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(11) **EP 1 435 461 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.07.2004 Bulletin 2004/28

(51) Int Cl.7: **F15B 15/22**

(21) Application number: **03104805.1**

(22) Date of filing: **18.12.2003**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PT RO SE SI SK TR**
Designated Extension States:
AL LT LV MK

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(30) Priority: **30.12.2002 DE 10261412**

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(54) **Pneumatic cylinder with cushioning means**

(57) A pneumatic cylinder comprising a cylinder tube (1), a piston (3) sliding within the cylinder tube (1), at least one piston packing ring (13a;13b) disposed on the outer peripheral surface of the piston (3) for defining at least one pressure chamber (6a;6b), at least one port (5a;5b) for supplying and discharging compressed air to and from said pressure chamber (6a;6b) separated by the piston (3), a respective air outlet (7a;7b) for communicating with the pressure chamber (6a;6b) associated with a port (5a;5b) and positioned with an axial cushioning distance (X) to the end of the cylinder tube (1), cushioning means for stopping the piston (3) in a cushioning manner by restraining the discharged air flow from the pressure chamber (6a;6b), wherein said cushioning means comprise at least one piston channel (9a;9b) with a cushioning nozzle (8a;8b) arranged in the piston (3) in order to discharge compressed air within the pressure chamber (6a;6b) only through the cushioning nozzle (8a;8b) when the piston packing ring (13a;13b) passes over the air outlet (7a;7b) on the discharge side just before the piston (3) reaches the end of its stroke, wherein furthermore the piston channel (9a;9b) connects the pressure chamber (6a;6b) with the air outlet (7a;7b).

ioning means for stopping the piston (3) in a cushioning manner by restraining the discharged air flow from the pressure chamber (6a;6b), wherein said cushioning means comprise at least one piston channel (9a;9b) with a cushioning nozzle (8a;8b) arranged in the piston (3) in order to discharge compressed air within the pressure chamber (6a;6b) only through the cushioning nozzle (8a;8b) when the piston packing ring (13a;13b) passes over the air outlet (7a;7b) on the discharge side just before the piston (3) reaches the end of its stroke, wherein furthermore the piston channel (9a;9b) connects the pressure chamber (6a;6b) with the air outlet (7a;7b).

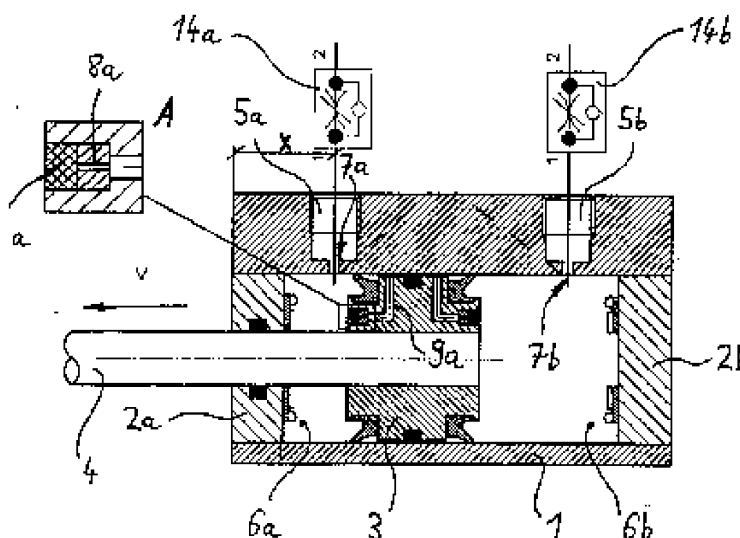


Fig.1

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Description

[0001] The present invention relates to a pneumatic cylinder comprising a cylinder tube, a piston sliding within the cylinder tube, at least one piston packing ring disposed on the outer peripheral surface of the piston for defining at least one pressure chamber, at least one port for supplying and discharging compressed air to and from said pressure chamber separated by the piston, a respective air outlet for communicating with the pressure chamber associated with a port and positioned with an axial cushioning distance (X) to the end of the cylinder tube, and cushioning means for stopping the piston in a cushioning manner by restraining the discharged air flow from the pressure chamber.

[0002] The US 5,307,729 discloses a pneumatic cylinder with such cushioning means. An adjusting screw is arranged on the end cover of the pneumatic cylinder for simultaneous setting of throttle means out from the cylinder for regulating the cushioning as well as the velocity. The end cover is provided with a cushion sleeve serving as a main inlet/outlet channel and extending into the pressure chamber. The piston is provided with a recess having a seal for the cooperating with the cushion sleeve. When the piston reaches the end of its stroke the discharged compressed air will pass through a bypass cushioning channel only, pass through the throttle means and thereafter leave the end cover through the outer port. The bypass channel is arranged with a radial distance from the central main inlet/outlet channel. The port serves also as inlet channel when the piston is moving in the opposite direction. Since the cushioning means are completely integrated into the end cover, the known pneumatic cylinder is quite oblong.

[0003] The GB 2 347 176 shows a short pneumatic cylinder wherein the cushioning means are integrated into the wall section of the cylinder tube. The cushioning means comprising discharge outlets and check valves. To move the inner piston compressed air initially enters the pressure chamber via an outer port through a bypass channel, a check valve and a first bore. As piston moves further a piston ring uncovers a second bore, so allowing unrestricted air flow from said port to the pressure chamber. Once piston reaches a cushioning distance from the end of its stroke a piston ring covers and blocks one of two outlet bores, so forcing air to discharge to the respective outer port via a check valve with throttling means and a bypass channel. Thus, the restricted outflow serves to decelerate the piston. In fact this construction allows a short design but a thick-walled cylinder tube is needed for placing the cushioning means.

[0004] It is an object of the present invention to provide a pneumatic cylinder with cushioning means which allows a short and thin-walled cylinder design.

[0005] This object is achieved with a pneumatic cylinder comprising the features as set forth in the characterizing portion of Claim 1.

[0006] The cushioning means of the present invention

comprise at least one channel with a cushioning nozzle arranged in the piston in order to discharge compressed air within the pressure chamber only through the cushioning nozzle when the piston packing ring passes over the air outlet on the discharge side just before the piston reaches the end of its stroke, wherein the piston channel connects the pressure chamber with the air outlet.

[0007] In the range of the invention it is also possible that the piston channel itself comprises the function of the cushioning nozzle. This means that a separate cushioning nozzle part is not needed. The pneumatic cylinder according to the present invention does not need a long cushion sleeve inside the pressure chamber and a long space for inserting the cushion sleeve, so that the length of the cylinder can be reduced, which enables the air cylinder to be miniaturized. Moreover, since most of the simple cushioning means are integrated in the piston, a thin-walled cylinder design is realized.

[0008] In a specific embodiment an additional elastomeric cushioning disc is disposed on the inner side of the cylinder tube's end cover. The elastomeric cushioning disc serves to absorb hard strokes, especially for pneumatic cylinders with a high piston speed.

[0009] In a preferred embodiment each port is connected to an outer check choke valve for speed regulating the piston movement. In order to arrange a check choke valve outside of the cylinder a block to which that speed-regulating means are assembled may be either fixed to the pneumatic cylinder or arranged in a place separated from the pneumatic cylinder to be connected to each other by piping.

[0010] In order to avoid a pollution of the cushioning nozzle in a further embodiment a filter element is placed between the cushioning nozzle and the pressure chamber. The filter element consists of porous ceramic or metal material whereby said filter element is changeable disposed inside the piston channel.

[0011] In a specific embodiment the at least one piston packing ring has the additional function of a non-return valve in order to speed up the piston when supplying compressed air to the pressure chamber.

[0012] According to a further embodiment the at least one cushioning nozzle is directly integrated in the piston packing ring forming a bore through the piston packing ring. In this case a separate piston channel through the piston is redundant.

[0013] The invention will now be further described by way of examples with reference to the accompanying drawings in which:

Fig. 1 is a side-sectional view of a first embodiment of a pneumatic cylinder with cushioning means showing the state before cushioning begins (during the stroke),

Fig. 2 is a side-sectional view of a first embodiment of a pneumatic cylinder with cushioning means

showing the state after cushioning process (end of stroke), and

Fig. 3 is a side-sectional view of a second embodiment of a pneumatic cylinder with cushioning means showing the state before cushioning begins (during the stroke).

[0014] The pneumatic cylinder according to Fig. 1 includes a cylinder tube 1, both ends thereof being closed by end covers 2a, 2b, respectively, a piston 3 which reciprocates within the cylinder tube 1 sliding air-tightly, and a piston rod 4 connected to the piston 3.

[0015] In the vicinities of ends in the head and rod sides of the cylinder tube 1, two ports 5a, 5b for supplying and discharging compressed air are disposed, respectively, with an axial cushioning distance X. These ports 5a, 5b communicate with a pair of pressure chambers 6a, 6b defined at both sides of the piston 3, via air outlets 7a, 7b, respectively. The piston 3 is driven to be reciprocated in the cylinder tube 1 by supplying and discharging compressed air to/from the pressure chambers 6a and 6b from/to the ports 5a, 5b via the air outlets 7a, 7b. Ports 5a, 5b are connected to outer check choke valves 14a and 14b, respectively, for speed regulating the piston movement when supplying the pressure chambers 6a or 6b with compressed air.

[0016] Furthermore, cushioning means are provided for stopping the piston 3 in a cushioning manner by restraining the flow of discharged air from the pressure chambers 6a, 6b, respectively. The cushioning means comprise - referring to on side of the pneumatic cylinder only - a cushioning nozzle 8a (see detail A) inserted in a 90°-offset piston channel 9a. An additional filter element 12a is placed between the cushioning nozzle 8a and the pressure chamber 6a in order to avoid a pollution of the cushioning nozzle 8a.

[0017] As shown in Fig. 2, discharged air within the pressure chamber 6a runs only through the cushioning nozzle 8a when the piston packing ring 13a passes over the air outlet 7a on the discharge side just before the piston 3 reaches the end of its stroke, wherein the piston channel 9a connects the pressure chamber 6a with the air outlet 7a. The end of the piston stroke is defined by an elastomeric cushioning disk 11a disposed on the inner side surface 10 of the end cover 2a. The elastomeric cushioning disk 11a absorbs hard strokes of the piston 3. When supplying the pressure chamber 6a with compressed air the piston packing ring 13a has the function of a non-return valve in order to speed-up the piston 3.

[0018] As shown in Fig. 3 according to a second embodiment the cushioning nozzles 8a, 8b are directly integrated in the respective piston packing rings 13a, 13b forming bores through the piston packing rings 13a and 13b. Both piston packing rings 13a, 13b are shaped as lip sealing rings fastened on the piston 3 in order to complete a non-return valve function for speed up the piston when supplying compressed air to the pressure cham-

ber 6a or 6b. A middle sealing ring 15 between both piston packing rings 13a and 13b is shaped as an O-ring.

[0019] Since the configuration and operations in the second embodiment is substantially identical to those in the first embodiment except as set forth above, like reference characters designate like main functional portions common to each embodiment with the description thereof omitted for brevity.

[0020] By cushioning means according to the present invention it is not needed to form a long cushioning sleeve inside the pressure chamber fixed on the piston or on the end cover. Furthermore, a thin-walled cylinder design is possible.

References

[0021]

- | | |
|----|---------------------|
| 1 | cylinder tube |
| 2 | end cover |
| 3 | piston |
| 4 | piston rod |
| 5 | port |
| 6 | pressure chamber |
| 7 | air outlet |
| 8 | cushioning nozzle |
| 9 | piston channel |
| 10 | inner side surface |
| 11 | cushioning disk |
| 12 | filter element |
| 13 | piston packing ring |
| 14 | check choke valve |
| 15 | middle sealing ring |

Claims

1. A pneumatic cylinder comprising a cylinder tube (1), a piston (3) sliding within the cylinder tube (1), at least one piston packing ring (13a;13b) disposed on the outer peripheral surface of the piston (3) for defining at least one pressure chamber (6a;6b), at least one port (5a;5b) for supplying and discharging compressed air to and from said pressure chamber (6a;6b) separated by the piston (3), a respective air outlet (7a;7b) for communicating with the pressure chamber (6a;6b) associated with a port (5a;5b) and positioned with an axial cushioning distance (X) to the end of the cylinder tube (1), cushioning means for stopping the piston (3) in a cushioning manner by restraining the discharged air flow from the pressure chamber (6a;6b),
characterized in that said cushioning means comprise at least one piston channel (9a;9b) with a cushioning nozzle (8a;8b) arranged in the piston (3) in order to discharge compressed air within the pressure chamber (6a;6b) only through the cushioning nozzle (8a;8b) when the piston packing ring

(13a;13b) passes over the air outlet (7a;7b) on the discharge side just before the piston (3) reaches the end of its stroke, wherein the piston channel (9a;9b) connects the pressure chamber (6a;6b) with the air outlet (7a;7b).

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2. A pneumatic cylinder according to claim 1,
characterized in that an additional elastomeric cushioning disc (11a; 11b) is disposed on the inner surface (10) side of the cylinder tube's (1) end cover (2a;2b) in order to absorb hard strokes. 10
3. A pneumatic cylinder according to claim 1,
characterized in that each port (5a;5b) is connected to an outer check choke valve (14a;14b) for speed regulating the piston movement. 15
4. A pneumatic cylinder according to claim 1,
characterized in that a filter element (12a;12b) is placed between the cushioning nozzle (8a;8b) and the pressure chamber (6a;6b) in order to avoid pollution of the cushioning nozzle (8a;8b). 20
5. A pneumatic cylinder according to claim 1 or 4,
characterized in that the cushioning nozzle (8a; 8b) and/or the filter element (12a;12b) is/are changeable disposed inside the piston channel (9a; 9b). 25
6. A pneumatic cylinder according to claim 1, 30
characterized in that the at least one piston packing ring (13a;13b) has the function of a non-return valve in order to speed up the piston (3) when supplying compressed air to the pressure chamber (6a; 6b). 35
7. A pneumatic cylinder according to one of the preceding claims,
characterized in that the at least one cushioning nozzle (8a;8b) is directly integrated in the piston packing ring (13a;13b) forming a bore through the piston packing ring (13a;13b). 40
8. A pneumatic cylinder according to claim 6 or 7,
characterized in that a middle sealing ring (15) shaped as an o-ring is disposed between both piston packing rings (13a, 13b). 45
9. A pneumatic cylinder according to one of the preceding claims, 50
characterized in that a fixed or adjustable restrictor is provided for the at least one cushioning nozzle (8a, 8b). 55

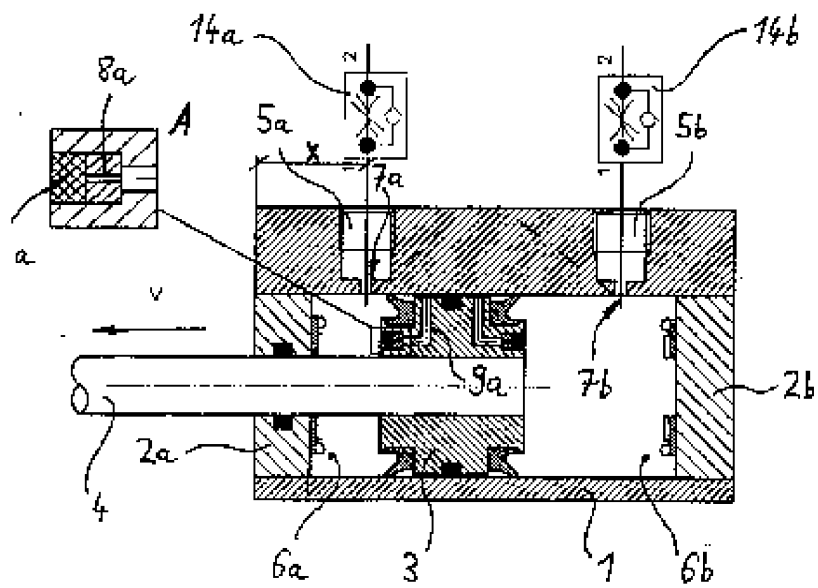


Fig.1

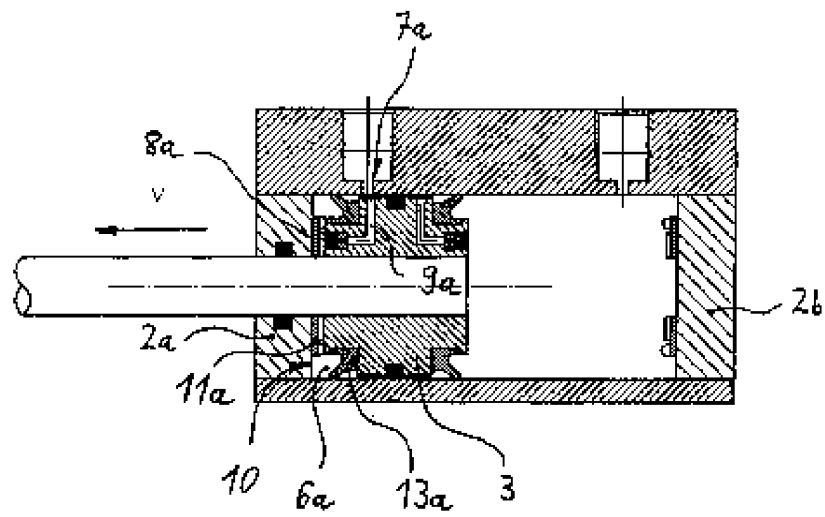


Fig.2

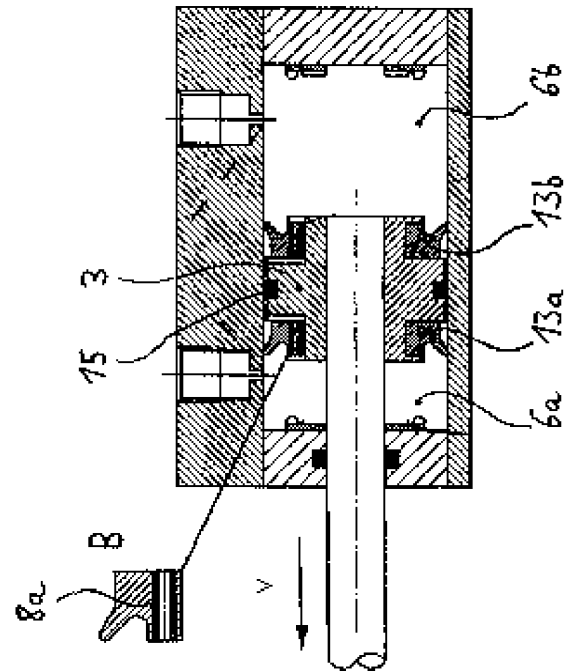


Fig. 3



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