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ART OF CONSERVING LUBRICANT IN GAS COMPRESSORS

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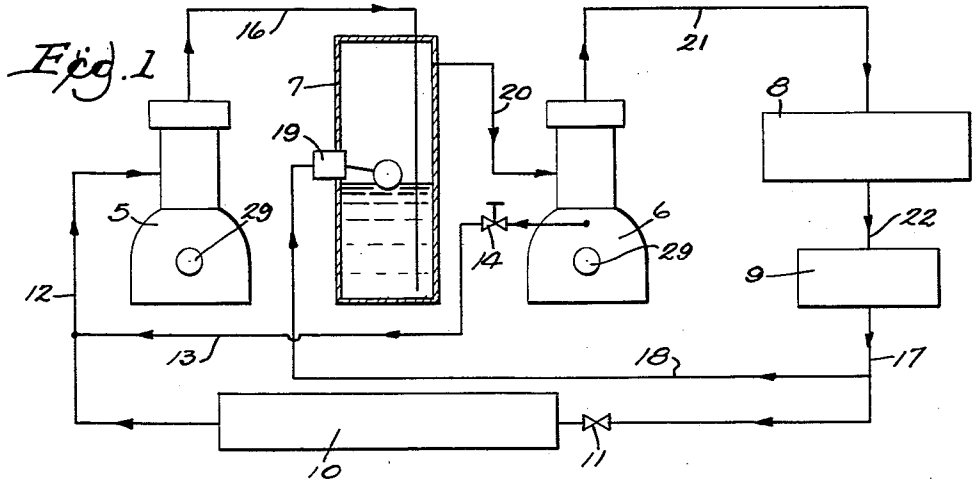
Fig. 1



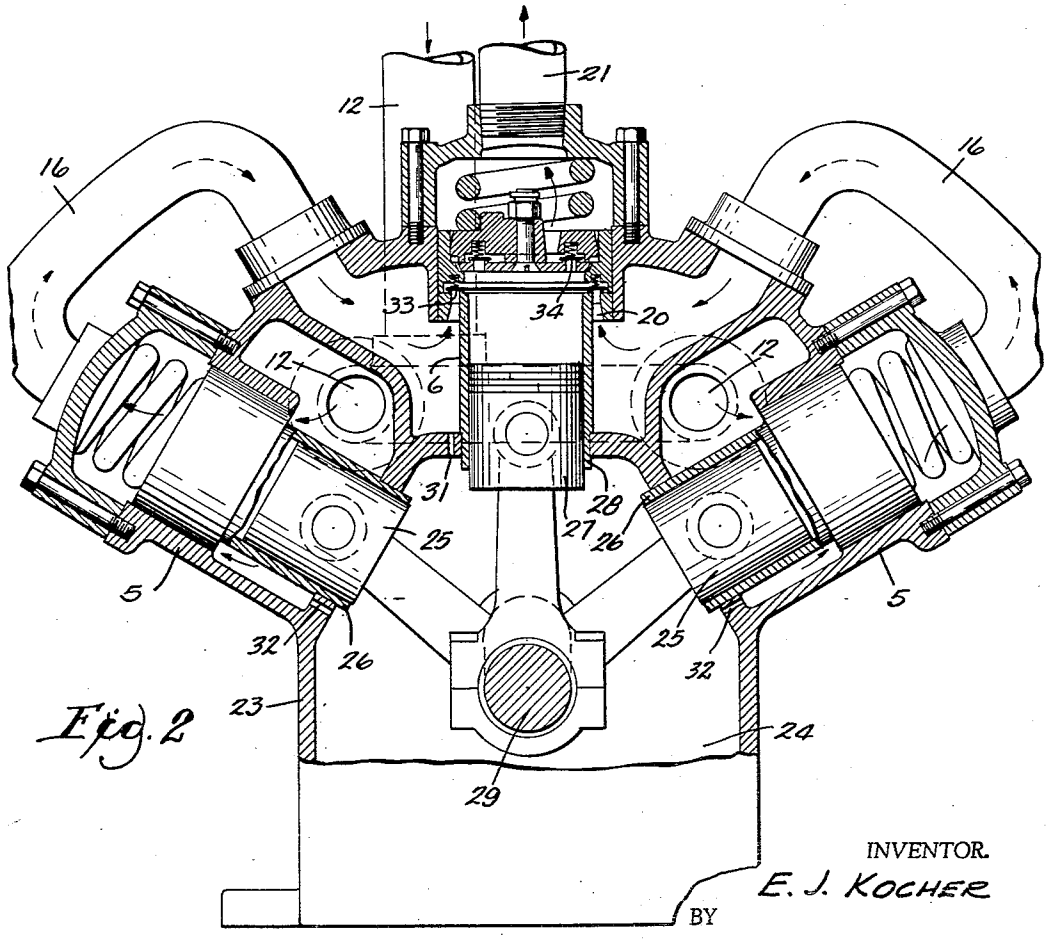


Fig. 2

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ART OF CONSERVING LUBRICANT IN GAS COMPRESSORS

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The present invention relates in general to improvements in the art of conserving lubricant in gas compressors, and it relates more specifically to an improved method or system for minimizing the loss of lubricating oil in multi-stage refrigerant compressors.

The principal object of this invention is to prevent excessive escape of oil from the lubricating system of a compound gas compressor especially of the two-stage reciprocating piston type, and to thereby maintain proper lubrication of the compressor.

It has heretofore been customary in single-acting refrigerant compressors of the reciprocating piston type to maintain a body of lubricating oil for the crankshaft bearings and the piston in the bottom of the crankcase and to drain oil which escapes with the compressed gases back into the oil supply within the crankcase in various ways. Excessive escape of lubricant with the compressed gases in a single-stage compressor may thus be avoided, but considerable difficulty has heretofore been encountered when attempting to avoid such loss of oil in multi-stage compressors wherein both low and higher pressure cylinders are in open communication with a common crankcase while the discharge chambers of the lower stages communicate with the intake chamber of a subsequent higher compression stage.

It is therefore an important object of the present invention to provide an improved method of effectively preventing loss of lubricant with the compressed gas finally delivered by a multi-stage compressor in order to insure proper lubrication of the working parts of such machines at all times.

Another important object of the invention is to provide a system whereby simple but dependable apparatus may be utilized to minimize the loss of lubricant in a two- stage gas compressor of the reciprocating piston type wherein both cylinders are exposed to a common crankcase.

These and other more specific objects and advantages of the invention will be apparent from the following detailed description.

A clear conception of the several steps involved in the present improved method, and of the construction and functioning of a typical refrigeration system having a two-stage compressor for effecting operation of the system, may be had by referring to the drawing accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the several views.

FIG. 1 is a diagram of a refrigeration system adapted to exploit the present invention, and embodying two-stage compression wherein the compressors are shown separately; and

FIG. 2 is an enlarged central vertical section through a typical two-stage reciprocating piston gas compressor such as shown diagrammatically in FIG. 1.

While the invention has been shown and described herein as being advantageously applicable to a system embodying a compressor of the type specifically illustrated in FIG. 2, it is not intended to limit its application to a two-stage compressor embodying several low pressure stages cooperating with the same high pressure stage; and it is also contemplated that specific descriptive terms employed herein be given the broadest possible interpretation consistent with the disclosure.

Referring to FIG. 1, the refrigerating system shown therein comprises in general a two-stage system having low and high stage compressors 5, 6, respectively; an intercooler 7 interposed between the compression stages 5, 6; a condenser 8 connected to the high pressure stage 6; a receiver 9 communicating with the condenser 8; an evaporator 10 adapted to receive liquid refrigerant from the receiver 9 past an expansion valve 11 and to deliver spent refrigerant gas through a passage 12 into the suction of the low pressure stage 5; and a conduit 13 connecting the crankcase of the high pressure stage 6 with the passage 12 and having a bleeder valve 14 therein.

While the diagram of FIG. 1 discloses the use of an intercooler 7 between compression stages, this is not essential, but when used, the lower portion of the intercooler is connected with the discharge of the low pressure stage 5 by a conduit 16, a medial portion communicates with the discharge line 17 of the receiver 9 through a conduit 18 and past a float valve 19 operable to control the quantity of liquid refrigerant admitted to the intercooler, and the upper portion of the latter above the liquid level is connected with the suction of the high pressure stage 6 by another conduit 20. The discharge of the high pressure stage communicates with the condenser 8 by a conduit 21 and the latter is connected with the receiver 9 by a connection 22 thus completing the refrigeration system.

As illustrated in FIG. 2, the intercooler is omitted, and the compressor comprises a pair of identical low pressure stages 5 cooperating with the same high pressure stage 6 all mounted in the same casing 23 having a common crankcase 24 containing oil for lubricating the bearings and moving parts of all stages. In this two-stage compressor, the two low pressure pistons 25 are reciprocable within fixed cylinders 26, and the single high pressure piston 27 is simultaneously reciprocable within a fixed cylinder 28 by means of the same crankshaft 29 which is rotatable within the crankcase 24 and is adapted to splash lubricating oil from within the latter into all of the cylinders 26, 28. While only one set of low and high pressure stages 5, 6 is illustrated, the compressor may embody several of such stage sets located laterally adjacent to each other and operable by the same crankshaft 29, depending upon the capacity required, and this crankshaft may be rotated from any suitable power source such as an electric motor.

In the compressor of FIG. 2, the discharge conduits 16 of the two lower pressure stage sections both communicate directly with the high pressure stage intake conduits 20 and are connected with the single crankcase 24 by one or more restricted ports 31, while the suction side of each low pressure stage 5 is likewise connected with this crankcase by ports 32 which correspond to the conduit 13 of FIG. 1 but do not embody a bleeder valve 14 since the ports 32 may be made sufficiently restricted so as to function as bleeders and maintain a lower pressure in the crankcase than in the high pressure chamber 6 in order that oil in the cylinder 28 is drawn down into the crankcase 24. Each stage of the compressor is provided with an annular inlet valve 33 and with an outlet valve 34 both located at the same end of its cylinder 26, 28, such valves being of well-known construction and therefore being shown only in the high pressure stage 6 of FIG. 2.

When the refrigeration system and its compressor have been constructed and assembled as above described and properly adjusted, it functions as follows while exploiting the present improved method. The crankshaft 29 will be revolving at relatively high speed to reciprocate the pistons 25, 27 and to splash oil from within the crankcase

24 into the cylinders 26, 28. The two sections of the low pressure stage 5 will withdraw refrigerant gases from the evaporator 10 through the passage 12 and will initially compress these spent gases and deliver the same under pressure into the suction conduit 20 of the high pressure stage 6 either directly through the conduit 16 or through an intercooler 7 if used. The high pressure stage 6 will then further compress these gases and discharge the same through the conduit 21 into the condenser 8 wherein the high pressure refrigerant is liquified and delivered through the connection 22 into the receiver 9. The evaporator 10 will thereafter withdraw high pressure liquid refrigerant as required from the receiver through the pipe line 17 and past the expansion valve 11, and as this liquid refrigerant is converted into gas in the evaporator it is withdrawn through the passage 12 to complete the cycle.

While the system is operating in this manner, considerable lubricating oil is mixed with and carried by the refrigerant through sections of the low pressure stage 5, and if the pressures within the crankcase 24 and in the high pressure stage suction conduit 20 are not equalized, this entrained oil will enter the high compressor pressure stage 6 in considerable quantity. Besides the fact that such entry of incompressible liquid into the high pressure stage 6 may damage the piston 27, the escaping oil if not removed from the high pressure stage discharge will be carried by the refrigerant into the condenser 8, receiver 9, and evaporator 10, thus reducing the efficiency of the entire system and also resulting in loss of considerable oil. But by connecting the low pressure discharge conduits 16 with the high pressure crankcase 24 as with ports 31 and by also connecting the crankcase 24 with the lower pressure stage suction zones as by ports 32, the pressures in the crankcase and low pressure suction may be substantially equalized thus permitting the oil from within the suction chamber of the high pressure stage 6 to drain by gravity into the crankcase 24 so that this oil cannot enter the compression chamber of the high pressure stage.

The present invention therefore provides a method of effectively preventing escape of excessive quantities of lubricating oil with the finally compressed refrigerant gas, and which can be carried on automatically with the aid of simple equipment or apparatus. The removal and return of the entrained oil to the crankcase 24 also insures proper lubrication of all moving parts of the compressor and insures most efficient functioning of the entire refrigeration system while in operation. The improved method is obviously capable of being exploited with various types of multi-stage compressors regardless of whether all stages are housed within a common casing or whether one or more low pressure stages precede the final high pressure stage.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. The system for minimizing lubricating oil loss in a multi-stage reciprocating piston gas compressor having at least one high pressure stage and one low pressure stage provided with a crankcase, which comprises, conduit means interconnecting the discharge of said low pressure stage with the high pressure stage crankcase and conduit means also interconnecting said crankcase with the suction zone of said low pressure stage of the compressor to induce the oil to flow from said low pressure stage discharge into the crankcase.

2. In a refrigerating system having at least one low pressure stage and one high pressure stage reciprocating piston for circulating refrigerant within the system, a crankcase for the high pressure stage piston, and restricted conduit means interconnecting the crankcase of the high pressure stage piston with the suction inlet and discharge of the low pressure stage to reduce pressures within said crankcase and induce oil flow from the low pressure stage discharge back to the crankcase.

3. In a refrigerating system having at least one low pressure stage and one high pressure stage reciprocating piston and a common crankcase, conduit means connecting the discharge of the low pressure stage with the common crankcase, and other conduit means connecting said crankcase with the suction inlet of the low pressure stage, whereby lubricating oil may escape from the discharge of said low pressure stage into said crankcase via said first conduit means.

4. In a refrigerating system having at least one low pressure stage and one high pressure stage cylinder each containing a reciprocating piston for circulating refrigerant within the system, a crankcase, conduit means connecting the outlet end of the low pressure stage cylinder with the crankcase, and other conduit means connecting said crankcase with the suction inlet of the low pressure stage.

5. In a multi-stage reciprocating piston type refrigeration compressor having at least one low pressure stage provided with a suction inlet and a discharge line communicating with a high pressure stage, a crankcase containing lubricating oil for the compressor pistons, and conduit means interconnecting the crankcase with the suction inlet and with the discharge line of the low pressure stage to thereby lower the pressure normally existing in the crankcase during operation of the compressor and induce fluid flow from the discharge line to the crankcase.

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