Feb. 5, 1946. C. STEENSTRUP 2,394,409

COMPRESSOR

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Fig. 1.

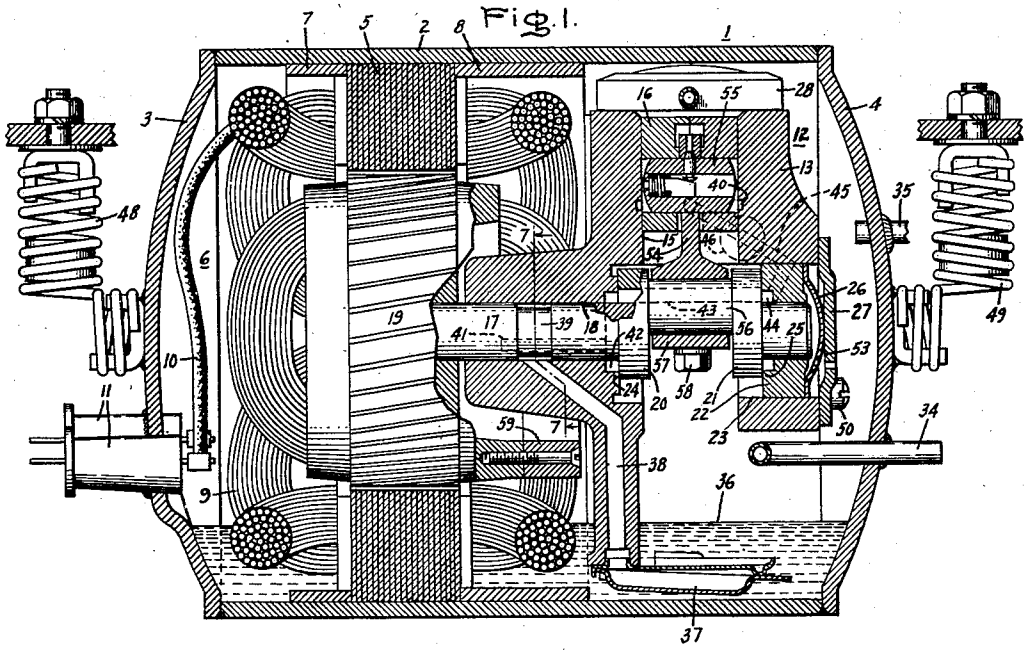
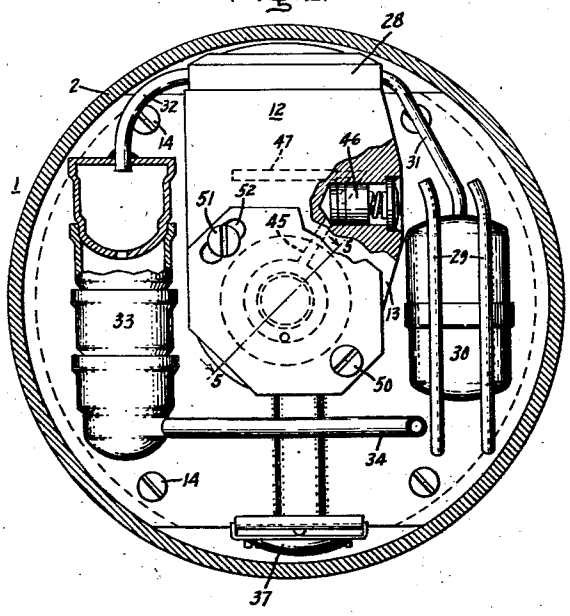


Fig. 2.



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Christian Steenstrup,
by Harry E. Dunham
His Attorney.

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Fig. 3.

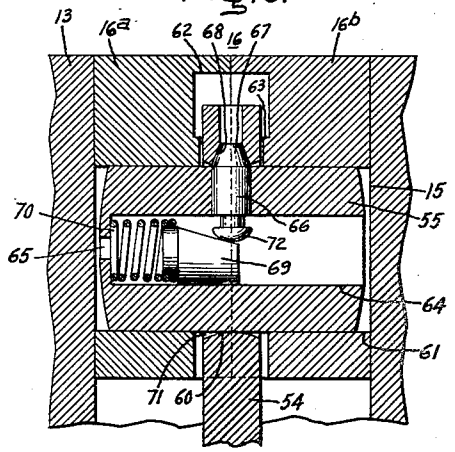


Fig. 4.

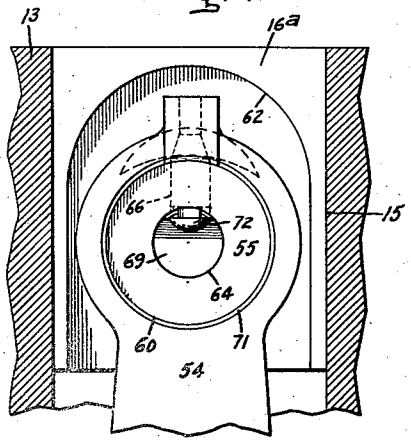


Fig. 5.

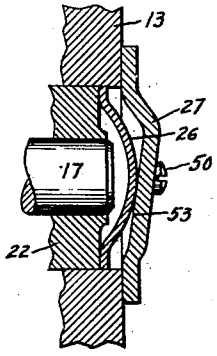


Fig. 6.

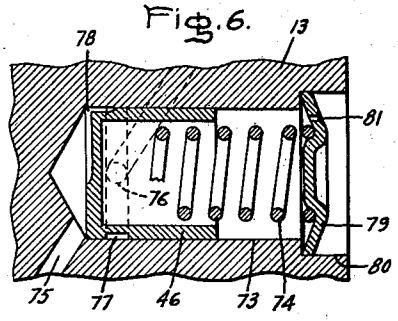
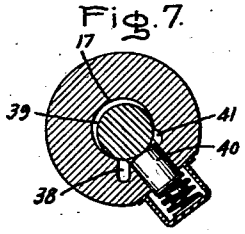


Fig. 7.



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Patented Feb. 5, 1946 2,394,409

UNITED STATES PATENT OFFICE

2,394,409

COMPRESSOR

Christian Steenstrup, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application June 20, 1944, Serial No. 541,145

8 Claims. (Cl. 309—19)

My invention relates to compressors for refrigerating machines and the like and particularly to reciprocating compressors.

In the production of compressors on a large scale, it is desirable to eliminate as far as possible the rejection of parts due to even very slight inaccuracies in alignment. In other words, it is desirable that fairly wide tolerances be permissible at least for certain elements of the apparatus. For example, when a reciprocating compressor is driven by a crank it is difficult to machine accurately large numbers of parts so that they are interchangeable and still make possible the exact alignment of the crank with respect to the cylinder. Inaccuracies in alignment of the crank and the cylinder will result in binding and eventually loose fits due to wear and as a result noise is produced by the operation of the compressor. In the assembly of a reciprocating compressor such as employed in refrigerating machines, it is necessary to provide proper alignment of the crank shaft and piston and also to provide proper spacing and clearances for the crank shaft itself. In the construction of refrigerant compressors, particularly those for the hermetically sealed machines, it is desirable to eliminate or minimize all noises produced by the normal operation of the compressor and proper alignment of the parts is essential. Accordingly, it is an object of my invention to provide a compressor for refrigerating machines and the like including an improved arrangement for minimizing noise produced during the normal operation of the compressor.

It is another object of my invention to provide a compressor for refrigerating machines and the like including improved arrangements for insuring alignment of the moving parts of the compressor.

It is another object of my invention to provide an improved wrist pin and piston assembly for reciprocating compressors or the like.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawings in which Fig. 1 is a longitudinal side elevation partly in section of a hermetically sealed refrigerant compressor embodying my invention; Fig. 2 is an end view of the compressor shown in Fig. 1 with the casing cut away and with portions of the compressor shown in section; Fig. 3 is an enlarged sectional view of the wrist pin and piston shown in Fig. 1; Fig. 4 is an end view of Fig. 3 with one-half the piston removed; Fig. 5 is an enlarged view of the shaft alignment device shown in Fig. 1; Fig. 6 is an enlarged view of the lubricant pressure regulator illustrated in Fig. 2; and Fig. 7 is a sectional view on the line 7—7 of Fig. 1 showing the construction of the lubricant pump.

Briefly, the compressor illustrated in the accompanying drawings comprises a hermetically sealed casing within which is arranged a reciprocating compressor driven by an electric motor, the compressor and the stator of the motor being supported directly on the casing. A separate lubricant pump is provided for supplying a sufficient quantity of lubricant to all moving parts of the mechanism under control of a suitable pressure regulator. A crank shaft for driving the compressor is provided with shoulders engaging the thrust bearings and a clearance between the pairs of shoulders may be adjusted by a cam arrangement at the end of the shaft which may be locked in position to maintain the proper clearances throughout the life of the compressor. In order to insure correct alignment of the piston and crank or connecting rod bearing, the wrist pin and connecting rod are secured together by a device which permits sufficient adjustment of the alignment between the connecting rod and the piston to compensate for any slight variations of alignment between the cylinder and the connecting rod bearing. The aligning device includes a spring pressed wedge which maintains the wrist pin always in contact with the connecting rod on the side of the wrist pin toward the crank shaft thereby minimizing noise which might otherwise be produced due to clearance between the wrist pin and connecting rod.

Referring now to Figs. 1 and 2, I have provided a hermetically sealed motor driven refrigerant compressor unit 1 including a cylindrical shell 2 having end plates 3 and 4 welded or otherwise suitably bonded thereto to form an enclosing casing. The shell 2 is constructed preferably of steel and constitutes the frame in which is supported a laminated magnetic core structure 5 of an alternating current driving motor 6. The laminations 5 are held in place between annular rings 7 and 8 which are welded or otherwise suitably secured to the shell 2. The motor is provided with stator windings 9 which are energized through leads 10 passing through sealed fittings 11 to the exterior of the casing. A compressor

12 is arranged within the casing 1 and comprises a compressor block 13 which is rigidly secured to the ring 8 by suitable bolts or screws 14. The compressor block 13 is provided with a cylinder 15 in which is located a piston 16. The piston is driven by a crank shaft 17 mounted in a bearing 18 in the block 13, motor 6 being provided with a squirrel cage rotor 19 mounted on the shaft 17. The shaft 17 is provided with annular shoulders 20 and 21 near the end of the shaft remote from the motor 19 and is mounted in the bearing block 22 which is slidably arranged in a circular opening 23 in the compressor block 13. The shoulders 20 and 21 are mounted in running engagement with annular thrust bearings 24 and 25, respectively, formed on the compressor block 13 and bearing block 22, respectively, and are retained in position by a dished bridging member or disk 26 in cooperation with a movable camming member or adjusting plate 27. The compressor is provided with intake and exhaust valves (not shown) which are located within a cylinder head 28. Refrigerant gas which is admitted to the compressor through a pair of intakes 29 flows through an intake muffler 30 and thence into the compressor head through a conduit 31. The gas compressed within the cylinder 15 in cooperation with the piston is discharged through a connection 32 into an exhaust muffler 33 and flows from the exhaust muffler and out of the casing through a conduit 34 to the remaining components of the refrigerating system (not shown). Refrigerant returning from the refrigerating system is admitted to the casing through a suction line or return conduit 35.

In order to lubricate the compressor, a body of oil or lubricating fluid is maintained in the casing 1 to a level indicated at 36, the bottom of the casing forming a lubricant sump. Lubricant is withdrawn from the sump through a velocity reducing intake baffle 37 and an intake passage 38 in the block 13 by operation of a pump 39 the details of which are shown in Fig. 7. The intake baffle 37 prevents the admission to the pump of gaseous or liquid refrigerant and also of particles of foreign matter which may collect in the bottom of the casing. This intake baffle construction is the invention of Carl H. Steenstrup and is described and claimed in application, Serial No. 541,143, filed concurrently with the present application and assigned to the same assignee. The pump 39 comprises an eccentrically formed section of the shaft 17 and a spring pressed vane 40 for separating the intake and exhaust sides of the pump. During the operation of the pump, lubricant is drawn in from the duct 38 and is discharged through a duct 41 formed as a groove in the walls of the shaft bearing. The oil then enters an annular passage 42 about the shaft adjacent the thrust bearing 24 and flows through a passage 43 in the crank shaft to an annular groove 44 in the bearing block 22. From the groove 44, the oil flows through a passage 45 to an oil pressure regulator 46 of the spring pressed piston type. Oil discharged from the regulator 46 then flows to an annular groove 47 about the walls of the cylinder 15 for lubricating the piston 16. It is thus apparent that oil is supplied to all moving parts of the compressor assembly.

The motor compressor unit may be supported in any suitable manner on the structure with which it is to be employed and has been illustrated as resiliently suspended on springs 48 and 49 at either end thereof.

During the assembly of the motor compressor unit the shaft 17 is first inserted in the bearing 18, the opening 23 in the block 13 providing room for the passage of the shoulders 20 and 21 longitudinally into position. The block 22 is then placed over the right-hand end of the shaft 17 and is moved into engagement with the thrust bearing 25, it being noted that the end of the shaft projects slightly beyond the block 22. The dished disk 26 is then placed in position bridging the end of the shaft 17 and engaging the block 22. The block and disk are preferably made approximately of the same diameter as the opening 23 so that they are guided by the walls of the opening in their axial movement. The camming plate 27 is then adjusted to press the bearing block 22 against the shoulder 21 and also to press the shoulder 20 against the thrust bearing 24. The camming plate 27 is constructed so that the correct clearances between the thrust bearings and the shoulders 20 and 21 may be adjusted quickly and plate 27 may then be locked in place to maintain the adjustment. This arrangement is described and claimed in my copending application Serial No. 596,497 filed May 29, 1945, and assigned to the same assignee.

The details of construction of the camming device 27 and the associated parts will be apparent from Figs. 1, 2 and 5. The plate is secured to the block 13 by suitable cap screws 50 and 51, the plate being arranged to pivot on the screw 50 and being provided with a slot 52 affording lateral adjustment of the plate with respect to the shaft 17. As clearly shown in Fig. 5, the plate 27 is provided with a sloping camming surface 53 which engages the outermost portion or apex of the disk 26.

By loosening the screws 50 and 51 and pivoting the plate in a clockwise direction about the screw 50, the camming surface 53 may be made to force the disk 26 toward the left to press the block 22 into engagement with the shaft shoulder 21. After the shaft is in position, the piston 16 together with a connecting rod 54 and wrist pin 55 is inserted in the cylinder so that the top half of the crank bearing formed in the connecting rod engages the crank indicated at 56. The lower half of the connecting rod bearing indicated at 57 is then secured in place by suitable screws 58. The compressor block is then placed in a suitable fixture and the crank 17 turned until the piston 16 is in its outermost position so that the crank is on dead-center. The camming plate 27 is then turned in a counterclockwise direction and the screws 50 and 51 tightened in a position such that the shaft is locked against rotation, the camming plate forcing the shoulders and thrust bearings into tight engagement. The block is then released from the fixture and placed in a fixture on which is located the rotor 19 having a counterweight 59 located so that when the shaft and rotor are pressed together in the fixture, the counterweight is located in its proper position with respect to the crank 56. Thereafter the plate 27 is released and the compressor placed in another fixture provided with means for gauging the longitudinal movement of the shaft 17. The plate 27 is then adjusted until the movement of the shaft, which is a measure of the clearances of the thrust bearings and shoulders, is within the required tolerances. The plate 27 is then locked in place by tightening of the screws 50 and 51 to maintain the required running engagement of the thrust bearings 24 and 25 and the shoulders 20 and 21.

It is readily apparent that the arrangement just described for adjusting the shaft to its required position provides a simple and effective way for adjusting large numbers of parts in production. It has been found, however, that very slight variations of alignment between the cylinder and the crank shaft and between the piston and the wrist pin, which inaccuracies may be of the order of a very few thousandths of an inch or even less than a thousandth of an inch in some cases, produce vibration, noise and undue wear. The presence of these inaccuracies makes it necessary to align each compressor individually and greatly reduces the speed of production. It is extremely difficult to machine the compressor block so that the shaft bearing and cylinder will be in alignment within the narrow clearances permissible.

In order to obviate these difficulties in obtaining accurate alignment, I have provided a connecting rod and piston assembly which insures correct alignment to compensate for any inaccuracies within predetermined permissible tolerances and which effectively minimizes noise and vibration of the mechanism.

As shown in Figs. 1, 3 and 4, the piston and connecting rod assembly includes the connecting rod 54 which has a circular opening 60 in its upper end and the piston 16 which is provided with a cylindrical wrist pin bearing 61 and a wrist pin 55 which is journalled in the bearing 61 and passes through the opening 60 in the connecting rod. The piston is constructed of two halves 16*a* and 16*b* which are duplicate parts and are formed with upwardly extending recesses 62 having crescent-shaped shoulders 63 adjacent the upper side of the bearing 61 which serve as guides or bearings for the upper end of the connecting rod 54. The two halves 16*a* and 16*b* are secured together, preferably by brazing, to form a unitary piston. The wrist pin 55 is hollow and has a cylindrical opening 64 therein which is open at one end and closed at the other end, except for a small opening 65. The wrist pin is locked in position in the opening 60 by a locking pin or key 66 which extends laterally from the interior of the wrist pin and is provided with a cone-shaped head 67 which fits the conically reamed lower end of a drill hole or recess 68 in the connecting rod at the top of the opening 60. The pin 66 is pressed upwardly into engagement with the connecting rod 54 by a wedge 69 slidably mounted in the inner passage 64 of the wrist pin and pressed toward the pin 66 by a spring 70 held under compression between the wedge 69 and the end of the wrist pin about the opening 65. The spring 70 is selected so that it will urge the pin 66 upwardly and press the wrist pin against the bottom of the opening 60 with sufficient force to maintain contact between the wrist pin 55 and the connecting rod 54 throughout the operation of the compressor. The opening 60 is not cylindrical but is relieved as indicated by the clearance around the opening at 71. In the drawings, the clearance 71 has been exaggerated as it is necessary to provide only a few thousandths of an inch for the required purpose. Because of the clearance 71, the wrist pin 55 may rock slightly laterally in the opening 60 and may pivot about the cone 67 at the upper end of the pin 66. This rocking movement makes it possible to vary slightly the angle between the connecting rod 54 and the piston 16. This slight variation in position is employed to offset inaccuracies in the alignment of the piston and bearing 61 and also in the alignment of the cylinder 16 and the crank 56. This change in alignment takes place automatically when the wrist pin is assembled in the compressor. The only movement which is necessary during the operation of the compressor may be a slight movement axially of the bearings and this is permitted since the connecting rod bearing may move axially of the crank 56 the few thousandths of an inch necessary.

During the assembly of the wrist pin and the piston, the upper end of the connecting rod is first placed in the recess 62 with the opening 60 in alignment with the bearing 61. The spring 70 and the wedge 69 are placed in the opening 64 in the wrist pin and the spring is compressed so that the pin 66 may be inserted from outside the pin until a head 72 on the pin 66 lies below the front edge of the wedge 69 and retains the spring in its compressed position when the original pressure is released. The wrist pin is then inserted in the bearing 61 passing through the opening 60 until the pin 66 is in alignment with the conical opening 68. The spring 70 is then compressed and the pin 66 pressed upwardly until the head 72 is above the sloping portion of the wedge and is forced into position by the spring 70. The opening 65 makes it possible to tap the wedge 69 outwardly against the head 72 to be sure the head and the sloping portion of the wedge are in proper engagement. It will readily be understood that the reverse operation may be effected in order to take the assembly apart, the head 72 on the pin 66 serving as a shoulder making it possible to draw the pin 66 into the hollow interior of the wrist pin after the wedge 69 has been pressed back against the spring 70.

The simple wrist pin and piston assembly described above not only provides alignment to offset inaccuracies in production machining operations but also maintains the wrist pin and connecting rod in engagement at one point throughout the operation of the compressor regardless of changes in load and thereby minimizes noise. The locking or keying arrangement including the pin 66 thus serves not only to lock the wrist pin to the connecting rod and prevent rotation of the wrist pin in the opening 60 but also provides for the necessary initial alignment of the parts and maintains the required pressure at all times between the wrist pin and the connecting rod.

To obtain satisfactory operation of the compressor and to minimize noise it is desirable that the lubricating system operate to provide oil or other fluid lubricant at the desired uniform pressure and the regulator 46 is provided for this purpose. The details of the regulator are more clearly shown in Fig. 6, the piston 46 being mounted in a cylinder 73 and pressed toward the left by a spring 74. The cylinder 73 includes an intake port 75 which is the upper end of the passage 45 and an exhaust port 76. During the operation of the refrigerating machine the piston 46 moves back and forth across the exhaust port 76 and, if the cutoff is sharp, so that the flow of the stream of oil is suddenly started or stopped, noise results. In order to minimize the noise due to sharp cutoff there is provided a bypass between the intake 75 and the exhaust port 76 which comprises an annular groove 77 arranged about the end of the piston 46 and communicating with the end of the cylinder 73 adjacent the intake port through a groove 78 formed in one side and across the top of the piston. The spring 74 is mounted between the piston and a stationary

disk 79 securely pressed into an opening 80 at the outer end of the cylinder 73 and the piston 46 may rotate within the cylinder 73; however, since the groove 77 extends entirely about the piston, the bypass is maintained between the inlet and exhaust ports of the cylinder 73 regardless of the position of the piston. Since there is always a flow of lubricant through the bypass during the operation of the mechanism, sharp cutoff is prevented and noise is minimized. A damping action for the piston 46 is obtained by providing a small restricted opening 81 in the disk 79 providing communication between the cylinder 73 and the casing about the cylinder block 13. Oil or a mixture of oil and gas will fill the cylinder 73 back of the piston 46 and the restricted opening 81 will limit the rate of passage of the fluid from the cylinder to the outside and thereby damp sudden movements of the piston 46. This further effects a reduction of noise. This regulator construction is described and claimed in my copending application Serial No. 596,498, filed May 29, 1945, and assigned to the same assignee.

From the foregoing it is readily apparent that I have provided simple and effective arrangements for minimizing difficulties due to the unavoidable inaccuracies in machining of the parts of a compressor during quantity production and that these arrangements facilitate the interchanging of parts without the sacrifice of accurate alignment.

While I have described my invention in connection with a particular type of refrigerant compressor other applications will readily be apparent to those skilled in the art. I do not, therefore, desire my invention to be limited to the particular construction described and illustrated and I intend by the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A piston and connecting rod assembly for compressors and the like comprising a piston having a wrist pin bearing therein, a connecting rod having a crank bearing at one end and an opening at its other end, a hollow wrist pin arranged in said opening and engaging said wrist pin bearing, and means arranged in said wrist pin and including a member extending from said wrist pin and engaging said connecting rod on the side of said opening remote from said crank bearing for urging said wrist pin against the opposite side of said opening and for affording limited angular movement of the longitudinal axis of said wrist pin with respect to said crank bearing, said member cooperating with said connecting rod to prevent rotation of said wrist pin in said opening.

2. A piston and connecting rod assembly for compressors and the like comprising a piston having a wrist pin bearing therein, a connecting rod having a crank bearing at one end and an opening at its other end, a hollow wrist pin arranged in said opening and engaging said wrist pin bearing, and means mounted in said wrist pin for locking said pin against rotation in said opening and for maintaining said pin in contact with the side of said opening adjacent said crank bearing throughout the operation of said piston whereby the forces acting between said rod and said piston are transmitted between said wrist pin and said rod through said adjacent side of said opening.

3. In a compressor or the like having a cylinder block provided with a cylinder and a crank for reciprocating a piston in the cylinder, a piston and connecting rod assembly comprising a piston having a wrist pin bearing therein, a connecting rod having a crank bearing at one end and an opening at its other end, a hollow wrist pin arranged in said opening and journaled in said wrist pin bearing, and means mounted in said wrist pin for locking said pin against rotation in said opening and for maintaining said pin in contact with the side of said opening adjacent said crank bearing throughout the operation of said piston whereby the forces acting between said rod and said piston are transmitted between said wrist pin and said adjacent side of said opening, said means affording limited angular movement of said wrist pin with respect to said crank bearing to offset misalignment of the compressor cylinder with respect to the crank.

4. A piston and connecting rod assembly for compressors and the like comprising a piston having a wrist pin bearing therein, a connecting rod having a crank bearing at one end and an opening at its other end, a hollow wrist pin arranged in said opening and engaging said wrist pin bearing, and means arranged in said wrist pin and including a member extending from said wrist pin and engaging said connecting rod on the side of said opening remote from said crank bearing for urging said wrist pin against the opposite side of said opening and for preventing rotation of said wrist pin in said opening, said means affording limited pivotal movement of the longitudinal axis of said wrist pin about the contact area between said member and said connecting rod to permit alignment of the piston with respect to said crank bearing.

5. A piston and connecting rod assembly for compressors and the like comprising a piston having a wrist pin bearing therein, a connecting rod having a crank bearing at one end and an opening at its other end, a hollow wrist pin arranged in said opening and engaging said wrist pin bearing, and means including a spring-pressed wedge movable longitudinally in said wrist pin and a key extending laterally from said pin and urged outwardly by said wedge for locking said wrist pin against rotation in said opening.

6. A piston and connecting rod assembly for compressors and the like comprising a piston having a wrist pin bearing therein, a connecting rod having a crank bearing at one end and an opening at its other end, a hollow wrist pin arranged in said opening and engaging said wrist pin bearing, a longitudinally slidable wedge mounted in said wrist pin, a key slidably mounted in said wrist pin and extending laterally thereof into engagement with said connecting rod, and a spring arranged within said wrist pin for urging said wedge against said key to hold said key in engagement with said connecting rod for locking said assembly together.

7. A piston and connecting rod assembly for compressors and the like comprising a piston having a wrist pin bearing therein, a connecting rod having a crank bearing at one end and an opening at its other end, said connecting rod having a conical recess therein communicating with said opening, a wrist pin arranged in said opening and engaging said wrist pin bearing, said wrist pin having a longitudinal recess therein and a laterally extending opening in alignment with said connecting rod, a slidable key arranged in said lateral opening and having a conical end arranged to fit the conical recess in said connect-

ing rod, and a spring-pressed wedge arranged in said longitudinal recess for pressing said key into engagement with said connecting rod to lock said assembly together.

8. A piston and connecting rod assembly for compressors and the like comprising a piston having a wrist pin bearing therein, a connecting rod having a crank bearing at one end and an opening at its other end, a hollow wrist pin arranged in said opening and engaging said wrist pin bearing, and means including a spring-pressed wedge movable longitudinally in said wrist pin and a key extending laterally from said pin and urged outwardly by said wedge for locking said wrist pin against rotation in said opening, the end of said key within said wrist pin being provided with a shoulder whereby the key may be engaged and drawn into said pin upon retraction of said wedge to permit removal of said wrist pin from said assembly.

CHRISTIAN STEENSTRUP.