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PNEUMATIC IMPACT DEVICE
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FIG. 1

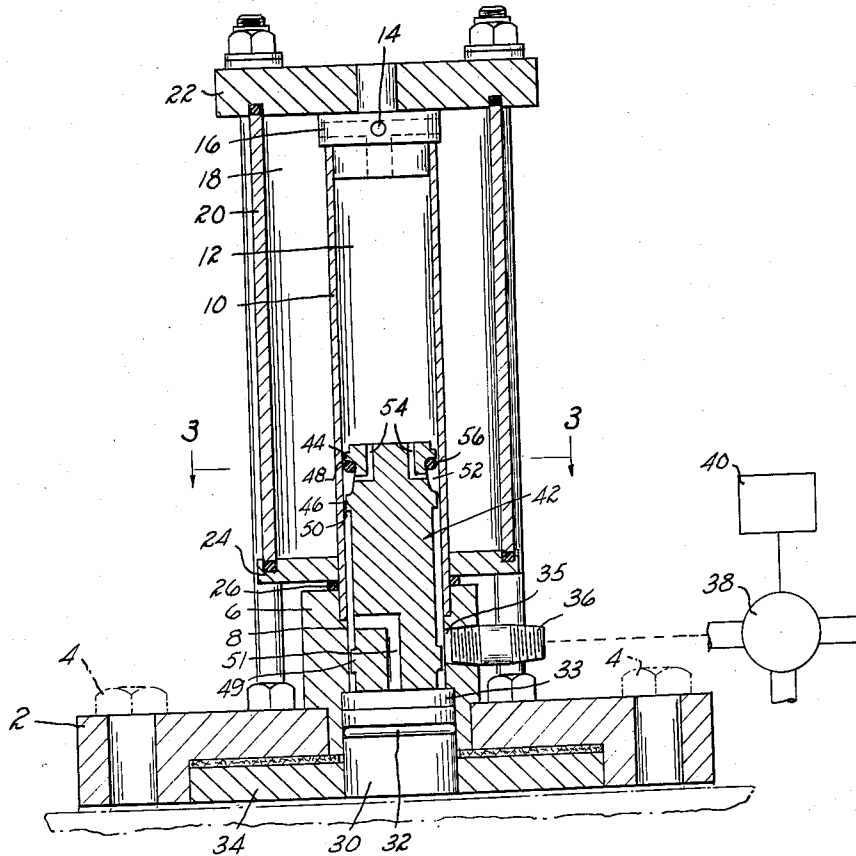


FIG. 2

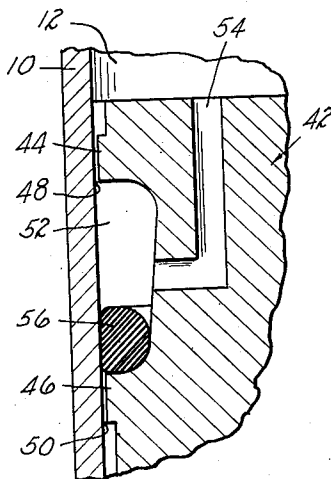
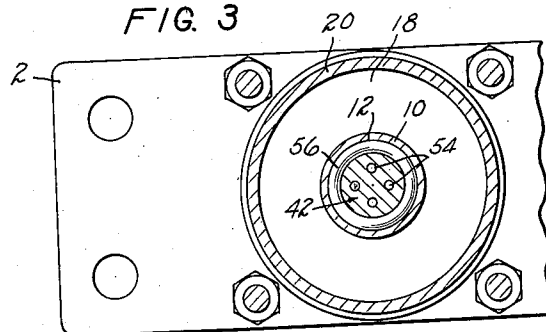


FIG. 3



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PNEUMATIC IMPACT DEVICE

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9 Claims. (Cl. 121-13)

This invention relates to pneumatic impact devices of the type having a cylinder and an impact piston therein operated by air pressure. The device of the present invention has particular utility as a vibrator for imparting vibrations to an associated structure although it may be used in impact devices generally such as in drills, hammers, impact presses and the like.

One object of the invention is to provide a vibrator having particular usefulness in industrial applications in that it is capable of delivering blows of great magnitude in a device of comparatively small size, is economical in use of pressurized air, is simple and easy to install and operate, and is capable of withstanding wear even under adverse operating conditions.

Another object is to provide such an impact device which is characterized by features affording simplicity of construction and reduced manufacturing cost and which requires a supply of pressurized air only at one end of the cylinder and only intermittently.

Other objects will be in part obvious, and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application of which will be indicated in the appended claims.

In the drawing:

Figure 1 is a vertical sectional view of an impact device constructed in accordance with the invention;

Figure 2 is an enlarged fragmentary sectional view of a portion of the structure shown in Figure 1; and

Figure 3 is a fragmentary sectional view of the structure of Figure 1 taken on the line 3-3 thereof.

For convenience an impact device constructed in accordance with the invention is illustrated in the form of a pneumatic vibrator. Referring to the drawing the vibrator includes a base or attaching head 2 which is adapted to be secured by bolts 4 or the like to the apparatus to be vibrated. Supported in a central opening in the attaching head is an upstanding cylindrical housing 6 having a central cylindrical throughbore 8. Supported at its lower end in the housing is a cylindrical tube 10, the inner surface of which is continuous with the bore in the housing and together therewith forms a continuous cylinder 12. The upper end of the cylinder 12 is connected through one or more passages 14 in an adapter 16 to an airtight chamber or reservoir 18. The chamber is formed by an outer casing 20 concentric with tube 10, a header 22 bolted to the attaching head and sealing the top of the casing, and a flange 24 closing the bottom of the casing and sealed to tube 10 and housing 6 by a packing 26. The lower end of the cylinder has an enlarged diameter portion closed by an impact plunger 30 which is slidably received therein and makes an airtight seal therewith by means of a sealing ring 32. The impact plunger 30 serves as the anvil member of the vibrator and carries an impact plate 34 which is accommodated in a recess on the underside of the attaching head 2 and serves to transmit

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the blows of the vibrator to the surface of the apparatus being vibrated. To abate noise and prevent deformation, the impact plunger may be covered with a protective pad 33 of non-metallic material. The cylinder 12 is provided with a single port 35 adjacent its lower end which is connected through a pipe 36 to a three-way valve 38 by which the cylinder may be either charged with pressurized air or may be exhausted. The valve 38 is arranged to be automatically cycled between pressure and exhaust positions under the control of a timer 40.

Within the cylinder is a free piston 42 which serves as the percussion member of the vibrator. According to the invention the piston is arranged to permit charging of both ends of the cylinder and chamber 18 when pressurized air is admitted to the cylinder through port 35, and the high velocity impact stroke of the piston is obtained by abruptly exhausting air from below the piston, such cooperation of the piston and cylinder being obtained by the provision of novel valve means of simplified construction carried by the piston itself. To this end the piston is dimensioned to fit the cylinder loosely, and is provided adjacent its upper end with a pair of circumferential lands 44, 46 dimensioned to form clearance spaces 48, 50 with the cylinder wall through which air may flow past the piston. The piston may also have a guiding land 49 adjacent its lower end by-passed by a passage 51.

The lands 44, 46 are separated by a circumferential groove 52 having a bottom which slopes radially inwardly and increases in depth towards its upper end. The groove 52 is connected to the top face of the piston through the clearance space 48 between land 44 and the cylinder wall and may also be connected to the top of the piston by one or more passages 54 in the piston. Situated in groove 52 is a valve in the form of a resilient seal 56 of toroidal shape, such as an O-ring. The size of the seal 56 relative to the depth of groove 52 is such that the seal is in slight frictional engagement with the cylinder wall, as shown in Figure 1, when at the upper end of the groove, and when at the lower end of the groove the seal is substantially squeezed between the piston and cylinder wall, as shown in Figure 2, so as to effectively seal the clearance space 50 between land 46 and the cylinder wall. Further in accordance with the invention, the axial dimension of groove 52 is a multiple of the cross sectional periphery of the seal so that the seal may roll from one end of the groove to the other, and, in so doing, will turn about its own annular axis through one or more full revolutions. It is believed that the position which sealing ring 56 assumes in the groove 52 results in part from the frictional engagement with the cylinder wall and in part from the differential of air pressure on opposite sides of the piston. Thus when the piston moves downwardly, the ring 56 tends to move to the top of groove 52 and when the piston moves upwardly, the ring 56 tends to move to the bottom of the groove 52. This tendency may be counteracted, at least during a portion of the piston movement, by the differential air pressure.

The operation of the vibrator is initiated by admitting pressurized air to the lower end of the cylinder and thereby displacing piston 42 in an upward direction. In the initial position of the piston, the seal 56 is disposed at the upper end of groove 52 as shown in Figure 1, making only slight frictional engagement with the cylinder wall, and leaving passages 54 uncovered. Thus air admitted to the lower end of the cylinder may initially leak through clearance 50, groove 52 and passages 54 to the upper side of the piston, thereby partially charging the portion of the cylinder above the piston as well as chamber 18 with pressurized air as the upward movement of the piston begins. During the upward movement of the piston and particularly after some air pressure has

built up behind the piston, the frictional engagement of seal 56 with the cylinder wall causes the seal to move to the lower end of groove 52. Upon this occurrence, the piston seal 56 becomes tightly squeezed between the piston and cylinder adjacent land 46 and closes off clearance space 50. Further upward movement of the piston compresses the air above the piston and in chamber 18. Upward piston movement continues until the pressure on the upper side of the piston is substantially the same as that on its lower side. During the first few cycles of operation, before chamber 18 becomes fully charged with air, the piston may reach the top of cylinder before a pressure balance on opposite sides of the piston is reached. However, once steady state conditions prevail, the air pressure across the piston will balance and cushion the piston, stopping its upward movement before it reaches the top of the cylinder.

After upward movement of piston 42 ceases, valve 38 is timed to switch to the exhaust position, thereby abruptly releasing air from the lower end of the cylinder through port 35. This instantly creates a substantial pressure differential across the piston, enabling the substantial stored energy of the compressed air in chamber 18 and the upper end of the cylinder to drive the piston downward with explosive-like force and at high velocity.

As the piston moves downward the relative movement of the piston and cylinder tends to cause seal 56 to move from the lower end to the upper end of the groove, thus permitting limited air flow through clearance space 50. This limited air flow enables the clearances between lands 44, 46 and 49 and the cylinder to act as air bearings minimizing piston friction without appreciably reducing the pressure behind piston 42 because the flow area of clearance space 50 is relatively small and the time required for the piston to travel to the bottom of the cylinder is quite short. The piston therefore strikes the pad 33 covering impact plunger 30 with substantial velocity, providing an impact of exceptional sharpness.

After the piston has delivered its blow to the impact plunger, valve 38 is switched by the timer from the exhaust to the pressure position. The lower end of the cylinder is thus recharged with pressurized air, and the cycle is repeated, the seal 56 moving from the upper end to the lower end of the groove during upward movement of the piston and again sealing off flow past the piston after the charge in the chamber 18 has been replenished. The by-pass 51 breaks any vacuum between the piston and pad 33 which might otherwise interfere initially with the upward stroke of the piston.

An impact device constructed in accordance with the invention has many advantages. In each cycle the rolling action of the seal 56 responsive to movement of the piston and the air pressure differential automatically valves the flow of air past the piston so as to allow replenishment of any portion of the propellant air charge lost during the preceding cycle while insuring compression of this charge substantially to the pressure applied to the lower side of the piston. Once the first few cycles are completed and chamber 18 becomes substantially charged with air, only enough pressurized air need be supplied during each upward piston stroke to replenish that lost by leakage past the piston during its downward stroke. Thus the apparatus is extremely economical in use of pressurized air. Also, since the air in chamber 18 is not replaced after each piston stroke, loss of heat energy imparted to this air during each piston compression stroke is prevented, and the operating efficiency of the apparatus is thereby increased. The seal 56 provides an automatic control valve of extreme simplicity, low cost, and long life, completely eliminating the need for more complicated and expensive valve arrangements, and thus the apparatus is substantially simplified in construction and economical to manufacture. Also because a loose fit between the piston and cylinder is permitted, wear of the moving parts is greatly reduced insuring

a long life and infrequent breakdown even under adverse operating conditions.

The dimensions of the device can be varied over a wide range to vary the performance characteristics. It is an advantage of the invention, however, that blows of desired magnitude for many industrial purposes can be attained with a piston as small as 1½" in diameter. Variations in performance result not only by varying the dimensions of the cylinder and piston but also by varying the dimensions of the anvil and the base 2, the latter of which is attached to the associated structure and bridges the anvil. Since the time required for a stroke of the piston is only a fraction of a second, the timer can be set to produce vibrations extending over a wide range of frequencies.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limited sense.

It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

I claim:

1. A pneumatic vibrator comprising a housing having means for attachment to an associated structure, an anvil supported by the housing but movable relative thereto, a cylinder supported by the housing in alignment with the anvil, a free piston in the cylinder, means for alternately admitting pressurized air to the cylinder adjacent the anvil to move the piston away from the anvil and releasing the air therefrom to permit the piston to return toward the anvil, and means including a restricted passageway for by-passing a portion of the admitted air to the side of the piston, said means being effective to by-pass air to said side of the piston only when the piston is adjacent to the anvil.

2. In the pneumatic vibrator defined in claim 1, means for by-passing a portion of the admitted air around the piston comprising a resilient toroidal seal seated in a circumferential groove of the piston and in engagement with the cylinder for limited movement in retard of movement of the piston relative to the cylinder, said piston having a by-pass which is opened by movement of the seal relative to the piston in a direction opposite to the anvil.

3. A pneumatic impact device comprising a housing having a cylindrical chamber, an anvil at one end of the cylinder, a free piston of shorter length than the chamber mounted in the chamber for axial movement therein toward and away from the anvil, means for alternately admitting pressurized air to said one end of the cylinder to move the piston away from the anvil and abruptly releasing the air therefrom to permit the piston to return toward the anvil, means forming an air by-pass in the piston, and a valve carried by the piston in engagement with the cylinder for movement to a closed position responsive to movement of the piston relative to the cylinder when the piston moves away from said one end of the cylinder.

4. In a pneumatic impact device, a cylinder, a piston in the cylinder, a by-pass passage connecting opposite sides of the piston including a circumferential groove in the piston having a sloping bottom, said groove communicating at its shallow end with a clearance space between the piston and the cylinder, and a resilient toroidal seal in the groove frictionally engageable with the cylinder and axially movable between an open position spaced from the shallow end of the groove and a closed position squeezed between the piston and cylinder at the shallow end of the

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groove and sealing off the groove from said clearance space.

5. In a pneumatic vibrator, a housing having a cylindrical chamber, an anvil closing one end of the chamber and mounted for limited movement relative to the housing, a free piston in the chamber having a face for engagement with the anvil, a resilient pad on the anvil, said piston having an air by-pass communicating with said face to break any vacuum occurring between said face and the resilient pad, and pneumatic means for moving the piston away from and toward the anvil.

6. In a pneumatic impact device, a cylinder, a piston in the cylinder forming a percussion member, a bypass passage connecting opposite sides of the piston including a circumferential groove in the piston having a sloping bottom and means forming a clearance space between the piston and cylinder at the shallow end of said groove, and a valve for said bypass passage including a resilient seal of toroidal shape in said groove having a cross-sectional area such as to be squeezed in sealing relation between said piston and cylinder when at the shallow end of said groove and to be frictionally engaged with said cylinder when at the deep end of said groove, said groove having an axial length which is an even multiple of the cross sectional periphery of the seal.

7. In a pneumatic impact device, a stationary cylinder connected at one end to a closed chamber forming a compression reservoir, a free piston in the cylinder forming a percussion member, port means in the cylinder adjacent the end thereof opposite said chamber through which pressurized air may be introduced into the cylinder and exhausted therefrom, a bypass passage connecting opposite sides of the piston and dimensioned to permit air flow therethrough, and valve means associated with said piston operable to close said bypass passage during piston movement toward said chamber and open said bypass passage during piston movement away from said chamber.

8. In a pneumatic impact device, a base, a cylinder

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fixed at one end to the base, a cylindrical closed chamber fixed to the base and surrounding the cylinder forming a compression reservoir communicating with the other end of the cylinder, a free piston in the cylinder dimensioned to form a clearance space therewith permitting air flow past the piston, a port in the cylinder adjacent the said one end thereof through which pressurized air may be introduced into the cylinder and exhausted therefrom, and valve means associated with said piston operable to seal said clearance space during piston movement toward said other end of the cylinder and to unseal said clearance space during said piston movement away from said other end of the cylinder.

9. In a pneumatic impact device, a cylinder connected at one end to a closed chamber forming a compression reservoir, an anvil mounted at the other end of the cylinder, a free piston in the cylinder forming a percussion member, an air bypass passage connecting opposite sides of the piston including a circumferential groove in the piston having a sloping bottom increasing in depth toward said one cylinder end, a valve for the bypass passage including a resilient toroidal seal in said groove axially rollable between an open position spaced from the shallow end of the groove and a closed position squeezed between the piston and cylinder at the shallow end of the groove, said seal having a cross-sectional periphery less than the axial dimension of said groove, means for introducing pressurized air into the cylinder on the side of the piston opposite said compression reservoir, and means for abruptly exhausting air from said cylinder on the side of the piston opposite said compression reservoir.

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