May 27, 1952 F. E. KLOSTERMAN 2,598,271

SERVOMOTOR WITH LUBRICATED ROTATABLE PISTON ROD

Filed Jan. 8, 1947 2 SHEETS—SHEET 1

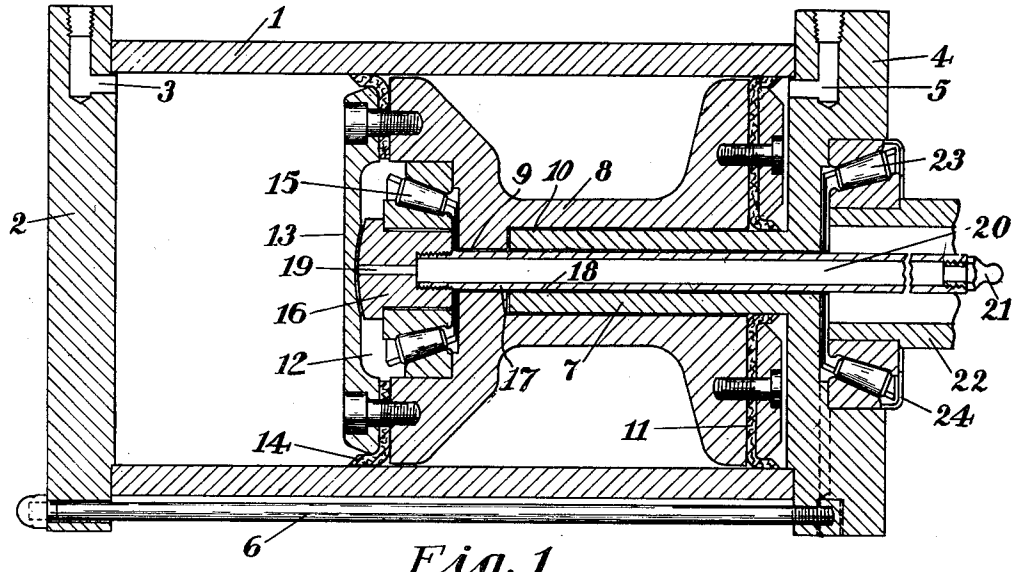


Fig. 1

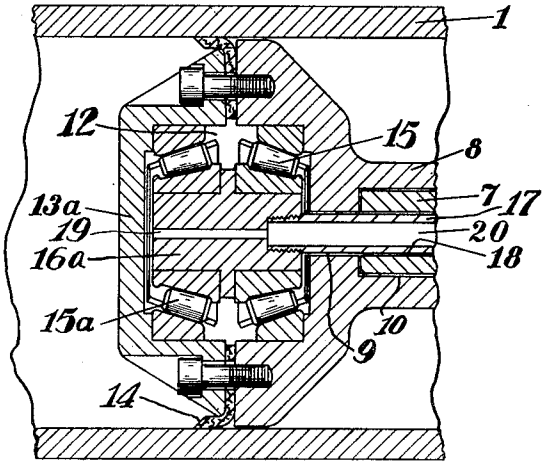


Fig. 2

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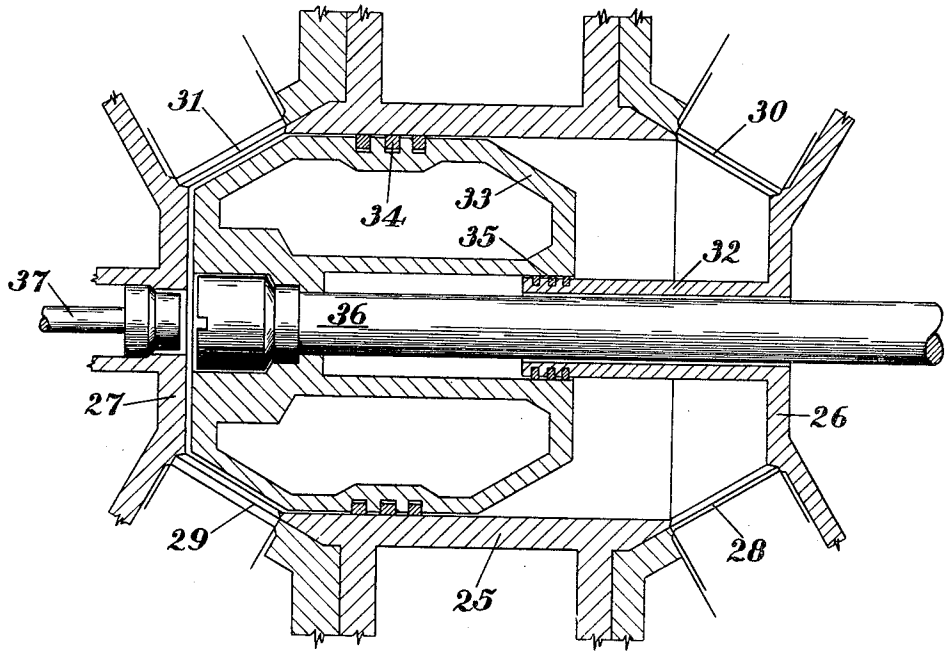


Fig. 3

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SERVOMOTOR WITH LUBRICATED ROTATABLE PISTON ROD

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9 Claims. (Cl. 121—1)

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This invention relates to improvements in servo-motors of the non-rotating cylinder type which are particularly suited for use in operating chucks, clutches, punch presses and the like.

Heretofore, double acting air operated servo-motors have been made in non-rotating cylinder types which are suited for some uses and in rotating cylinder types which are suited for other uses. In the rotating type, the cylinder rotates with the chuck spindle at speeds normally ranging from 100 to 400 R. P. M. Due primarily to cylinder rotation, the rotating type has a number of objections or drawbacks among which are: it requires considerable manufacturing care to produce an evenly balanced structure; it involves special connections for flowing air into and out of the rotating cylinder; it usually results in a somewhat cumbersome installation; and its operation involves the hazards necessarily incident to the rapid rotation of a part which usually is located near the operator and often is of substantial size.

The principal object of the present invention is to overcome these objections and drawbacks through the provision of a non-rotating type of cylinder which may be employed in most if not all installations where a rotating type has heretofore been required.

Another object is to provide a simple and compact form of servo-motor which is relatively inexpensive to manufacture and easy to install and operate.

Another object is to provide, in a double acting servo-motor, having a reciprocating and rotatable or non-rotatable piston rod, a novel form of piston rod seal which eliminates the stuffing box.

The invention is illustrated in the accompanying drawings wherein:

Fig. 1 is a vertical section through a double acting air cylinder constructed in accordance with my invention;

Fig. 2 is a modified form of piston head which may be substituted for one of the piston heads shown in Fig. 1; and

Fig. 3 is a vertical section through an air compressor incorporating the present invention.

The servo-motor shown in Fig. 1 comprises: a stationary open ended cylinder member designated by the numeral 1; an end wall 2 closing one end of the cylinder member and containing an air flow connection 3; an end wall 4 closing the opposite end of the cylinder and containing an air flow connection 5; and a series of tie bolts 6, only one of which is shown, connecting the end walls 2 and 4 and rigidly clamping them against

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the adjacent ends of the cylinder 1. The end wall 4 is integrally formed with a sleeve 7 extending centrally into the interior of the cylinder 1. The piston 8 is bored at 9 and counterbored at 10 to receive the sleeve 7, and is adapted to reciprocate thereon, a working clearance being provided between sleeve 7 and bore 10. One end of the piston carries an annular gasket 11 held thereon by an annular plate and screws, the gasket serving to seal the joint between the cylinder and piston at one end, and the running clearance between the sleeve 7 and bore 10. The opposite end of the piston has a chamber 12, and a gasket 14 and cover plate 13 serve to seal the chamber from the cylinder and seal the joint between the cylinder and piston at that end.

Chamber 12 contains a combined radial and end thrust bearing 15 in which is journalled a hub 16 suitably secured, as by a threaded connection, to a hollow piston rod 17 which passes through bore 9 in the piston and bore 18 in the sleeve 7. A duct 19 in the hub 16 connects with the bore 20 in the piston rod. A suitable lubricating nipple 21 is provided at the end of the rod, and lubricant under pressure can be introduced to bearing 15 through duct 19, bore 20 and nipple 21.

The stationary end wall 4 is arranged to provide a rotatable mounting for the adjacent end of a rotatable spindle 22 which carries the chuck or other device to be operated by the servo-motor. Accordingly, this end wall 4 is recessed to accommodate a combined radial and end thrust bearing assembly 23 for the spindle 22 which carries the reacting thrust of the spindle against the cylinder head 4. The annular opening between the spindle and the outlying portion of the end wall 4 is closed by a cover plate 24, in order to retain lubricant in the bearing assembly 23.

The operation of the apparatus now will be described. The cylinder 1 is suitably carried on the machine in non-rotatable relation thereto, and is located at the end of rotating spindle 22. When air pressure is applied to the right end of the piston through connection 5, the piston exerts a thrust to the left which is transmitted by piston rod 17, by means of a collar or other suitable connection, to the chuck or other device operated thereby and carried by the rotating spindle 22. The piston rod 17 thus is set into rotation, and the rotational end thrust between the piston and rod is carried by bearing 15. The piston is retained against rotation in the cylinder by the engagement of the packings 11 and 14, which serve to seal the connection between the piston and

cylinder to prevent air leakage. The reacting end thrust of spindle 22, on the cylinder, which is exerted to the left, is carried by bearing 23. The bearing 15 can be pressure lubricated through bores 19 and 20 by means of the pressure lubricating fitting 21. The introduction of lubricant under pressure at the fitting 21 forces air and excess lubricant in chamber 12 through the clearance space between the piston rod and bore 9, and between the piston rod and bore 10 in bearing 7 into bearing 23. The bearing cover 24 prevents oozing of lubricant but allows escape of excess lubricant when lubricant under pressure is introduced at fitting 21.

The arrangement shown in Fig. 1 is intended to do work or transmit power in one direction only, namely, toward the left as shown in Fig. 1. To transmit power in both directions, it is desirable to provide a double acting thrust bearing of Fig. 2 in place of a single acting thrust bearing shown in Fig. 1. The double acting thrust bearing shown in Fig. 2 comprises a closure plate 13*a*, a piston rod connection member 16*a* and another thrust bearing roller assembly 15*a*.

As indicated previously, the present invention may be usefully incorporated in air cylinders of various types such as air compressor cylinders. An embodiment of this character is shown in Fig. 3. The compressor cylinder shown in Fig. 3 comprises: a cylinder member 25; end walls 26 and 27, suction valve openings 28 and 29 and discharge valve openings 30 and 31. The end wall 26 is integrally formed with a centrally located tubular bearing 32 projecting inwardly within the cylinder 25 to provide an outer elongate seat for slidably receiving and encircling a snugly fitting piston and an inner elongate bore for slidably receiving a snugly fitting piston rod.

The piston 33 is a double acting piston which contains an inner elongate bore for slidably receiving the snugly fitting tubular bearing 32. This piston fits snugly within the cylindrical chamber 25 but, since the air pressure may be relatively high, the space between the cylinder member 25 and the outer periphery of the piston 33 is slidably sealed by piston rings 34 preferably mounted in the periphery of the piston 33. Likewise the space between the piston 33 and the outer periphery of the tubular bearing 32 is slidably sealed by piston rings 35 preferably mounted in the bearing 32 although they may of course be mounted in the bore of piston 33.

The piston rod 36 extends through the bore of tubular bearing 32 and is rigidly connected to the piston 33 adjacent that end of piston 33 which is adjacent to the end wall 27.

The compressor shown in Fig. 3 is provided with a conventional unloader 37. Since the unloader 37 is conventional, it is not deemed necessary to describe its construction or operation.

With this arrangement, the sealing rings 34 and 35 provide effective seals between opposed chambers of the compressor and between chamber surrounding the bearing member 32 and the bore of that bearing member. This latter sealing is sufficiently effective as to eliminate the necessity of a stuffing box. Of course, it will be understood that a stuffing box may be employed and may even be desirable in some instances to reduce leakage as wear of the machine proceeds.

Having described my invention, I claim:

1. A servo-motor of the class described comprising: a stationary cylinder having front and rear end walls closing opposite ends of the cylinder; a tubular bearing centrally located on and rigidly secured to the rear end wall to project inwardly into the cylinder, said bearing providing an outer elongate periphery and an inner elongate bore extending through the bearing member and the rear end wall; a piston providing a relatively enclosed recess in the front end thereof and slidably mounted in the cylinder for movement longitudinally along the outer periphery of the bearing member, said piston being provided with an inner elongate bore to accommodate the tubular bearing; a hollow piston rod rotatably connected by a bearing assembly in said recess to the piston for rotational movement relatively thereto and for longitudinal movement therewith, said rod extending from said connection through the bore of the tubular member and projecting outwardly from the rear end wall, the connected end of the piston rod being in open communication with said recess, and arranged with the projecting end thereof to receive lubricant for said bearing assembly.

2. A servo-motor of the class described comprising: a stationary cylinder having front and rear end walls closing opposite ends of the cylinder; a tubular bearing centrally located on and rigidly secured to the rear end wall to project inwardly into the cylinder, said bearing providing an outer elongate periphery and an inner elongate bore extending through the bearing member and the rear end wall; a piston providing a relatively enclosed recess in the front end thereof and slidably mounted in the cylinder for movement longitudinally along the outer periphery of the bearing member, said piston being provided with an inner elongate bore to accommodate the tubular bearing; a hollow piston rod rotatably connected to the piston in said recess for rotational movement relatively thereto and for longitudinal movement therewith by a connector member rigidly secured to the piston rod and a bearing assembly between the connector member and the piston, said connector member having a lubricating bore therein; said rod extending from said connection through the bore of the tubular member and projecting outwardly from the rear end wall, the connected end of the piston rod being in communication with the lubricating bore of the connector member, and arranged with the projecting end thereof to receive a lubricant for lubricating the interior of said recess.

3. A servo-motor of the class described comprising: a cylinder having end closing walls; one end wall having a sleeve projecting into the cylinder providing a bore extending through the sleeve and end wall; a piston in said cylinder having a bore at one end to receive said sleeve and reciprocable thereon; a piston rod extending through the bore in the sleeve and end wall and connected in rotatable relation to the piston adjacent the end of the piston bore, said rod providing a lubricant passage therethrough to the rotatable connection with the piston; and a pressure lubricating fitting on said rod connected to said passage.

4. A servo-motor as specified in claim 3 wherein the rotatable connection of the piston rod and piston is provided by a combined radial and end thrust anti-friction bearing.

5. A servo-motor as specified in claim 4 wherein said bearing is double acting.

6. An air cylinder of the class described comprising: a cylinder having heads closing the ends thereof; a piston in said cylinder providing a closed end and having an axial bore in the other

end; a tubular sleeve on one head received in said bore; a piston rod extending through said sleeve with a working clearance; means securing one end of said piston rod within the piston for relative rotatable and conjoint reciprocating movement; and means sealing the sleeve and bore against escape of air from the cylinder and permitting reciprocation of the piston on said sleeve.

7. An air cylinder of the class described comprising: a cylinder having heads closing the ends thereof; a piston in said cylinder having an axial bore in one end; a tubular sleeve on one head received in said bore; an anti-friction bearing in said piston adjacent the end of said bore; a piston rod extending through said sleeve with a working clearance and secured to said bearing; and means sealing the sleeve and piston bore against escape of air from the cylinder and permitting reciprocation of the piston on said sleeve; and a pressure tight cover on the piston for said anti-friction bearing.

8. An air motor of the class described comprising: a cylinder having end walls; a piston reciprocable in said cylinders and having an axial bore therein; a hollow sleeve extending from one end wall into said bore and providing a sliding bearing for said piston; means sealing the joint between said sleeve and piston bore; a combined end and radial thrust bearing in said piston; and a piston rod secured to said bearing and extending through said sleeve with a working clearance to the exterior of said cylinder.

9. An air motor of the class described comprising: a cylinder having end walls; a piston reciprocable in said cylinder and having an axial bore therein; a hollow sleeve extending from one end wall into said bore and providing a sliding bearing for said piston; said latter end wall carrying an anti-friction thrust bearing on its exterior adapted to receive a rotatable spindle; means sealing the joint between said sleeve and piston bore; a combined end and radial thrust bearing in said piston; a piston rod secured to said latter bearing and extending through said sleeve with a working clearance to the exterior of said cylinder.

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