

April 18, 1939.

C. L. PAULUS

2,155,351

REFRIGERATING APPARATUS

Filed April 30, 1936

2 Sheets-Sheet 1

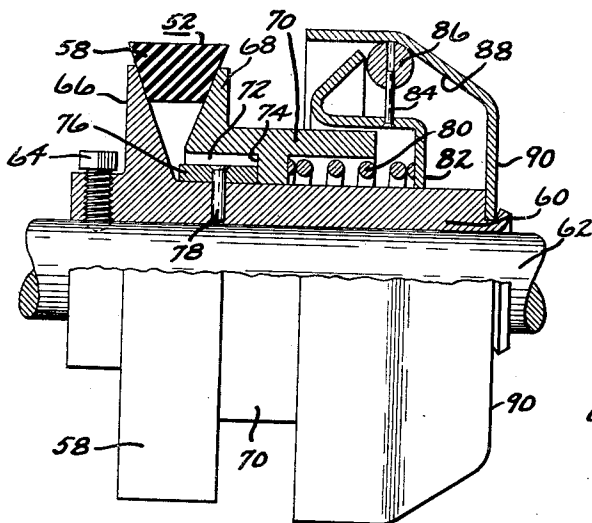


Fig. 5

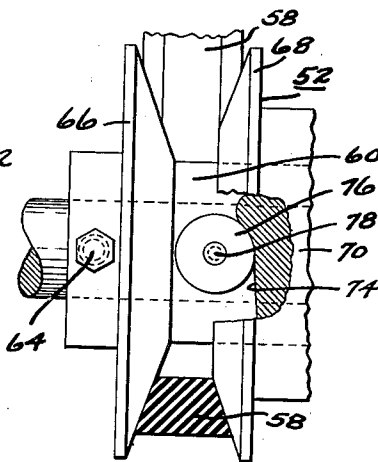


Fig. 6

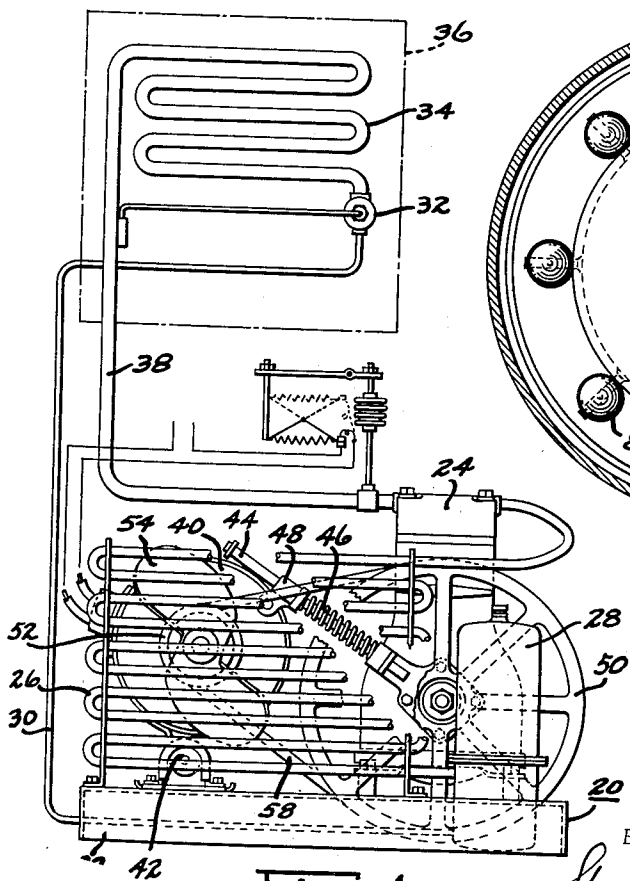


Fig. 1

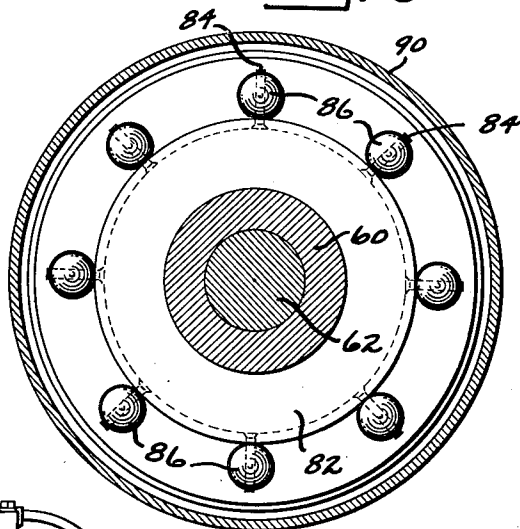


Fig. 7

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2 Sheets-Sheet 2

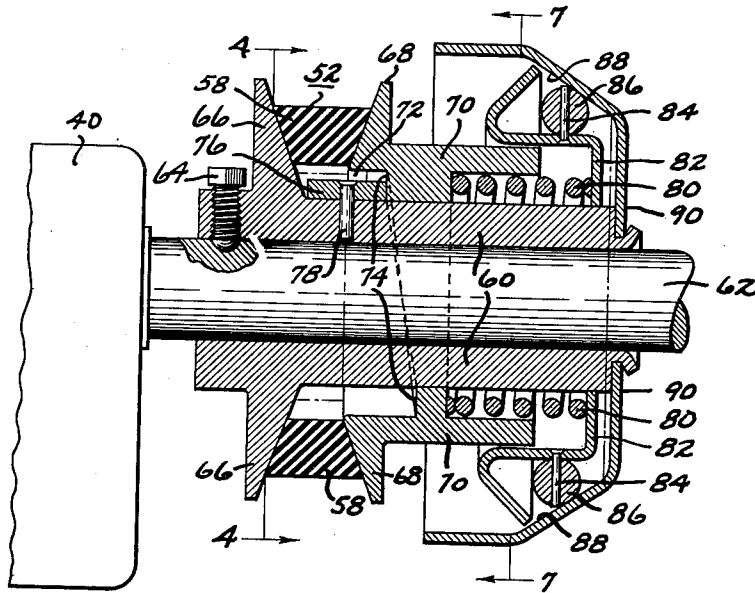


Fig. 2

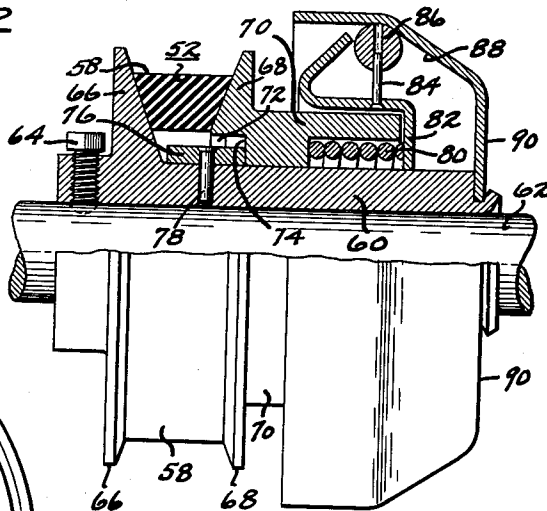


Fig. 3

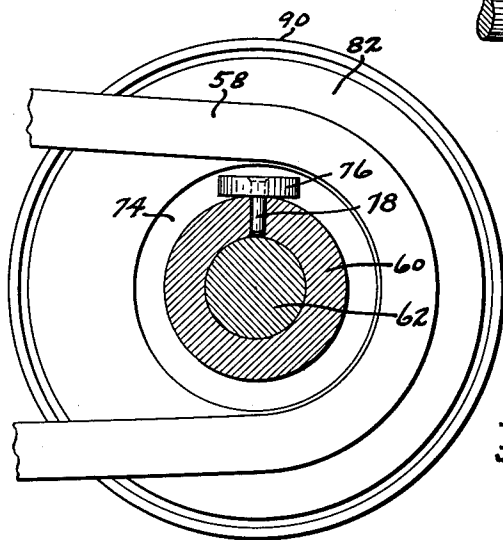


Fig. 4

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REFRIGERATING APPARATUS

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Application April 30, 1936, Serial No. 77,235

5 Claims. (Cl. 74—230.17)

This invention relates to refrigerating apparatus and more particularly to a combined torque and speed responsive driving means for the compressors of refrigerating apparatus and similar devices.

Compressors and other intermittently operated devices in their simplest form must start under a relatively heavy load. This load includes not only the actual pumping of the compressor, but also the starting friction and the force required to break the oil film and the force required to overcome the inertia of the moving parts of the compressor. There have been a number of different ways employed to meet this problem which differ in their merit and in first cost. One is by using a motor of sufficiently large size to take care of all requirements under all conditions. Another way is to use a motor having a high starting torque such as a repulsion induction motor. Another way is to unload the compressor in some sort of means so that the pumping action does not begin until the compressor approaches its maximum speed. Still another way which has been tried, but heretofore has not proven very successful, is the use of centrifugal clutches and control devices which permit the motor to start without load and then connect the motor with the compressor or other device driven by the motor. However, in substantially all of these situations it is necessary to use a motor slightly larger than is ordinarily necessary for the major portion of the running period.

It is an object of my invention to provide a device for making it possible to drive a compressor or similar device by a motor of relatively small starting torque and full load capacity, simply by the use of varying driving ratio.

It is another object of my invention to provide a combined torque and speed responsive means for controlling the driving ratio between the driving and driven device so as to facilitate starting and to keep the torque required of the motor at a safe limit at all times.

It is a further object of my invention to provide a V-type pulley having a movable flange, rotatably and axially movable under the control of a cam and a spring means which in turn is controlled by a centrifugal device to vary the effective diameter of the pulley according to the combined effect of torque and speed.

It is another object of my invention to provide driving means which will so control the driving ratio of the motor that the load upon the motor will be kept sufficiently low to permit the motor to rapidly come up to normal run-

ning speed and to keep the load upon the motor within its capacity at all times.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a view of a refrigerating system partly diagrammatic embodying my invention;

Fig. 2 is a sectional view through the driving pulley shown in Fig. 1 with the parts positioned as under idle conditions;

Fig. 3 is a fragmentary sectional view similar to Fig. 2 showing the pulley under substantially full speed and high torque conditions;

Fig. 4 is a sectional view taken along the lines 4—4 of Fig. 2;

Fig. 5 is a sectional view similar to Fig. 3 but under high speed and low torque conditions;

Fig. 6 is a view looking down upon the pulley shown in Fig. 5; and

Fig. 7 is a sectional view taken along the line 7—7 of Fig. 2.

Briefly, I have disclosed a refrigerating system provided with a motor-compressor unit having a belt tightening device and a V-belt motor pulley having a movable flange which is controlled both by the speed of the motor and by the torque reaction to vary the effective diameter of the pulley.

An electric motor 40 is provided for driving the compressor 24. Beneath the motor 40 there is provided a pivotal connection 42, provided with vibration absorbing materials which pivotally connects the motor 40 to the base 22. Extending from the compressor 24 is a spring brace which serves as a belt tensioning device and comprises a rod 44 extending from the compressor which has a coil spring 46 threaded thereon having one end resting upon a bracket extending from the compressor, while the other end is provided with a spring retainer 48 which is pivotally connected to the upper portion of the motor 40. The compressor 24 is provided with a large pulley 50, while the motor is provided with a small pulley 52 as well as a fan 54 for circulating cooling air through the air passages in the condenser 26. The belt 58 extends over the two pulleys and provides the driving connection between the motor and the compressor.

The motor 40 is made just sufficiently powerful to carry the normal refrigerating load, that is, to drive the compressor at the normal speed under normal running conditions. Heretofore,

it has been necessary to provide a motor with about 25% overload capacity and in addition to provide some means to facilitate starting such as an unloading device or a repulsion start motor having a high starting torque or a centrifugally controlled driving device.

My driving device for connecting a motor with a device to be driven is applicable to a very wide number of uses, particularly whenever a motor remains connected to its load under both starting and running conditions. A refrigerating system is only one of the many examples of its application, but it is a particularly good application for illustration and has special advantages in this application.

In ordinary refrigerating systems, the motor-compressor unit is cycled in order to provide a control of the temperature produced by the refrigerating system. During the idle period the back pressure or suction pressure of the compressor increases and this, as well as the other accompanying factors, provides an increased load during the first portion of each running period. In addition to this starting load, there are other factors common to practically all motor driven units which increase the starting requirements, such as starting friction (which is much higher than running friction), the adhesion of the oil film, and the inertia of the moving parts, all of which make the starting load higher than the normal running load. Although specifically shown as applied to a V-belt pulley having means for changing its effective diameter, my invention is applicable to other forms of driving means wherein a variable driving ratio may be obtained.

I propose to provide a driving device between the motor and compressor unit which is responsive not only to the speed of the motor, but also to the torque required of the motor so that other devices for facilitating starting may be eliminated and a smaller motor than heretofore deemed necessary may be used. By this device the driving ratio, whenever the unit is idle or operates at a slow speed, is made low, that is, the motor turns a relatively large number of revolutions to one turn of the compressor. When the torque required is great, the same underdrive situation exists, namely the driving ratio is low by providing a relatively large number of turns of the motor to a turn of the compressor or driven unit. It is only when the motor approaches full speed and the torque required is small, that there is a relatively high driving ratio or overdrive providing a smaller number of turns of the motor to one turn of the compressor.

Referring now to Figs. 2 to 7 inclusive, which illustrate the pulley 52 in detail and which embodies one form of my invention, there is shown a sleeve 60 mounted upon the motor shaft 62 and fixed thereto by a seat screw 64. This sleeve 60 is provided at one end with a flange 66 which serves as the fixed flange of the V-pulley of the motor. The other flange of the pulley 68 is provided at one end of a sleeve 70 which is slidably and rotatably mounted upon the sleeve 60. The sleeve 70 is provided with a recessed portion 72 provided with an inner face 74 which is in the form of an eccentric which acts in a direction parallel to the axis of the sleeve 60 and the motor shaft 62, rather than radially as is common with most eccentrics.

Cooperating with this axially directed eccentric inner face 74 is a roller 76 against which the face of the eccentric 74 rests. This roller is ro-

tatably mounted upon a pin 78 which extends into and is held by the sleeve 60. The eccentric face 74 is held against the roller 76 by a compression type coil spring 80 which is threaded upon the sleeve 60 and extends into a recess provided in the adjacent end of the movable sleeve 70. The other end of the compression spring 80 is supported by a movable pressed sheet metal member 82 which is slidably mounted upon the sleeve 60 and which is provided with a plurality of radially projecting pins 84 having movable weights 86 in the form of balls slidably mounted thereon. Eight relatively small balls are provided, but these balls may be increased or decreased in number and increased or decreased in weight and size in order to provide sufficient centrifugal force for the purposes of my device. These balls 86 act against the inner conical surface 88 of a cup-shaped member 90, which is riveted to the outer end of the sleeve 60.

In this pulley, the spring 80 should be relatively weak as compared to the force of the centrifugal weights 86 under running conditions of from one-half to full speed and the belt tensioning device 46 should have a force greater than the force of the spring 80 when it is extended as shown in Fig. 2 so that the belt tensioning device will be able to force the belt to assume a position between the lower portions of the flanges 66 and 68 under slow speed running conditions when the centrifugal weights 86 are retracted.

Thus, there are several opposing forces, one the pressure of the spring 80 acting through the sleeve 70, under the control of eccentric surfaces 74 and the roller 76 which tends to move the flanges of the pulley 52 together to increase its effective diameter so as to cause the belt 58 to assume a position upon the extreme outer portion of the flanges to provide an overdrive. This force, however, is reduced at low speeds since the tension of the spring 80 is relieved by the movement of the member 82 away from the sleeve 70 when there is little centrifugal force upon the weights 86. On the other hand the belt tensioning device, by tending to turn the motor 40 in a counter clockwise direction about its pivotal connection 42, tends to wedge the belt in tightly between the flanges of the pulley and thereby reduce the effective diameter of the pulley. Also, when the torque is heavy, there is sufficient creeping of the belt which causes the flange 68 and the sleeve 70 to turn with respect to the flange 66 and the sleeve 60 so as to cause the roller 76 in a relative sense to climb upwardly upon the eccentric face 74 to a higher portion of the eccentric so that by this action the flanges of the pulley are separated against the opposing force of the spring 80 so that the effective diameter of the pulley will be reduced, thus providing an underdrive which reduces the torque imposed upon the motor.

The increase in speed of the motor causes the weights 86 to fly outwardly and coast with the conical inner surface 88 of the cup-shaped member 90 to move the pressed sheet metal member inwardly to increase the tension of the spring 80. However, under heavy torque loads, the turning movement caused by the creeping of the belt, is sufficiently powerful to overcome the opposing turning effect of the maximum tension of the spring 80 so as to cause the belt 58 to remain in an underdrive position. It is only when the torque is light and within the capacity of the motor, and the forces are small tending to produce

creeping of the belt that the effective diameter of the pulley is increased by the movement of the flanges closer together so as to provide a higher driving ratio for overdrive. Since most motors operate most efficiently under full load and normal speed, such an arrangement will increase the overall efficiency of the unit by making it possible for the motor to operate under its most efficient load at all times.

- 10 As the motor slows down, prior to stopping, the pressed metal member 82 moves away from the sleeve 70 under the force of the spring 80 which is sufficiently strong to overcome the reduced force of the balls 86 against the conical face 88.
- 15 Under this weakened extended condition of the spring 80 and with the aid of the normal torque load, the belt tensioning device is readily able to move the belt to its underdrive position by spreading the flanges 66 and 68 to reduce the effective diameter of the driving pulley. Thus, whenever the motor stops, it is prepared to start in its underdrive position.

When the motor starts, the parts remain in the underdrive position shown in Fig. 2 with the member 82 as far away from the sleeve 70 as it is possible to get. The roller 76 is in contact with the highest portion of the eccentric face which it is possible for it to reach so that the sleeve 70 and its flange 68 remains as far away from the flange 66 as possible. By providing this underdrive position for starting, a relatively inexpensive split phase electric motor may be used in the place of the more expensive repulsion start or capacity start induction motors.

- 35 If desired, pins or other devices may be used to limit the movement of the movable sleeve 70 and its flange 68 and the contour of the eccentric face 74 may be changed to provide a variable slope which would be preferably greater at the high portion of the face and be progressively smaller to the lowest portion of the face 74.

40 While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In combination, a driving device, a driven device, pulley and belt means providing a driving means between said devices, one of said pulleys being of the V-belt type and having a movable flange portion, said pulley being provided with a combined speed and torque responsive means for shifting said movable flange portion to control the effective pulley diameter, said combination being provided with an automatic belt tightening device for changing the distance between the axes of the pulleys of the pulley and belt means.

2. In combination, a pulley shaft, a pulley flange fixed to said shaft, a cooperating pulley flange mounted upon said shaft and movable with respect to said shaft, helical guiding means cooperating with said pulley shaft and said cooperating flange for guiding said cooperating flange in a combined longitudinal and rotational movement in a definite relationship with respect to said fixed flange, and centrifugal means for urging the movable flange in an axial direction.

3. In combination, a pulley shaft, a pulley flange fixed to said shaft, a cooperating pulley flange mounted upon said shaft and movable with respect to said shaft, helical guiding means cooperating with said pulley shaft and said cooperating flange for guiding said cooperating flange in a combined longitudinal and rotational movement in a definite relationship with respect to said fixed flange, centrifugal means for urging the movable flange in an axial direction, and spring means for transmitting force between said centrifugal means and the movable flange.

4. In combination, a pulley shaft, a pulley flange fixed to said pulley shaft, a movable pulley flange mounted upon said shaft and movable toward and away from the fixed pulley flange, torque responsive reaction means operated in accordance with the rotation of the movable flange with respect to the fixed flange, for moving the movable flange toward the fixed flange in response to decreasing torque, and for urging the movable flange away from the fixed flange in response to increasing torque, and speed responsive means for urging the movable flange toward the fixed flange in response to increasing speed and for decreasing the urging of the movable flange toward the fixed flange in response to decreasing speed.

5. In combination, a pulley shaft, a pulley flange fixed to said pulley shaft, a movable pulley flange mounted upon said shaft and movable toward and away from the fixed pulley flange, torque responsive means for moving the movable flange away from the fixed flange in response to an increase in torque, and for urging the movable flange toward the fixed flange in response to a decrease in torque, centrifugally operated speed responsive means for urging the movable flange toward the fixed flange in response to an increase in speed and for decreasing the urging of the movable flange toward the fixed flange in response to a decrease in speed, one of said means including spring means extending between said movable flange and the centrifugal means for transmitting force between the movable flange and the centrifugal means.

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