade part 33 is normally pressed downwardly against a shoulder 38 on the blade part 32 by a spring 39 which engages the stop 17 and an armature portion 40 of the blade part 33.

A transverse passage 41 is provided in the blade part 32 for permitting communication between the ports 10 and 11 under certain conditions of operation. Under normal conditions, as illustrated in Fig. 6, the slight energization of the solenoid 19 is overbalanced by the force exerted by the spring 39 and the blade part 33 is held in engagement with the shoulder 38, blocking the passage 41. Under these conditions the blade 31 acts in the same manner as a solid one-piece blade of a conventional compressor and fluid is pumped by the compressor in the conventional manner. Under starting conditions or under other conditions wherein an excessive load is imposed on the motor the increase current through the solenoid 19 moves the armature 40 and the blade part 33 upwardly beyond the end 42 of the passage 41, as illustrated in Fig. 7. It can be seen that, in this position of the blade part 33, the passage 41 provides for communication through the blade between the inlet port 10 and the discharge port 11, unloading the compressor. When the rotor 8 has turned sufficiently to move the blade upwardly to a point where the shoulder 38 and the lower edge 43 of the passage 41 are just within the housing 7 communication through the passage 41 is blocked by the housing itself and hence the compressor operates to pump fluid in the normal manner during this portion of each revolution. In this respect the modified form shown in Figs. 6 and 7 operates in a manner similar to the form shown in Figs. 4 and 5 wherein, even under unloading conditions, the compressor is effective to pump fluid during a portion of each revolution.

While I have shown and described specific embodiments of my invention, I do not desire my invention to be limited to the particular constructions shown and described, and I intend, by the appended claims, to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, said blade being normally biased into engagement with said rotor, and electromagnetic means connected in series with said motor for positively moving at least a portion of said blade in a direction away from said rotor to provide communication between said inlet and said discharge ports for unloading said compressor during at least a portion of each revolution of said rotor in response to a predetermined maximum current supplied to said motor.

2. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, said blade being normally biased into engagement with said rotor, and electromagnetic means connected in series with said motor for positively moving said blade away from said rotor to provide communication between said inlet and said discharge ports for unloading asid compressor in response to a predetermined maximum current supplied to said motor.

3. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, said blade being normally biased into engagement with said rotor, a solenoid having an armature arranged for movement in the direction of movement of said blade for positively moving at least a portion of said blade in a direction away from said rotor to provide communication between said inlet and said discharge ports for unloading said compressor during at least a portion of each revolution of said rotor, and means dependent on the load on said motor for energizing said solenoid to move at least said portion of said blade out of engagement with said rotor.

4. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, said blade being normally biased into engagement with said rotor, a solenoid having an armature arranged for movement in the direction of movement of said blade for positively moving said blade away from said rotor to provide communication between said inlet and said discharge ports for unloading said compressor during at least a portion of each revolution of said rotor, and means dependent on the load on said motor for energizing said solenoid to move said blade out of engagement with said rotor.

5. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, said blade being normally biased into engagement with said rotor, a solenoid having an armature arranged for movement in the direction of movement of said blade for positively moving said blade away from said rotor to provide communication between said inlet and said discharge ports for unloading said compressor, and means dependent on the load on said motor for energizing said solenoid to move said blade out of engagement with said rotor.

6. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, said blade including two relatively movable parts, one of said parts of said blade being biased into engagement with said rotor, said one of said parts of said blade having a passage therein for providing communication between said inlet port and said discharge port, the other of said parts of said blade being normally biased to one position to block communication through said passage, a solenoid for shifting said other of said parts of said blade to a second position out of blocking relationship with said passage to provide communication between said inlet port and said discharge port for

unloading said compressor during at least a portion of each revolution of said rotor, and means dependent on the load on said motor for energizing said solenoid to move said other of said parts of said blade to its second position.

7. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, said blade being normally biased into engagement with said rotor, and a solenoid for positively moving at least a portion of said blade in a direction away from said rotor to provide communication between said inlet and discharge ports for unloading said compressor during at least a portion of each revolution of said rotor, said solenoid being connected in series with said motor whereby energization of said solenoid is dependent on current flow to said motor.

8. In combination, a rotary compressor and an electric motor for driving said compressor, said motor including a starting winding and a running winding, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, said blade being normally biased into engagement with said rotor, and a solenoid for positively moving at least a portion of said blade in a direction away from said rotor to provide communication between said inlet and discharge ports for unloading said compressor during at least a portion of each revolution of said rotor, said solenoid being connected in series with one of said windings of said motor whereby energization of said solenoid is dependent on current flow through said one of said windings.

9. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, a spring for biasing said blade into engagement with said rotor, a solenoid having an armature arranged for movement in the direction of movement of said blade for positively moving said blade away from said rotor in opposition to said spring to provide communication between said inlet and discharge ports for unloading said compressor, and means dependent on a load condition of said motor for energizing said solenoid to move said blade out of engagement with said rotor.

10. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, a spring for biasing one end of said blade into said chamber and into engagement with said rotor, a solenoid having an armature arranged for movement in the direction of movement of said blade for positively moving said blade away from said rotor and out of said chamber to provide communication between said inlet and discharge ports for unloading said compressor, and means dependent on a load condition of said motor for energizing said solenoid to move said blade.

11. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, a spring for biasing one end of said blade into said chamber and into engagement with said rotor, a solenoid having an armature arranged for movement in the direction of movement of said blade for positively moving said blade away from said rotor to provide communication between said inlet port and said discharge port for unloading said compressor, means dependent on a load condition of said motor for energizing said solenoid, and means for limiting the movement of said blade away from said rotor so that said one end of said blade rejects into said chamber when said solenoid is energized whereby said rotor engages said blade during a portion of each revolution to effect normal pumping action during said portion of each revolution.

12. In combination, a rotary compressor and an electric motor for driving said compressor, said compressor including a housing having a chamber therein and a rotor eccentrically-mounted within said chamber, said housing including spaced inlet and discharge ports, a blade extending through said housing between said ports, said blade including two relatively movable parts, a spring for biasing one end of one of said parts of said blade into said chamber and into engagement with said rotor, said one of said parts having a passage therein for providing communication between said inlet port and said discharge port, a spring for biasing the other of said parts of said blade normaly to one position to block communication through said passage, a solenoid for shifting said other of said parts of said blade to a second position out of blocking relationship with said passage to provide communication between said inlet port and said discharge port for unloading said compressor, and means dependent on a load condition of said motor for energizing said solenoid to move said other of said parts of said blade to its second position, said passage being spaced from said one end of said one part of said blade a distance such that said passage portion of said one part of said blade is moved out of said chamber into said housing during a portion of each revolution of said rotor whereby communication between said inlet port and said discharge port through said passage is blocked by said housing during said portion of each revolution of said rotor regardless of the position of said other part of said blade.

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