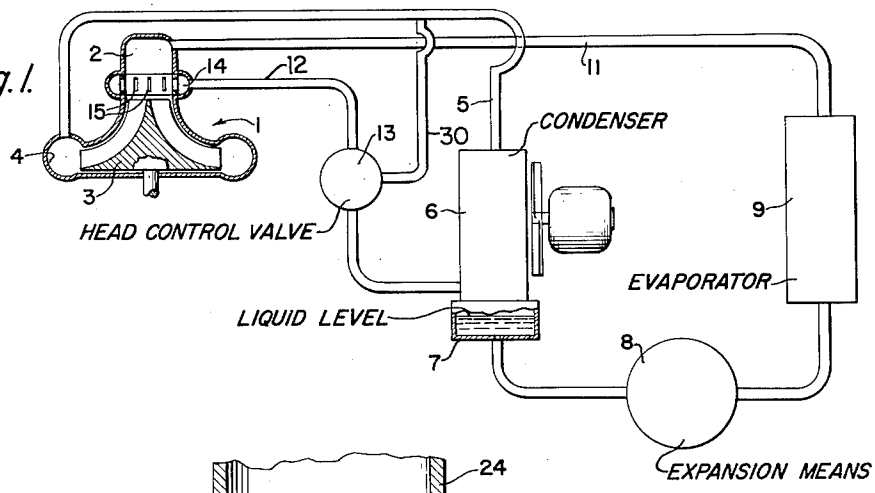
July 3, 1962 H. A. GREENWALD 3,041,848

VARIABLE HEAD COMPRESSOR

Filed June 1, 1959

Fig. 1.



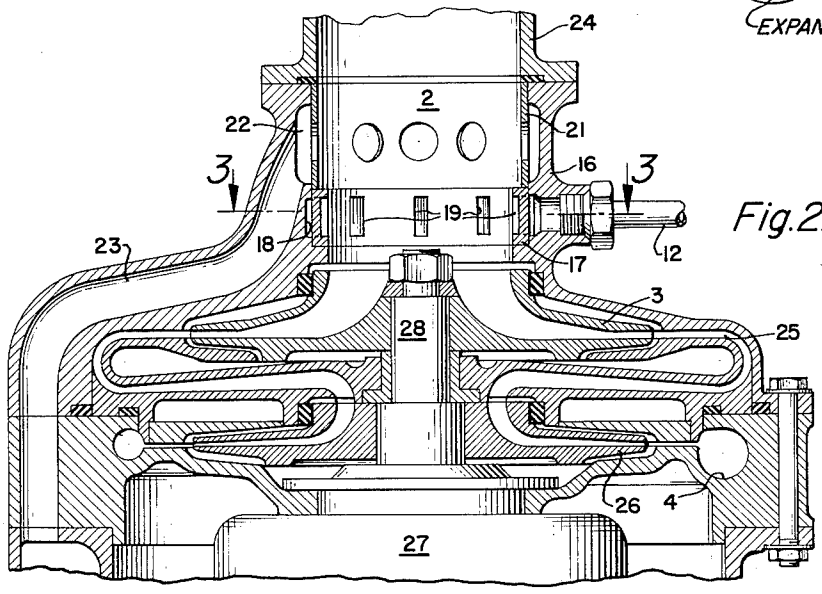


Fig. 2.

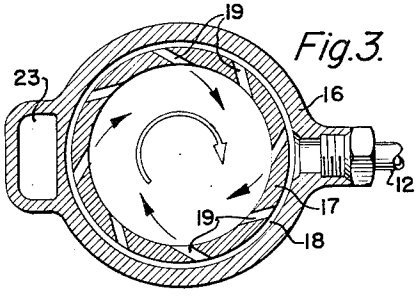


Fig. 3.

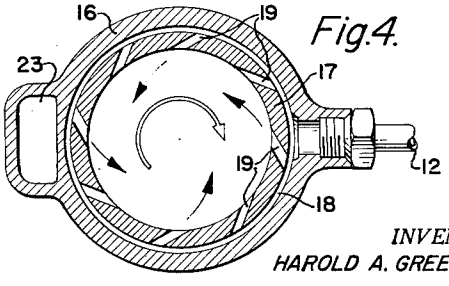


Fig. 4.

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VARIABLE HEAD COMPRESSOR

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2 Claims. (Cl. 62—197)

This invention relates to a centrifugal compressor in which the head or change in pressure through the compressor may be regulated in accordance with load requirements without changing the speed of rotation of the compressor and has for its object the provision of simple and effective means for imparting a pre-swirl to the elastic fluid or gas at the compressor inlet to vary the pressure change through the compressor.

In the operation of centrifugal compressors it is often desired to operate at constant speed while varying the compressor head in accordance with load requirements without changing compressor speed, or starting and stopping the compressor. In other cases it may be desired to maintain a constant head or pressure change through the compressor irrespective of variation in the speed of rotation of the compressor. Both of these results can be obtained by imparting a pre-swirl to the fluid drawn into the impeller of the compressor and according to this invention, such pre-swirl is created by feeding into the compressor inlet, fluid which has a substantial directional component tangential to the inlet so as to effect rotation of the inlet fluid prior to its entrance into the impeller.

While the fluid fed tangentially of the inlet to create the pre-swirl may be secured from any source, it is conveniently by-passed from the discharge side of the compressor and in a refrigeration system, for example, may be withdrawn from the receiver above the liquid level therein.

When the pre-swirl imparted to the inlet fluid has a direction of rotation the same as the direction of rotation of the compressor impeller, the head or pressure change through the compressor will be lowered and, conversely, when the pre-swirl has a direction of rotation opposite to the direction of rotation of the compressor impeller, the pressure change through the compressor will be increased.

Another advantageous effect of the pre-swirl imparted to the inlet fluid according to this invention, is a lessening of the tendency of the compressor to surge or hammer because of light loads and low flow, where such surging or hunting would otherwise manifest itself in a backflow of fluid into the impeller which adversely affects the efficiency of operation of the unit.

It is, therefore, an object of the invention to provide an improved and simplified means for imparting a pre-swirl to fluid drawn into the impeller of a centrifugal compressor by feeding fluid into the inlet of the compressor in a direction to produce a rotation of pre-swirl of the inlet fluid.

Another object of the invention is the provision of means for varying the pressure change through a centrifugal compressor in accordance with the preceding object, in which the auxiliary fluid producing the pre-swirl is by-passed from the system at the discharge side of the compressor.

A further object of the invention is to provide direction controlling means for the auxiliary fluid, useable in accordance with the preceding objects, which is readily reversible to effect pre-swirl in either the same or opposite direction of rotation as that of the compressor impeller, so as to decrease or increase the head or pressure change through the compressor as desired.

Other objects and features of the invention will be readily apparent to those skilled in the art from the specification and appended drawing illustrating certain preferred embodiments in which:

FIG. 1 is a schematic representation of the system employing a variable head compressor according to the present invention, and more particularly representing a closed cycle refrigeration system;

FIG. 2 is a vertical, sectional view through a variable head compressor according to the invention;

FIG. 3 is a transverse sectional view through the compressor inlet, showing the feeding nozzles for the pre-swirl producing fluid; and

FIG. 4 is a view similar to FIG. 3 but showing the nozzle ring reversed to produce a pre-swirl rotating contrary to the direction of impeller rotation.

In the schematic representation of FIG. 1 there is shown a typical refrigeration system including a centrifugal compressor 1 having an inlet 2 and impeller 3, and an outlet scroll 4. From the outlet scroll 4 the compressed refrigerant fluid, which may by way of example only be Freon gas, is fed through a duct 5 to a condenser 6 where it is liquefied to be received within a receiver 7. Liquid from receiver 7 passes through an expansion means 8, which may be an expansion valve, a restrictive tube, an orifice or other means well known in the art for producing a pressure drop, to an evaporator 9, where it performs its cooling function with the gas exhausting through a duct 11 to the inlet 2 of the compressor. To impart the pre-swirl to the fluid or refrigerant gas in the inlet 2, by-pass fluid is drawn from the system, for example from above the liquid level in the receiver 7, through a duct 12, having therein a head control valve 13, to an annular chamber 14 disposed about the compressor inlet and supplying a plurality of tangential nozzles 15.

Referring now to FIGS. 2, 3 and 4, compressor housing 16, defining in its upper portion the inlet 2, has disposed therein a ring 17 defining an annular chamber 18 disposed between the ring 17 and the housing 16 and communicating with the duct 12. Through the walls of the ring 17 are disposed a plurality of slots 19 spaced around and through the ring and directed substantially tangential to the inner wall of the ring or at least in a direction having a substantial component tangential to the ring wall. With the nozzle ring 17 disposed as shown in FIGS. 2 and 3, the fluid passing from chamber 18 through the nozzles 19 is directed so as to produce a pre-swirl or rotation of the fluid in the compressor inlet in the same direction as the rotation of the compressor impeller so that, as previously described, there will be effected a lessening of the head or pressure change through the compressor.

Above the ring 17 in FIG. 2, there is shown a second ring 21 defining a second annular chamber 22 communicating with a passage 23 in the housing 16, this structure being designed to feed by-passed cooling fluid back to the compressor inlet and forming no part of this invention, although the ring 21 in conjunction with inlet conduit 24 serves to maintain the nozzle ring 17 in assembled position. The compressor of FIG. 2 is shown as a two-stage compressor, with the discharge from impeller 3 passing through passageway 25 to a second impeller 26 and thence to the outlet scroll 4. The impellers 3 and 26 are driven by a suitable motor 27 through a shaft 28.

FIG. 4 illustrates the mode of operation with the nozzle ring 17 reversed top-for-bottom from the position of FIG. 2, so that the nozzles are now directing the pre-swirl imparting fluid in a direction opposite to the direction of rotation of the compressor impeller, whereby the operation is such that the pre-swirl or rotation of the inlet fluid increases the head or pressure change through the compressor.

The head control valve 13, which regulates the flow of the by-passed gas into the pre-swirl producing cham-

ber, is placed in communication with the compressor output, as by communicating means **30**, for response to pressure, temperature or other condition in response to variation of which it is desired to vary the head or pressure change through the compressor, this usually being a condition varying in accordance with the load on the compressor so that the head will be varied in accordance with the requirements of the system. Such valves and their operation are well known in the art, such a valve being shown, for example, in the patent to Wood, No. 2,734,443. Suitable controls therefor are found in the patent to Wood, No. 2,479,991 which shows a pressure responsive valve control, and to Jensen, No. 2,780,413 which shows a temperature responsive valve control.

The nozzles **19** have been shown as fixed in their directions through the ring **17**, but it will be obvious that adjustable nozzles of known form may be used to vary the direction of fluid flow therethrough to vary the tangential component of fluid movement and thereby control the degree of rotation imparted to the incoming fluid by a given amount of by-pass fluid.

While the invention has been specifically shown in FIG. 1 as applying to a refrigeration system, it is obvious that the pre-swirl producing arrangement of this invention may be utilized as well in any desired system and may be used where the compressor **1** is acting on other gases, for example air.

While a certain preferred embodiment of the invention has been specifically disclosed, it is understood that the invention is not limited thereto, as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation consistent with the prior art.

What is claimed is:

1. In a closed cycle refrigeration system, the combination of a variable head compressor comprising a housing having an inlet and an outlet, a centrifugal impeller within said housing drawing a gas in through said inlet and discharging through said outlet, said impeller having its axis of rotation substantially aligned with the axis of said inlet, a condenser for the compressed gas and a receiver for the liquid discharging from said condenser, means by-passing a portion of the gas from said receiver above the liquid level therein, an evaporator, expansion means controlling the passage of the liquid from said receiver to said evaporator, means connecting the exhaust from said evaporator to said compressor inlet, means including a head control valve for feeding said by-passed gas into said compressor inlet in a direction having a substantial component tangential to the inlet to impart a pre-swirl to the gas feeding into the impeller, and condition responsive means operating said control valve in accordance with the output of the compressor.

2. A closed circuit refrigeration system including a centrifugal compressor, a condenser, a liquid receiver, an expansion means and an evaporator connected in a closed circuit in that order, means for bypassing part of the fluid output compressed by the compressor and feeding it into the compressor inlet in a direction having a substantial component tangential to the inlet to impart a preswirl to the entering fluid, and means for controlling the amount of fluid so bypassed in accordance with the compressor output.

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