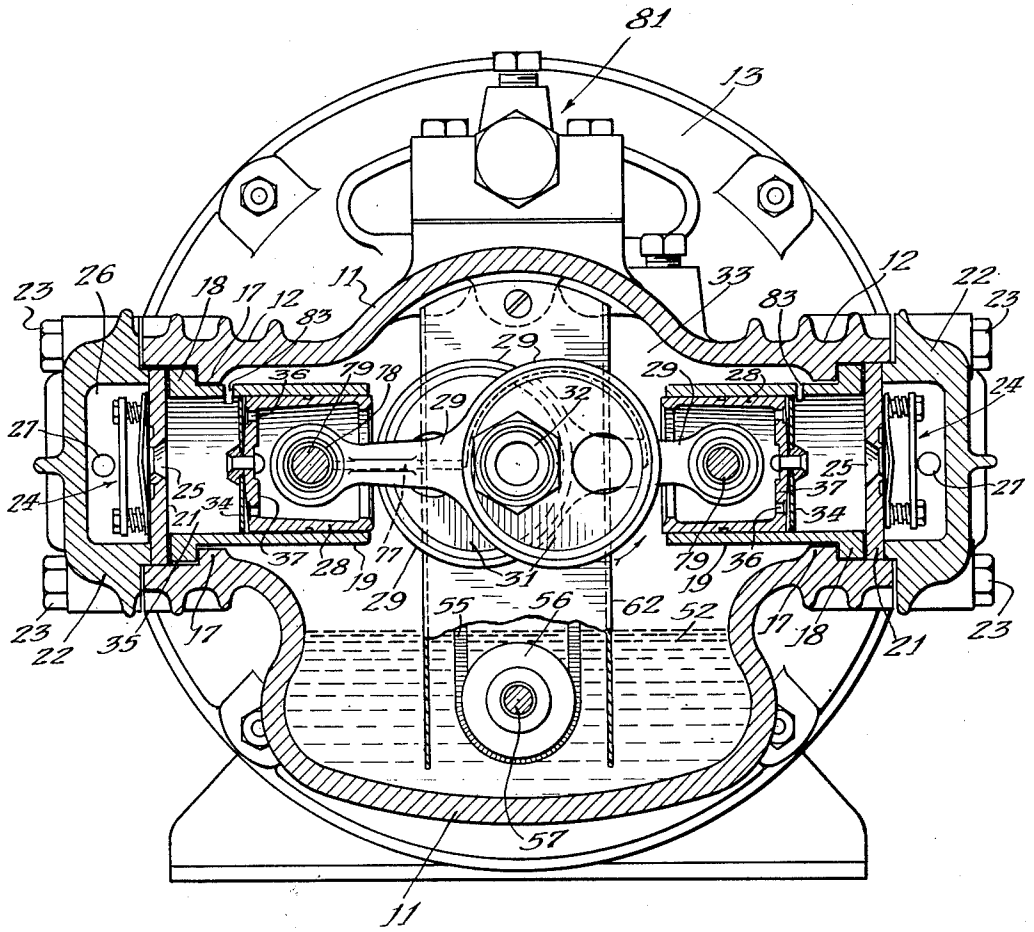
Dec. 23, 1952 A. RAMCLOW 2,622,788

REFRIGERATION COMPRESSOR

Filed Jan. 19, 1946 2 SHEETS—SHEET 1

Fig. 1.




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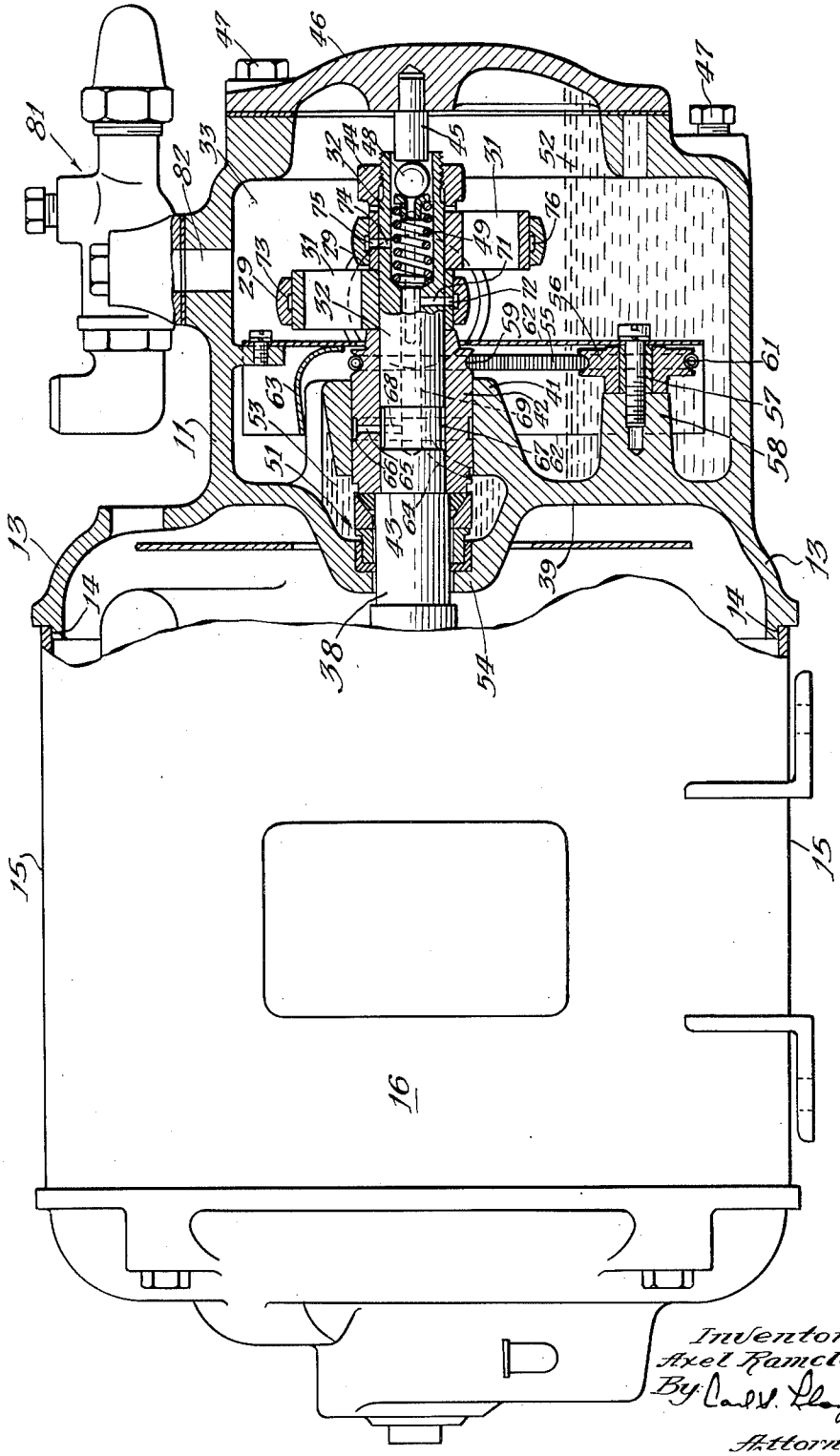


Fig. 2.

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# UNITED STATES PATENT OFFICE

2,622,788

## REFRIGERATION COMPRESSOR

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8 Claims. (Cl. 230—58)

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This invention relates to refrigeration compressors and is especially useful in compressors of the direct-drive type, that is, of the type in which the crank shaft of the compressor is connected directly to, and is in effect a continuation of, the drive shaft of a motor forming a part of a unitary motor-compressor unit, although certain features of the invention are not necessarily limited to this type of compressor.

It is the custom of the refrigeration industry to manufacture compressors in sizes to meet the power output of the standard sizes of electric motors available on the market. It is also the custom of the industry to produce condensing units having compressors of different displacement volume for each size of driving motor. For example, a choice of three different compressor displacements may be provided for a given size of motor and the selection will be determined by the requirements of the refrigeration application for which the unit is to be used. In one common type of compressor drive, in which the compressor is driven from the motor by mean of V-belts and sheaves, the desired selection of three compressor displacements for each motor size is readily obtained by the selection of sheaves having a pitch diameter ratio which will provide the desired speed ratio between the motor and compressor, it being understood that with this type of drive the compressor is operated at a speed slower than that of the driving motor.

On the other hand, when direct-drive compressors, in which the motor rotor and the compressor have one common shaft, are employed, different compressor displacements have heretofore been possible only through changes of cylinder diameter and piston stroke. Such changes could be made only by changing the fundamental dimensions of the compressor which involved an entirely different model and size of compressor for each compressor displacement. This inflexibility had been a serious disadvantage of direct-drive compressors, although in certain other respects such compressors have definite advantages over the so-called belted type. Among such advantages is that the size of a direct-drive compressor may be much less than that of the relatively slow speed belt-drive compressors employing speed reduction means of the type above described. Compressor size is in inverse ratio to speed and the relatively high speed direct-drive compressors may, therefore, be very small. They may also be close coupled in relation to the motor, and thus very compact. Lighter weight is also another advantageous characteristic.

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One of the objects of the present invention is to provide a direct-drive compressor construction in which the compressor displacement may be changed with substantially the same simplicity as is possible with the relatively slow speed belt-drive type of compressor.

A further object of the invention is the provision of a lubricating system particularly well adapted to this type of compressor, although from certain aspects also useful in other constructions.

Other objects and advantages of the invention will be apparent from the following description, taken in connection with the accompanying drawings, in which:

Fig. 1 is a cross-sectional view of a two-cylinder opposd type of refrigeration compressor adapted to be driven directly from the shaft of an electric motor; and

Fig. 2 is a cross-sectional view of the compressor taken at right angles to the plane of Fig. 1 and showing in elevation the motor housing.

As shown, the crankcase 11 of the compressor is cast integrally with opposed cylinder blocks 12 and with an arcuate flange 13 at one end which is formed with a shoulder 14 adapted to receive the edge of the housing or casing 15 of the drive motor, generally indicated by the reference numeral 16.

Each of the cylinder blocks 12 is formed with an interior annular flange 17 adapted to be engaged by an annular flange 18 on a cylinder sleeve 19 positioned within the cylinder block 12 and extending inwardly toward the center of the crankcase 11. A valve plate 21 is positioned in the cylinder block 12 in contact with the annular sleeve flange 18 and the assembly is held in place by means of a cylinder head 22 and cylinder head screws 23 which extend through the head and into tapped holes in the cylinder block 12.

The clearance of the sleeve flange 18 within cylinder block 12 may be sufficient to permit ready assembly and conformity of the flange to the cylinder shoulder 17, it having been found in practice that a clearance of five-thousandths to six-thousandths of an inch is a desirable clearance. The clearance of the valve plate 21 within the cylinder wall is preferably less than the clearance of the sleeve flange 18, a clearance of one-thousandths to three-thousandths of an inch having been found satisfactory in practice. Thus there is preferably a differential of, say, three-thousandths of an inch between the clearance of the sleeve flange and that of the valve plate. The relatively loose fit of the sleeve greatly facilitates manufacture and assembly. The sleeve flange 18 is held tightly against the shoul-

der 17 by the valve plate 21 and cylinder head 22, and these parts may be assembled in gas-tight contact by lapping the contacting surfaces or by the use of suitable gaskets therebetween. They are held in permanent compression by means of the cylinder head screws 23.

A discharge valve assembly 24 is provided on the valve plate 21 and, being of known construction, need not be described in detail. It may be constructed in accordance with United States Patent No. 2,106,775, and provides for discharge of compressed gas through an opening 25 in the valve plate 21 into a chamber 26 in the cylinder head 22 in accordance with conventional practice. The compressed gas is conducted from the chamber 26 through a discharge opening 27 to the condenser (not shown) in the usual manner.

A piston 28 is positioned within the cylinder sleeve 19 for reciprocating motion therein and is connected by means of a connecting rod 29 with an eccentric 31 mounted on a crank shaft 32 extending lengthwise through the gas chamber 33 of the compressor. An intake valve 34 is positioned on the head of the piston 28 which is of hollow construction, said intake valve serving to admit refrigerant gas from the chamber 33 to a compression chamber 35 in the sleeve 19 through openings 36 in the head 37 of the piston upon the retracting stroke of the piston, said openings 36 being closed by the valve 34 upon the compression stroke of the piston.

The shaft 32 is in effect a continuation of a drive shaft 38 of the motor 16 which passes through an end plate 39 on the crankcase 11 and is supported by a bearing 41 integrally formed on the inside of said end plate 39. A removable sleeve-type bronze journal 42, secured to the shaft 38, 32 provides bearing contact with said bearing 41. Said journal 42 is held in place against a shoulder 43 on the shaft 38 by means of a nut 44 positioned on the end of the shaft section 32 and affording pressure against the two eccentrics 31 which are mounted on said shaft section. Adjacent the inner end of the shaft section 32 is a thrust bearing 45 carried by a crankcase cover 46 which is secured to the crankcase casting by means of screws 47. A steel ball 48 and thrust spring 49 are mounted within a hollow end portion of the shaft 32, said ball engaging the thrust bearing 45 and the spring serving to push the shaft 32, 38 toward the motor to maintain contact of the elements of a shaft seal 51 provided at the point of entrance of the shaft section 38 into the crankcase. Said seal may be of any suitable or desired construction, as, for example, the construction shown in Patent No. 2,245,106.

A body of oil 52 is contained within the lower part of the crankcase 11 and an oil reservoir 53 is provided between the bearing 41 and a boss 54 on the wall 39 of the crankcase casting 11 through which the shaft 38 extends. A coil spring belt 55 is mounted upon the journal 42 and an idler sheave 56 rotatably mounted on a screw 57 extending into a boss 58 provided on the inside of the wall 39 below the level of the oil in the crankcase. Said belt is held in place by means of a groove 59 in the journal 42 and a groove 61 in the sheave 56. It is located within a channel-shaped baffle 62 and above the inner end of the journal 42 within said channel shaped baffle, a curved baffle 63 is provided.

Said coil spring belt 55 is under such tension as to separate the coils slightly and said coils are adapted to open up somewhat more as they pass around the bottom of the sheave 56 and the top of the grooved journal 42. Capillary attraction causes lubricating oil to enter the interior of the spring and to be held between the coils as the belt travels upwardly from the body of oil 52. As it passes around the top of the journal 42, centrifugal force acting on the oil exceeds the capillary attraction and the adhesion tending to retain the oil within the coils, and this, coupled with the opening up of the coils, causes the oil to leave the belt and to be thrown against the curved baffle 63 which deflects it into the reservoir 53. The latter is thus kept filled with oil and the exposed parts of the seal 51 are submerged within the body of oil in this reservoir.

The journal 42 has a helical oil groove 64 in the periphery thereof which communicates with a radial oil hole 65 extending through the journal from an annular groove 66 formed on the exterior thereof. The shaft 38 has an annular groove 67 adapted to receive oil passing through the hole 65, and said shaft 38 is provided with an oil hole 68 opening into an oil passage 69 drilled longitudinally in the shaft 38, 32. Said passage extends to the hollow portion of the shaft section 32 in which the spring 49 and ball 48 are located. An oil hole 71 extends from the passage 69 radially through the shaft section 32 and registers with an oil hole 72 in one of the eccentrics 31 from which the oil passes into a semicircular groove 73 in the large end of the connecting rod 29 which is nearest the motor. An oil hole 74 in the shaft section 32 registering with an oil hole 75 in the other eccentric supplies oil to a semicircular groove 76 in the other connecting rod.

From said semicircular grooves in the large ends of the connecting rods an oil passage 77 leads to an oil groove 78 in the wrist pin 79 by which the connecting rod is connected to the piston 28.

The connecting rods 29 are assembled on the eccentrics 31 in such manner that the direction of rotation will force oil in the connecting rod oil grooves 73 and 76 through the passages 77 to the piston pin oil grooves 78. The adhesion of the oil to the eccentrics during the rotation of the latter builds up in the oil grooves 73 and 76 an accumulated pressure which forces the oil through the passages 77 to the wrist pin grooves 78.

The refrigerant vapor to be compressed enters the crank case through a conventional valve 81 and an opening 82, and, as previously indicated, is drawn into the compression chamber 35 in the cylinder sleeves on the suction stroke of the pistons. After compression it passes through the discharge valve 24 and outlet opening 27.

In order to provide a different compressor displacement when required for a particular use of the compressor, the cylinder sleeves 19 may be readily removed and replaced with sleeves having a bore of different diameter. The construction above described makes it possible to make this substitution easily while at the same time providing the gas-tight relationship of the parts which is essential in compressor construction.

For the purpose of determining the extent of the effective stroke of the piston, openings 83 may, if desired, be provided in the walls of the cylinder sleeves 19, the location of these openings or slots obviously determining the length of the effective stroke. Thus the compressor displacement may be varied by substitution of sleeves having the openings 83 differently located

lengthwise thereof as well as by the substitution of sleeves of different bore diameter.

The operation of the compressor does not differ substantially from that of other known constructions, with the exception of the lubrication system which has heretofore been described, but the new construction has many advantages from the standpoint of manufacturing and servicing which previous constructions do not have.

The use of the replaceable cylinder sleeves 19 which may have various bores and be fitted with corresponding pistons, permits the use of a single model of cylinder block casting to produce compressors having various displacements. This is a great advantage in direct-drive compressors wherein the displacement cannot be changed by changing the compressor speed as can be done with belt-driven compressors. The use of the present invention thus makes it unnecessary to have a greater number of cylinder block models for direct-drive compressors than would be necessary in a comparable line of belt-driven compressors.

In the conventional refrigeration compressor, in which the cylinder is cast integrally with the crankcase and is machined to provide the surfaces necessary to cooperate with the piston (without the use of a separate cylinder-sleeve), the machining of the cylinder bore is a very difficult and exacting job. The accuracy of the cylinder bore dimension must be held within tolerance limits of a few ten-thousandths of an inch in relation to the piston, and if any error is made in the machining of either of the cylinders in the casting, the entire casting must be discarded or the efficiency of the compressor will be impaired. It is much quicker and less critical to machine a cylinder sleeve and cylinder block separately than it is to machine the two units combined in one casting and, furthermore, the cylinder block does not have to be machined nearly so accurately to properly receive the sleeve as if the piston were to work directly in a cylinder bore formed in the casting. With the construction of my invention only a relatively short portion of the cylinder block need be machined and the short machined surfaces which are contacted by the cylinder sleeve may have a relatively generous dimensional tolerance as compared with the tolerance between the piston and the surface against which it operates.

The separate cylinder sleeves can be machined in automatic screw machines with every operation complete except the final finish of the bore which can be done quicker and more accurately in individual cylinder sleeves than it could be in a complicated cylinder block.

For the above and other reasons, a great deal of time and expense is saved in the manufacture of compressors constructed in accordance with the present invention and less skill is required than in the manufacture of conventional compressors.

Another advantage of the present invention lies in the elimination of cylinder wall distortion which is sometimes caused in conventional compressor construction by radial thrust of cylinder head screws when they are tightened into the cylinder block. These screws are ordinarily located in a circle around the cylinder bore in the casting and the thrust is at times sufficient to cause deflection of the cylinder wall toward the center of the cylinder. This deflection may be of sufficient amplitude to exceed the amount by which the piston is smaller than the cylinder



bore and it may cause sticking of the piston for an instant at the outer end of its stroke, resulting in a clicking noise. In the present construction, the diameter of the valve plate is greater than the diameter of the annular flange on the sleeve and therefore the radial thrust would be on the valve plate and not on the sleeve. Furthermore, any distortion permitted by the valve plate would be taken up by the internal shoulder in the cylinder block, the internal diameter of which exceeds the outside diameter of the cylinder sleeve by an amount greater than any likely deflection of the shoulder.

A further advantage of the present construction is that the assembly of the mechanism is much simpler and a more compact unit can be obtained than with prior construction. This is by reason of the fact that a sub-assembly of the piston, connecting rod, eccentric and certain other parts may be made within the crankcase before the cylinder sleeve is inserted, which could not be done if integral cylinders were employed since the assembly referred to would be too long to fit between the inner ends of opposed cylinders. There are also other assembly advantages which will be apparent to those familiar with the manufacture of apparatus of this character.

It will also be apparent that with the present construction the cylinder sleeves (and pistons, if necessary) may be readily and quickly replaced by a serviceman in the field or in a local shop.

The lubricating mechanism hereinabove described is particularly useful in a direct-drive type of compressor for the purpose of lubricating the motor shaft and seal elements, as well as providing effective piston pin lubrication, and, as has been pointed out, the cylinder sleeve construction of the present invention has especial advantages in such compressors since the displacement volume thereof cannot be changed by merely changing the compressor speed as in the case of belt-driven compressors.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, but the appended claims should be construed as broadly as permissible in view of the prior art.

I claim:

1. A refrigeration compressor comprising a crankcase having a cylinder block formed therein, the latter having an internal annular shoulder formed therein, a separate cylinder sleeve positioned entirely within said cylinder block and extending into the crankcase, said sleeve having an external annular flange engaging said shoulder, a valve plate of greater diameter than said flange engaging said flange and having its periphery in contact with the interior of the cylinder block, a cylinder head contacting said plate, cylinder head screws holding said parts in assembled relation against said shoulder under compression, a piston reciprocably mounted in said cylinder sleeve, and means for actuating said position.

2. A refrigeration compressor comprising a crankcase having opposed cylinder blocks formed therein, the latter each having an internal annular shoulder formed therein, a separate cylinder sleeve positioned entirely within said cylinder sleeve positioned entirely within said cylinder block and extending into the crankcase, said sleeve having an external annular flange engaging said shoulder, a valve plate of greater diameter than said flange engaging said flange and

having its periphery in contact with the interior of the cylinder block, a cylinder head contacting said plate, cylinder head screws holding said parts in assembled relation against said shoulder under compression, a piston reciprocably mounted in said cylinder sleeve, and means for actuating said piston.

3. A refrigeration compressor comprising a crankcase having a cylinder block formed therein, the latter having an internal annular shoulder formed therein, a separate cylinder sleeve positioned entirely within said cylinder block and extending into the crankcase, said sleeve having an external annular flange engaging said shoulder, a valve plate of greater diameter than said flange engaging said flange and having its periphery in contact with the interior of the cylinder block, a cylinder head contacting said plate, cylinder head screws holding said parts in assembled relation against said shoulder under compression, a piston reciprocably mounted in said cylinder sleeve, and means for actuating said piston, said means including a compressor shaft and a motor directly connected with said shaft for driving the same.

4. A refrigeration compressor comprising a crankcase having a cylinder block formed therein, the latter having an internal annular shoulder formed therein, a separate cylinder sleeve positioned entirely within said cylinder block and extending into the crankcase, said sleeve having an external annular flange engaging said shoulder, the clearance between said sleeve and the walls of the cylinder block being sufficiently great to permit ready manual assembly of the sleeve in the block, a valve plate of greater diameter than said flange engaging said flange and having its periphery in contact with the interior of the cylinder block, a cylinder head contacting said plate, cylinder head screws holding said parts in assembled relation against said shoulder under compression, a piston reciprocably mounted in said cylinder sleeve, and means for actuating said piston.

5. A refrigeration compressor comprising a crankcase having a cylinder block formed therein, the latter having an internal annular shoulder formed therein, a separate cylinder sleeve positioned entirely within said cylinder block and extending into the crankcase, said sleeve having an external annular flange engaging said shoulder, a valve plate engaging said flange and having its periphery in contact with the interior of the cylinder block, the clearance between the sleeve and the walls of the cylinder block being substantially greater than that between the valve plate and the walls of said cylinder block, a cylinder head contacting said plate, cylinder head screws holding said parts in assembled relation against said shoulder under compression, a piston reciprocably mounted in said cylinder sleeve, and means for actuating said piston.

6. A refrigeration compressor comprising a crankcase having a cylinder block formed therein, the latter having an internal annular shoulder formed therein, a separate cylinder sleeve positioned entirely within said cylinder block and extending into the crankcase, said sleeve having an external annular flange engaging said shoulder, a valve plate of greater diameter than said flange engaging said flange and having its periphery in contact with the interior of the cylinder block, a cylinder head contacting said plate, cylinder head screws holding said parts in assembled relation against said shoulder under compression, a piston reciprocably mounted in said cylinder sleeve, and means for actuating said piston, said cylinder sleeve being slotted intermediate its ends to determine the length of the effective stroke of said piston.



7. In a compressor of the class described, the combination of a cylinder block, a cylinder sleeve, a circular valve plate, a cylinder head and cylinder head screws, said cylinder block having an internal annular shoulder and said cylinder sleeve having an external annular flange nesting in said cylinder block in contact with said internal anular cylinder block shoulder, said circular valve plate being of greater diameter than said flange and being positioned within said cylinder block in contact with the external annular flange of said cylinder sleeve, said cylinder head being in pressure-exerting relationship with said valve plate, and said cylinder head screws being secured into said cylinder block under tension holding said cylinder head in place, said valve plate and said external flange of said cylinder sleeve being in fixed series relationship against said internal annular shoulder of said cylinder block and being disposed inside said block in close-fitting relationship with the wall thereof.

8. In a compressor of the class described, the combination of a cylinder block, a cylinder sleeve, a circular valve plate, a cylinder head and cylinder head screws, said cylinder block having an internal annular shoulder and said cylinder sleeve having an external annular flange nesting in said cylinder block in contact with said internal annular cylinder block shoulder, said circular valve plate being positioned within said cylinder block in contact with the external annular flange of said cylinder sleeve, said cylinder head being in pressure-exerting relationship with said valve plate, and said cylinder head screws being secured into said cylinder block under tension holding said cylidner head in place, said valve plate and said external flange of said cylinder sleeve being in fixed-series relationship against said internal annular shoulder of said cylinder block and being disposed inside said block in close-fitting relationship with the wall thereof, said circular valve plate being of greater diameter than the maximum diameter of said sleeve.

AXEL RAMCLOW.


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