March 11, 1930. E. T. WILLIAMS 1,750,293

SYSTEM AND METHOD OF LUBRICATING COMPRESSORS

Filed July 31, 1926 3 Sheets-Sheet

Fig. 1A.

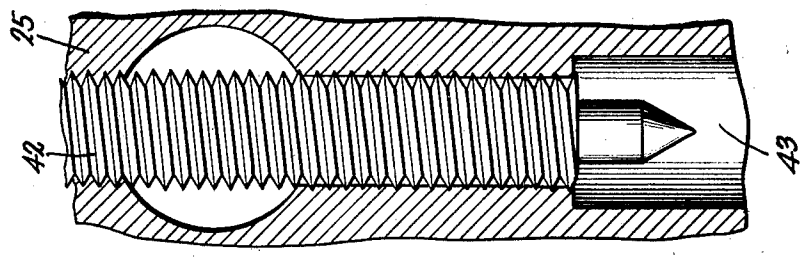
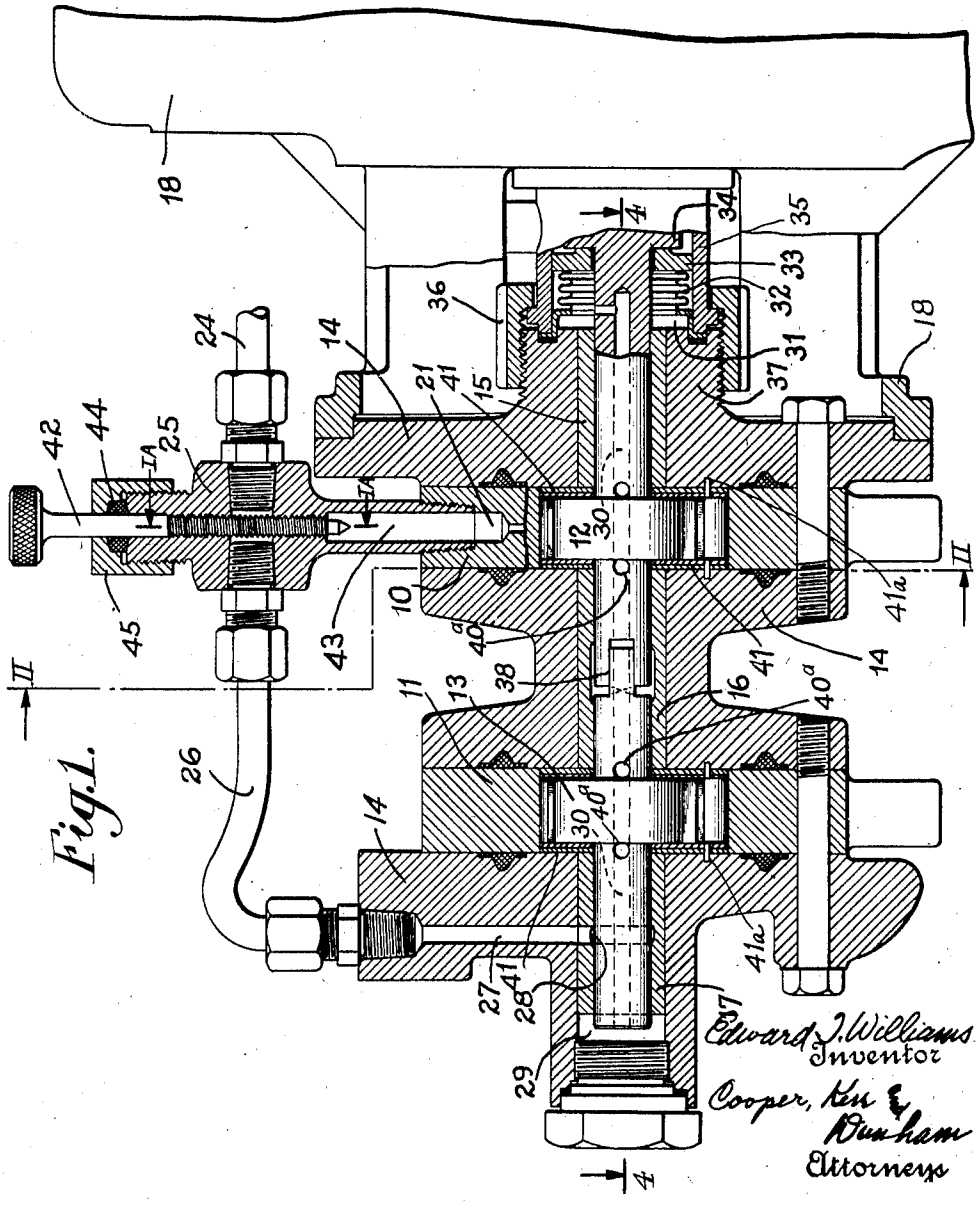


Fig. 1.



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Filed July 31, 1926 3 Sheets-Sheet 2

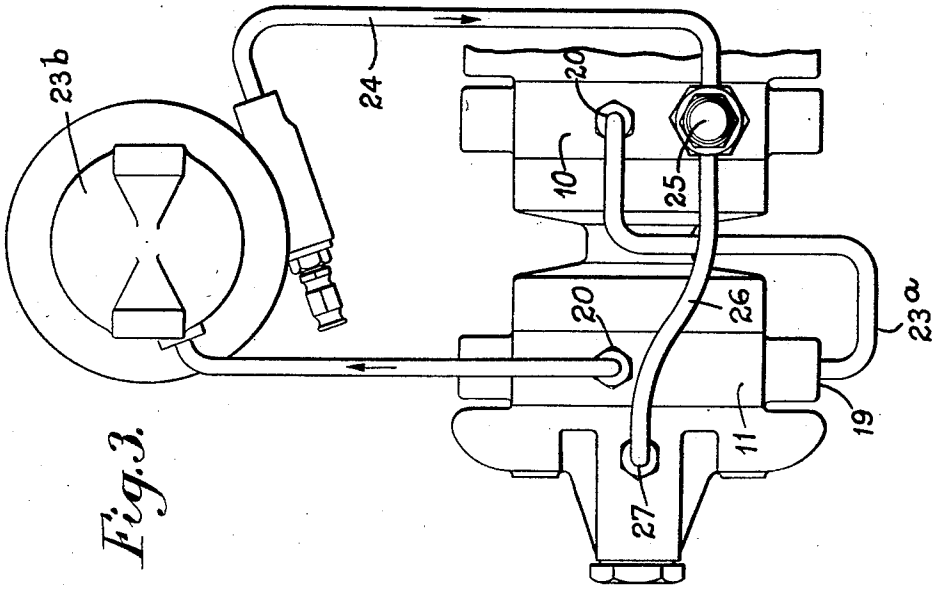


Fig. 3.

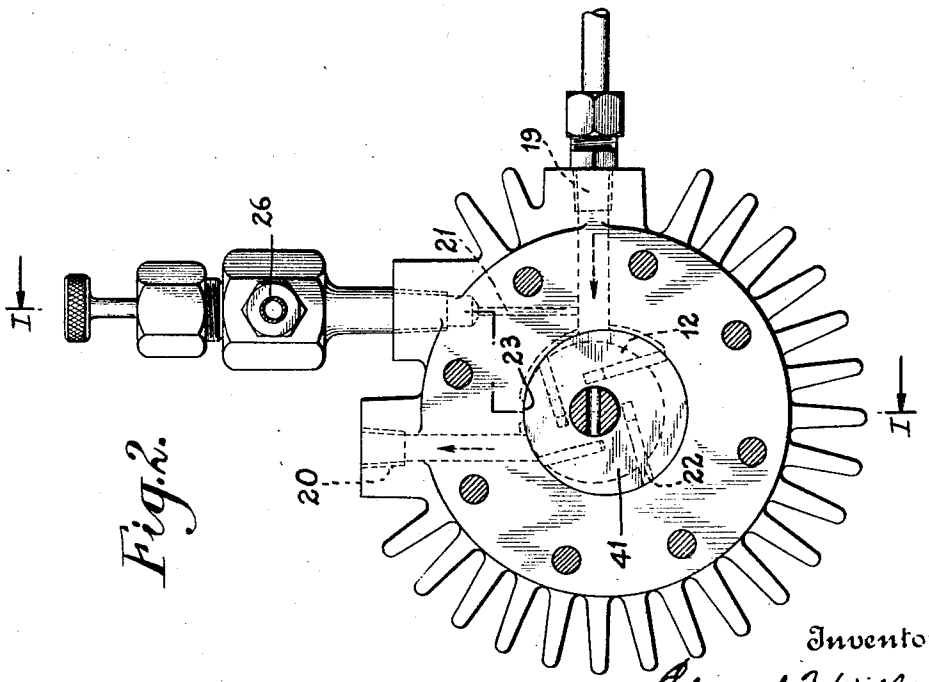


Fig. 2.

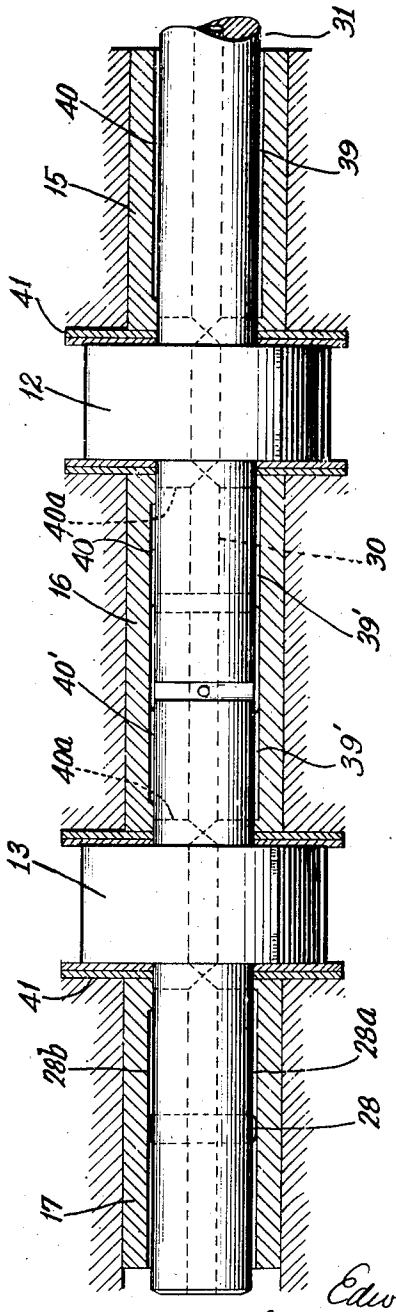
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SYSTEM AND METHOD OF LUBRICATING COMPRESSORS

Filed July 31, 1926 3 Sheets-Sheet 3

Fig. 4.



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UNITED STATES PATENT OFFICE

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SYSTEM AND METHOD OF LUBRICATING COMPRESSORS

Application filed July 31, 1926. Serial No. 126,172.

This invention relates to compressors and more particularly to a system and method of lubricating compressors in which rotors are mounted eccentric to the cylinders.

It has among its purposes to produce a rotary compressor having perfection in its lubrication system to such an extent as to insure thorough lubrication of all moving parts during the operation of the compressor, the lubricant being maintained in a continuous state of flow by a difference in pressures which will cease to be existent upon the stoppage of the operation of the compressor. Another object resides in supplying the correct quantity of lubricant to the cylinder of a compressor under various operating loads and in introducing some of the lubricant into the cylinder at such particular places as to cause it to form an efficient seal between the high and low pressure sides of the rotor.

Another object resides in obtaining thorough dispersion of lubricant within a cylinder by introducing it into the inlet port of the cylinder and directly into the path of the incoming refrigerant.

Another object resides in controlling the rate of flow of the lubricant into the inlet port of the cylinder by a device which permits of self-cleaning without the necessity of relieving the lubricant feeding pressure or of causing an interruption of the operation of any part of the refrigerating machine.

Another object resides in effectively increasing the sealing efficiency between the rotor and the cylinder.

A still further object is to increase the sealing efficiency between the flat sides or ends of the rotor and the cylinder cover-plates. The question of tolerances in this matter, that is permissibility in variation of measurements, has given manufacturers of rotary compressors a great deal of trouble, so much so, that compressors of the rotary type may be said to have met with only mediocre success. Expansion and contraction play a part in the matter of end clearance. Too small a clearance at low temperature is liable to result in binding at higher temperature. To overcome the difficulties incident to the problem of end clearance, I propose to subdivide the clearance space by using one or more axially movable disks at each flat side or end of the rotor. These disks space themselves due to oil pressure. By so doing I can build a compressor with an actual clearance of, say, one thousandth of an inch at each end while having an effective clearance in operation, of only one-third of a thousandth of an inch.

In a compressor not equipped with these loose disks, having only one oil space between each end of the rotor and the adjacent cylinder cover, if the tolerance allowed is too great, the efficiency and amount of pressure obtainable are low. To get high efficiency, low end clearance is necessary, but the manufacture of parts with sufficiently small clearances would be too expensive. Furthermore there is the danger of binding which is eliminated in the present invention.

To illustrate this phase of the invention, assume a total clearance of 0.002 inch between the flat sides or ends of the rotors and the adjacent cover-plates and assume that we insert one loose disk at each end. The total clearance will now be divided into four spaces of 0.0005 of an inch width each. Thus the employment of only two disks gives an effective clearance reduction of fifty percent. More disks will give still greater reduction. Other objects and advantages are brought out more fully in the description and claims.

The drawings illustrate a preferred embodiment of my invention and Fig. 1 illustrates a vertical section of a compressor on line 1—1 of Fig. 2.

Fig. 1A is a detail on line 1A—1A of Fig. 1.

Fig. 2 is an end view of a cylinder and rotor taken on line 11—11 of Fig. 1.

Fig. 3 is a diagrammatic plan view illustrating the external paths of flow of the lubricant.

Fig. 4 is a diagrammatic plan view illustrating the grooves in the bearings of the compressor.

The compressor illustrated is a two-stage compressor of a built up type in which the cylinders 10 and 11, and rotors 12 and 13 are flanked by cover-plates 14 carrying bearings

15, 16 and 17 for the rotor-shafts. The compressor is illustrated as being supported by a frame 18 at one end. Each cylinder has an inlet port 19 (Fig. 2) and an outlet port 20. Communicating with the inlet port 19 of the first stage compression cylinder 10 is an oil passage 21 through which oil is introduced into the low pressure side of that cylinder and into the path of the inflowing refrigerant which picks up the oil and thoroughly disperses it within the cylinder. In addition to lubricating the blades 22, the oil serves to form a seal at the line of contact 23 between the rotor and the cylinder, and, after having thoroughly lubricated the bore of cylinder 10, all of the oil within the cylinder is discharged with the compressed refrigerant through conduit 23^a (Fig. 3) to the low pressure side of the second stage compression cylinder 11 in which it serves to lubricate that cylinder in the manner just described. The refrigerant discharged from the high pressure side of the second stage compression cylinder 11 is conducted to an oil separator 23^b (which may also include a storage chamber or reservoir). The oil which is separated from the refrigerant is returned under pressure to the compressor through conduit 24 which is connected with the oiler-body 25. The oiler-body 25 discharges into the low pressure side of the first stage compression cylinder 10 in a manner to be described hereinafter. It is apparent that the oil will continue to follow the cycle just described as long as a differential pressure exists and, consequently, as long as the compressor is operating. Upon a discontinuance of operation, the oil flow will stop and no oil will accumulate in the cylinders. In Fig. 3 I have chosen to exemplify my lubrication system by illustrating this complete cycle of lubricant flow, and reference may be had to my United States Patent No. 1,392,997 for details of construction of an oil separator and associated parts.

The cycle of oil flow just outlined may be considered as comprising the primary circuit and the course of the lubricant which serves to lubricate the various bearings and effectively seal the sides of the rotors will now be described. Considered as a whole, it will be appreciated that all of the oil supplied to a cylinder will serve to create a sealing relation adjacent all contacting surfaces of the rotor and thereby maintain uncommunicable the high and low pressure sides of a single cylinder. The circuit designed to lubricate the various bearings includes a conduit 26 which is connected conveniently to oiler-body 25 so as to receive oil direct from conduit 24 and conduct it to an oil passage 27 drilled in an end cover-plate and piercing bearing 17. Oil passage 27 leads directly to an annular groove 28 on the inner surface of bearing 17. A plurality of linear grooves 28^a, 28^b, Fig. 4, along the inner surface of bearing 17 serves to conduct oil to a closed space 29 at the end of the shaft of rotor 13. The rotor shafts have holes 30, 30 along their axes so that space 29 is directly connected with space 31 which is defined by the inner surface of a bellows 32 and ring 33 to which the far end of the bellows is secured. Ring 33 contacts collar 34 which rotates with the shaft. Ring. 33 is supported by a collar 35 which is itself held in place by a nut 36 screwed to the hub 37. The present invention is not concerned with any particular design of shaft sealing device except to the extent of using one which permits of lubrication around the rotor shaft.

The shaft of rotor 12 is connected to the shaft of rotor 13 by a mortise and tenon connection 38 which is surrounded with oil emanating at the end of the tenon from the co-axially aligned holes 30 of the shafts. This oil travels along the surface of the shafts toward the respective rotors thereby performing the function of lubricating the bearings of the shafts in a manner similar to that accomplished at the outer ends of the shafts where the ever-present oil in spaces 29 and 31 is being forced continuously from the ends of the shafts and toward the respective rotors.

Grooves 28^a and 28^b are continued along the portion of bearing 17 lying intermediate annular groove 28 and the bore of cylinder 11 but they are terminated so as not to communicate directly with the bore of cylinder 11. Groove 28^a is somewhat longer than groove 28^b in order that the oil therein be enabled to approach directly close enough to the low-pressure side of rotor 13 as to permit a restricted flow of oil about the shaft and into the cylinder on the low pressure side of rotor 13.

Grooves 39 and 40 in bearing 15 serve to lubricate this bearing and to permit a restricted flow of oil to low pressure side of rotor 12. Grooves 39′ and 40′ in bearing 16 are of a design similar to grooves 39 and 40, respectively, and they are maintained flooded by the oil emanating at the end of tenon 38. It is readily understood that there will be a continuous flow of oil in grooves 39′ toward the low pressure sides of both of the rotors as long as the compressor is operating.

The quantity of oil fed in this manner into the low pressure sections of each cylinder is dependent, in part, upon the design of the grooves in the bearings and, whatever their design might be, thorough lubrication of the shafts within bearings 15, 16 and 17 is assured.

Holes 40^a are drilled transverse to and through the axes of the shafts close to the sides of the rotors and they serve to conduct oil from the co-axially aligned holes 30, in the shafts to the inner edges of the disks 41. The number of disks used is largely a matter of choice depending upon the increase in

manufacturing tolerances desired. In the present disclosure, four disks are used with each rotor. The pressure on the oil within the shaft together with the effect of centrifugal force causes the oil which is delivered through holes 40[a] to travel toward the outer edges of the disks in the spaces therebetween, and between the disks and the rotor. The greater viscosity of the oil over that of the gas will reduce the leakage very materially.

The use of four disks divides a given total clearance between the parallel sides of a rotor and of cylinder cover-plates by six by reason of the six spaces produced. It is therefore apparent that if a total clearance of 0.002 of an inch be permitted the space immediately adjacent a side of a rotor would be 0.00033 plus of an inch when four disks are used as compared to 0.001 of an inch when no disks are used. The use of more disks would increase in manufacturing tolerances of the rotor and cylinder cover-plates resulting from increased end clearance variation of manufacturing limits between the rotor and the cylinder cover-plates.

The disks 41, particularly those adjacent the rotor, may be made of an anti-friction bearing metal. The disks are free to move axially but cannot rotate. They are preferably held from any tendency to rotation by pins or keys 41[a] fixed in the cover-plates and extending within holes in plates 41. The fit of the pins in the holes of the plates is loose to permit the disks to space themselves axially to given even spaces. This even spacing caused by the even pressure of oil reduces a relatively large total clearance to a small effective operating clearance.

The oiler-body 25 through which oil is conducted from conduit 24 to the low pressure side of the first stage compression cylinder 10 will now be described. Fitted so as to be capable of being displaced along its own axis is a threaded stem 42, the end of which may extend into a drilled hole 43 into the oiler-body. This hole communicates directly with passage 21. The tapped portion of the oiler body which engages the threaded portion of the stem 42 above conduit 24 is of the usual standard which forms a snug fit about the stem. The tapped portion of the oiler-body which engages the threaded portion of the stem below conduit 24 is designed to form an helical channel about the threads on the stem. This channel may be obtained by removing the apex of the thread in the lower portion of the tapped hole by a drilling operation. This drilling operation must leave the root of the outer thread unaltered so that the apex of the thread on the stem will be firmly engaged. The helical channel created about the lower portion of threaded stem 42 permits of a light feed of oil to the cylinder from conduit 24.

The quantity of oil fed into the cylinder through the channel is dependent upon the pressure in conduit 24 and hence upon the load on the compressor. Ordinarily, the flow might be by drops, but an increase in load will be accompanied by an increase in oil flow. The desirability of this self-regulation is apparent.

For insuring non-interference by foreign matter of the flow of the quantity of oil fed to the cylinder through the oiler-body, an attendant may withdraw the stem 42 to such an extent as to permit that threaded portion of the stem that normally serves to form a channel to be engaged by the unaltered portion of the tapped hole. The thread on the stem will be cleaned as a result of this operation without necessitating the shutting down of the operation of the unit. A gland 44 and follower 45 is provided to assist in preventing a loss of pressure from the oiler-body. All of the oil used in lubricating the compressors is carried away through the outlet ports with the refrigerant and is then separated therefrom and strained preparatory to passing it again through the compressor.

The complete cycle of flow of the lubricant has been described and it will be understood that continuous lubrication of the compressor will be had as long as the compressor is operating, the difference in pressure upon the lubricant in the separator, and hence in the oiler-body, and at the low pressure sides of the respective rotors being the propelling force by which complete lubrication is achieved.

I claim:

1. A lubricating system for compressing apparatus comprising, in combination, an oiler-body, means for supplying lubricant to said oiler-body, a cylinder, means for supplying lubricant from said oiler-body to said cylinder, a rotor in said cylinder having a hole drilled along its axis, means for supplying lubricant directly to said hole, a plurality of disks on the sides of said rotor, passages transverse to said first-named hole and disposed near to the sides of said rotor whereby lubricant is fed between said disks and toward the bore of said cylinder.

2. A compressing apparatus comprising, in combination, a cylinder, a rotor, a cover-plate on each flank of said cylinder, and a plurality of non-rotatable, axially movable disks fitting the bore of said cylinder and spacing said rotor from said cover-plates.

3. The method of lubricating compressors comprising, injecting lubricant under pressure into the path of the incoming fluid, forcing another quantity of lubricant through the bearings of the compressor toward the rotor and into the cylinder, removing the lubricant from the cylinder in the compressed fluid, separating the lubricant from the compressed fluid, and utilizing the lubricant un-

der the compression pressure to repeat the lubricating cycle.

4. The method of lubricating compressors comprising, supplying the lubricant under pressure and distributing it into the path of incoming fluids, utilizing the same supply of lubricant for lubricating the bearings of the compressor, conducting this last-named flow of lubricant about the sides of the rotor, mixing the last-named flow of lubricant with the lubricant distributed into the path of incoming fluid, conducting said combined flows of lubricant away with the discharge of the fluid of said compressor, separating all of the lubricant from the compressed fluid, and conducting the separated lubricant so as to again be utilized to lubricate said compressor.

5. The method of lubricating compressors by injecting lubricant under pressure into the low pressure side of a cylinder comprising, introducing a portion of the lubricant directly into the cylinder, conducting another portion of the lubricant through the bearings of the compressor into the cylinder, separating substantially all of the lubricant from the fluid discharged from the cylinder, and again utilizing the same lubricant by forcing it under discharge pressure into the low pressure side of the cylinder.

6. The method of lubricating compressors by injecting lubricant under pressure into a cylinder comprising introducing a portion of the lubricant directly into the low pressure side of the cylinder, forcing another portion of lubricant through the bearings of the compressor into the low pressure side of the cylinder, forcing another portion of lubricant along the walls of the cylinder adjacent the rotor, separating all of the lubricant from the fluid discharged from the cylinder, and returning the separated lubricant to the compressor under pressure.

7. A compressing apparatus comprising a cylinder having an end wall, a rotor, and a non-rotatable disk between said end wall and the side of said rotor arranged for free axial movement with respect to said rotor.

8. A compressing apparatus comprising a cylinder having an end wall, a rotor, and a plurality of non-rotatable disks between said end wall and the side of said rotor arranged for free axial movement with respect to said rotor.

9. A compressing apparatus comprising a cylinder having an end wall, a rotor, one or more non-rotatable disks between said end wall and the side of said rotor, said rotor having a central passageway, means to supply oil to said central passageway, and means to convey oil from said passageway to the sides of said one or more disks.

10. A lubricating system for compressing apparatus comprising, in combination, with a compressor having inlet and outlet ports, and a reservoir for lubricant, said reservoir being connected through the outlet port with the discharge side of said compressor, of a conduit for conducting lubricant from said reservoir directly to the open bore of said compressor on the intake side thereof, said conduit having a restricted portion through which the lubricant is forced from said reservoir and by which the lubricant is caused to drop into the stream of gaseous fluid incoming through the inlet of said compressor whereby the lubricant may be finely dispersed throughout the bore of the compressor by the gaseous fluid.

11. The combination set forth in claim 10 in which the restricted portion of the conduit comprises an external body having an helical channel about the thread of a removable stem fitting within said body.

12. A compressor comprising a housing including a cylinder, a rotor within said cylinder, an inlet in said housing for fluid to be compressed, a restricted inlet for lubricant opening into the inlet for the fluid to be compressed, and means connected with said restricted inlet to supply oil thereto.

In testimony whereof I hereto affix my signature.

EDWARD T. WILLIAMS.