Aug. 20, 1963 W. E. HENNELLS, SR 3,101,194

PNEUMATIC SPRING

Filed Sept. 11, 1961

Fig. 1

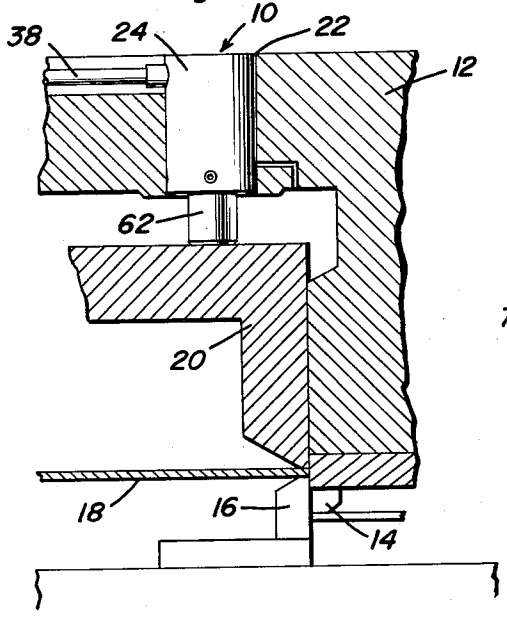


Fig. 2

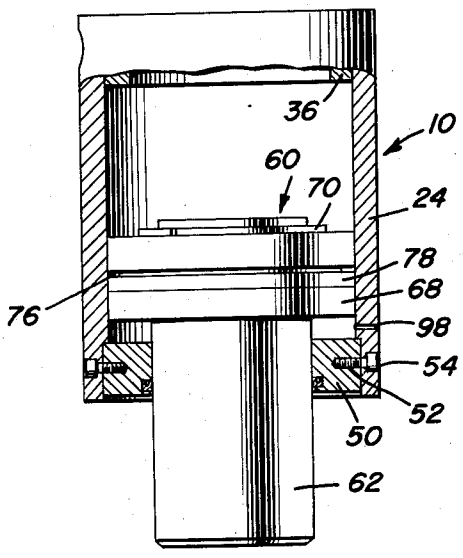


Fig. 3

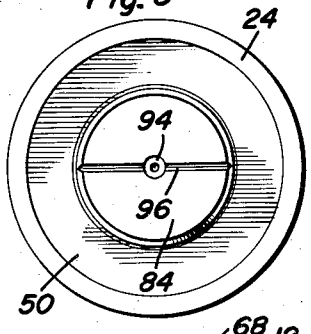


Fig. 4

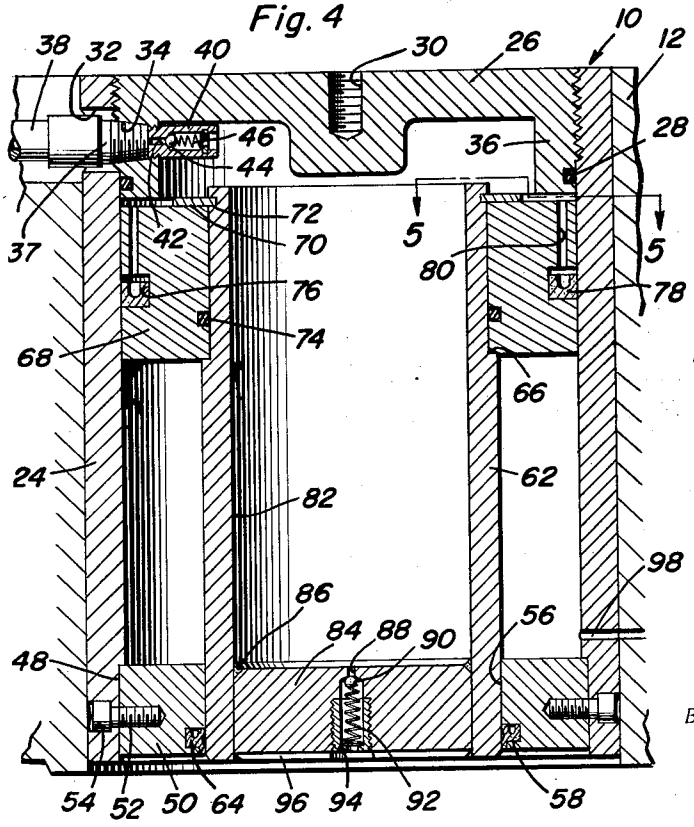
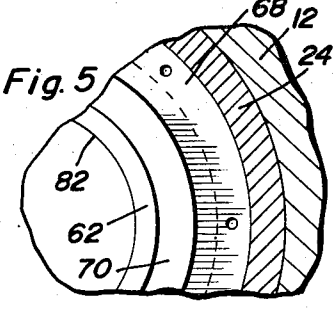


Fig. 5



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PNEUMATIC SPRING

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9 Claims. (Cl. 267—1)

The present invention generally relates to a spring or cushioning device and more particularly to a pneumatic compression spring which is self-contained and has for its primary object the provision of an efficient, economical, dependable, and safe air operated self-contained pneumatic spring, shock absorber, equalizer, holding device or the like incorporating generally the principle of a self-contained unit including a cylinder and piston forming an air chamber which is charged with air at a predetermined pressure when the piston is extended whereby inward movement of the piston will cause a decrease in volume in the chamber and a corresponding increase in pressure thus increasing the resistance to inward movement of the piston in the cylinder thereby cushioning such movement so that the device may have a large variety of applications and uses.

This application is a continuation-in-part of my co-pending application Serial No. 785,464, filed January 7, 1959.

The present invention is disclosed as being used in conjunction with a cutting or shearing die but may have many uses such as in a shaping or forming die. In current use with dies of this nature is an assembly in which an air operated piston and cylinder assembly is provided which is not self-contained and which is provided with a complex surge tank arrangement together with complex piping systems and manifold arrangements for cushioning the movement of the elements of the die such as the movement of the movable shear or cutter. While these currently employed devices are expensive, complex and not always dependable, another objection is the movement of air from the cylinder back into the supply line which air is heated somewhat due to the heat of compression thus causing the air lines to become heated and subsequently damaged due to the air pressure causing rupture of the heated lines. The present invention overcomes the objections to the currently employed systems and provides a simplified manner of using air pressure in conjunction with various types of pneumatic tools thereby eliminating the complexities involved in the use of conventional types of cylinders which require the use of directional valves, surge tanks, manifolds, complex piping systems and the like.

Briefly, the present invention incorporates a cylinder with a piston movable therein which piston and cylinder provides an air chamber which is charged with a predetermined air pressure that may be required, the initial charge of air pressure being automatically sealed in the air compression chamber. As the pneumatic spring is compressed by means of application of force on one end thereof while the other end is held stationary or by the movement of both ends, the volume in the air chamber is decreased thereby increasing the pressure and increasing the working force of the spring. The decrease in chamber volume may be calculated and may be set to a variety of pressure ratios as may be required, there being actually no limitations as to size, pressure or other specific dimensions.

In using the pneumatic spring of the present invention, the device is placed in its working position and an air supply line is connected to the inlet port of the spring, the inlet port being provided with an integrally mounted check valve thus permitting air to be received into the chamber of the pneumatic spring through the inlet port

and then sealing the air within the chamber, the check valve being primarily provided for this particular purpose. This structure eliminates the surge of air back into the supply line which reverse surge of air into the supply line would sometimes effect other equipment using the same air supply and this would possibly cause some damage to the other equipment. The inlet port is also employed for replenishing the air since a small amount of air will necessarily be lost during inward and outward movement of the piston due to the construction of the piston and cylinder and due to the beneficial cooling effects of the loss of a certain amount of air.

The device is also provided with a safety check or relief valve which will discharge some air in the event air pressure exceeds a predetermined maximum and the relief valve is so arranged that it will drain any water, oil or other foreign matter from the air chamber when the pressure builds up in the air chamber above a predetermined maximum.

The cylinder is also provided with an air bleed having a filter therein for permitting inlet and exhaust air behind the piston during movement thereof in the cylinder.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a partial sectional view of a shear die illustrating the pneumatic spring of the present invention installed therein in position for use;

FIGURE 2 is a side elevation of the pneumatic spring with a portion of the cylinder broken away illustrating the structure of the piston and relationship thereof to the cylinder;

FIGURE 3 is a bottom plan view of the construction of FIGURE 2;

FIGURE 4 is a vertical sectional view taken substantially upon a plane passing the longitudinal center of the structure of the device; and

FIGURE 5 is a plan sectional view taken substantially upon a plane passing along section line 5—5 of FIGURE 4 illustrating the construction of the piston and also illustrating the air passageways.

Referring now specifically to the drawings, the numeral 10 generally designates the pneumatic spring of the present invention which is illustrated as being mounted on the movable die member 12 having a shear 14 mounted thereon which moves past a stationary blade 16 for cutting or shearing a piece of work 18. A work holddown 20 is normally provided which engages the work 18 in opposition to the stationary blade 16 thus clamping the work 18 to prevent movementt hereof towards the movable shear 14 during the shearing or cutting operation which movement is an existing problem in this type of die and is even more pronounced in a forming or stamping die arrangement. As shown in FIGURE 1, the movable member 12 is provided with a socket 22 for receiving the pneumatic spring 10 and the working face of the ram (not shown) engages the upper surface of the member 12 as well as the upper surface of the pneumatic spring 10 thus holding the spring 10 within the socket 22.

As shown in FIGURE 1, the movable member 12 is at the bottom of its stroke and is now ready to be raised. The pneumatic spring is partially compressed and is applying clamping force to the work 18. As the movable shear 14 passes back above the work 18, there is a tendency for the same to drag against the work 18 and would normally pick the work 18 up off of the stationary member 16. However, the decompression or expansion of the compressed air causes the pneumatic spring to expand thus maintaining a gripping action against the work 18 until such time as the movable shear 14 moves above the work

18. During the shearing or cutting operation, the pneumatic spring is completely expanded and will engage the clamp or holding device 20 so that it will be forced downwardly to grippingly engage the work 18 prior to engagement of the movable shear 14 with the work 18 thus assuring that the work 18 will be properly held in position with the pressure exerted by the spring being variable depending upon the scope or degree of movement of the movable member 12 which carries the pneumatic spring of the present invention.

The pneumatic spring assembly 10 includes a cylindrical member 24 that has a constant cross-sectional area and is provided with an end plate 26 at the upper end thereof which is in screw-threaded engagement with the inner surface of the cylindrical member 24 but which may be secured thereto by any other means for rigidly fixing the end plate 26 to the cylindrical member 24. As shown, the end plate 26 is provided with an O-ring seal 28 along with a groove therefor and is also provided with a centrally disposed threaded socket 30 for receiving a threaded member for ease of removal and insertion of the pneumatic spring 10 in the socket 22.

The cylindrical member 24 is provided with an opening 32 adjacent the upper end thereof in alignment with a screw threaded opening 34 in a depending cylindrical flange 36 on the end plate 26. The threaded opening 34 receives an adapter fitting 37 which may have a quick disconnect coupling for engagement by an air supply line 38 received in a recess in the movable member 12. Threaded into the opening 34 from the inner end thereof is a check valve housing 40 having a passageway 42 and a ball check valve 44 urged into seating engagement with the end of the passageway 42 by a spring 46 which is a one-way check valve which will enable air to enter into the interior of the cylindrical member 24 but will not permit air to exit therefrom through the adapter fitting 37 into the supply line 38 thereby preventing surges of air back into the supply line 38.

The lower end of the cylindrical member 24 is provided with a shoulder 48 spaced from the lower end thereof which engages an annular bearing plate 50 which is held in position by a plurality of cap screws 52 having the heads thereof disposed in sockets or countersink areas 54 in the exterior surface of the cylindrical member 24. The annular bearing plate 50 is provided with an enlarged central opening 56 which has a groove 58 adjacent the lower edge thereof.

A piston generally designated by the numeral 60 is reciprocable within the cylindrical member 24 and includes a hollow piston rod 62 which may be in the form of a tubular member having substantially a constant cross-sectional area for sliding movement in the opening 56 in the bearing plate 50. The groove 58 is provided with a combined sealing and wiping ring 64 of resilient material for maintaining a seal between the bearing plate 50 and the piston rod 62 and preventing entry of foreign material into the area inwardly of the bearing plate 50.

The tubular member or piston rod 62 is provided with a peripheral shoulder 66 in spaced relation to the upper end thereof which receives an annular piston member 68 that is held in position by a snap ring 70 received within a groove 72 adjacent the upper end of the piston rod 62. The snap ring 70 rigidly holds the piston 68 on the piston rod 62 and an O-ring seal 74 is disposed between the inner surface of the annular piston member 68 and the external surface of the piston rod 62.

The external peripheral surface of the piston member 68 is provided with a peripheral groove 76 which receives a peripheral ring 78 of resilient material and of substantially U-shaped configuration. It is noted that the groove 76 is slightly larger in height than the ring 78 and the area of the piston 68 extending above the groove 76 is provided with a series of vertical air passages 80 communicating with the top of the piston member 68 whereby air may pass downwardly through the passageways 80 and force

the seal ring 78 into engagement with the internal surface of cylindrical member.

The tubular member 62 is provided with an enlarged hollow interior 82 which is closed by a bottom plate 84 which may be secured to the tubular member 62 as by welding 86 or by any other suitable means. The bottom plate 84 is provided with an air passageway 88 which has a ball check valve 90 disposed therein for closing the same the ball check valve being spring urged by spring 92 mounted on an adjustable member 94 for varying the resiliency of the spring 92. The bottom of the plate 84 is provided with a transverse groove 96 which communicates with the passageway in the bottom plate 84 and the periphery of the piston rod 62 thus allowing air and any other material discharged from the aperture 88 to pass outwardly and be discharged. The ball check valve assembly permits air flow out of the interior of the piston rod 62 but prevents inflow of air.

The cylindrical member 24 is also provided with a bleed aperture 98 immediately above the bearing plate 50 for providing for exhaust and inlet of air trapped between the bearing plate 50 and the piston member 68. This bleed passageway 98 may be equipped with a filter to prevent inflow of foreign material into this area. The bleed passageway will also permit discharge of any air which may blow by the piston ring seal 78.

The bleed aperture 98 is of significant importance because it permits air in the space between the plate 50 and piston member 68, which air becomes heated during use of the spring by frictional and compressive effects, to be expelled when piston member 68 is moved toward plate 50. Further, upon movement of piston member 68 away from plate 50 fresh, cooler ambient air is drawn in the space. Thus, excessive build up of heat does not occur within the member 24 and the operating life of the pneumatic spring is increased correspondingly.

With the device installed as illustrated in FIGURE 1, air under predetermined pressure such as normal service line pressure is admitted into the interior of the cylindrical member 24 above the piston 68 thus filling the entire volume of the interior of the piston rod 62 and the cylindrical member 24 when the piston 68 is moved downwardly to a position adjacent to the annular bearing plate 50. Thus, when the bottom of the piston 62 engages the surface, the article engaged will be moved by pressure exerted thereon with subsequent movement of the cylindrical member causing an increase in the pressure exerted by the piston due to the decrease in volume since the piston member 68 is moving inwardly in relation to the cylindrical member 24. Thus, as the pressure exerted on the device is increased, the working force exerted by the device is increased. In the event excessive pressure is caused in the device for any reason whatsoever, the ball check valve 90 will permit the same to be discharged through the groove 96. This also will cause discharge of any foreign material such as condensed water or moisture, dirt, oil or the like.

The self-contained unit of the present invention is extremely simple to manufacture and is highly efficient for its particular purposes. In practical operation, the device has been used with a line pressure of from 80 to 125 p.s.i. with a ratio of 2 to 1 and with an application of more than 100 cycles per minute. The heat of compression of the air has been negligible and has been found to rise only several degrees.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all suitable modification and equivalents may be resorted to falling within the scope of the invention as claimed.

What is claimed is:

1. A self-contained pneumatic spring comprising a tubular member having one closed end, a piston slidably

disposed within said tubular member, a piston rod connected to the piston and extending outwardly through the open end of the tubular member, said tubular member having a bearing plate in the open end thereof for slidably receiving the piston rod for guiding the movement thereof and limiting the outward movement of the piston, said piston rod being in the form of an enlarged hollow member having a closed end an an open end communicating through the piston with the air chamber defined between the piston and said closed end of said tubular member, the closed end of said piston rod having a downwardly opening, spring-urged pressure relief check valve therein communicating with said air chamber at the lowermost point thereof for relieving pressure in excess of a predetermined value therefrom and also discharging foreign matter therefrom; and a valve mounted on said tubular member adjacent to the closed end thereof for admitting air under pressure into said air chamber.

2. A self-contained pneumatic spring as defined in claim 1 including means defining a bleed opening through said tubular member adjacent to said bearing plate for providing communication between the interior thereof and the ambient atmosphere whereby air is expelled from the space between said piston rod and said tubular member when said piston moves toward said bearing plate and air is drawn into said space when said piston moves away from said bearing plate.

3. A pneumatic spring comprising a cylindrical member having one closed end, with a planar outer face free of projections extending outwardly therefrom and longitudinally of said member, a piston slidably disposed within said cylindrical member, a piston rod connected to the piston and extending outwardly through the open end of the cylindrical member, said cylindrical member having an annular bearing plate in the open end thereof for slidably receiving the piston rod for guiding the movement thereof and limiting the outward movement of the piston, said piston and rod including an enlarged hollow area for combining with the interior of the cylindrical member for providing an air chamber, means connected with said cylindrical member for charging the air chamber with predetermined air pressure thus extending the piston and piston rod whereby inward movement of the piston and piston rod will be cushioned by the air pressure with the reduction in volume of the air chamber caused by inward movement of the piston and piston rod causing a corresponding increase in pressure and increase in working force exerted by the piston and piston rod, said piston rod being in the form of an enlarged hollow member having a closed end and an open end extending through the piston for forming a part of the air chamber, the closed end of the piston rod having a downwardly opening pressure relief check valve therein for relieving excessive pressure in the air chamber and discharging foreign matter therefrom, said pressure relief valve including a longitudinal bore in the outer closed end of said piston rod, a transverse grooved formed in the outer face of said closed end, the outer end of said longitudinal bore communicating with said transverse groove.

4. In a pneumatic spring, the combination of a cylinder having a closed upper end with a planar outer face free of projections extending outwardly therefrom and longitudinally of said cylinder and an open lower end, an annular bearing plate secured in the open lower end of said cylinder and defining a central opening therein, a tubular piston rod slidable in said central opening of said bearing plate, said piston rod having a closed outer end with a planar outer face and an open inner end, an annular piston head secured externally to the inner end portion of said piston rod and slidably engaging the inner surface of said cylinder, the portion of the cylinder above said piston head communicating with the interior of said piston rod and coacting therewith to provide an air chamber of a variable volume governed by the position of the piston rod relative to the cylinder, spring-

loaded check valve means provided at the upper end of said cylinder for admitting compressed air into said chamber, and spring-loaded check valve means provided in the closed end of said piston rod for relieving excess pressure from the chamber, said last mentioned check valve means including a longitudinal bore in said closed end of said piston rod, a transverse groove formed in the outer face of said closed end, the outer end of said longitudinal bore communicating with said transverse groove.

5. The device as defined in claim 4 wherein said piston head is provided in its outer periphery with an annular groove, and a sealing ring positioned in said groove in engagement with the inner surface of said cylinder, said piston head also being provided with air passages extending upwardly from said groove to the upper surface of the piston head and communicating with said chamber, whereby air pressure in the chamber may be exerted upon said ring to urge the same into engagement with said cylinder.

6. A self-contained pneumatic spring comprising a tubular member, an end plate rigidly secured to said tubular member and extending across and closing off one end of said tubular member, said end plate having an unobstructed outer surface, said tubular member having an opening through the side thereof adjacent said end plate, said opening communicating with the interior of said tubular member and having a valve therein whereby pressure fluid can be supplied to the interior of said tubular member, a piston and piston rod assembly slidably disposed within said tubular member, means on said end plate extending into said tubular member to a point below said opening for limiting movement of said assembly toward said end plate so that said opening continuously communicates with the interior of said tubular member, said tubular member having a bearing plate mounted in the other end thereof, said bearing plate having a central opening through which said piston rod slidably extends whereby said bearing plate guides and limits outward movement of said assembly, said piston rod having a closed outer end and having a bore through said closed end, and a spring-urged check valve mounted in said bore for relieving excess pressure from said tubular member.

7. A self-contained pneumatic spring as defined in claim 6 including also means defining a bleed aperture communicating between the interior of said tubular member and the ambient atmosphere whereby air is expelled from the space between said piston rod and said tubular member when said piston moves toward said bearing plate and air is drawn into said space when said piston moves away from said bearing plate.

8. A self-contained pneumatic spring according to claim 6 in which said bearing plate is mounted internally of said tubular member whereby the external surface of said tubular member is unobstructed and wherein said piston rod has an outer surface which lies within a plane, the bore in said piston extending substantially longitudinally and said check valve being mounted in said bore adjacent to the outer end thereof.

9. A self-contained pneumatic spring comprising a tubular member having one closed end, a piston slidably disposed within said tubular member, a piston rod connected to the piston and extending outwardly through the open end of the tubular member, said tubular member having a bearing plate in the open end thereof for slidably receiving the piston rod for guiding the movement thereof and limiting the outward movement of the piston, said piston rod being in the form of an enlarged hollow member having a closed end and an open end communicating through the piston with the air chamber defined between the piston and said closed end of said tubular member, one of said closed ends being at the bottom of said pneumatic spring and having an outwardly opening, spring-urged pressure relief check valve therein communicating with said air chamber for relieving pressure

in excess of a predetermined value therefrom and also discharging foreign matter therefrom; and a valve mounted on said tubular member adjacent to the closed end thereof for admitting air under pressure into said air chamber.

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