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AIR CYLINDER ARRANGEMENT FOR PNEUMATIC BRAKES AND THE LIKE

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FIG. 1

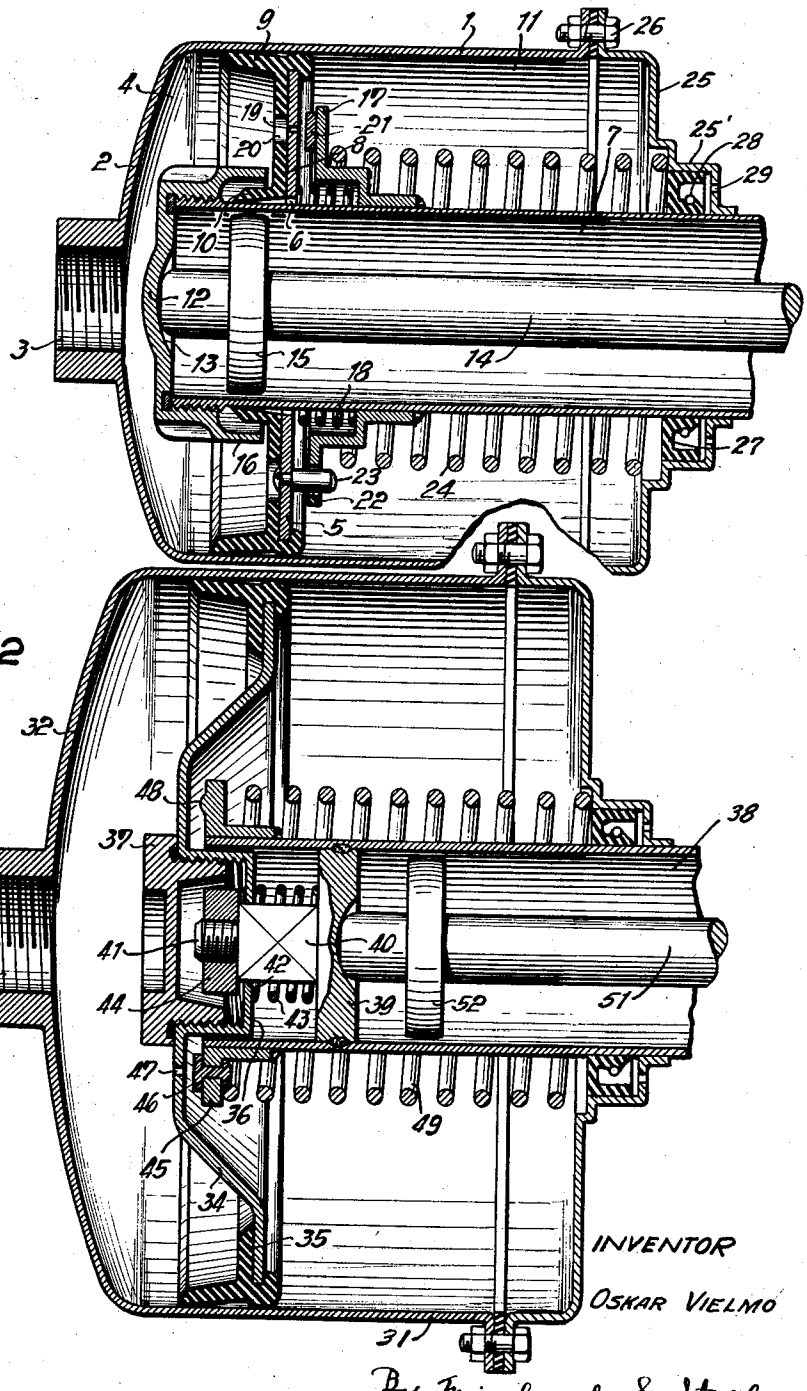


FIG. 2




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# AIR CYLINDER ARRANGEMENT FOR PNEUMATIC BRAKES AND THE LIKE

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11 Claims. (Cl. 121—38)

The present invention relates to pneumatic arrangements.

More particularly, the present invention relates to pneumatic and piston arrangements of the type used, for example, in vehicles having air brakes.

In devices of this latter type it is customary to provide in the cylinder a working chamber and a residual air chamber separated by the piston which is in the cylinder. Air under pressure is admitted to the working chamber to move the piston along its working stroke and the air in the residual air chamber moves out of the residual air chamber during the working stroke when this residual air chamber decreases in volume, and it is conventional to admit air from the outer atmosphere back into the residual air chamber when the latter increases in volume during the return stroke of the piston. Filters are usually provided to filter the air entering back into the residual air chamber during the return stroke of the piston in order to prevent foreign particles from entering into the cylinder, but such filters are incapable of preventing liquids from entering into the cylinder, and this fact is a considerable disadvantage of the conventional pneumatic arrangements. Attempts have already been made to overcome this problem, but no satisfactory solution has as yet been provided. For example, it has been proposed to provide the cylinder with a closed bellows which receives the air from the residual air chamber when the volume of the latter decreases and which returns air back into the residual air chamber when the volume thereof increases, this air thus never coming in contact with the outer atmosphere. However, this solution is extremely impractical because of the complications involved and because of the large space required for such a bellows. Other solutions to the problem which have been thus far proposed also are impractical because of the complications and cost involved.

One of the objects of the present invention is to overcome the above drawbacks by providing an arrangement which prevents fluids from entering into the cylinder during the return stroke of the piston and which at the same time is far simpler than the known constructions for solving the above problems.

Another object of the present invention is to provide an arrangement which admits fluid into the residual air chamber of the cylinder during the return stroke of the piston only when the pressure in the working chamber of the cylinder is within a predetermined range.

A further object of the present invention is to incorporate the invention into pneumatic arrangements of widely different capacities.

An additional object of the present invention is to provide a pneumatic arrangement having relatively rugged parts which are very reliable in operation as well as relatively weak parts and in arranging the parts so that the weak parts are not unduly stressed during the operations.



With the above objects in view the present invention mainly consists of a pneumatic arrangement which includes a piston means and a cylinder housing the piston means for reciprocating movement in the interior of the cylinder axially in one direction along a working stroke and in an opposite direction along a return stroke, the cylinder having a working chamber on one side of the piston means and a residual air chamber on the other side of the piston means, the volume of the working chamber increasing and of the residual air chamber decreasing during the working stroke of the piston means and the volume of the working chamber decreasing and of the residual air chamber increasing during the return stroke of the piston means, the fluid in the residual air chamber being adapted to flow only outwardly of the cylinder during the working stroke of the piston means so that no fluid enters into the residual air chamber during the return stroke of the piston means. A passage means of small cross section provides communication between the working chamber and residual air chamber, and a means is provided to close the passage means during the working stroke of the piston means when the pressure in the working chamber reaches a given value and to again provide communication between the chambers through the passage means when the pressure in the working chamber drops to a predetermined range during the return stroke of the piston means in order to provide at least partial equalization between the pressures in the working chamber and residual air chamber during the return stroke of the piston means.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a fragmentary sectional elevational view of a pneumatic arrangement according to the present invention, the section of Fig. 1 being taken along a central plane of the cylinder and piston means; and

Fig. 2 is a sectional elevational view of another embodiment of the pneumatic arrangement according to the present invention, the section of Fig. 2 also being taken along a central plane.

Referring now to the drawings, Fig. 1 shows a braking cylinder 1 of a conventional one-chamber air brake of a vehicle. At its left end wall 2, as viewed in Fig. 1, the cylinder 1 is provided with a tubular extension 3 which may be internally threaded, for example, in order to be connected to a conduit for air under pressure, air under pressure moving through such a conduit into and out of the working chamber 4 of the cylinder 1 located between the end wall 2 thereof and the piston means, this air under pressure moving into and out of the working chamber 4 in a purely conventional manner forming no part of the present invention.

Within the interior of the cylinder 1 is located a piston and piston rod means, the piston means including the annular plate 5 which is formed with a central bore 6 through which the hollow piston rod 7 freely passes in the manner indicated in Fig. 1. A sealing disk 8 of a flexible soft material such as rubber or the like which is also resilient is fixed to the left face of the plate 5 as by being vulcanized thereto, and the sealing disk 8 is provided at its outer periphery with an annular flange 9 engaging the inner cylindrical face of the cylinder 1 in a fluid-tight manner and being slidable therealong, the flange 9 surrounding the outer periphery of the plate 5, in the manner shown in Fig. 1, and the sealing disk 8

further including at its inner periphery a tubular projection 10 extending to the left along the hollow piston rod 7 so that in this way a seal is provided between the piston and the cylinder on the one hand and the piston rod on the other hand, the piston 5 being axially slidable in both directions with respect to the piston rod 7.

The piston separates the working chamber 4 in the interior of cylinder 1 on the left side of the piston, as viewed in Fig. 1, from the residual air chamber 11 in the interior of the cylinder 1 on the right side of the piston, as viewed in Fig. 1. The piston moves to the right, as viewed in Fig. 1, along its working stroke upon entry of air under pressure into the working chamber 4, and during this working stroke the volume of chamber 4 increases while the volume of chamber 11 decreases, and during the return stroke of the piston, when the pressure in the chamber 4 decreases, the volume of chamber 11 increases while the volume of chamber 4 decreases.

The right end portion of the hollow piston rod 7 is guided for axial movement in a known way by the right end wall 25 connected to the cylinder 1 by screw means 26 as shown in Fig. 1. The end wall 25 serves as abutment for the right end of the spring 24 and furthermore a means 27 such as a suitable non-return valve is provided in the end wall 25 for permitting air in the chamber 11 to discharge from the interior of the cylinder during the working stroke of the piston but preventing any air or other fluid from moving into the interior of the chamber 11 during the return stroke of the piston. This means 27 is shown in the form of a substantially U-shaped rubber ring, the inner flange of which is held by an annular spring spiral 28 against the outer surface of the hollow piston rod 7 whereas the outer flange of the rubber ring abuts against the cup-shaped portion 25' of the end wall 25. When the pressure in the interior of the chamber 11 increases during the working stroke of the piston, the rubber ring 27 will be deformed to permit discharge of air from the interior of the cylinder 1 through the opening 29 formed in the end wall 25, however, the ring 27 will prevent any fluid from moving into the chamber 11 during the return stroke of the piston.

A strong metal cap 12 is threaded onto the left free end portion of the hollow piston rod 7 to close the left end of the tubular piston rod 7 in a fluid-tight manner, and the cap 12 is formed with a bulged central portion providing a depression 13 into which an end of the piston rod 14 extends, this piston rod 14 having its left end, as viewed in Fig. 1, located in the depression 13 as a result of the return force of the brake structure. The piston rod 14 and the structure which coacts therewith is purely conventional, and this piston rod 14 carries in a conventional way a guide disk 15 which has an outer periphery located next to the inner cylindrical face of the tube 7.

An annular projection 16 extending from the cap 12, as by being formed integrally therewith, toward the piston 5 forms together with the cap 12 a first stop means for limiting the movement of the piston means to the left, as viewed in Fig. 1, with respect to the piston rod 7, and in the residual air chamber 11 there is located a second stop means in the form of an annular ring 17 of stepped cross section which is fixed to the outer face of the rod 7 as by being welded thereto, the stop means 17 limiting the movement of the piston rod means to the right, as viewed in Fig. 1, with respect to the hollow piston rod 7.

A coil spring 18 is coiled about the rod 7 and engages the stop 17 and the piston 5 to urge the latter to the left, as viewed in Fig. 1, into engagement with the stop means 16 when the brake is fully released.

The piston 5 is formed with one or more bores 19 of very small cross section, and the sealing disk 8 is formed with one or more bores 20 respectively in register with the bores 19, as shown in Fig. 1, so that when the brake is released the chambers 4 and 11 are placed in communication with each other through the bores 19.

When the pressure in the working chamber 4 increases to shift the piston to the right, as viewed in Fig. 1, with respect to the rod 7, the bore or bores 19 move into engagement with one or more sealing disks 21, respectively, which thus close the bores 19 and prevent communication between the chambers 4 and 11. The piston member 5 is provided with three projections extending from its right face, as viewed in Fig. 1, toward the stop ring 17, these projections being located at the same radial distance from the axis of the cylinder as the bore 19 and being spaced from each other by equal angular distances. The projections engage the stop ring 17 and having such a length that the sealing disk 21 is compressed sufficiently in order to close the bore 19 and at the same time the major force is transmitted to the stop ring 17, these projections also serving to prevent tilting of the piston 5 with respect to the piston rod 7. In other words these projections have a length to the right of the plate 5, as viewed in Fig. 1, which is slightly less than the thickness of the disk 21.

The ring 17 is furthermore formed with a bore 22 into which freely extends with sufficient clearance a pin 23 fixed to the plate 5 as by being riveted thereto, so that in this way angular turning of the piston 5 with respect to the rod 7 is prevented.

A return spring 24 is coiled about the piston rod 7, bears with its unillustrated right end against the unillustrated right end wall of the cylinder 1, and bears with its left end against the stop ring 17 in order to urge the piston means to the left, as viewed in Fig. 1, back to its rest position, spring 24 being stronger than the spring 18, and in the rest position of the parts the cap 12 engages the tubular extension 3 of the end wall 2 of the cylinder 1.

To apply the brakes air under pressure is admitted into the working chamber 4. A part of this air passes through the bore or bores 19 into the residual air chamber 11, but because of the small cross section of the bore or bores 19 the air pressure in the working chamber 4 quickly builds up, so that the piston 5 is moved against the force of spring 18 toward the stop means 17 until the bore or bores 19 are closed by the sealing disk or disks 21 in order to cut off communication between the chambers 4 and 11. The spring 18 has such a size that the closing of the chambers 4 and 11 from each other takes place at a pressure of approximately 0.3 atmosphere above atmospheric pressure, and this is the pressure at which the braking force starts to become applied in conventional brake installations.

Upon admission of further air under pressure into the working chamber 4, the pressure in the latter increases, and the piston 5 is shifted to the right, as viewed in Fig. 1, along its working stroke, this piston 5 acting on the stop means 17 to shift the piston rods 7 and 14 together with the piston 5. Because of the above described means such as a non-return valve communicating with the working chamber 11, the air which is compressed in the residual air chamber 11 moves outwardly to the exterior of the cylinder 1, and the braking action takes place in a manner which prevents any air loss.

When the air under pressure is discharged from the chamber 4 to reduce the pressure therein in order to release the brakes, the tube 7 is urged together with the piston back to its rest position along its return stroke by the return spring 24. The bore or bores 19 remain closed, and no air or other fluid enters into the residual air chamber 11 either from the exterior of the cylinder or from the working chamber 4. The pressure in the working chamber 4 drops very quickly and arrives at the above mentioned pressure of 0.3 atmosphere above atmoshperic pressure and then drops beneath this latter pressure. At this time the spring 18 is capable of shifting the piston 5

to the left, as viewed in Fig. 1, with respect to the tube 7, and as a result of this shifting of the position 5 the bore or bores 19 are opened and pressure equalization between chambers 11 and 4 can take place.

The embodiment of the invention which is shown in Fig. 2 is particularly suitable for cylinders of large diameter.

The cylinder 31 of the embodiment of Fig. 2 is provided at its left end wall 32 with a tubular extension 33, in the same way as the embodiment of Fig. 1. A piston 34 made of sheet steel reciprocates in the interior of the cylinder 31 and is provided at its outer periphery with a sealing ring 35. At its central portion the piston 34 is provided with a hollow, cup-shaped hub portion 36 whose hollow interior is directed toward the end wall 32. A plug 37 is threaded onto the piston 34 to close the interior of the hub portion 36 in a fluid-tight manner.

The hollow, cylindrical, hub portion 36 of the piston 34 extends freely into the open left end of the hollow piston rod 38 which corresponds in all respects to the piston rod 7, so that in this way the piston 34 is guided for free axial movement with respect to the hollow piston rod 38. In the interior of the hollow piston rod 38, adjacent to its left open end, as viewed in Fig. 2, there is fixed, as by welding or the like, a disk 39 extending across the interior of the piston rod 38 and having affixed thereto a non-circular guide member 40, of square cross section, for example, which extends to the left from the disk 39, as viewed in Fig. 2, and a threaded member 41 is fixed to the guide member 40 and extends to the left therefrom, as viewed in Fig. 2.

The piston 34 is formed in the central portion of the hub 36 thereof with an opening of a non-circular cross section mating with the cross section of the guide member 40, and the latter extends through this opening in order to guide the piston 34 while preventing turning thereof with respect to the piston rod 38. A nut 44 is threaded onto the threaded portion 41, and a coil spring 43 is coiled about the guide member 40 and engages disk 39 and hub portion 36 to urge the piston 34 to the left, as viewed in Fig. 2, the piston 34 engaging the nut 44 in the rest position of the parts.

The hollow piston rod 38 carries a stop ring 45 which is fixed to the tubular rod 38 as by being welded thereto, and this stop ring 45 carries a sealing disk 46 located opposite a bore 47 formed in the piston 34, so that when the latter moves to the right, as viewed in Fig. 2, against the force of the spring 43, the bore 47 will be closed by the sealing disk 46 in order to cut off communication between the working and residual air chambers of the cylinder 31, in the same way as was described above in connection with Fig. 1.

Three projections 48 are formed integrally with the stop ring 45 and extend from the latter toward the piston 34 to limit the movement of the latter to the right, as viewed in Fig. 2, with respect to the hollow piston rod 38. These projections 48, of which only one is shown in Fig. 2, correspond to the above described projections fixed to the piston 5 and not shown in the drawings. Thus, the projections 48 are located at the same radial distance from the cylinder axis as the bore 47, are angularly spaced from each other by 120°, and have a length slightly less than the thickness of the sealing ring 46. Thus, the latter will not be excessively loaded but will still be capable of closing the bore 47 while the force of the piston will be transferred to the piston rod 38 and the piston 34 also will not tilt with respect to the piston rod 38.

A return spring 49 is coiled about the hollow piston rod 38, bears with its left end against the stop ring 45, as viewed in Fig. 2, and bears with its right end against the unillustrated right end wall of the cylinder 31. The structure of the cylinder and the piston rod means at the residual air chamber side of piston 34 corresponds in all respects to the above described structure of Fig. 1. A piston rod 51 with a guide disk 52 are located in the hollow piston rod 38, elements 51 and 52 corresponding in all respect to elements 14 and 15, although the left end of piston rod 51 cooperates with a depression in the right face of the disk 39, as shown in Fig. 2.

The operation of the embodiment of Fig. 2 corresponds in all respects with respect to the cooperation of bore 47 of cylinder 34 with the sealing ring 46 and with respect to the guiding of the piston on the piston rod 38 and cooperation with the stop ring 45 to the above described operation of the embodiment of Fig. 1.

A relatively small axial play of the piston on the hollow piston rod is sufficient for the above described operation of the structure of the invention. Moreover, the invention may also be used with cylinders having pistons which do not cooperate with a special hollow piston rod but which instead are provided with piston rods guided by an end wall of the cylinder. Moreover, other control arrangements may be provided, such as, providing a throttling passage in the hollow piston rod and providing the piston with a control disk or the like which moves with the piston for closing and opening such a passage. Also, the piston may be provided with a controlling ring piston, or the piston may be in the form of a flexible membrane type of piston.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of pneumatic arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in pneumatic arrangements for air brakes, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A pneumatic arrangement comprising, in combination, piston means; a cylinder housing said piston means and guiding the same for reciprocating movement in said cylinder in one direction along a working stroke and in an opposite direction along a return stroke, said cylinder having on one side of said piston means a working chamber and on the opposite side of said piston means a residual air chamber; air passage means communicating with one end of said cylinder for admitting air under pressure only into said working chamber for moving said piston means along its working stroke and for discharging air from said working chamber during the return stroke of said piston means, the volume of said working chamber increasing and the volume of said residual air chamber decreasing during the working stroke of said piston means and the volume of said residual air chamber increasing and the volume of said working chamber decreasing during the return stroke of said piston means; means at the other end of said cylinder permitting air to move only outwardly of said residual air chamber during the working stroke of said piston means while sealing said other end of said cylinder during the return stroke of said piston means; and means for providing communication between said working chamber and residual air chamber during the return stroke of said piston means when the pressure in said working chamber is within a predetermined range to provide at least a limited pressure equalization between said working chamber and residual air chamber.

2. A pneumatic arrangement comprising, in combina-

tion, a cylinder having a working chamber and a residual air chamber; piston rod means extending axially along the interior of said cylinder; piston means freely surrounding said piston rod means for free axial movement in opposite directions therealong, said piston means separating said working chamber and said residual air chamber from each other; stop means carried by said piston rod means for limiting the movement of said piston means axially with respect to said piston rod means; passage means of relatively small cross section providing communication between said working chamber and said residual air chamber; and means for closing said passage means when said piston means engages said stop means during an increase of pressure in said working chamber and for opening said passage means when said piston means moves away from said stop means during a decrease of pressure in said working chamber.

3. A pneumatic arrangement comprising, in combination, a cylinder having a working chamber and a residual air chamber; piston rod means extending axially along the interior of said cylinder; piston means in said cylinder freely surrounding said piston rod means for axial movement with respect to the latter, said piston means being formed with a bore of relatively small cross section passing therethrough and providing communication between said working chamber and said residual air chamber, said piston means separating said working chamber and residual air chamber from each other; stop means carried by said piston rod means for limiting the axial movement of said piston means with respect to said piston rod means and for closing and opening said bore of said piston means; and spring means engaging said piston means and stop means for urging said piston means away from said stop means to open said bore, said piston means being moved into engagement with said stop means when the pressure in said working chamber increases to a value great enough to move said piston means along said piston rod means against the force of said spring means into engagement with said stop means.

4. A pneumatic arrangement comprising, in combination, a cylinder having a working chamber and a residual air chamber; piston rod means extending axially along the interior of said cylinder; piston means freely surrounding said piston rod means for free axial movement in opposite directions therealong, said piston means separating said working chamber and said residual air chamber from each other; stop means carried by said piston rod means for limiting the movement of said piston means axially with respect to said piston rod means; passage means of relatively small cross section providing communication between said working chamber and said residual air chamber; means for closing said passage means when said piston means engages said stop means during an increase of pressure in said working chamber and for opening said passage means when said piston means moves away from said stop means during a decrease of pressure in said working chamber; and means operatively connected to said piston means for preventing angular turning thereof with respect to said piston rod means.

5. A pneumatic arrangement comprising, in combination, a cylinder having a working chamber and a residual air chamber; piston rod means extending axially along the interior of said cylinder; piston means freely surrounding said piston rod means for free axial movement in opposite directions therealong, said piston means separating said working chamber and said residual air chamber from each other; stop means carried by said piston rod means for limiting the movement of said piston means axially with respect to said piston rod means; passage means of relatively small cross section providing communication between said working chamber and said residual air chamber; means for closing said passage means when said piston means engages said stop means during an increase of pressure in said working chamber and for opening said passage means when said piston means moves away from said stop means during a decrease of pressure in said working chamber; and means for preventing tilting of said piston with respect to said piston rod means when said passage means is closed.

6. A pneumatic arrangement comprising, in combination, a cylinder having in its interior a working chamber and a residual air chamber; elongated piston rod means extending axially along the interior of said cylinder and adapted to reciprocate axially therein; annular piston means freely surrounding said piston rod means for free axial movement with respect to the same, said piston means separating said working chamber and residual air chamber from each other and said piston means being formed with at least one bore of relatively small cross section providing communication between said working chamber and residual air chamber; a pair of stop means respectively carried by said piston rod means in said working chamber and said residual air chamber and respectively directed toward opposite faces of said piston means for limiting the movement of the latter axially with respect to said piston rod means; first spring means engaging said piston rod means for urging the same and said piston therewith along a return stroke where the volume of said working chamber decreases and the volume of said residual air chamber increases; second spring means located between said piston means and said stop means in said residual air chamber and being weaker than said first spring means for urging said piston means away from said stop means in said residual air chamber; and means carried by said stop means in said residual air chamber for closing said bore of said piston means when the latter moves against the force of said second spring means into engagement with said stop means in said residual air chamber.

7. In a pneumatic arrangement, in combination, elongated piston rod means; piston means freely movable axially with respect to said piston rod means and having a wall portion formed with a bore of relatively small cross section providing communication between chambers on opposite sides of said piston means; stop means carried by said piston rod means for limiting the movement of said piston means with respect to said piston rod means, said stop means having a wall portion spaced from and directed towards said wall portion of said piston means; a sealing member carried by said stop means opposite said bore of said piston means for closing said bore when said piston means moves toward said stop means; and a projection on one of said wall portions extending toward the other of said wall portions and limiting the movement of said piston means toward said stop means to an extent permitting said sealing member to close said bore while transferring the full load of said piston means to said stop means.

8. In a pneumatic arrangement, in combination, a cylinder having a working chamber and a residual air chamber; a hollow piston rod extending axially along said cylinder; a member fixed to and extending across the interior of said piston rod; a piston separating said working chamber and said residual air chamber from each other and having a hub portion extending freely into the interior of said piston rod so that said piston is freely movable in an axial direction with respect to said piston rod, said hub portion being formed with an opening in a wall of said hub portion directed toward said member fixed in the interior of said piston rod and said piston being formed with a bore of relatively small cross section providing communication between said working chamber and said residual air chamber; a guide member fixed to said member in said piston rod and extending through said opening of said piston for guiding the latter for reciprocating movement with respect to said piston rod; stop means limiting the movement of said piston with respect to said piston rod; a sealing member carried by said stop means for closing said bore when said piston moves toward said stop means; and a closure member

located in said working chamber and closing said hub portion of said piston.

9. In a pneumatic arrangement, in combination, a hollow piston rod having an open end; a disk fixed to said piston rod in the interior thereof adjacent to but spaced from said open end thereof; a non-circular guide member fixed to said disk and extending axially along the interior of said hollow piston rod toward said open end thereof; a piston located adjacent said open end of said piston rod and having a hollow hub portion extending freely into the interior of said open end of said piston rod so that the piston is freely movable axially with respect to said piston rod, said hub portion having an opening of the same cross section as said guide member into which the latter extends so that said guide member guides said piston for axial movement with respect to said piston rod and prevents angular turning of said piston with respect to said piston rod, said piston having a wall portion formed with an opening of relatively small cross section passing therethrough to provide communication between chambers on opposite sides of said piston; stop means carried by said piston rod for limiting the movement of said piston with respect to said piston rod; and a sealing member carried by said stop means for closing said opening of said piston when the latter moves axially in a given direction with respect to said piston rod.

10. A pneumatic arrangement comprising, in combination, a cylinder having a working chamber and a residual air chamber therein; an annular piston member axially slidable along the interior of said cylinder and separating said working chamber and residual air chamber from each other, said annular piston having a central opening and being formed with a bore of relatively small cross section providing communication between said chambers; a piston rod extending freely through said opening of said piston, so that the latter is freely movable axially with respect to said piston rod; a pair of stops fixed to said piston rod respectively in said chambers for limiting the axial movement of said piston with respect to said piston rod, one of said stops being formed with an opening passing therethrough and the stop in said residual air chamber having thereon a sealing member for closing said bore of said piston when the latter moves toward said stop in said residual air chamber; and a pin fixed to said piston and extending through said opening of said one stop for preventing angular turning of said piston with respect to said piston rod.



11. In a pneumatic arrangement, in combination, a cylinder having a working chamber and a residual air chamber; a hollow piston rod extending axially along the interior of said cylinder; a disk fixed to and extending across the interior of said hollow piston rod; a piston separating said working chamber and said residual air chamber from each other and having a hollow, cup-shaped hub portion extending freely into the interior of said piston rod so that said piston is freely movable with respect to said piston rod, said hub portion of said piston having a wall directed toward said disk formed with an opening of non-circular cross section; a guide member fixed to said disk, extending through said opening in said wall of said hub portion of said piston and having the same cross section as said opening so that said piston is guided for axial movement with respect to said piston rod by said guide member and is prevented from angular turning with respect to said piston rod by said guide member, said piston being formed with a bore of relatively small cross section providing communication between said working chamber and said residual air chamber; stop means carried by said piston rod for limiting the movement of said piston; a sealing member carried by said stop means for closing said bore when said piston moves toward said stop means; and a closure member located in said working chamber and closing said hollow cup-shaped portion of said piston for preventing communication between said working chamber and the interior of said cup-shaped hub portion of said piston.


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