March 21, 1967 R. C. WIRTH 3,310,230

HYDRAULIC GAS SEAL SYSTEM FOR PISTON-TYPE GAS COMPRESSOR

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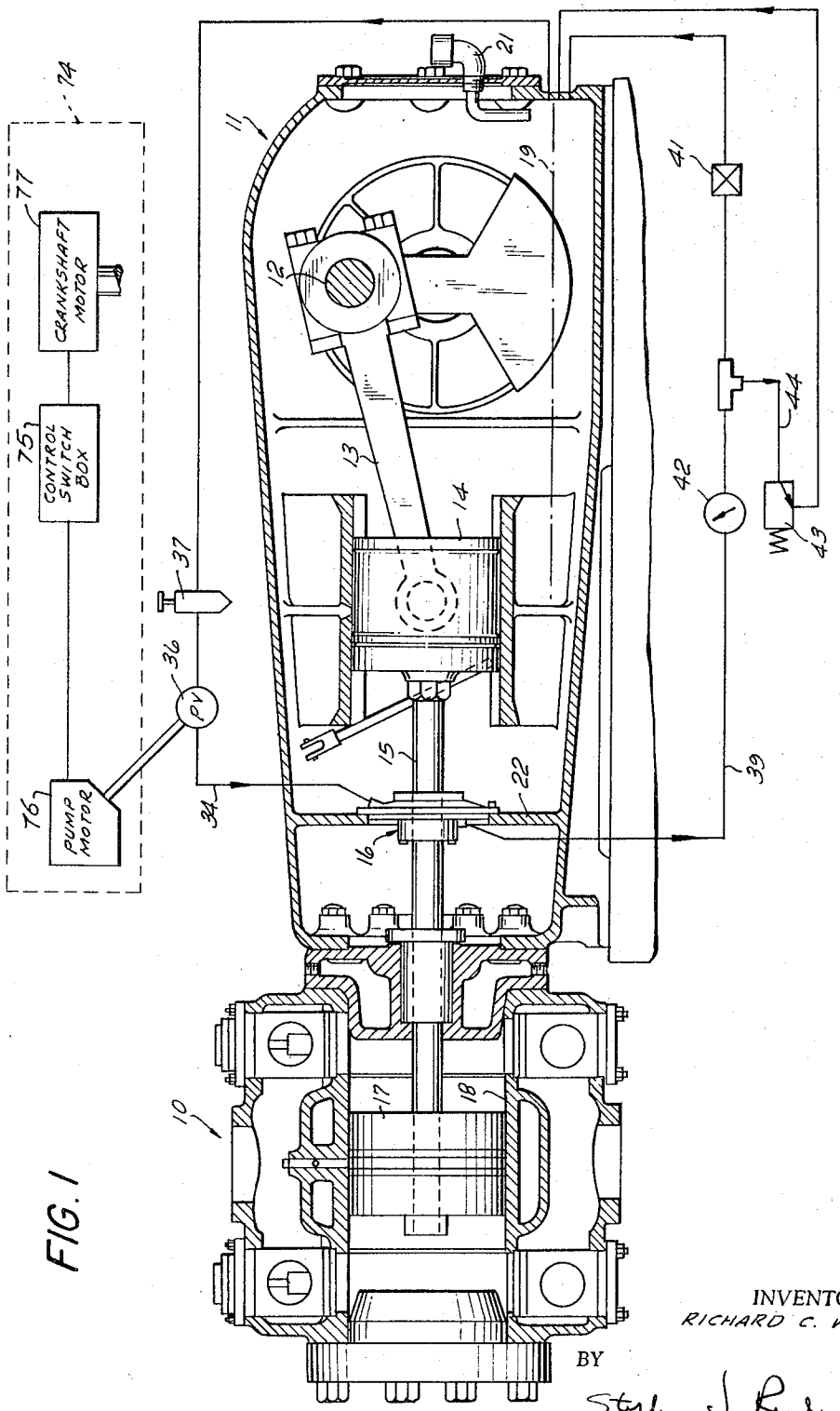


FIG. 1

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HYDRAULIC GAS SEAL SYSTEM FOR PISTON-TYPE GAS COMPRESSOR

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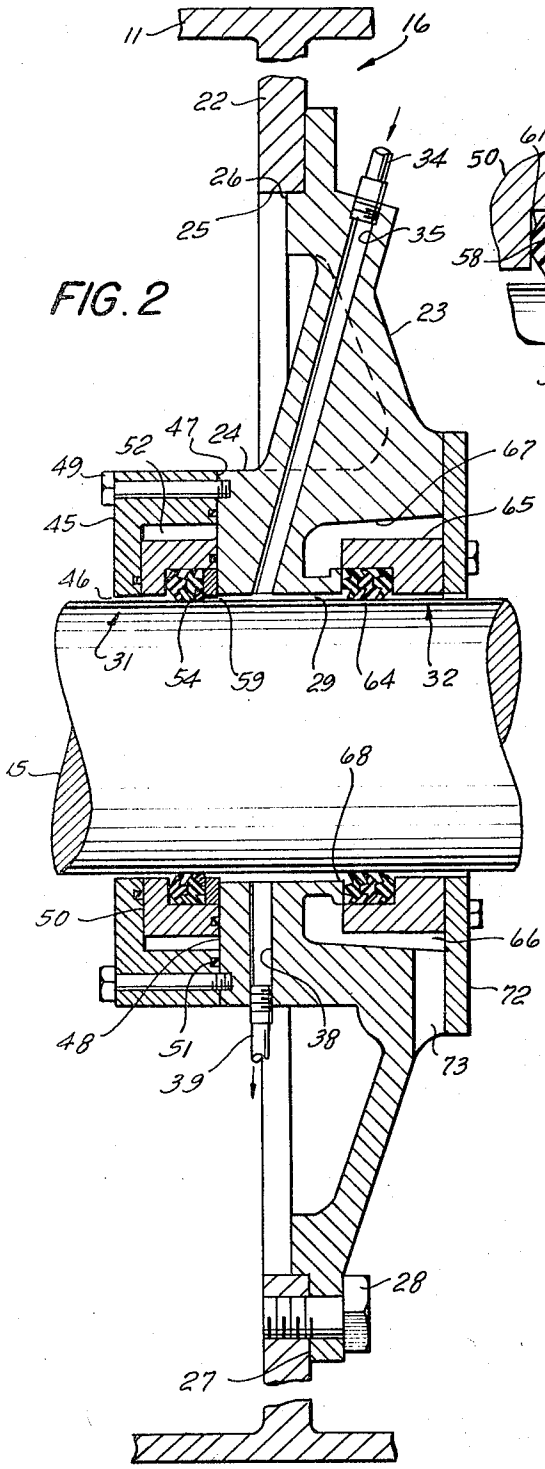


FIG. 2

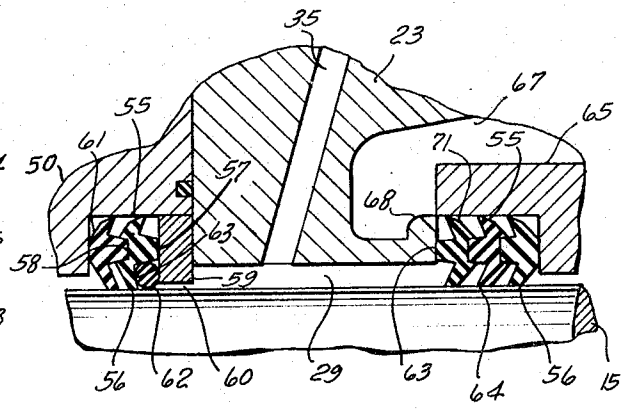


FIG. 3

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HYDRAULIC GAS SEAL SYSTEM FOR PISTON-TYPE GAS COMPRESSOR

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7 Claims. (Cl. 230—203)

This invention relates to gas compressors of the piston-type; and it has special application to compressors working with special gases, such as refrigerants, precious or lethal gases.

A problem associated with compressors working with special gases is concerned with preventing the gases from leaking around the reciprocating piston rod from the compressor head section of the apparatus into the crankcase. Some of these special gases are of a lethal nature, accordingly it is essential that they be prevented from leaking into the crankcase and escaping to atmosphere through the usual crankcase breather vent. Others are likely to contaminate the lubricating oil in the crankcase; and others are of a precious or costly nature so that it is a matter of economy to prevent leakage of such gases.

Another problem associated with piston-type compressors is concerned with dissipating undesirable heat developing in the rapidly reciprocating piston rod.

A general object of this invention is to provide a practical solution to these problems.

A more specific object is to provide a hydraulic gas seal system which functions in an efficient and practical manner to seal against leakage of gas from the compressor section of a piston-type gas compressor to the crankcase section and also functions to dissipate undesirable heat developing in the piston rod.

In the accompanying drawings:

FIG. 1 is a schematic showing of a piston-type gas compressor apparatus embodying the invention;

FIG. 2 is a detail in cross section of the false head mounted in the compressor apparatus; and

FIG. 3 is a fragmentary enlarged detail of the packing seal arrangement at each end of the hydraulic sealing cavity of the false head.

In the drawings, the invention is shown as applied to a stationary gas compressor apparatus of the piston-type. The apparatus as schematically shown in FIG. 1 includes a compressor head section **10** connected in tandem to a crankcase section **11**. The crankcase supports a crankshaft **12** which acts through a crankarm **13** and a crosshead **14** to reciprocate a piston rod **15**. The latter extends axially through a false head **16**, located near one end of the crankcase, and serves to reciprocate a piston **17** in a compression chamber **18** of the compressor section. The crankcase provides at its bottom an oil sump **19** which serves as a source of cooling and lubricating oil for the crankshaft and other components of the apparatus. A breather tube **21** serves to vent the crankcase of undesirable fumes.

As earlier explained, the compressor apparatus is of a type which may be used for compressing special gases; and that it is accordingly necessary to prevent leakage of such gases from the compressor section into the crankcase section. A hydraulic gas seal system, as will be shortly described herein, is provided for this purpose. This system schematically included in FIG. 1 represents a desired improvement and technical advance in this art. It provides a positive hydraulic seal which prevents leakage of gases from the compressor section **10** around the piston rod **15** into the crankcase section **11**; and simultaneously with such action functions to cool the piston rod. As a result of this hydraulic gas seal system, contamination of the sump oil, leakage of lethal gases into the crankcase and their escape through the crankcase vent **21**, and undesirable heating of the piston rod are avoided.

The hydraulic gas seal system includes the false head unit **16**. The latter is mounted to an annular internal flange **22** at one end of the crankcase section **11** to define with the flange partition which separates and seals gas-tight the interior of the crankcase section from the compressor section. The false head, best shown in FIG. 2, includes an annular disc body member **23** having a central hub portion **24** extending axially into an opening **25** defined by the inner diameter wall of the crankcase flange **22**. A short axial extension of the body member provides an annular shoulder **26** which is seated in the opening **25** in abutment with the surrounding inner diameter wall of the flange. An outer marginal portion **27** around the body member overlies the flange **22**, and is bolted gas-tight to it by means of a ring of bolts **28**. The body member is provided with an axial hole of greater diameter than the piston rod so as to provide a desired clearance **29** about the piston rod. This clearance is sealed over at opposite ends by sealing means, respectively designated generally by numerals **31** and **32**, whereby the clearance **29** serves as a hydraulic chamber or cavity about the piston rod for the reception of oil from the crankcase sump **19**, or from some other suitable source. In this system, a pipe line **34** (FIGS. 1, 2) is connected at one end to the sump, and at the other end is connected to an inlet passage **35** passing through the body member **23** to the cavity **29**. A variable pressure pump **36** in this pipe line serves to draw sump oil through a filter **37**, and to force the oil through the inlet passage to fill the cavity **29**. The oil circulates in the cavity about the piston rod and returns to the sump through a hydraulic return passage **38** extending from the cavity through the body member, and a return pipe line **39**. A manual hydraulic pressure regulating valve **41** in the return line serves to control the rate of return oil flow from the cavity so as to maintain the cavity constantly filled with oil and at a desired pressure. The valve is controlled by the operator so as to maintain the oil pressure in the cavity at a greater value than the pressure of gases accumulating at the compressor side **10** of the cavity. In this manner, the pressurized oil circulating through the cavity serves as a hydraulic seal preventing leakage of gases from the compressor section around the piston rod into the cavity, and also serves to extract heat from the reciprocating piston rod. A gage **42** in the return line serves to indicate the hydraulic pressure in the cavity. A maximum pressure relief valve **43**, connected in a by-pass line or branch **44** of the return line leading to the sump, prevents development of undesirable excessive hydraulic pressure in the cavity.

The sealing means **31** and **32** serve to contain the pressurized hydraulic fluid in the cavity; and also serve to strip oil from the reciprocating piston rod. The sealing means **31** at the compressor end of the false head includes an outer packing seal cup **45** having an axial hole **46**, the wall of which surrounds the piston rod with a slight clearance. It further has a flat annular inner end wall **47** which lies flush against a flat end wall **48** of the body member **23** and is held fast to the latter by means of a ring of bolts **49**. An O-ring seal **51** is provided between the opposed wall surfaces **47**, **48**. Seated within the outer cup with a peripheral clearance **52** is an inner packing seal cup **50** through which the piston rod passes with a slight clearance. Seated within this inner cup in surrounding relation to the piston rod is a group of packing seal rings **54** (FIGS. 2, 3) arranged one forwardly of the other. The packing rings are formed of soft material having some resilience. Rubber, or plastic material such as that known by the trade name

neoprene, and synthetic soft resilient rubber compounds suitable for this purpose. The outer periphery of each ring is defined by a forwardly extending lip 55 (FIG. 3); and the inner periphery of each ring is defined by a similar lip 56. The lips diverge from one another. The rings are seated in the inner cup with the inner lip in wiping contact with the piston rod, and with the outer lip in contact with the surrounding wall of the cup. Each ring is also formed with an annular rib 57 centrally of its forward face. The rib of the rear ring fits into a complementary groove 58 formed in an arcuate back of the next preceding ring, and the rib of the leading ring abuts centrally of a back-up disc plate 59. A rounded back 61 of the rear ring seats against the bottom of the inner cup. The rings are of such a nature that upon being squeezed or compressed axially, the lip portions tend to expand radially outward. Here, the packing rings are squeezed between the bottom of the inner cup 50 and the back-up plate 59 by means of the outer cup 45 which presses upon the inner cup whereby the inner lips 56 press firmly upon the piston rod. The packing rings are arranged so that the inner lips are opposite to and face toward the corresponding end of the hydraulic cavity 29. In this arrangement of the packing rings and the direction of the lips, the rings serve to scoop or strip and wipe oil from the piston rod as the latter reciprocates.

It is noted that a soft resilient O-ring seal 62 is seated in an annular groove 63 defined between the rib 57 and the inner lip 56 of the leading packing ring. This O-ring is squeezed between the inner lip 56 and the back-up plate 59 whereby it functions to press and hold the adjacent inner lip 56 tightly against the surface of the piston rod. This tight relation of the inner lip to the piston rod further aids in stripping oil from the latter. This O-ring is of still further advantage in that it serves to hold the adjacent lip down against the piston rod and thereby prevents the opposing pressure of gas in the compressor section from lifting the lip upwardly away from the piston rod. It can be seen that, if because of some deficiency in operation, the hydraulic pressure in the cavity 29 should become excessive so as to force the inner lips of the packing rings in the opposite direction, nevertheless, gas from the compressor section will be prevented from entering the cavity 29 as the hydraulic fluid is forced around the packing rings into the compressor section. It is noted that there is a slight annular clearance 60 between the back-up plate 59 and the piston rod, which clearance is relatively smaller than the thickness of the O-ring 62, and that the O-ring abuts against a side face of the back-up plate. In this arrangement, the back-up plate functions to prevent the O-ring from being drawn through it into the hydraulic cavity 29.

The sealing means 32 sealing over the opposite end of the hydraulic cavity 29 comprises a group of packing rings 64 similar to those described, but here three in number arranged one forwardly of the other. These rings are seated in a packing cup 65 in surrounding relation to the piston rod. The piston rod extends axially and with a slight clearance through this packing cup. The packing cup is disposed with a surrounding clearance 66 in an annular recess 67 formed in the hub of the body member 23. A short internal extension 68 of the body member extends into the recess 67 and abuts the rib 63 of the leading packing ring 71. An annular retaining plate 72, bolted fast to the end face of the body member, closes over the recess 66 and presses the packing cup 65 inwardly to compress the packing rings between the bottom of the cup and the extension 68. In this arrangement of the packing rings 64, the lips 55, 56 thereof are opposite to and face toward the hydraulic cavity 29. The outer lips 55 are in pressed contact with the surrounding wall of the packing cup 65 and the inner lips 56 are in pressed contact with the piston rod. In this arrangement, the packing rings 64 serve to seal the corresponding end of the cavity 29; and the forwardly extending inner lips

function to scoop or strip and wipe oil from the piston rod as the latter reciprocates. Further, it can be seen that if hydraulic pressure in the cavity 29 should, because of some deficiency in operation, become excessive so as to force hydraulic fluid past the packing rings 64, the hydraulic fluid will seep around the packing cup into the clearance 66 and drain through a slot 73 into the crankcase.

It is to be noted that except for the several packing rings 54, 64, the piston rod otherwise reciprocates clear of the false head thus subjecting the piston rod to a minimum of frictional contact with the false head.

The pump 36 is associated in a suitable electrical circuit generally indicated at 74 in FIG. 1 in such manner that the compressor apparatus will not operate without the pump simultaneously operating. This is desired so that the hydraulic cavity 29 can be immediately supplied with sealing and cooling hydraulic fluid to avoid possible damage by heat to the packing seals. The circuit is also such that if the compressor for some reason is stopped, the pump will nevertheless continue to operate. This precaution is desired to continually maintain the hydraulic seal in the cavity 29 so as to prevent possible bleeding of gas from the compressor section into the crankcase. A suitable control switch mechanism 75 controls the pump motor 76 and the crankshaft motor 77.

It is to be noted that the crankcase sump 19 is used here for supplying the circulating hydraulic fluid to cool the piston rod and effect the hydraulic seal. However, a suitable reservoir or source provided independently of the crankcase sump may be utilized for this purpose, and the hydraulic fluid therein may be pre-cooled to the extent desired.

What is claimed is:

1. A piston-type gas compressor apparatus comprising a crank case section, a compressor head section, a piston reciprocable in the compressor head section having a piston rod extending into the crankcase section, a crank supported in the crankcase section drivingly connected to the piston rod, and a hydraulic gas seal system for sealing the compressor head section against leakage of gas around the piston rod into the crankcase section, the hydraulic gas seal system comprising: a false head mounted transversely of the compressor apparatus partitioning the compressor head section from the crankcase section, a cavity axially of the false head surrounding the piston rod, first sealing means about the piston rod sealing one end of the cavity from the compressor head section, other sealing means about the piston rod sealing an opposite end of the cavity from the crankcase section, a hydraulic sump within the crankcase adjacent the corresponding end of the false head, means for circulating hydraulic fluid from the sump through the cavity around the piston rod and back to the sump, and control means for maintaining the fluid circulating through the cavity at a pressure greater than that of gas in the compressor head section, wherein the first and other sealing means are of soft resilient material and provide together with the hydraulic fluid the sole contact with the piston rod within the false head.

2. A piston-type gas compressor apparatus comprising a crankcase section, a compressor head section, a piston reciprocable in the compressor head section having a piston rod extending into the crankcase section, a crank supported in the crankcase section drivingly connected to the piston rod, and a hydraulic gas seal system for sealing the compressor head section against leakage of gas around the piston rod into the crankcase section, the hydraulic gas seal system comprising: a false head mounted transversely of the compressor apparatus partitioning the compressor head section from the crankcase section, a cavity axially of the false head surrounding the piston rod, first sealing means about the piston rod sealing one end of the cavity from the compressor head section, other sealing means about the piston rod sealing an opposite end

of the cavity from the crankcase section, a hydraulic sump, means for circulating hydraulic fluid from the sump through the cavity around the piston rod and back to the sump, and control means for maintaining the fluid circulating through the cavity at a pressure greater than that of gas in the compressor head section; wherein the false head includes a main annular body member axially of which the cavity is provided, an inlet passage in the body member communicating at one end with the cavity, piping connecting an opposite end of the inlet passage with the sump, a hydraulic fluid circulating pump connected in the piping, an outlet passage in the body member communicating at one end with the cavity, return piping connecting an opposite end of the outlet passage with the sump, and a pressure regulating valve connected in the return piping.

3. A piston-type gas compressor apparatus as in claim 2, wherein maximum pressure relief control means is connected in the return piping intermediately of the regulating valve and the outlet passage.

4. A piston-type gas compressor apparatus comprising a crank case section, a compressor head section, a piston reciprocable in the compressor head section having a piston rod extending into the crankcase section, a crank supported in the crankcase section drivingly connected to the piston rod, and a hydraulic gas seal system for sealing the compressor head section against leakage of gas around the piston rod into the crankcase section, the hydraulic gas seal system comprising: a false head mounted transversely of the compressor apparatus partitioning the compressor head section from the crankcase section, a cavity axially of the false head surrounding the piston rod, first sealing means about the piston rod sealing one end of the cavity from the compressor head section, other sealing means about the piston rod sealing an opposite end of the cavity from the crankcase section, a hydraulic sump, means for circulating hydraulic fluid from the sump through the cavity around the piston rod and back to the sump, and control means for maintaining the fluid circulating through the cavity at a pressure greater than that of gas in the compressor head section; wherein each of the first and the other sealing means includes at least one packing ring of soft resilient material surrounding the piston shaft having inner and outer peripheral diverging lips, the inner lip of which has wiping contact with the piston rod and faces toward the corresponding end of the cavity.

5. A piston-type gas compressor apparatus as in claim 4, wherein the first sealing means includes an annular back-up plate surrounding the piston rod and lying in abutment with the main body member about one end of the cavity, the said packing ring of the first sealing means includes a centrally located annular rib whereby an annular groove is defined between the rib and the inner lip, and an O-ring is squeezed in the groove between the inner lip and the back-up plate so as to press the inner lip against the surface of the piston rod.

6. A piston-type gas compressor apparatus as in claim 5, wherein the back-up plate has a close clearance about the piston rod of relatively shorter radial extent than the radial extent of the cavity and of the radial extent of the O-ring.

7. A piston-type gas compressor apparatus comprising a crankcase section, a compressor head section, a piston reciprocable in the compressor head section having a piston rod extending into the crankcase section, a crank supported in the crankcase section drivingly connected to the piston rod, and a hydraulic gas seal system for sealing the compressor head section against leakage of gas around the piston rod into the crankcase section, the hydraulic gas seal system comprising: a false head mounted transversely of the compressor apparatus partitioning the compressor head section from the crankcase section, a cavity axially of the false head surrounding the piston rod, first sealing means about the piston rod sealing one end of the cavity from the compressor head section, other sealing means about the piston rod sealing an opposite end of the cavity from the crankcase section, a hydraulic sump, means for circulating hydraulic fluid from the sump through the cavity around the piston rod and back to the sump, and control means for maintaining the fluid circulating through the cavity at a pressure greater than that of gas in the compressor head section; wherein control means is provided for simultaneously effecting operation of the compressor apparatus and of the means for circulating hydraulic fluid through the cavity, and is further provided for stopping operation of the compressor apparatus without stopping operation of said means for circulating hydraulic fluid through the cavity.

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