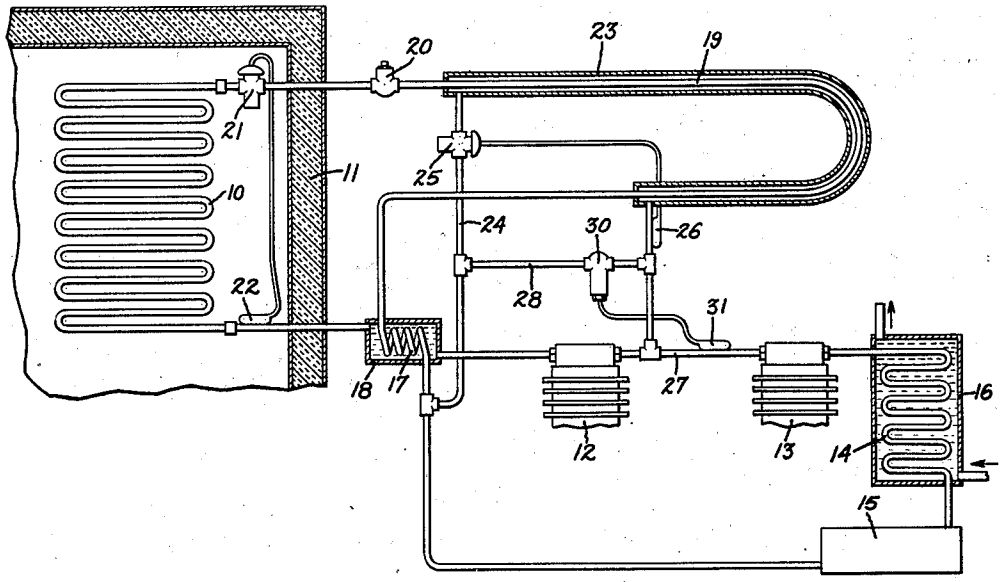
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MULTISTAGE REFRIGERATING SYSTEM

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MULTISTAGE REFRIGERATING SYSTEM

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2 Claims. (Cl. 62—115)

My invention relates to multi-stage compression refrigerating systems for producing very low temperatures.

Refrigerating systems provided with multi-stage compressors may be employed to obtain very low temperatures and for cooling test rooms and the like. The compressed refrigerant flowing from a low stage compressor to a higher stage compressor may contain superheat and it is desirable to remove this superheat before admitting the gas to the higher stage compressor. It is also desirable that the liquid refrigerant supplied to the evaporator have as much heat as possible removed from it before it flows through the pressure reducing device or expansion valve. The amount of cooling required for removing the superheat from the compressed gas in the interstage connection and the amount of cooling required for subcooling the liquid refrigerant on its way to the expansion valve vary over considerable ranges and it is desirable that some arrangement be provided for controlling the cooling of the liquid and of the interstage gas. It is an object of my invention to provide a multi-stage compression refrigerating system including an improved arrangement for controlling the subcooling of the liquid refrigerant on its way to the evaporator and for controlling the removal of superheat from the gas in the connection between two compression stages.

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 a part of this specification.

For a better understanding of my invention reference may be had to the accompanying drawing the single figure of which illustrates diagrammatically a two-stage compression refrigerating system embodying my invention.

Briefly, the refrigerating system illustrated in the drawing comprises a refrigerating system having two compressors or two compressor cylinders arranged to operate at different pressures and connected in series in a refrigerant circuit including a condenser, a liquid receiver, and an evaporator controlled by a thermostatic expansion valve. The refrigerant circuit between the receiver and the expansion valve includes a liquid subcooler and two bleed-off connections, one for supplying refrigerant to cool the subcooler and the other for supplying refrigerant to the connections between the two compressor cylinders. The two bleeder circuits are separately controlled in such a manner that the temperature of the gas admitted to the second stage compressor is maintained substantially constant and adequate subcooling is provided at all times for the liquid refrigerant flowing into the expansion valve of the system.

Referring now to the drawing, the refrigerating system shown in the single figure thereof includes an evaporator 10 arranged to cool the air within a thermally insulated compartment 11. The evaporator is connected in the circuit of a refrigerating system including a low pressure compressor 12 and a high pressure compressor 13, a condenser 14 and a liquid receiver 15. The compressors 12 and 13 may be separately driven or may comprise low and high stage cylinders of a single compressor, these alternative constructions being well known in the art. The condenser 14 is provided with a surrounding casing 16 through which cooling water may be circulated to absorb heat from the hot compressed refrigerant in the condenser; this absorption of heat condenses and liquefies the refrigerant which flows into the liquid receiver 15. The liquid refrigerant collects in the receiver 15 and flows therefrom through a liquid line including a coil 17 arranged in a casing 18, the casing 18 being connected in the suction line of the compressor cylinder 12 between the cylinder and the evaporator 10 so that the cold gas returned to the compressor absorbs heat from the liquid refrigerant in the coil 17 and cools it. Heat exchangers of this type are commonly employed to improve the efficiency of refrigerating systems. After flowing through the main heat exchanger, just described, the liquid refrigerant flows through a U-shaped coil or conduit section 19 and then through a pressure regulating valve 20. The valve 20 reduces the pressure of the refrigerant to a predetermined value before it flows to the main expansion valve illustrated as a thermostatic expansion valve 21. The expansion valve is provided with a temperature responsive element or feeler bulb 22 arranged in heat exchange relation with the suction line at the outlet of the evaporator 10. In order to subcool the liquid refrigerant passing through the coil 19 a jacket 23 is arranged about the coil and liquid refrigerant from the liquid line is bled to the jacket 23 through a connection 24 under control of a thermostatic expansion valve 25. The valve 25 has its thermal feeler bulb, indicated at 26, arranged in heat exchange with the outlet from jacket 23 so that the valve 25 maintains a predetermined amount of superheat in the vaporized refrigerant leaving the jacket 23. The refrigerant in the

casing 23 is vaporized at the interstage pressure, and the vaporized refrigerant is withdrawn by operation of the high pressure compressor 13, the casing 23 being connected in communication with the interstage connection between the compressors 12 and 13 which is indicated at 27. The valve 25 then operates to provide adequate subcooling of the liquid in the coil 19.

In order to control the temperature of the refrigerant admitted to the second stage compressor 13 and thereby to de-superheat the gas flowing from the compressor 12 to the compressor 13, a bypass or bleeder connection 28 is provided between the liquid line and the interstage connection 27 and is controlled by a temperature responsive valve 30 having a thermal feeler bulb 31 responsive to the temperature of the refrigerant admitted to the intake of the compressor 13. A temperature control valve for controlling the temperature of the refrigerant flowing to a higher pressure compressor of a multi-stage compression refrigerating system is disclosed and broadly claimed in a copending application of Harold F. Lathrop, Serial No. 521,518, filed Feb. 8, 1944, and assigned to the same assignee as the present invention.

By providing independent control of the subcooler and a separate bleeder for obtaining refrigerant to cool the gas in the interstage connection under control of the temperature responsive valve, the refrigerating system is made to operate over a wide range of conditions, for example, adequate subcooling is provided at all times whether or not refrigerant is required for cooling the interstage gas. Furthermore, adequate interstage cooling may be provided whether or not subcooling is required. The subcooler and the interstage cooler functioning together in the arrangement illustrated provide a very efficient refrigerating system which is effective to produce very low temperatures under a wide range of operating conditions.

While I have described my invention in connection with a two-stage water cooled refrigerating system, other applications will readily be apparent to those skilled in the art. I do not, therefore, desire my invention to be limited to particular arrangements 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. A multi-stage refrigerating system comprising high and low pressure compressors, an evaporator and a condenser, an interstage connection for conveying refrigerant from the outlet of said low pressure compressor to the inlet of said high pressure compressor, a liquid line for conducting liquid refrigerant from said condenser to said evaporator, a heat exchanger for subcooling the liquid in a portion of said line, means providing two parallel paths for bleeding refrigerant from said liquid line to said interstage connection, one of said paths being arranged to supply refrigerant to said heat exchanger and the other of said paths communicating directly with said interstage connection, means for controlling the flow of refrigerant through said first path in accordance with a condition of said subcooler, and means responsive to the temperature of the refrigerant at the inlet of said high pressure compressor for controlling the flow of refrigerant through said second path.

2. A multi-stage refrigerating system comprising high and low pressure compressors, an evaporator and a condenser, an interstage connection for conveying refrigerant from the outlet of said low pressure compressor to the inlet of said high pressure compressor, a liquid line for conducting liquefied refrigerant from said condenser to said evaporator, a heat exchanger for subcooling the liquid in a portion of said line, means for bleeding refrigerant from said line to supply said heat exchanger and for conducting refrigerant vaporized in said heat exchanger to said interstage connection, means for bleeding refrigerant from said line directly to said interstage connection, a thermostatic expansion valve for controlling the flow of refrigerant to cool said heat exchanger, and means responsive to the temperature of the refrigerant at the inlet of said high pressure compressor for controlling the flow of refrigerant through said second bleeding means.

WAYNE E. DODSON.