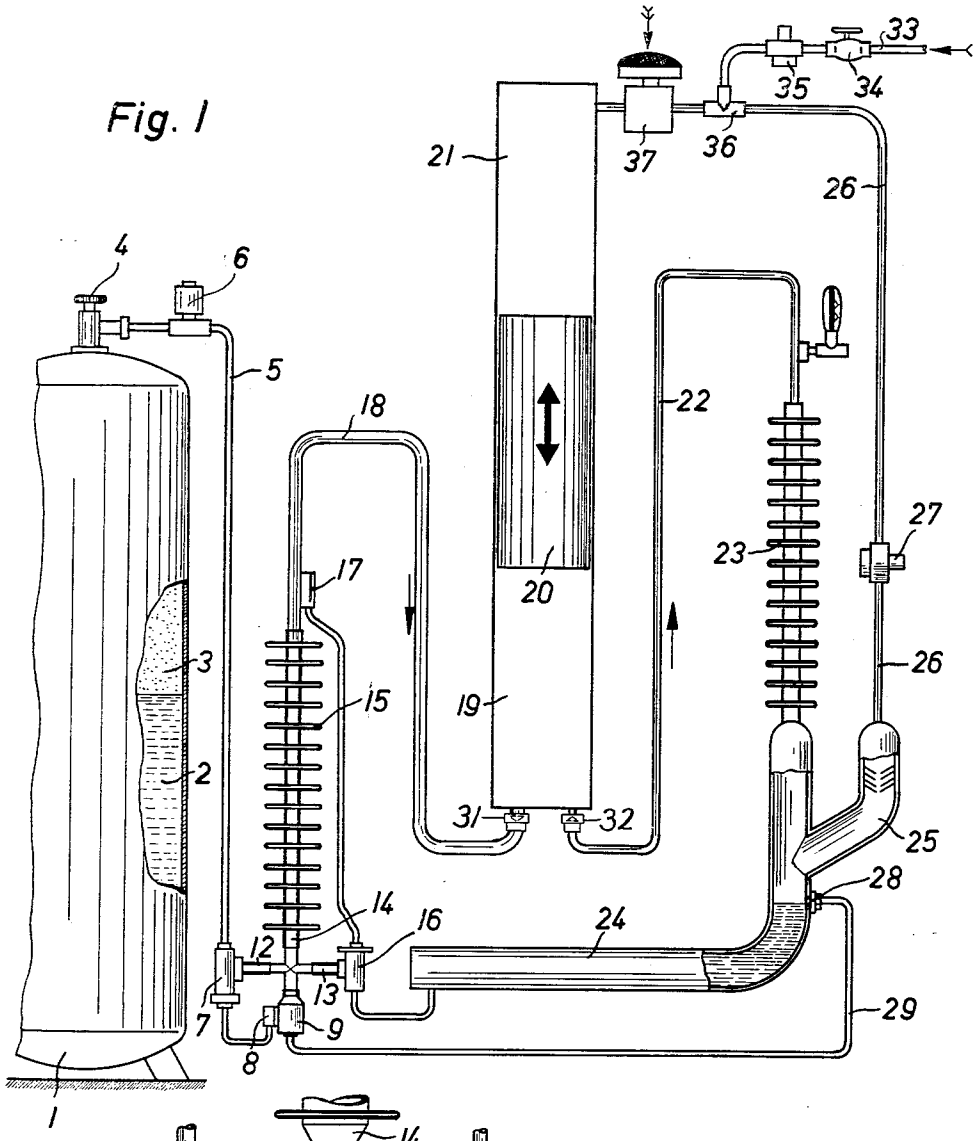
May 23, 1961 P. SCHLUMBOHM 2,984,987

METHOD OF OPERATING A COMBUSTION-DRIVEN COMPRESSION-REFRIGERATING SYSTEM

Filed Feb. 26, 1960

Fig. 1



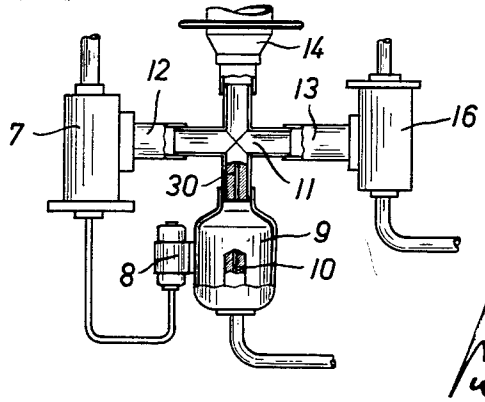


Fig. 2

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METHOD OF OPERATING A COMBUSTION-DRIVEN COMPRESSION-REFRIGERATING SYSTEM

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4 Claims. (Cl. 62—7)

The present application is a continuation in part of my co-pending application Ser. No. 756,254, filed August 20, 1958, for "Compression-Refrigerating System Utilizing a Free-Piston Compressor," now Patent No. 2,932,172, and of my co-pending application Ser. No. 826,292, filed July 10, 1959, now abandoned, for "A Method and Apparatus for Using Hydrocarbons as Fuel and as Refrigerant."

The parent application, Ser. No. 756,254, refers to a compression-refrigerating system utilizing a free-piston compressor and a refrigerant which is suitable as motor fuel, comprising an evaporating, compressing and condensing circuit having an evaporator, a suction line, a compression line, a condenser, a receiver, a purging line and a free-piston compressor oscillating between a combustion space and the refrigerant-compression and condensing space. Fuel or combustion gases which leak from the combustion space via the piston surface into the condensing space can be purged by a purging line leading from the condensing space to the combustion space. Refrigerant vapors which leak from the condensing space via the surface of the piston into the combustion space assist the combustion process.

In my application #756,254 I had given two examples: one, in which propane is used as the fuel and as the refrigerant and the other, in which butane is used as the fuel and the refrigerant. The present application widens the possibilities of the invention of the parent application and establishes the critical conditions which must be respected, if a motor fuel shall be used, which is chemically different from the refrigerant. Also, the present invention provides new structure in the form of a separate fuel line for such chemically different motor fuel.

While retaining the advantages of the parent application, this additional invention makes it possible—to give a few examples—to use natural gas as the fuel and propane as the refrigerant; or, natural gas as the fuel and butane as the refrigerant; or, propane as the fuel and butane as the refrigerant. The critical aspect is: that the substance used as the fuel must have a condensation pressure higher than that of the substance used as the refrigerant. Only under these circumstances can fuel, which has leaked into the condensing space, be tolerated in the refrigerating circuit, as only under these circumstances it can be purged in its vapor phase. Thus, negatively spoken, it would not be possible to use butane as the fuel and propane as the refrigerant: the butane would be liquified in the condensing space, and this would upset the entire controls of a circuit set for propane as refrigerant.

The apparatus for performing the invention is illustrated in Fig. 1 and Fig. 2 of the accompanying drawings,

Fig. 1 is essentially diagrammatical, especially concerning the free-piston compressor; structures are shown in

sideview, partly broken away to show liquid levels of the refrigerant.

Fig. 2 is an enlargement of a detail structure of Fig. 1.

In Fig. 1 a supply container 1 holds refrigerant in its liquid phase 2 and its vapor phase 3. A fill-up line 5, controlled by valves 4, 6 and 7, connects the tank 1 with the intake 14 of the evaporator 15 by means of the outlet 12 of the thermal valve 7, whose thermal bulb 8 is in heat exchange with an auxiliary evaporator 9. The refrigerant leaves the evaporator 15 through the suction tube 18 and enters through intake valve 31 the compression space 19. On the downward stroke of the piston 20 the compressed vapor enters through outlet valve 32 and tube 22 into the condenser 23. From here, liquified refrigerant flows into the receiver 24, while non-condensable gas or vapor, mixed with refrigerant vapor leaves the condenser space through purging lines 25 and 26, passes a pressure reduction valve 27, enters a carburetor 37 and ends up in the combustion space 21 as fuel.

A fuel chemically different from the refrigerant enters through line 33, controlled by valve 34, passes through a pressure reduction valve 35 (tuned to the same end-pressure as the valve 27) and joins in a T 36 the fuel line 26 leading to the carburetor 37.

Inasmuch as the refrigeration circuit loses refrigerant by purging, means are provided to fill up the receiver 24 to the level 28 by opening valve 7 in response to said level. A tube 29 branches off at the level 28 and leads to the auxiliary evaporator 9, which is, through tube 30, connected to the main evaporator 15 and suction line 18.

If the liquid level of refrigerant in the receiver sinks below level 28, line 29 will carry hot vapor from the condenser and receiver space into the auxiliary evaporator 9. This hot vapor will heat bulb 8 and thereby will open valve 7. The opening of valve 7 allows vapor from tank 1 to enter into the evaporator 15 from where it is withdrawn by the compressor and condensed in the condenser 23. When the condensate has raised the level to level 28, line 29 will carry liquid refrigerant to a capillary nozzle 10, where it evaporates and cools bulb 8. This closes valve 7. A conventional expansion valve 16 controls—by its bulb 17—the flow of liquid refrigerant through line 13 into the main evaporator 15.

I claim as my invention:

1. The method of operating a combustion-driven compression-refrigerating system in which the combustion space of the fuel and the compression space of the refrigerant are in leakage communication with each other, characterized by using a hydrocarbon as fuel and a chemically different hydrocarbon as refrigerant, said fuel-hydrocarbon having a higher condensation pressure than the condensation pressure of said refrigerant-hydrocarbon, whereby fuel leaking from the combustion space into the compression space can be purged from it in vapor phase.

2. In the method as claimed in claim 1, the use of natural gas as the fuel and of propane as the refrigerant.

3. In the method as claimed in claim 1, the use of natural gas as the fuel and of butane as the refrigerant.

4. In the method as claimed in claim 1, the use of propane as the fuel and of butane as the refrigerant.

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