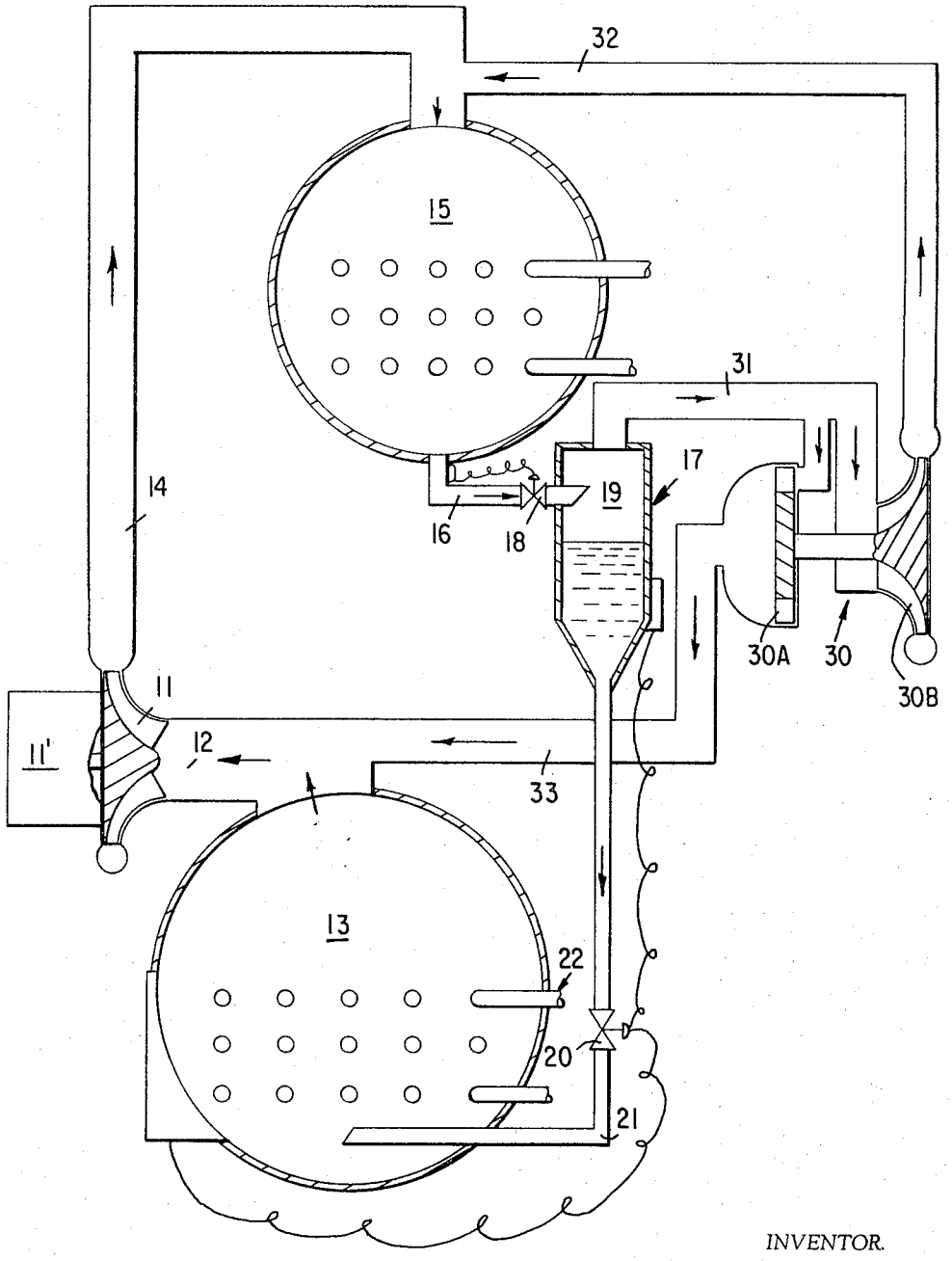
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REFRIGERATION SYSTEM

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REFRIGERATION SYSTEM

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This invention relates to a refrigeration system and a method of providing refrigeration and, more particularly, to a method and circuit for improving the efficiency of a refrigeration system. Refrigerant gas, such as a portion of the economizer flash gas, which in a sense may be considered a loss as far as refrigerating effect is concerned, is utilized to lift the remainder of the economizer flash gas to the high pressure side of the system so that the energy of the gas is utilized to improve the efficiency of the system.

In the past it has been proposed to expand refrigerant in an expansion motor prior to passing it into an evaporator, the expansion motor being used to drive a refrigerant compressor or perform other work in the system. While such expedients may provide advantages in a refrigeration system, for the most part they do not utilize the energy in an efficient manner.

It is a primary object of this invention to provide a new and improved refrigeration system and method of providing refrigeration.

An important object of this invention is to increase the efficiency of a refrigeration system.

A further object of this invention is to increase the efficiency of a refrigeration system employing a single stage centrifugal compressor.

Another object is the provision of a new and improved refrigeration system in which refrigerant gas compression means is driven by a portion of the flash gas in the system for lifting the remainder of the flash gas to a relatively high side of the system so that the energy of the flash gas is utilized to improve the efficiency of the system. A related object is provision in a refrigeration system having an economizer, for driving refrigerant gas compression means with economizer flash gas.

Another object is to provide a new and improved method of increasing the efficiency of a refrigeration system wherein a portion of the flash gas in the system is utilized for driving a compressor which lifts refrigerant vapor to a relatively high side of the system, thereby utilizing the energy of the flash gas to improve the efficiency of the system.

The invention is embodied in a small turbocompressor which is driven by refrigerant gas in the system, for example, economizer flash gas. A portion of the flash gas is expanded in the turbocompressor and discharged into an evaporator while the remainder of the flash gas is lifted from the economizer to the refrigerant condenser. While the invention is equally applicable to heat pumps, absorption refrigeration systems and other types of refrigeration systems, it is illustrated in a compression type refrigeration system with the turbocompressor and a single stage main refrigerant compressor. With the arrangement illustrated, the pressure drop across the turbine section of the turbocompressor is of the same magnitude as the lift of the compressor section thereof, allowing the turbine wheel and compressor wheel to be aerodynamically matched and therefore highly efficient.

Refrigeration systems employing the economizer principle wherein the liquid refrigerant formed in the condenser is passed to an economizer chamber having communication with an intermediate stage of a multistage compressor so as to be at a pressure intermediate the high and low pressure sides of the system are utilized to cool water for use in air conditioning installation for

large buildings. The use of an economizer with single stage refrigerant compressors has heretofore been limited due to the difficulty encountered in efficiently utilizing the intermediate pressure economizer gas.

This invention contemplates, in its preferred form, using a portion of the flash gas formed as the liquid refrigerant flowing from the condenser enters the economizer chamber, as a power fluid for driving a turbocompressor, the compressor portion of which is connected between the economizer and the condenser of the refrigeration system for the purpose of delivering a portion of the gas generated in the economizer to the condenser and expanding the remainder through the turbine section of the turbocompressor to the evaporator. Turbocompressors of the kind under consideration are often used as superchargers for internal combustion engines.

The attached drawing is a flow diagram of a refrigeration system incorporating the arrangement illustrating a preferred embodiment of the invention.

In the drawing, a first or main compressor **11** of any desired type is driven by a suitable means such as an electrical motor or a turbine **11'**, and receives refrigerant vapor through a main suction line **12** from an evaporator **13** and passes compressed refrigerant through a main discharge line **14** to a refrigerant condenser **15**. From the condenser **15** the refrigerant flows through a condensate line **16** to refrigerant flow control means, here in the form of an economizer **17** for sub-cooling the refrigerant. The economizer has a first valve **18** which receives the condensed refrigerant and passes the refrigerant into an economizer chamber **19** for collecting economizer flash gas and from which the flash cooled refrigerant passes through a second valve **20** and an evaporator supply line **21** into the evaporator **13** provided with a chilled water line **22** to a load to be cooled. From the evaporator the vaporized refrigerant enters the suction line **12** thus completing the refrigerant circuit.

A refrigerant economizer circuit includes a second or auxiliary refrigerant compressor, preferably a centrifugal turbocompressor **30**, which is connected in parallel with the main compressor **11** between the economizer **17** and the condenser **15**. More particularly, line **31** between economizer **17** and turbocompressor **30** passes refrigerant vapor from the economizer to the turbine section **30A** and the compressor section **30B** of turbocompressor **30**, the refrigerant compressed by compressor section **30B** passing to the refrigerant condenser **15** through line **32** and the refrigerant vapor expanded through turbine section **30A** passing to the evaporator **13** through line **33**.

The refrigerant flash gas in the economizer chamber **19** is at an intermediate pressure between that of the high pressure side of the system (between the discharge of the main compressor **11** and the valve **18**) and the low pressure side of the system (between the second valve **20** and the suction of the main compressor **11**) so that the flash gas driving the turbine passes from a zone of intermediate pressure within the economizer chamber **19** to a zone of low pressure within the evaporator **13**, while the flash gas being compressed passes from a zone of intermediate pressure within the economizer chamber **19** to a zone of high pressure within condenser **15**. By passing only gas to the turbine, cavitation of the turbine is effectively prevented.

It is to be understood that a turbine drivingly connected to a compressor could be used in place of the turbocompressor **30**. However, a turbocompressor does offer a few distinct advantages. Because both the turbine and compressor sides of the turbocompressor are passing the same fluid, that is, refrigerant, it is not necessary to provide relatively tight seals between the turbocompressor sections, and the shaft **37** mounted in any suitable type of bearings can be lubricated by the refrigerant gas therein.

The economizer circuit is self-balancing since it is driven by flash gas and compresses flash gas. The capacity of the turbocompressor is governed by the supply of economizer gas generated in the refrigeration circuit. Accordingly, at low lifts the speed and thus the pumping capacity of the turbocompressor is relatively low. At high lifts when additional pumping capacity is desirable, the turbocompressor operates at higher speeds thus rendering additional capacity to the main compressor. Because of the relationship between the turbocompressor performance and the refrigeration system operating condition as indicated by the economizer gas, the turbocompressor can improve cycle efficiency without special controls such as suction guide vanes, throttling valves or the like. Because of the simplicity of this system, the turbocompressor portion thereof may be provided as an accessory on any existing refrigeration systems employing a condenser and evaporator and automatically balances to any particular operating condition of the system.

Another advantage obtained with the turbocompressor unit is realized in heat pump applications where an increased lift is required when operating during the heating cycle. The turbocompressor will assist the main compressor so that a smaller and less expensive main compressor may be employed.

Another advantage of the proposed system incorporating an economizer and turbocompressor is its applicability to single stage compression systems to provide single stage system efficiency comparable to two stage systems.

Still another advantage is the efficiency of the turbocompressor when utilized in the manner described. By providing a pressure drop across the turbine section thereof of comparable magnitude with the lift on the compressor section, the turbocompressor efficiency can be optimized.

While a preferred embodiment of the invention has been described and illustrated, it will be understood that the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. A method of improving the efficiency of a refrigeration system including a relatively low pressure refrigerant evaporator, a relatively high pressure refrigerant condenser and a refrigerant compressor having a prime mover drivingly connected thereto comprising the steps of: passing refrigerant from the evaporator to the condenser, expanding liquid refrigerant passing from the condenser to the evaporator, thereby creating flash gas at an intermediate pressure and cooling the liquid refrigerant passing to said evaporator to improve the efficiency thereof, passing a portion of the flash gas to the prime mover for driving the compressor, passing the remainder of the flash gas to the compressor, and passing the compressed flash gas from the compressor to the condenser, thereby utilizing the energy of the flash gas to improve the efficiency of the system.

2. A refrigeration system comprising a relatively low pressure evaporator, a relatively high pressure condenser, a refrigerant compressor for lifting refrigerant from an intermediate pressure portion of the system to said condenser and means for driving said compressor by expanding refrigerant gas from an intermediate pressure to evaporator pressure.

3. A refrigeration system according to claim **2** wherein said means for driving said compressor comprises a turbine operatively connected thereto.

4. A refrigeration system according to claim **3** further including an economizer, means for passing a portion of the economizer gas to said compressor for lifting economizer gas to the condenser, and means for passing a portion of the economizer gas to said turbine for expansion therethrough.

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