Jan. 30, 1923. 1,443,764

H. J. SMITH.
COMPRESSOR.
FILED JUNE 7, 1920. 3 SHEETS-SHEET 1

Fig. 1.

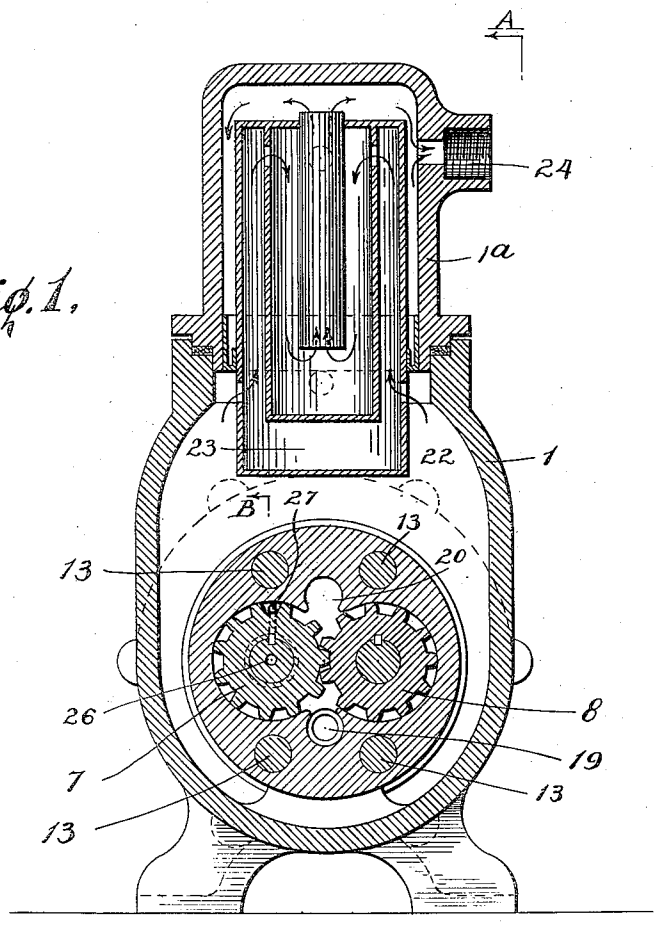
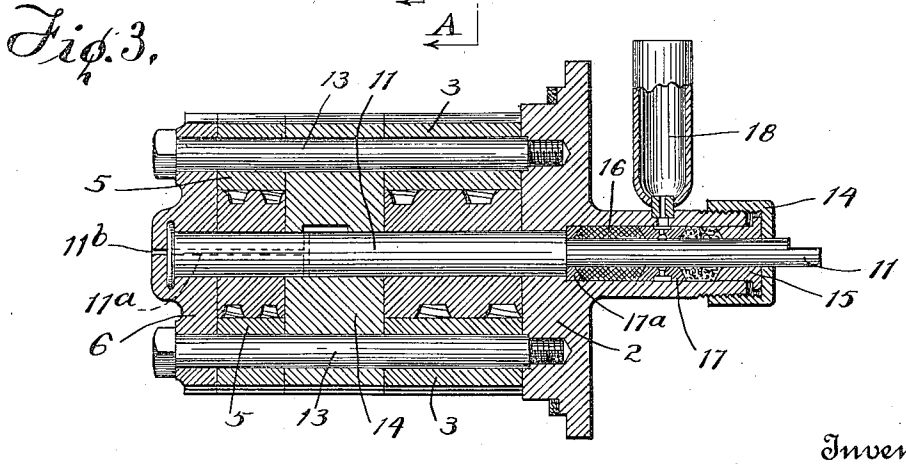


Fig. 3.



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Fig. 2.

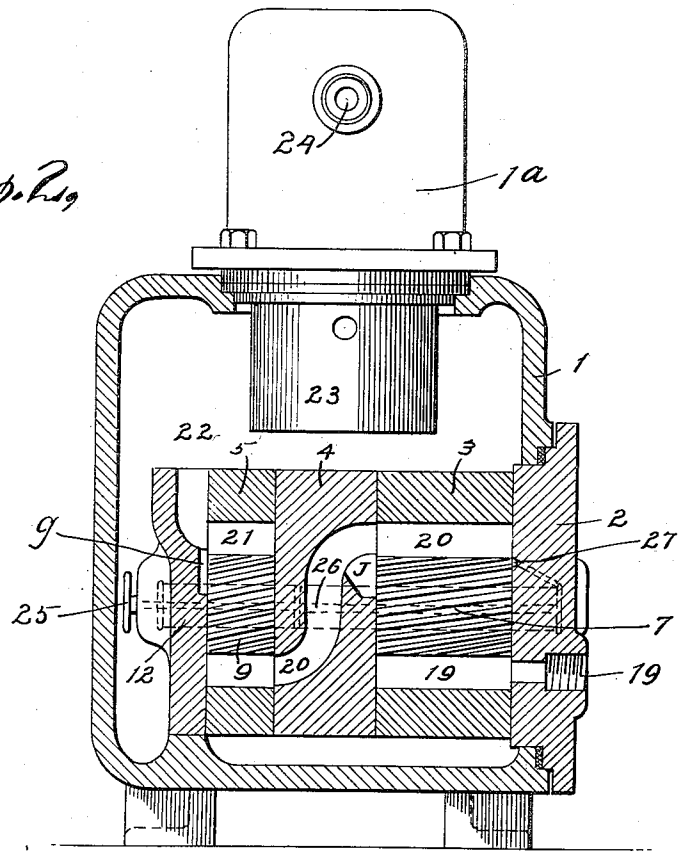
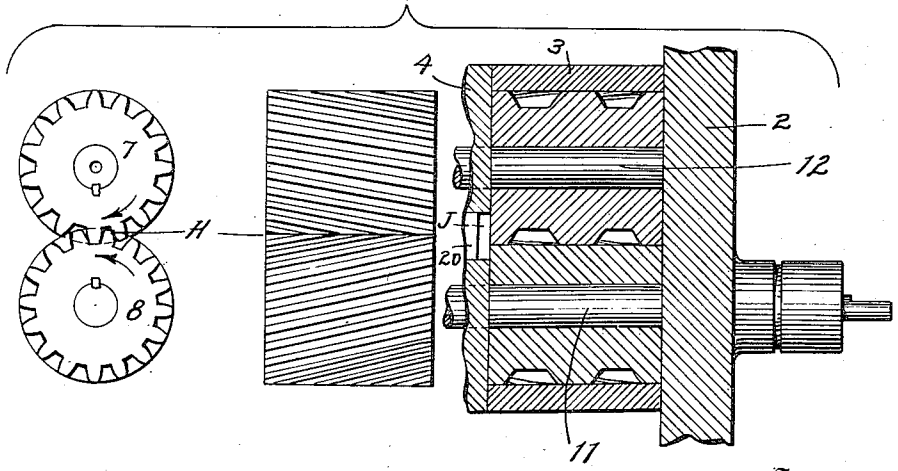


Fig. 4.



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H. J. SMITH.
COMPRESSOR.
FILED JUNE 7, 1920. 3 SHEETS-SHEET 3

Fig. 5,

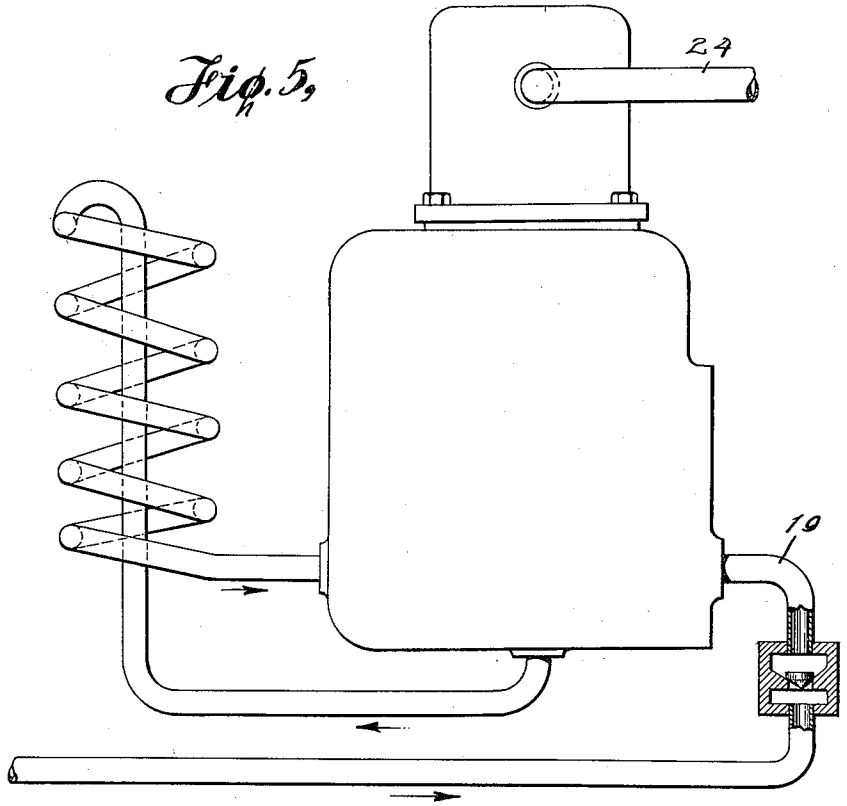
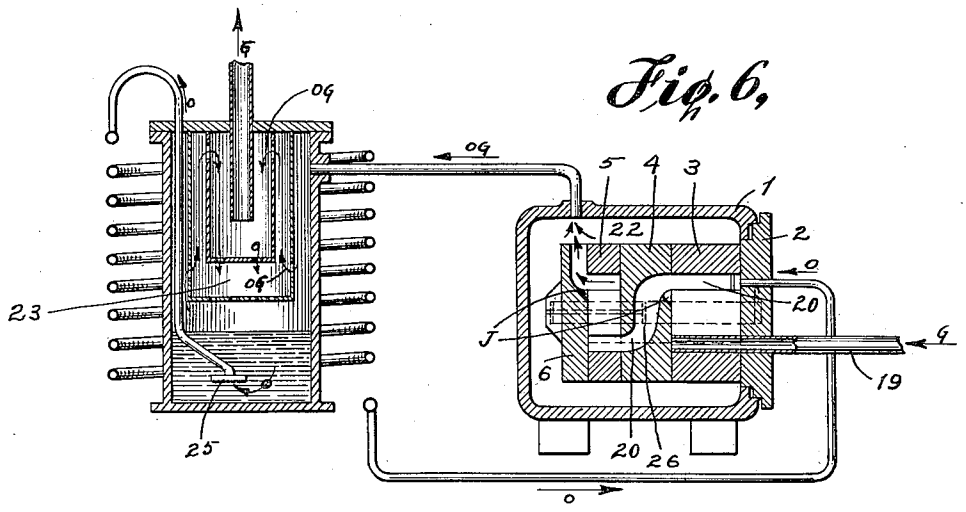


Fig. 6,



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By his Attorney
Edwin Bowlinsky

Patented Jan. 30, 1923. 1,443,764

UNITED STATES PATENT OFFICE.

HAZOR J. SMITH, OF CHICAGO, ILLINOIS, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, OF ONE-FOURTH TO WILLARD REID AND ONE-HALF TO ALFRED HASTINGS CHAPIN, BOTH OF SPRINGFIELD, MASSACHUSETTS.

COMPRESSOR.

Application filed June 7, 1920. Serial No. 387,248.

To all whom it may concern:

Be it known that I, HAZOR J. SMITH, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Compressors, of which the following is a specification.

This invention relates to compressors of the type used in refrigerating systems of the private dwelling type, and more specifically, relates to a compressor having a series of compression chambers for the cooling gas and means for cooling and separating the lubricating oil used therein.

The invention consists essentially of a two stage pump having two or more pairs of meshing helical gears, similar gears of each pair being mounted on one shaft; a differential pressure being applied to the motor driven gear shaft whereby it is kept lubricated without the lubricant escaping; an escape for the gas and oil from the meshing gears just prior to complete meshing whereby no back pressure results; and means for separating the oil from the gas after compression.

The preferred embodiment of my invention I have illustrated in the accompanying drawings in which—

Figure 1 is a vertical sectional view through the compressor on a line transverse to the gear shafts.

Fig. 2 is a longitudinal vertical section along line A—A of Fig. 1.

Fig. 3 is a longitudinal vertical section along line B—B of Fig. 1.

Fig. 4 is a composite view showing the arrangement of the gears.

Figs. 5 and 6 show modified forms for cooling the oil.

Referring now by reference characters to the drawings, the compressor consists mainly of a housing 1, a face plate 2 upon which is assembled the spacing elements 3, 4, 5 and 6 held in axial alignment by the bolts 13. In the gear pocket, between members 3 is a pair of helical gears 7 and 8 in mesh each keyed to its respective shaft 11 and 12; gear 7 on the idler shaft 12, and the gear 8 on the drive shaft 11. Member 4 serves as a central bearing for the shafts and also provides an integral cross-over passage by which the compressed medium from the top of the initial gears 7 and 8 is delivered to the bottom of the secondary gears 9 and 10 in the gear pocket between members 5. The plate 6 serves as an end bearing for the two shafts 11 and 12 and also as the abutment plate for the gears 9 and 10. As shown the ratio of volumetric capacity between the two pairs of gears is 2 to 1, although any desired ratio may be used.

The drive end of the shaft 11 is protected against leakage by the gland shown in Fig. 3. It consists of an adjustment block 14, a gland block 15, gland packing 16 separated by the oiling lantern 17 which takes its oil from the container 18, and the alignment ring 17^a. It will be seen that the inner ends of the shafts are exposed to the pressure of the high side, nominally about 40 pounds absolute, while atmospheric pressure presses against the outer ends of the shafts. This difference in pressure serves to keep the shafts tightly pressed against the alignment rings 17^a and keeps a constant pressure upon the gland packing which normally is sufficient to prevent leakage of the gland without adjustment of the gland adjustment nut 14. Where a machine is to run for a long period of time without attention it is quite necessary to provide means whereby the pressures of the machines themselves shall serve to adjust their glands during periods of inattention.

In Figs. 6, 5 and 2, is illustrated a method pursued to cure one of the meanest troubles connected with the successful operation of gear compressors running at high speeds. Considering that the gears run close to an abutment plate on each end and also within a close fitting housing it will be seen that if the gears are close fitting there exists a pocket between the gears and the face plate that has no outlet. This pocket is formed by each succeeding tooth as it reaches that point in the circle where it meets the contact surface of the next following tooth in the opposite gear. If only gas is being pumped it has been found that this pocket produces no other apparent effect than to produce a pocket of sufficient internal pressure to force a leakage of the gas through the mesh line, through the contact line of the teeth and between the gears and the abutment plate. This takes power and heats the gas but the

effect is comparatively small. When, however, oil is used to seal the gear mesh line it will be seen that there is an incompressible body enclosed in a constantly decreasing chamber with no outlet except that produced by pressure forcing the mesh line open or forcing the gears away from the abutment. The result has been to produce an amount of heat and strain on the bearings that make practical operation very difficult. This, however, is cured by clearing away the abutment plate on the tooth line by the width of one half a tooth above the mesh line.

Referring to Figs. 2 and 4, the recesses J are cut in the abutment plates 4 and 6 and fashioned to connect with its contiguous gas passage and approaching the center line closely enough to clear the chamber H. The position is indicated as at H but the pocket to be cleared is formed first on one side of the center line and then on the other according to the tooth coming into mesh. Therefore the cutout is wide enough to clear the full width of a pitch depth. The chambered cutout does not go below the center of the gears.

This relief feature in connection with helical gear compressors is a very valuable one because of the power saved. The elimination of all possible sources of mechanical heat as distinct from the heat of compression of the gas itself produces a highly efficient combination.

Without the relief afforded by the recess described, the oil becomes very hot, broken up into a fine mist, and very frothy. The pressure and other combinations cause the oil and the refrigerating agent to blend or mix in such a way that separation does not take place efficiently. The oil seems to absorb the refrigerating agent and both circulate. This naturally reduces the capacity of the machine.

In operation, the course of the compressed medium and the oil which is used for sealing the clearance spaces of the gear elements as well as lubricating the mechanism is as follows and it constitutes the unique features of the device described:

Gas from the expander elements or coils enters the compressor at the connection 19. The tension of the low or evaporated side being held at about 17 inches of vacuum or about 7 pounds absolute, through the control of the expansion valve, (not shown) in the usual manner. From the passage 19 the gas is carried in the spaces between the teeth of the gears to the top of the gear couple or into the passage or intermediate section 20 where it is left as a result of the meshing of the gears on the mesh line, each tooth of a gear displacing the gas in the gear opposite. The passage 20 is a cross-over to the intake side of the succeeding pair of gears 9 and 10 where the process of passing around the gears to the discharge side is repeated. From the chamber 21 the gas is discharged into the housing chamber 22 where it passes to and through the separator 23 and finally passes to the condenser through the connection 24. If it were possible to make gears that meshed perfectly without any clearance in the root of the teeth a gear pump would function efficiently without seal of any kind but it is impossible to so construct gears and therefore a sealing medium is necessary if a high degree of volumetric efficiency is to be obtained. This is accomplished in my compressor by utilizing a stream of oil which is carried through the strainer 25 on the plate 6, thence through the opening 26 in the shaft 12 to the clearance space in the face plate 2 thence through the passage 27 to the end of the passage or intermediate section 20 where it drops into the mesh of the gears at the initial mesh point of the helical teeth. The lead of the helix carries the oil with the gas along the mesh line of the gears and seals with its high viscosity, the clearance openings of the gears themselves. Only a small portion of the oil passes through the mesh to the lower side and this is only sufficient to furnish oil to seal the small clearance between the gear teeth and the walls of the housing 3. The surplus of oil is carried along the passage 20 to the bottom of the high pressure gears 9 and 10 where it is picked up by the gears and carried around with the gas to the top side and is discharged after sealing the gears along with the gas. Separation of the gas and oil takes place in the chambers 22 and the separator 23.

Fig. 5 shows the arrangement found satisfactory where it is desirable to carry the oil outside of the compressor shell for the purpose of cooling it before returning it for use as a seal. It will be noted that all three bearings of the shaft 12 are lubricated by the forced feed of the oil in its passage through the shaft. Bearings of the shaft 11 are lubricated by the oil passage 11^a which is fed through the hole 11^b in the plate 6. The gland end of the shaft 11 is lubricated by the gradual seepage of oil toward atmospheric pressure and by the supply in the container 18.

Fig. 6 shows the approved form of the device where it seems advisable to remove the oil separator and cooler from the housing of the compressor. In this form of connecting compressor and separator oil and gas are passed to the separator from top of passage 22 where the oil is deposited in the bottom of the separator housing, the gas passing on to the condenser (not shown). The oil is passed through a strainer 25 and thence through a cooling coil and thence back to

the compressor and discharged into the passage 20 through the face plate, from whence it performs the specified cycle of lubricating and sealing the gears. The oil is fed to the gears at an angle to the direction of rotation of the gears at a point ahead of the exposure of the teeth of the gears at their successive discharge positions. It is obvious that there may be any number of pairs of gears in sequence and any number of stages of compression. The difference in pressure between the initial intermediate stage and the discharge pressure will always be sufficient to force a flow of oil. A predetermined restriction in the passage at any point between the strainer and the discharge opening into passage 20 will control the amount of oil passed and prevent an excess in the oil feed.

While I have shown and described certain specific constructions, I do not wish to be limited thereto, as they are merely illustrative of the principle of my invention and obviously various modifications may be used without departing from the spirit of my invention.

What I claim is:

1. In a multiple stage gear pump of the type described a plurality of pairs of meshing gears, no two pairs having the same volumetric capacity, mounted upon two parallel shafts one of which is the drive shaft to which the gears are radially fixed, but axially movable, all mounted in a suitable housing, a shoulder upon the drive shaft, an aligning ring within a stuffing box normally resting against the shoulder of the drive shaft a mass of packing surrounding the shaft, an oiling lantern upon the shaft, a secondary mass of packing, an adjustable gland block, means for maintaining a gravity pressure of oil upon the oiling lantern, and means for maintaining the drive shaft in pressure contact with the alining ring of the stuffing box.

2. In a multiple stage pump of the type described a plurality of pairs of meshing gears, each pair of gears in stages from low to high having less volumetric capacity than the preceding pair, means for circulating an oiling and sealing medium along the faces of the helical gears, means for feeding the oil on top of and at the ends of the gears, just prior to the point of entry of the oil in the intermediate section, whereby the oiling and sealing medium is prevented from entering the gas inlet.

3. In a multiple staged gear compressor of the type described means for preventing leakage of gas along the drive shaft through the gland when the machine is at rest; and means for preventing the admission of air along the drive shaft through the gland into the compressor when the machine is in operation, which consists of an axially movable drive shaft having a smaller diameter through the gland than back of the gland; an oiling ring resting against the shoulder so formed on the shaft; a section of packing material around the shaft; an oiling lantern around the shaft; another section of packing material an adjustable gland nut; a reservoir of oil connected with the oiling lantern through the side of the stuffing box; said reservoir being adapted to intercept the seepage of oil along the drive shaft when the machine is at rest and the internal pressure of the compressor exceeds atmospheric pressure and adapted to supply oil to the shaft as a seal when atmospheric pressure exceeds the internal pressure of the compressor, and means for maintaining the drive shaft in pressure contact with the alining ring of the stuffing box.

4. In a compressor of the type described a pair of meshing gears mounted on two parallel shafts, one shaft being the drive shaft, a packing gland, a shoulder provided on the drive shaft, an aligning ring on the inner end of the packing gland normally resting against the shoulder of the drive shaft, means whereby the difference in pressure between the discharge side and the atmospheric pressure is utilized to hold the drive shaft in pressure contact with the inner end of the packing gland.

5. In a multiple stage compressor a plurality of pairs of meshing gears, means for circulating an oiling and sealing medium along the faces of the gears, means for feeding the oil on top of and at the ends of the gears just prior to the exposure of the teeth in their successive discharge position.

6. In a multiple stage pump of the type described, a plurality of pairs of helical gears each pair in the stages from low to high having less volumetric capacity than the preceding pair and means utilizing the difference in pressure between the discharge pressure and an intermediate stage to produce a forced circulation of the sealing medium.

7. In a multiple stage pump, a plurality of pairs of helical gears and housings mounted upon two shafts one of which is the driving shaft each pair in the stages from low to high having less volumetric capacity than the pair preceding and means for utilizing the difference in pressure between the discharge and any intermediate stage to produce a forced circulation of the oiling medium.

8. A multiple stage pump having an initial inlet pressure, intermediate and final discharge pressures each higher than the preceding and utilizing the difference in pressure between an intermediate and high stages to produce a forced circulation of the sealing, cooling and oiling medium.

9. In a multiple stage compressor of the

type described a plurality of pairs of meshing gears, no two having the same volumetric capacity, an intermediate section between the pairs of gears, means for circulating an oiling and sealing medium along the faces of the gears, means for feeding the oil on top of and at the ends of the gears just prior to the point at which the gear tooth arrives at the intermediate section whereby the oiling and sealing medium is prevented from entering the gas inlet.

10. In a multiple stage pump, pairs of meshing gears, a shaft carrying one gear of each pair, a packing gland for one end of said shaft, said gears being radially fixed on said shaft but permitting longitudinal movement of the shaft through the gears, and pressure means for maintaining the shaft pressed against the packing gland.

In testimony whereof I affix my signature.

HAZOR J. SMITH.

Witnesses:
WILLARD REID,
R. L. SWENIGEN.