ABSTRACT

In an apparatus having movable members and a buffer therebetween, improved buffer structure which comprises rectangular spring wire stock wound to cylindrical helix form so that the outer edges of the stock are stretched and thinned. The helix is axially compressed to interengage its inner edges leaving axial spaces between the outer edges. Upon axial impact the convolutions distort to close the spaces, thus providing the buffer effect.
COMBINATION OF APPARATUS AND BUFFER STRUCTURE

This invention relates generally to apparatus having relatively movable members between which a buffer is required. More particularly, the invention involves the combination of such apparatus and an improved buffer structure. Selected for illustration of the invention is a pneumatically or hydraulically actuated marking tool.

Such a marking tool conventionally comprises a pneumatic or hydraulic cylinder with a piston and piston rod therein, the piston rod projecting through one end wall of the cylinder and carrying a marking die for marking workpieces. Such tools are used extensively in automated production lines which typically intermittently move a succession of workpieces past the marking tool which is actuated to mark each workpiece when aligned therewith.

Not infrequently, such a production line has workpiece carriers moving past the marking tool without any workpieces therein. Hence, during such periods there are no workpieces to absorb the thrust of the marking tool piston when the marking tool is actuated. The piston therefore slams violently against the end wall of the cylinder upon each cycle of operation thereof which relatively quickly results in serious damage or destruction of the tool. Where the piston is retracted by a spring, effectiveness of the return spring is even more quickly destroyed.

Conventional efforts to meet this problem have involved such expedients as venting the cylinder so as to trap a cushion of air between the piston and the end wall of the cylinder, and the provision of a metal sleeve positioned axially between the end wall and piston for absorbing the thrust of the piston. These efforts have been unsatisfactory since the air cushion provides inadequate buffering and the sleeve ultimately becomes distorted and interferes with functioning of the tool.

The object of the present invention is to provide, in an apparatus having relatively movable members, a relatively simple, inexpensive buffer structure which is improved to provide adequate buffering between the members and which nevertheless will have an effective life virtually as long as that of the apparatus as a whole.

Generally, the invention contemplates the use of a series of elements each having an edge and ends adjoining the edge at junctures spaced apart in the direction of relative movement of the members of the apparatus. The ends extend transversely of said direction. The juxtaposed ends of successive elements in the series are contiguous proximal to their junctures with the edges and, distal of their junctures, are spaced apart in said direction. The elements are resiliently distortable so that the spacing between juxtaposed ends is diminished responsive to engagement of the apparatus members against end ones of the elements in the series.

One form of the invention is shown in the accompanying drawings.

FIG. 1 is a side elevational view of a marking tool which embodies the present invention.

FIG. 2 is a left end elevational view of the tool.

FIG. 3 is an enlarged scale elevational view of the tool with parts broken away and shown in section to illustrate structural details.

FIG. 4 is a side elevational view of the buffer structure per se.

FIG. 5 is an enlarged scale, partly diagrammatic sectional view of the buffer structure and its mounting in the tool.

FIG. 6 is a further enlarged, fragmentary, partly diagrammatic sectional view of a portion of the buffer structure.

Shown in the drawings is a marking tool 10 according to the present invention having a mounting bracket 12 anchored to a base 14 by bolts 16. A succession of workpieces W is presented to the tool on a conveyor or fixture represented at 18. Marking tool 10 has a cylinder 20 with a side wall 22 and ends closed by a front cap 24 and a rear cap 26 threaded onto the side wall as shown in FIG. 3. The interior of cap 24 defines a front end wall 28 of the cylinder and the interior of cap 26 defines a rear end wall 30 of the cylinder. Bracket 12 has an apertured upright leg 32 through which side wall 22 extends and leg 32 is anchored between axially disposed shoulders 34 and 36 on side wall 22 and cap 24, respectively. Bracket 12 has a base leg 38 which is anchored to base 14 by bolts 16.

Side wall 22 has a cylindrical inner surface 40 within which a piston 42 is disposed. A piston rod 44 on the piston projects slidably through an axial opening 46 in the portion of cap 24 defining end wall 28. The free end 48 of the piston rod has a socket 50 which receives a marking die 52. The die is removably retained within the socket by means of a resilient modified U-shaped clip 54 having one leg 56 extending over the top of the piston rod and another leg 58 which projects removably through aligned locking notches 60, 62 in the rod and die 52 respectively.

Piston rod 44 has an axially extending key-way slot 64. A key 66 mounted within cap 24 fits slidably within slot 64 and is retained in position by a set screw 68 within cap 24. The key and slot cooperate to prevent the piston rod from turning about its axis to maintain marking die 52 in its proper orientation. Piston 42 is moved to the left as the drawings are viewed by fluid under pressure introduced into the interior of cylinder 20 from a suitable conduit 70 through a port 72 in cap 26. The fluid could be hydraulic or pneumatic and for purposes of this disclosure, it will be assumed that air under pressure is employed.

The piston carries a seal 74 which is in sliding, sealing engagement against cylinder interior 40. When the air pressure in the cylinder is relieved, piston 42 is returned to the right as the drawings are viewed by a coil spring 76 disposed around rod 44 and compressed between end wall 28 and an axial disposed face portion 78 of the piston. Return movement of the piston is buffered by a coil spring 80 disposed between a shoulder 82 on the piston and end wall 30.

A buffer 84 according to the invention is contained between end wall 28 and an axially disposed shoulder 86 within cylinder 20. In the structure illustrated, shoulder 86 comprises a diametral enlargement of cylinder interior 40.

In the form of the invention illustrated, buffer 85 comprises a length of spring metal wire having rectangular sectional shape wound into the form of a cylindrical helix. In the course of the winding, the outer edge portions 88 of the wire are stretched to an extent greater than the inner edge portions 90 with the result that the outer edge portions are axially thinner than the
inner edge portions. The turns of helix thus form a series of elements 92 each having a sectional shape with a relatively longer inner edge 90 and a relatively shorter outer edge 88 interconnected by ends 94.

Ends 94 adjoin inner edges 90 at junctures 96. The juxtaposed ends 94 of successive elements 92 have portions 98 proximal to junctures 96 which are axially closer together than the portions of ends 94 distal of junctures 96. When the helix is axially compressed to solid condition, juxtaposed end portions 98 interengage while the portions of the ends extending toward outer edges 88 diverge from each other.

When the buffer 84 is assembled within cylinder 20, it surrounds both piston 44 and return spring 76. As shown in FIG. 5, shoulder 86 engages axially against a radially outer portion of one end element 92 of the helix and the other end element 92 is engaged against end wall 28. Radially inner portions of elements 92 are disposed in the path of movement of piston 42 toward end wall 28. Buffer 84 may be in its axially expanded or free condition as illustrated in FIG. 4 or may be axially compressed so that juxtaposed end wall portions 98 are contiguous, that is to say touching or nearly touching as illustrated in FIGS. 5 and 6. In most structures, the contiguous relation will probably be preferred since a certain amount of space is saved.

In use, it will be assumed that marking tool 10 has been mounted on base 14 for marking a series of workpieces W and that conduit 70 has been connected with a two-way pneumatic valve 100. When a workpiece on conveyor or fixture 18 is positioned in alignment with tool 10, valve 100 is actuated to introduce air under pressure through conduit 70 and port 72 into the right hand end of cylinder 20 as the drawings are viewed. Piston 42, piston rod 44 and marking die 52 are advanced leftward to the intermediate dotted line position of FIG. 1 where the marking die strikes the workpiece with sufficient force to impress the image on the die into the workpiece. When valve 100 is actuated to exhaust air under pressure from within the cylinder, piston 42 together with rod 44 and die 52 are retracted to the right by return spring 76. The next time a workpiece is in alignment with tool 10, the cycle is repeated.

Should the overall apparatus of FIG. 1 continue to cycle while empty of workpieces, valve 100 would be operated in each cycle of operation to cause piston 42 to advance and be retracted. However, upon each advancing stroke, piston rod 44 would be permitted to travel to the extreme leftward position illustrated in dotted lines in FIG. 1 and it is under these conditions that buffer 84 becomes effective. During the work or advancing stroke of the piston, its end face 78 strikes the right hand end of the buffer and if the buffer is not already axially compressed so that juxtaposed end portions 98 are interengaged, it becomes so compressed in a further short increment of movement of the piston. Thereafter, the buffering action of buffer 84 occurs.

As the force exerted by the piston on the buffer increases, elements 92 distort resiliently in such a way that the spaced apart portions of juxtaposed ends 94 move toward each other thereby closing or partially closing the axial space therebetween as represented in dotted lines in FIG. 6. When pressure is relieved in the cylinder, spring 76 retracts piston 42 and elements 92 return resiliently from the dotted line condition to the solid line condition illustrated in FIG. 6. Each time tool 10 is cycled without a workpiece W before it, the described buffering action of buffer 84 takes place.

Description of a typical working tool follows. Piston 42 has a diameter of 1 3/16 inch, a stroke of 2 3/4 inches and is actuated by air under pressure 60 P.S.I. Buffer 84 is made from spring steel wire 1/4 inch by 1/4 inch square and has a free length of about 1.72 inch. The buffer has a solid length, that is a length wherein juxtaposed wall portions 98 are touching, of about 1.585 inch. When the tool is cycled without a workpiece in place, the piston delivers a blow against buffer 84 of about 3 tons. The buffer compresses axially about 0.028 inch under this blow. A tool having these specifications has been cycled hundreds of thousands of times in a test fixture with no workpieces and in each cycle allowing the piston to deliver its full impact against buffer 84. This test resulted in no damage to the buffer or other components of the tool.

While end wall 28 is sloped with respect to the compression direction of buffer 84, it is believed that this slope does not significantly contribute to the relative closing movement of juxtaposed ends 94 since the same phenomenon has been observed where the buffer has been compressed between members extending perpendicular to the axis of the buffer. However, it is believed that the angle of elements 92 relative to a plane perpendicular to the axis of buffer 84 may contribute to the phenomenon. In the typical tool described above, this angle is about 6 degrees when the buffer is compressed so that end portions 98 are touching.

While buffer 84 is illustrated as being in the form of a single wire wound to a cylindrical helix, it will be appreciated that elements 92 could comprise individual rings having the sectional shape illustrated in FIGS. 5 and 6 and mounted with juxtaposed ends in contiguous relation as at 98. Moreover, in some apparatus, elements 92 could advantageously be made as a series of bars having the sectional shape of FIGS. 5 and 6 with end portions 98 thereof contiguous.

I claim:

1. Apparatus which comprises, two members assembled for relative movement wherein respective portions thereof approach each other, a buffer comprising means defining a series of elements disposed between said portions, each of said elements having an edge and ends adjoining said edge and forming junctures therewith, said ends extending transversely in the direction of said movement and the junctures between said ends and edge being spaced apart in said direction, said ends of successive elements in said series being arranged in juxtaposed pairs, said ends of each juxtaposed pair having portions proximal to said junctures which are relatively close together, said ends of each juxtaposed pair having portions distal of said junctures which are spaced relatively further apart in said direction than are said proximal portions, said proximal portions of said ends being generally aligned in said direction, each of said elements having portions which extend continuously in said direction between said proximal portions thereof,
said members, responsive to said relative movement thereof, being effective to exert force on the end ones of said elements in said series, said pairs of aligned proximal portions being interengaged when said force is so exerted, said continuously extending portions cooperating to form a solid column in said direction when said proximal portions are so interengaged, said elements being resiliently distortable so that, responsive to an increase of said force upon further said relative movement of said members, the spacing between said distal portions of said juxtaposed pairs of ends is diminished.

2. The apparatus defined in claim 1 wherein said elements extend arcuately about a common axis generally parallel to said direction.

3. The apparatus defined in claim 2 wherein said means comprises a helical wound length of resiliently distortable material, said elements comprising successive turns of the helix.

4. Apparatus which comprises, two members assembled for relative movement wherein respective portions thereof approach each other, a buffer comprising means defining a series of elements disposed between said portions, each of said elements having an edge and ends adjoining said edge and forming junctures therewith, said ends extending transversely of the direction of said movement and the junctures between said ends and edge being spaced apart in said direction, said ends of successive elements in said series being arranged in juxtaposed pairs, said ends of each juxtaposed pair having portions proximal to said junctures which are relatively close together, said ends of each juxtaposed pair having portions distal of said junctures which are spaced relatively further apart in said direction than are said proximal portions, said proximal portions of said ends being generally aligned in said direction, said members, responsive to said relative movement thereof, being effective to exert force on the end ones of said elements in said series, said pairs of aligned proximal portions being interengaged when said force is so exerted, said elements being resiliently distortable so that, responsive to an increase of said force upon further said relative movement of said members, the spacing between said distal portions of said juxtaposed pairs of ends is diminished, each of said elements having another edge shorter than the first mentioned edge, said end adjoining said other edge, each of said elements having a sectional shape in which each of said edges and ends extends along a generally straight line, said means comprising a helical wound length of resiliently distortable material, the helix having an axis generally parallel to said direction, said elements comprising successive turns of the helix.

5. The structure defined in claim 4 wherein said means comprises a length of spring metal stock initially having rectangular sectional shape and being wound to cylindrical helical form, said elements comprising successive turns of the helix, the first-mentioned edge and said other edge of each element being disposed respectively inwardly and outwardly of said helix.

6. The apparatus defined in claim 5 wherein said members comprise a cylinder and a piston movable therein by fluid under pressure, said portions comprising an end wall of said cylinder and a radially extending face of said piston.

7. The apparatus defined in claim 6 and including means defining a radially extending shoulder in said cylinder, said buffer being contained between said end wall and shoulder, a portion of said buffer projecting radially inwardly of said shoulder into the path of movement of said piston face.

8. The apparatus defined in claim 7 wherein said shoulder comprises a diametral enlargement of the cylinder interior.

9. The apparatus defined in claim 6 wherein a piston rod on said piston extends through said buffer and to the exterior of said cylinder.

10. The apparatus defined in claim 9 wherein a helical return spring compressed between said end wall and said piston face is disposed around said piston rod and within said buffer.

11. The apparatus defined in claim 9 wherein said piston rod has an outer end provided with a tool for performing work on a workpiece.

12. The apparatus defined in claim 11 wherein said tool comprises a marking die.

13. A marking tool which comprises, a cylinder and a piston movable therein by fluid pressure, a rod on the piston extending through an end wall of the cylinder, and a marking die carried by the rod, a buffer comprising a length of spring metal stock initially having rectangular shape and being wound to cylindrical helical form so that the outer edges of the stock are stretched and have shorter axial length than the inner edges of the stock, successive turns of the helical form having ends which extend generally radially, face generally axially and adjoin said inner edges at junctures, said ends of said successive turns being arranged in juxtaposed pairs, said ends of each pair having portions proximal to said junctures which are relatively close together, said ends of each pair having portions distal of said junctures which are spaced relatively further apart in an axial direction than are said proximal portions, means containing said form axially between said end wall of said cylinder and said piston so that portions of said form defining said junctures and portions of said form radially outwardly thereof are disposed in the path of relative advancement of said piston and end wall toward each other, said piston and end wall being effective to exert force on the end ones of said turns of said helical form upon said relative advancement.

14. said pairs of aligned proximal portions being interengaged when said force is so exerted, said turns being resiliently distortable so that, responsive to an increase of said force upon further said relative advancement, said spacing between said distal portions of said juxtaposed pairs of ends is diminished.

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