May 1, 1956 L. C. MILLER 2,743,703

PNEUMATIC ACTUATOR HAVING TANDEM POWER CYLINDERS

Filed July 7, 1952 2 Sheets-Sheet 1

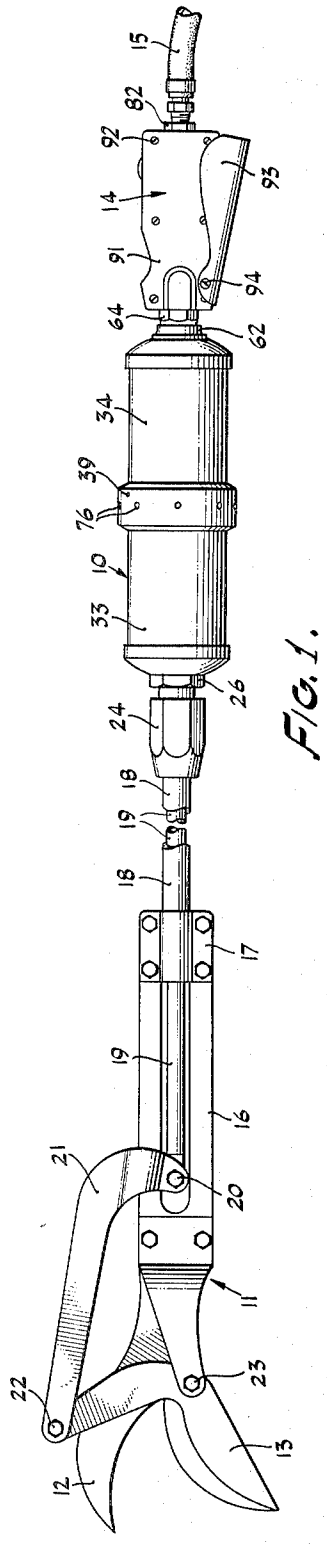

FIG. 1.

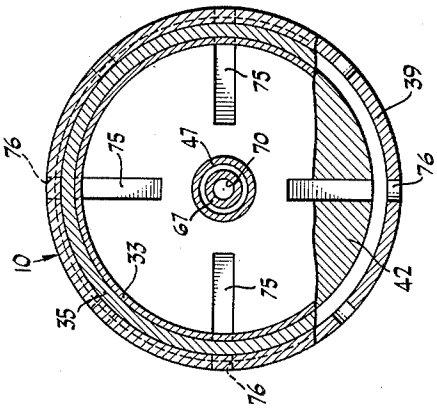

FIG. 4.

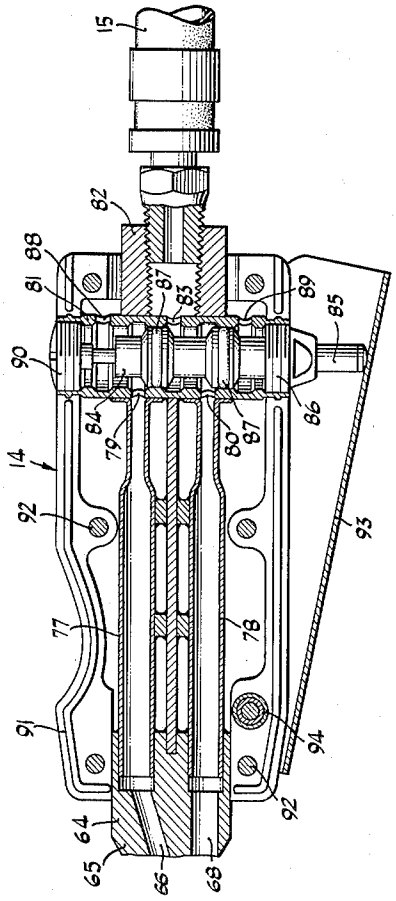

FIG. 5.

LEONIDAS C. MILLER
INVENTOR.

BY Lyon & Lyon
ATTORNEYS

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Filed July 7, 1952 2 Sheets-Sheet 2

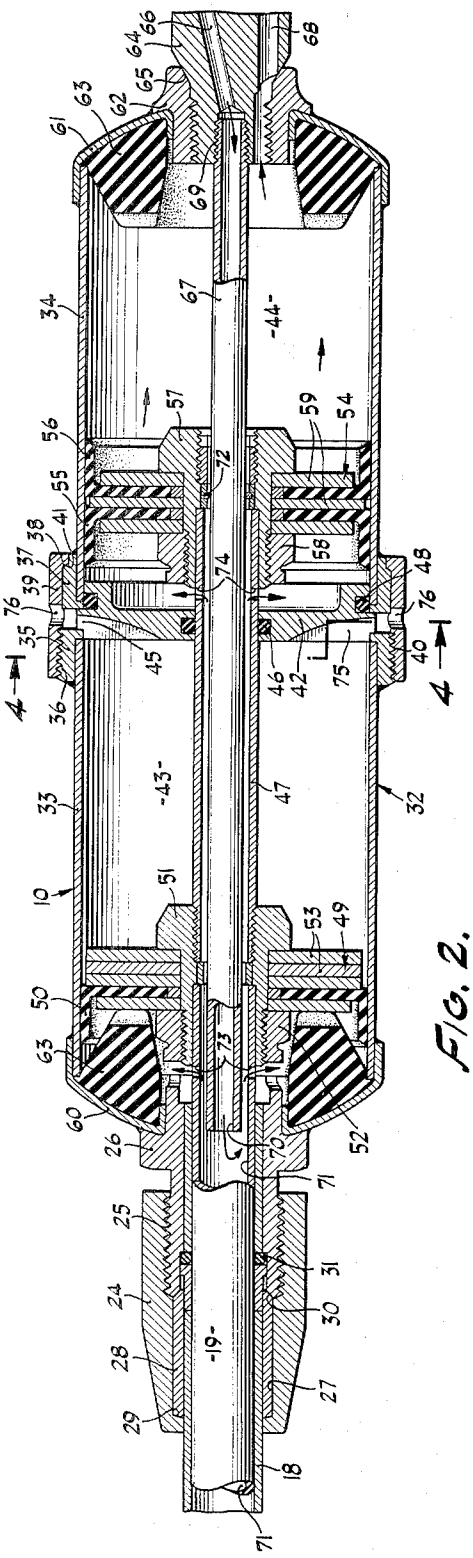

FIG. 2.

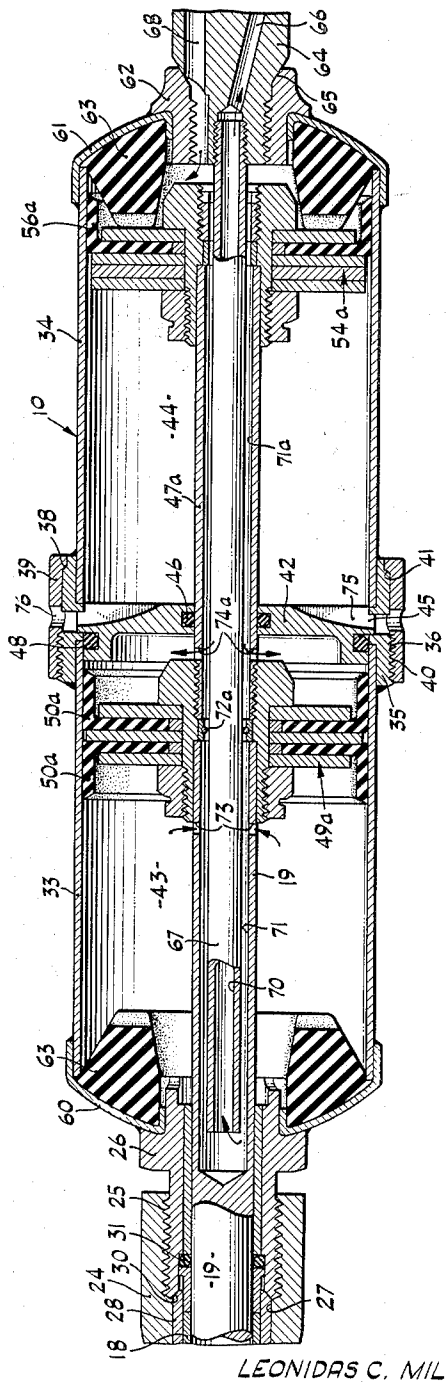

FIG. 3.

LEONIDAS C. MILLER
INVENTOR.

BY Lyon & Lyon

ATTORNEYS

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PNEUMATIC ACTUATOR HAVING TANDEM POWER CYLINDERS

Leonidas C. Miller, Los Angeles, Calif.

Application July 7, 1952, Serial No. 297,481

9 Claims. (Cl. 121—38)

This invention relates to portable power operated tools and is particularly directed to improvements in reciprocating pneumatic actuators for such tools. Cutting tools employing relatively movable blades commonly require a greater amount of force on the pull stroke than on the push stroke, or vice versa. The greatest force is required on the power stroke or cutting stroke, and a lesser amount of force is required to restore the position of the cutting tools to their initial position. It is often desirable to employ interchangeable cutting heads with a given pneumatic actuator and control valve assembly, but in devices commercially available it is not possible to adjust or otherwise change the actuator mechanism to produce the greatest power on the pull stroke or push stroke as required. For example, if an operator has two cutting tools which are interchangeable in their connection to the actuator assembly, and if one of them requires maximum power on the pull stroke while the other requires maximum power on the push stroke, the single actuator assembly cannot be employed efficiently for actuation of both of the tools.

Accordingly, it is the principal object of my invention to provide an improved form of reciprocating pneumatic actuator which is so constructed that it can be readily converted to produce maximum thrust on either the pull stroke or push stroke as desired.

Another object is to provide a device of this type for actuation of a tool, the device employing a pair of power cylinders mounted in tandem.

Another object is to provide a device of this type having tandem power cylinders which is so constructed that it can be readily converted to make either of the power cylinder assemblies double-acting and the other single-acting.

Another important object of my invention is to provide a power tool actuator having a pair of power cylinder assemblies acting in tandem so that a greater force can be produced on the power stroke from a given source of pressure fluid and without increasing the outer diameter of the actuator.

Other and more detailed objects and advantages will appear hereinafter.

In the drawings:

Figure 1 is a side elevation showing a portable power tool embodying my invention.

Figure 2 is a longitudinal section of the pneumatic actuator embodying my invention and showing the parts assembled to produce greater thrust on the pull stroke than the push stroke.

Figure 3 is a view similar to Figure 2 showing the parts assembled to produce greater thrust on the push stroke than the pull stroke.

Figure 4 is a transverse sectional view taken substantially on the line 4—4 as shown in Figure 2.

Figure 5 is a longitudinal sectional view showing construction of the control valve assembly.

Referring to the drawings, the portable power operated tool shown in Figure 1 includes a reciprocating

pneumatic actuator 10 connected to operate the work member 11. The work member 11 may comprise any one of a number of tools, and as shown in the drawings comprises a pruning shear having a stationary blade 12 and a movable blade 13. A control valve assembly 14 is connected to the pneumatic actuator 10. A hose 15 supplies a pressure fluid such as compressed air to the control valve assembly 14.

The shear assembly 11 includes a frame or body 16 having a bracket 17 for securing the body 16 to a stationary support tube 18. A piston rod member 19 is guided for sliding movement within the support tube 18. This piston rod member 19 is connected by pivot pin 20 to the operating link 21 which is in turn connected to the movable blade 13 by means of pivot pin 22. The blade 13 is pivotally connected to the body 16 by means of the pivot bolt 23. From this description it will be understood that reciprocation of the piston rod member 19 serves to open and close the movable blade 13 with respect to the stationary blade 12.

The stationary support tube 18 is connected to the pneumatic actuator 10 by means of the coupling collar 24 which engages the threads 25 on the fitting 26. The collar 24 is provided with a counterbore 27 which receives the ring 28 fixed on the support tube 18. The shoulder 29 on the coupling collar 25 clamps the ring 28 against the shoulder 30 on the fitting 26 and also serves to compress the packing ring 31 about the piston rod member 19. This coupling collar is shown and described in my copending application, Serial No. 273,058, filed February 23, 1952, for Power Operated Tool.

In accordance with my invention, the housing 32 of the pneumatic actuator 10 comprises a pair of cylindrical shells 33 and 34 connected coaxially end-to-end. An annular rim 35 is fixed to the shell 33, and this rim is provided with external threads 36. A rim 37 is fixed to the shell 34, and this rim is provided with a taper shoulder 38. An apertured clamp ring 39 has internal threads 40 which engage the external threads 36. The clamp ring 39 also has a taper shoulder 41 which engages the taper shoulder 38.

A barrier disk 42 is mounted within the housing member 32 and serves to divide the interior of the housing into a front chamber 43 and a rear chamber 44. This barrier disk has a radially projecting annular lip or rim 45 which is clamped between the rims 35 and 37 by means of the clamp ring 39. A seal ring 46 on the barrier disk 42 slidably engages the tubular piston rod section 47. Another seal ring 48 on the barrier disk 42 seals within one of the shells 33 and 34, and as shown in Figure 2 engages the inner surface of the shell 34.

A piston 49 is fixed relative to the piston rod member 19 and is provided with a cup-shaped seal ring 50 which engages the inner surface of the shell 33 in sliding contact. The piston includes a hub 51 and a ring 52 threadedly connected thereto and clamping a plurality of disks 53 and the seal ring 50 therebetween. The hub 51 is fixed to the piston rod member 19 by any convenient means, such as, for example, by brazing.

The piston 54 is fixed relative to the piston rod element 47 and is provided with oppositely directed cup-shaped seal rings 55 and 56 which engage the inner surface of the cylindrical shell 34. The piston 54 includes the hub 57 and the ring 58 which clamp the plates 59 and seal rings 55 and 56 therebetween. The hub 57 is fixed to the piston rod element 47 by any convenient means such as, for example, by brazing. The piston rod element 47 comprises a part of the piston rod member 19 so that the pistons 49 and 54 are fixed in axially spaced position and operate in unison.

An end member 60 connects the shell 33 to the fitting 26, and similarly, an end member 61 connects the shell 34

to the bushing 62. Rubber bumper blocks 63 are mounted on the end members 60 and 61 and serve to cushion the action of the pistons 49 and 54 at the ends of their stroke. The bushing 62 is internally threaded to receive the external threads on the forward end of the control valve fitting 64. A pressure-tight connection is effected by means of the mating taper surfaces 65. The fitting 64 has a first passage 66 communicating with the spear tube 67 and a second passage 68 communicating directly with the chamber 44. The spear tube 67 is connected to the fitting 64 by means of threads 69. The spear tube 67 projects axially into the tubular piston rod member 19 in telescopic relationship. The spear tube 67 is open at its projecting end as shown at 70. The central bore 71 in the piston rod member 19 is sufficiently long to accommodate the spear tube 67 when the pistons 49 and 54 are at the rear end of their stroke. As shown in Figure 2, a seal ring 72 is provided on the piston 54 and slidably engages the outer surface of the spear tube 67.

When compressed air is admitted through passage 66 into the interior of the spear tube 67 it passes through the open end of the tube 70 into the bore 71 of the hollow piston rod member 19. The compressed air then passes outward through radial ports 73 in the wall of the piston rod member 19 and into the forward end of the chamber 43 on the left of the piston 49 as viewed in Figure 2. Compressed air also passes through radial ports 74 in the wall of the piston rod element 47 and into the forward end of the chamber 44 between the barrier disk 42 and the piston 54.

This air pressure as applied on the left side of the pistons 49 and 54 causes the pistons and piston rod member 19 to move to the right as viewed in Figure 2. The air within the chamber 43 between the piston 49 and barrier disk 42 is vented through passages 75 in the barrier disk 42 and through the ports 76 in the apertured clamping ring 39. The air in the chamber 44 to the right of the piston 54 is vented through passage 68 in the fitting 64. It will be observed that both pistons are effective to move the piston rod 19 to the right as viewed in Figure 2.

When air under pressure is supplied through passage 68 and exhausted through passage 66, the chamber 44 to the right of the piston 54 is pressurized. The air trapped in the space between the piston 54 and barrier disk 42 is vented through ports 74 into the interior of the hollow piston rod element 47 and into the open end 70 of the spear tube 67. Similarly, the air trapped in the chamber 43 to the left of the piston 49 is vented through ports 73 into the bore 71 of the piston rod member 19 and through the spear tube 67. Air enters the chamber 43 between the piston rod 49 and barrier disk 42 via port 76 and passages 75 in the barrier disk 42. It will be observed that only the piston 54 is effective to move the piston rod member 19 to the left as viewed in Figure 2. Accordingly, greater force is available to retract the piston rod member 19 than to project it. This is desirable because the shear 11 performs a cutting stroke when the piston rod member 19 is retracted. Less force is required to open the shear blade 13.

The control valve assembly 14 is similar to that shown and described in my copending application, Serial No. 272,956, filed February 23, 1952, for Control Valve for Portable Tool now Patent No. 2,709,446. As shown in Figure 5, this control valve assembly includes a pair of parallel tubes 77 and 78 connected to the fitting 64 and communicating with the first passage 66 and the second passage 68 respectively. These tubes communicate with lateral ports 79 and 80 in a transverse valve housing 81. A threaded inlet fitting 82 also communicates with the valve housing 81 through lateral port 83. A valve spool 84 is mounted for movement axially of the housing 81. A coil spring (not shown) is mounted within the spool 84 and serves to move it to the position shown. A stem 85 on the spool 84 projects slidably through a bushing 86 mounted on one end of the housing 81. Spaced seals 87 on the valve spool 84 seal within "lands" within the housing 81. When the spool 84 is in the position shown in Figure 5, air pressure supplied through hose 15 passes into the port 83 and out through port 80 into tube 78 and passage 68. At the same time, air pressure is vented through passage 66, tube 77, port 79 and vent port 88. When the stem 85 is depressed the spool 84 is shifted so that air entering port 83 passes out through port 79, tube 77 and through passage 66. At the same time passage 68 is vented through tube 78, port 80 and vent port 89. The bushing 86 and plug 90 may be changed end for end in the housing 81 and the spool 84 inserted in reversed position if desired in order that passage 66 or 68 may normally be pressurized. This feature of the control valve assembly is set forth in detail in said copending application, Serial No. 272,956 now Patent No. 2,709,446. The handle 91 is split into two halves held together by fasteners 92. A lever 93 pivoted to the handle at 94 is used for operating the valve stem 85.

While some tools require greater power on the pull stroke, as described above, certain other tools operate more effectively when the greater thrust is applied on the push stroke. The tandem cylinder arrangement of my invention can be readily adapted to the latter requirement for supplying greater thrust on the push stroke. This arrangement of the parts is shown in Figure 3. The piston 49*a* is provided with two oppositely directed sealing cups 50*a*, and the piston 54*a* is provided with a single sealing cup 56*a*. The barrier disk 42 is reversed in its position so that its outer seal ring 48 engages the inner surface of the shell 33 and so that its passages 75 serve to vent the forward end of the chamber 44 through the apertured clamping ring 39. The piston rod element 47 is replaced by the piston rod element 47*a* which has ports 74*a* at its forward end instead of at its rear end. The seal ring 72 is removed from its position within piston 54 and is placed at a new position at 72*a* within piston 49*a*.

When this rearrangement of the parts has been effected the tandem cylinder arrangement operates to apply the greater thrust to the push stroke. Thus, when air pressure is admitted through the first passage 68 in fitting 64 the space within the rear chamber 44 to the left of the piston 54*a* is pressurized while the space between the barrier disk 42 and piston 54*a* is vented through passages 75 and ports 76. Air pressure also passes into the interior of the piston rod element 47*a* and out through ports 74*a* into the chamber 43 between the barrier disk 42 and piston 49*a*. The forward end of the chamber 43 is vented through ports 73, bore 71, spear tube 67 and first passage 66. When compressed air is supplied through first passage 66 the forward end of the front chamber 43 is pressurized through ports 73, while the space between the piston 49*a* and barrier disk 42 is vented through ports 74*a*, bore 71*a* and second passage 68. At the same time the space to the right of the piston 54*a* is also vented through second passage 68. Air is drawn into the forward end of chamber 44 through ports 76 and passages 75.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details herein set forth, but my invention is of the full scope of the appended claims.

I claim:

1. In a reciprocating pneumatic actuator for a power tool, the combination of: a cylindrical housing member comprising a pair of cylindrical shells, means removably connecting the shells coaxially end to end, a tubular piston rod member extending coaxially into both of said shells and projecting through one end of the housing member, a barrier element clamped between adjacent ends of said shells and cooperating with said shells and said piston rod member to define a forward chamber and a rear chamber, a pair of pistons fixed on

the piston rod member, each of the pistons being mounted within one of the chambers and forming a sliding seal within one of the shells, the tubular piston rod member having a first port in a wall thereof communicating with the forward port of the forward chamber and a second port in a wall thereof communicating with the second chamber, and means including a spear tube mounted at the other end of the housing member projecting axially into the interior of the tubular piston rod member for introducing fluid pressure therein.

2. A reciprocating pneumatic actuator for a power tool, comprising in combination: a cylindrical housing member comprising a pair of cylindrical shells connected coaxially end to end, a tubular piston rod member extending coaxially into both of said shells and projecting through one end of one of said shells, a control valve assembly connected to the remote end of the other shell, a barrier element removably secured to and interposed between the adjacent ends of said shells, means forming a sliding seal between the barrier element and said piston rod member, said barrier element cooperating with said shells and said piston rod member to define a first chamber and a second chamber, a first piston fixed on the piston rod member mounted within the first chamber and forming a sliding seal within the first shell, a second piston fixed on the piston rod member within the second chamber and forming a sliding seal within the second shell, the tubular piston rod member having a first port in a wall thereof in advance of the first piston and communicating with the first chamber, and having a second port in a wall thereof communicating with the second chamber, and means including a spear tube attached to the control valve assembly and projecting axially into the interior of the tubular piston rod member for introducing fluid pressure therein.

3. In a reciprocating pneumatic actuator for a power tool, the combination of: a cylindrical housing member, a tubular piston rod member extending coaxially within the housing member, a pair of axially spaced pistons fixed on the piston rod member and each slidably engaging the housing member, a barrier element fixed within said housing member and slidably engaging the piston rod member in sealing relationship at a location between said pistons, said barrier element dividing the interior of the housing member into a front chamber and a rear chamber, means forming a sliding seal between the forward end of the front chamber and said piston rod member, a fitting mounted at the rear end of the rear chamber and provided with a first passage and a second passage, an axially immovable spear tube connected to said fitting and communicating with said first passage, the spear tube extending telescopically within said tubular piston rod member, seal means on the piston rod member adjacent one of the pistons slidably engaging the spear tube, a port in the wall of the tubular piston rod member establishing communication between the spear tube and the forward end of said front chamber, the housing member having a port therein adjacent the barrier element serving to vent one end of one of the chambers to atmosphere, another port in the wall of the tubular piston rod member establishing communication between one of said passages and the other chamber adjacent the barrier element, the said second passage communicating with the rear end of the rear chamber.

4. In a reciprocating pneumatic actuator for a power tool, the combination of: a cylindrical housing member, a tubular piston rod member extending coaxially within the housing member, front and rear pistons fixed on the piston rod member and each slidably engaging the housing member, a barrier element fixed within said housing member and having a sliding seal with the piston rod member at a location between said pistons, said barrier element dividing the interior of the housing member into a front chamber and a rear chamber, means forming a sliding seal between the forward end of the front chamber and said piston rod member, a fitting mounted at the rear end of the rear chamber and provided with a first passage and a second passage, an axially immovable spear tube connected to said fitting and communicating with said first passage, the spear tube extending telescopically within said tubular piston rod member, seal means on the piston rod member adjacent the rear piston slidably engaging the spear tube, a port in the wall of the tubular piston rod member establishing communication between the spear tube and the forward end of said front chamber, the housing member having a port therein adjacent the barrier element serving to vent the rear end of the front chamber to atmosphere, another port in the wall of the tubular piston rod member establishing communication between the spear tube and the forward end of the rear chamber, the said second passage communicating with the rear end of the rear chamber.

5. In a reciprocating pneumatic actuator for a power tool, the combination of: a cylindrical housing member, a tubular piston rod member extending coaxially within the housing member, front and rear pistons fixed on the piston rod member and each slidably engaging the housing member, a barrier element fixed within said housing member and having a sliding seal with the piston rod member at a location between said pistons, said barrier element dividing the interior of the housing member into a front chamber and a rear chamber, means forming a sliding seal between the forward end of the front chamber and said piston rod member, a fitting mounted at the rear end of the rear chamber and provided with a first passage and a second passage, an axially immovable spear tube connected to said fitting and communicating with said first passage, the spear tube extending telescopically within said tubular piston rod member, seal means on the piston rod member adjacent one of the pistons slidably engaging the spear tube, a port in the wall of the tubular piston member establishing communication between the spear tube and the forward end of said front chamber, the housing member having a port therein adjacent the barrier element serving to vent the forward end of the rear chamber to atmosphere, another port in the wall of the tubular piston member establishing communication between the rear end of the forward chamber and the second passage, the said second passage also communicating with the rear end of the rear chamber.

6. In a reciprocating pneumatic actuator for a power tool, the combination of: a housing member comprising a pair of cylindrical shells, means connecting the shells coaxially end to end, a hollow piston rod member extending coaxially within the housing member, a pair of axially spaced pistons fixed on the piston rod member and each slidably engaging one of the cylindrical shells, a barrier element removably secured within said housing member and having a sliding seal with the piston rod member at a location between said pistons, said barrier element dividing the interior of the housing member into a front chamber and a rear chamber, the housing member having a lateral port therein at a location adjacent the barrier element, the barrier element having a first portion engageable with the inner surface of one of said shells to form a seal and having a second portion establishing communication between said lateral port and the interior of the other shell, the hollow piston rod member having ports in the wall thereof communicating with each of said chambers, the barrier element, upon release of said connecting means, being reversible to connect either chamber to said lateral port, and a spear tube mounted at one end of the housing member projecting axially into the interior of the hollow piston rod member for introducing fluid pressure therein.

7. In a reciprocating pneumatic actuator for a power tool, the combination of: a housing member comprising a pair of cylindrical shells, means conecting the shells coaxially end to end, a barrier element removably se-

cured within said housing member, said barrier element dividing the interior of the housing member into a front chamber and a rear chamber, the barrier element having a seal ring engageable with the inner surface of either of said shells and having an annular rim clamped between adjacent ends of said cylindrical shells, the barrier element having passage means communicating with the rim and one side of the element, the barrier element, upon release of said connecting means, being reversible in position to vent either chamber through said passage means, a piston in each chamber, a hollow piston rod member fixed to each of said pistons and projecting axially through one end of said housing member, the hollow piston rod member having a first port in a wall thereof communicating with the forward port of the forward chamber and a second port in a wall thereof communicating with the second chamber, and means including a spear tube mounted at the other end of the housing member and projecting axially into the interior of the hollow piston rod member for introducing fluid pressure therein.

8. In a reciprocating pneumatic actuator for a power tool, the combination of: a housing member comprising a pair of cylindrical shells, means including an apertured clamp ring connecting the shells coaxially end to end, a barrier disk dividing the interior of the housing member into a front chamber and a rear chamber, the barrier disk having a seal ring engageable with the inner surface of either of said shells and having an annular rim clamped between adjacent ends of said cylindrical shells, the barrier disk having a passage means communicating with the rim and one side of the disk, the barrier disk, upon release of said connecting means being reversible in position to vent either chamber through said apertured clamp ring, a piston in each chamber, a hollow piston rod member fixed to each of said pistons and projecting axially through one end of said housing member, the hollow piston rod member having a first port in a wall thereof communicating with the forward port of the forward chamber and a second port in a wall thereof communicating with the second chamber,

and means including a spear tube mounted at the other end of the housing member and projecting axially into the interior of the hollow piston rod member for introducing fluid pressure therein.

9. In a reciprocating pneumatic actuator for a power tool, the combination of: a housing member, a pair of axially spaced coaxial pistons within the housing member each slidably engaging a wall thereof, a hollow piston rod fixed to both said pistons and projecting from a forward end of the housing member, barrier means on said housing member slidably engaging the piston rod at a location between said pistons, the parts defining forward and rear chambers, with one of the pistons in each of the chambers, said barrier means being provided with a vent passage communicating with an adjacent portion of one of said chambers, a spear tube held against axial movement relative to the housing member and projecting telescopically into said hollow piston rod from the rear end of the housing member to deliver pressure fluid into said hollow piston rod, the spear tube having an external cylindrical surface, seal means associated with said hollow piston rod forming a sliding seal with said surface of the spear tube, said hollow piston rod having a first port in a wall thereof at a location in advance of said seal means communicating with the forward portion of the forward chamber, and having a second port in the wall thereof communicating with the other chamber adjacent said barrier means.

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