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(54) Pneumatically powered fastener driving tool

(57) A pneumatically driven, fastener-driving tool (10), has a housing structure (12) with an upper chamber (16), and a tubular cylinder (30) mounted within it. A driving piston (40) is movable axially within the cylinder (30), between an upper position and a lower position, and a valve member (50) is movable axially within the housing structure (12), above the cylinder (30), between an upper position and a lower position. The valve member (50) has an upper surface facing the upper chamber (16). A sealing member (80) is arranged to provide a seal between the sealing member (80) and the valve member (50) under certain conditions and to provide seal between the sealing member (80) and the cylinder (30) under other conditions. An annular, elastomeric member (100) located within the upper chamber (16) of the housing structure (12) is engaged with the lower surface (18) of the upper portion (14) of the housing structure (12) and with the upper surface of the valve member (50) for biasing the valve member (50) downwards to its lower position, for permitting the valve member to be upwardly moved to its upper position, and for functioning as a bumper between the valve member (50) and the upper portion (14) of the housing structure (12) when the valve member (50) moves upwards.

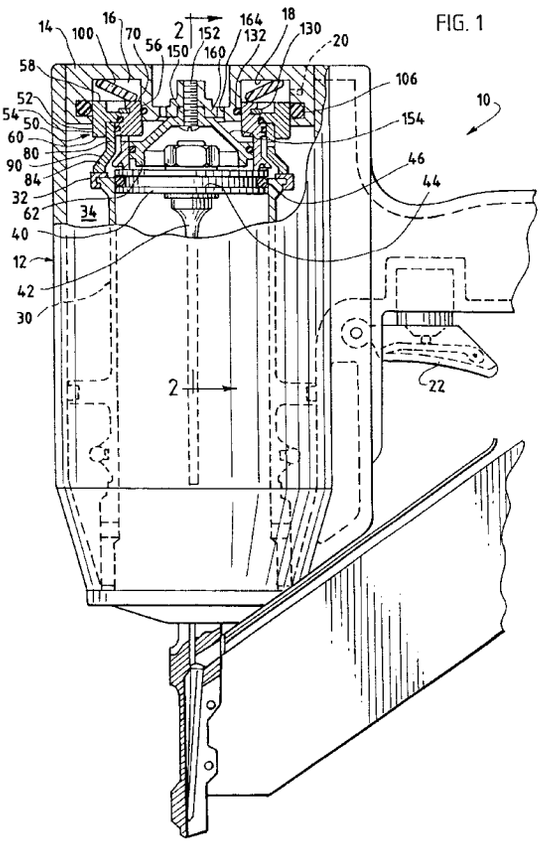


FIG. 1

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Description

This invention pertains generally to an improved, pneumatically powered, fastener-driving tool, such as a nail-driving tool or a staple-driving tool, of a type having a valve member for controlling a driving piston.

Pneumatically powered, fastener-driving tools of the type noted above are available commercially from ITW Paslode (a unit of Illinois Tool Works Inc.) of Lincolnshire, Illinois, under the PASLODE trademark. PASLODE 5300C Series Nailers exemplify those tools.

Typically, as illustrated and described in a Service Manual published by ITW Paslode, copyright 1989, for PASLODE 5300C Series Nailers, a coil spring is used to bias a valve piston in one axial direction and to permit the valve piston to be axially moved in an opposite direction. Moreover, as illustrated and described therein, O-rings are used to provide seals between the valve piston and the housing structure.

Typically, the coil spring is made from steel, the valve piston is made from a polymeric material, such as nylon 6/6, and the housing structure and other co-acting elements including an upper cap, against which the coil spring bears, are made from another metal, such as an aluminum or magnesium alloy. Therefore, galvanic corrosion tends to occur between the coil spring and the housing structure, particularly at the upper cap. Galvanic corrosion tends to produce oxide particles, which tend to abrade the O-rings. Moreover, high acceleration is imparted to the coil spring, which tends to be readily broken so as to damage the upper cap. Consequently, the coil spring, the upper cap, and the O-rings must be frequently replaced to maintain such a tool in prime operating condition.

According to this invention, a pneumatically driven, fastener-driving tool comprises:

(a) a housing structure defining a downwardly opening, upper chamber, the housing structure having an upper portion with a lower surface facing the upper chamber;

(b) a tubular cylinder mounted fixedly within the housing structure;

(c) a driving piston movable axially within the cylinder, between an upper position and a lower position; and

(d) a valve member movable axially within the housing structure, above the cylinder, between an upper position and a lower position, the valve member having an upper surface facing the upper chamber; and

(e) means including an annular, elastomeric member located within the upper chamber of the housing structure and engaged with the lower surface of the upper portion of the housing structure and with the upper surface of the valve member for biasing the valve member downwards to its lower position, for permitting the valve member to be upwardly moved to its upper position, and for functioning as a bumper between the valve member and the upper portion of the housing structure when the valve member is moved upwards.

An improved tool according to this invention does not employ a coil spring to bias a valve member, such as a valve piston, in one axial direction and to permit the valve member to be axially moved in an opposite direction, as discussed above. Rather, it uses an elastomeric member, which does not engender galvanic corrosion and which also functions as a bumper between the valve member and the housing structure. Functioning as a bumper between the valve member and the upper portion of the housing structure when the valve member is moved upwardly, the elastomeric member performs an additional function that the coil spring discussed above does not perform adequately.

Preferably, the upper portion of the housing structure has an radially inwardly facing, cylindrical wall facing the upper chamber. Thus, an O-ring is seated in an annular groove and engages the valve member so as to provide an annular seal as the valve member is moved between the upper and lower positions of the valve member. Preferably, moreover, the downwardly opening, upper chamber is annular, and the valve member has an annular portion, which has an outer, cylindrical wall engaged by the O-ring noted in the preceding sentence and which has an inner, cylindrical wall.

Preferably, furthermore, the upper portion of the housing structure has a radially outwardly facing, cylindrical wall facing the upper chamber. Thus, an O-ring is seated in an annular groove in the outwardly facing, cylindrical wall and engages the inner wall of the annular portion of the valve member so as to provide an inner seal as the valve member is moved between the upper and lower positions of the valve member.

The valve member may be advantageously made from a polymeric material, such as an acetyl polymer, and the co-acting elements of the housing structure may be advantageously made from an aluminum or magnesium alloy. Thus, the valve member has an inherent lubricity, which reduces and minimizes wear and tear on each O-ring engaging the valve member.

In one contemplated embodiment of the improved tool, the valve member has an upper, annular portion with an outer, cylindrical wall and with an inner, cylindrical wall and having a lower, tubular portion. The upper portion of the valve member has an upper surface facing the upper chamber and a lower surface facing the annular chamber. The lower portion of the valve member has an upper, tubular wall and a lower, annular flange, which has an upper surface.

In the foregoing embodiment of the improved tool, a sealing member having an upper, tubular wall and a lower, annular flange is movable between a lower position and an upper position. The upper wall of the sealing member surrounds the upper wall of the lower portion of the valve member. The lower flange of the sealing mem-

ber surrounds the lower flange of the lower portion of the valve member and is provided with a lower, annular, sealing lip conforming to an upper, annular, sealing lip of the cylinder. In the lower position, the sealing lip of the sealing member and the sealing lip of the cylinder respectively are engaged with each other so as to provide an annular seal. In the upper position, the sealing lips are disengaged from each other.

The lower flange of the sealing member has an upper surface with an effective surface area, as viewed downwardly along the axis, which is smaller than the effective surface area of the lower surface of the upper portion of the valve member, as viewed upwardly along the axis. The lower flange of the sealing member has a lower surface conforming to the upper surface of the lower flange of the lower portion of the valve member so as to provide an annular seal if the conforming surfaces of the sealing member and the valve member respectively are engaged with each other.

A preferred embodiment of this invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a partly broken away, elevational view of an improved, pneumatically powered, fastener-driving tool constituting a preferred embodiment of this invention;

Figures 2, 3, and 4, on a slightly larger scale, are fragmentary views, which are similar to Figure 1 but which show certain elements of the improved tool in successively changed positions; and

Figure 5 is a fragmentary, cross-sectional view of certain elements of the improved tool.

As shown in Figure 1 and other views, an improved, pneumatically powered, fastener-driving tool 10 constitutes a preferred embodiment of this invention. In many respects, the improved tool 10 is similar to known tools, as exemplified by PASLODE 5300C Series Nailers discussed above. However, in addition to numerous other improvements, the improved tool 10 differs markedly from known tools in that the improved tool 10 employs an elastomeric member for biasing a valve member in one axial direction, permitting the valve member to be axially moved in an opposite direction, and for functioning as a bumper between the valve member and a housing structure of the improved tool 10.

As employed herein and in the claims, directional terms such as "upwardly", "downwardly", "upper", and "lower" refer to the improved tool in a convenient orientation and are not intended to restrict this invention to any particular orientation of the improved tool 10.

Generally, the improved tool comprises a housing structure 12, which includes various assembled elements including an upper, removable cap 14 defining an annular, downwardly opening, upper chamber 16. Preferably, the housing structure 12 is made from an aluminum alloy. Preferably, dissimilar metals are not used to assemble the housing structure 12. The upper cap 14 is fastened suitably and removably to other elements of the housing structure 12 and has a lower surface 18 facing the upper chamber 16. As shown in Figure 1, the upper chamber 16 has a port 20, via which the upper chamber 16 is pressurized with compressed air in a known manner and via which compressed air in the upper chamber 16 is exhausted to ambient air when a trigger 22 of the improved tool 10 is actuated in a known manner.

Moreover, the improved tool 10 comprises a tubular cylinder 30 defining an axis. The cylinder 30 is mounted fixedly within the housing structure 12. A separate, upper, annular, sealing lip 32 is mounted fixedly to the cylinder 30. The cylinder 30 co-acts with surrounding elements of the housing structure 12 to define an annular chamber 34 around an upper portion 36 of the cylinder 30.

Moreover, the improved tool 10 comprises a driving piston 40 movable axially within the cylinder 30 between an upper position and a lower position and a driving blade 42 mounted to the driving piston 40 so as to be conjointly movable with the driving piston 40. The driving piston 40 has a radially outwardly opening, annular groove 44, in which a nitrile O-ring 46 engaging the cylinder 30 is seated. In Figures 1, 2, and 3, the driving piston 40 and the driving blade 42 are shown in the upper position. In Figure 4, the driving piston 40 and the driving blade 42 are shown as having been moved downwardly from the upper position, toward the lower position, so as to drive a fastener (not shown) from the improved tool 10 in a known manner.

Furthermore, the improved tool 10 comprises a valve member 50 movable axially within the housing structure 12, above the upper sealing lip 32 of the cylinder 30, between an upper position and a lower position. In connection with this embodiment, it is convenient to refer to the valve member 50 as a valve piston. In Figures 1 and 2, the valve piston 50 is shown in the lower position. In Figure 3, the valve piston 50 is shown in an intermediate position. In Figure 4, the valve piston 50 is shown in the upper position. Preferably, the valve piston 50 is made from a polymeric material, such as an acetyl polymer or nylon 6/6. An acetyl polymer is preferred.

The valve piston 50 has an annular portion 52, which has an outer, cylindrical wall 54, an inner, cylindrical wall 56, an upper, annular surface 58 facing the upper chamber 16, and a lower, annular surface 60 facing the annular chamber 34. The valve piston 50 has a downwardly extending portion 62, which has a tubular wall 64 extending below the annular portion 52 and a lower, annular flange 66. The lower flange 66 flares outwardly and downwardly, so as to have an upper, flared surface 68. Also, the downwardly extending portion has an upper surface 70, which faces the upper chamber 16 and which is co-planar with the upper surface 58 of the annular portion 52 of the valve piston 50.

Furthermore, the improved tool 10 comprises a sealing member 80, which has an upper, tubular wall 82 and

a lower, annular flange 84 provided with an integral, lower, annular, sealing lip 86 conforming to the sealing lip 32 of the cylinder 30. The sealing member 80 is movable between a lower position and an upper position. In the lower position, as shown in Figures 1, 2, and 3, the sealing lip 32 of the cylinder and the sealing lip 86 of the sealing member 80 are engaged with each other so as to provide an annular seal. In the upper position, the sealing lip 32 of the cylinder and the sealing lip 86 of the sealing member 80 are disengaged from each other.

The upper wall 82 of the sealing member 80 surrounds the upper wall 64 of the lower portion 62 of the valve piston 60. The lower flange 84 of the sealing member 80 flares outwardly and downwardly and surrounds the lower flange 66 of the lower portion 62 of the valve piston 60. The lower flange 84 of the sealing member 80 has an upper, flared surface 90 with an effective surface area, as viewed downwardly along the axis, which is smaller than the effective surface area of the lower surface 60 of the annular portion 52 of the valve piston 50, as viewed upwardly along the axis. The lower flange 84 of the sealing member 80 has a lower, flared surface 92 conforming to the upper, flared surface 68 of the lower flange 66 of the lower portion 62 of the valve piston 60, so as to provide an annular seal if the flared surface 92 and the flared surface 68 are engaged with each other.

In accordance with this invention, an annular, elastomeric member 100 is located within the upper chamber of the housing structure 12. Preferably, the elastomeric member 100 is made from polyurethane (80 durometer). The elastomeric element 100 is frusto-conical when unstressed but is arranged to be axially stressed within the upper chamber 16 even when the valve piston 50 is in its lower position. Thus, at any position of the valve piston 50, the elastomeric element 100 is engaged with the lower surface 18 of the upper cap 14 of the housing structure 12 and with the upper surface 70 of the downwardly depending portion 62 of the valve piston 50.

Therefore, the elastomeric member 100 biases the valve piston 50 downwardly to its lower position and permits the valve piston 50 to be upwardly moved to its upper position. Moreover, the elastomeric member 100 functions as a bumper between the upper surface 58 of the annular portion 52 of the valve piston 50 and the lower surface 18 of the upper cap 14 of the housing structure 12 when the valve piston 50 is moved upwardly.

The upper cap 14 has a radially inwardly facing, cylindrical wall 102 facing the upper chamber 16 and having an annular groove 104 opening radially inwardly. A nitrile O-ring 106 is seated in the annular groove 104. The upper, annular portion 52 of the valve piston 50 has an outer, cylindrical wall 112, which is engaged by the O-ring 106 as the valve piston 50 is moved between its upper and lower positions, and an outer, cylindrical wall 114. Because the valve piston 50 is made from a polymeric material having an inherent lubricity, wear and tear on the O-ring 106 engaging the valve piston 50 is minimized.

The upper cap 14 has a radially outwardly facing, cylindrical wall 122, which has an annular groove 124 opening radially inwardly. A nitrile O-ring 126 is seated in the annular groove 124 and engages the inner wall 114 of the upper, annular portion 52 of the valve piston 52 as the valve piston 50 is moved between its upper and lower positions. Because the valve piston 50 is made from a polymeric material having an inherent lubricity, wear and tear on the O-ring 126 engaging the valve piston 50 is minimized.

The annular portion 52 of the valve piston 50 and the lower portion 62 of the valve piston 50 are assembled via a retaining clip 130. A nitrile O-ring 132 is interposed between the assembled portions 52, 62, which are configured to accommodate the O-ring 132 there-between. Moreover, a nitrile O-ring 142 is seated in a radially outwardly opening, annular groove 144 in the lower, tubular portion 62 of the valve piston 50 and engages the upper, tubular wall 82 of the sealing member 80.

The housing structure 12 comprises a central element 150, which is fastened to the upper cap 14 via a machine screw 152 and which has a downwardly depending, flared flange 154 with a lower, annular lip 156. A nitrile O-ring 162 is seated in a radially outwardly opening annular groove 164 in the lower lip 156 and engages the lower, tubular portion 62 of the valve piston 50.

The upper cap 14 of the housing structure 12 has a central, annular portion 160, which has axially oriented, exhaust ports 162. The lower, tubular portion 62 of the valve piston 50 has radially oriented, exhaust ports 164.

When the tool 10 is charged with compressed air in a known manner, the upper chamber 16 and the annular chamber 34 are charged with compressed air. Also, the elastomeric member 100 biases the valve piston 50 downwardly such that the sealing lip 86 of the sealing member 80 is engaged with the sealing lip 32 of the cylinder so as to provide an annular seal between the annular chamber 34 and the exhaust ports 164 in the lower, tubular portion 62 of the valve piston 50.

Except as illustrated in the drawings and described herein, the improved tool 10 may be structurally and functionally similar to known tools, as exemplified by PASLODE 5300C Series Nailers discussed above.

When the trigger 22 is actuated in a known manner, compressed air in the upper chamber 16 is exhausted to ambient air, via the port 20, in a known manner. Because the upper, flared surface 90 of the lower flange 84 of the sealing member 80 has an effective surface area, as viewed downwardly along the axis, which is smaller than the effective surface area of the lower, annular surface 60 of the annular portion 52 of the valve piston 50, as viewed upwardly along the axis, compressed air in the annular chamber 34 moves the valve piston 50 upwardly and presses the sealing member 80 downwardly such the sealing lip 86 and the sealing lip 32 remain engaged.

Once the upper surface 68 of the lower flange 66 of the lower portion 62 of the valve piston 50 engages the lower surface 92 of the lower flange 84 of the sealing

member 80, an annular seal is provided at the engaged surfaces 68, 92, and the sealing member 80 is moved upwardly with the valve piston 50. Once the sealing member 80 has been moved upwardly, compressed air from the annular chamber 34 enters between the flared flange 154 of the central element 150 and the driving piston 40 so as to drive the driving piston 40 and the driving blade 42 downwardly.

When the valve piston 50 is moved upwardly, the elastomeric member 100 functions as a bumper between the upper surface 58 of the annular portion 52 of the valve piston 50 and the lower surface 18 of the upper cap 14 of the housing structure 12.

Claims

1. A pneumatically driven, fastener-driving tool (10) comprising:

   (a) a housing structure (12) defining a downwardly opening, upper chamber (16), the housing structure (12) having an upper portion (14) with a lower surface (18) facing the upper chamber (16);
   (b) a tubular cylinder (30) mounted fixedly within the housing structure (12);
   (c) a driving piston (40) movable axially within the cylinder (30), between an upper position and a lower position; and
   (d) a valve member (50) movable axially within the housing structure (12), above the cylinder (30), between an upper position and a lower position, the valve member (50) having an upper surface (70) facing the upper chamber (16); and
   (e) means including an annular, elastomeric member (100) located within the upper chamber (16) of the housing structure (12) and engaged with the lower surface (18) of the upper portion (14) of the housing structure (12) and with the upper surface (70) of the valve member (50) for biasing the valve member (50) downwards to its lower position, for permitting the valve member to be upwardly moved to its upper position, and for functioning as a bumper between the valve member (50) and the upper portion (14) of the housing structure (12) when the valve member (50) is moved upwards.

2. A tool according to claim 1, wherein the upper portion (14) of the housing structure (12) has a radially inwardly facing, cylindrical wall (102) facing the upper chamber (16) and having an annular groove (104) and wherein an O-ring (106) is seated in the annular groove (104) and engages the valve member (50) so as to provide a seal as the valve member (50) is moved between its upper and lower positions.

3. A tool according to claim 2, wherein the downwardly opening, upper chamber (16) is annular, wherein the valve member (50) has an annular portion, which has an outer, cylindrical wall (52) engaged by the O-ring (106) seated in the annular groove (104) in the radially inwardly facing, cylindrical wall of the upper portion (14) of the housing structure (12) so as to provide an outer seal as the valve member (50) is moved between its upper and lower positions.

4. The tool of claim 3, wherein the annular portion of the valve member (50) has an inner, cylindrical wall (56), wherein the upper portion (14) of the housing structure (12) has an radially outwardly facing, cylindrical wall (122) facing the upper chamber (16) and having an annular groove (124), and wherein an O-ring (126)is seated in the annular groove (124) in the outwardly facing, cylindrical wall (122) and engages the inner wall (56) of the annular portion of the valve member (50) so as to provide an inner seal as the valve member (50) is moved between its upper and lower positions.

5. A tool according to any one of the preceding claims, wherein the upper portion (14) of the housing structure (12) is made from an aluminum or magnesium alloy and has a cylindrical wall with an annular groove (104), wherein an O-ring (106) is seated in the annular groove (104) and engages the valve member (50) so as to provide a seal as the valve member (50) is moved between its upper and lower positions, and wherein the valve member (50) is made from a polymeric material having an inherent lubricity, which minimizes wear and tear on the O-ring (106) engaging the valve member (50).

FIG. 1

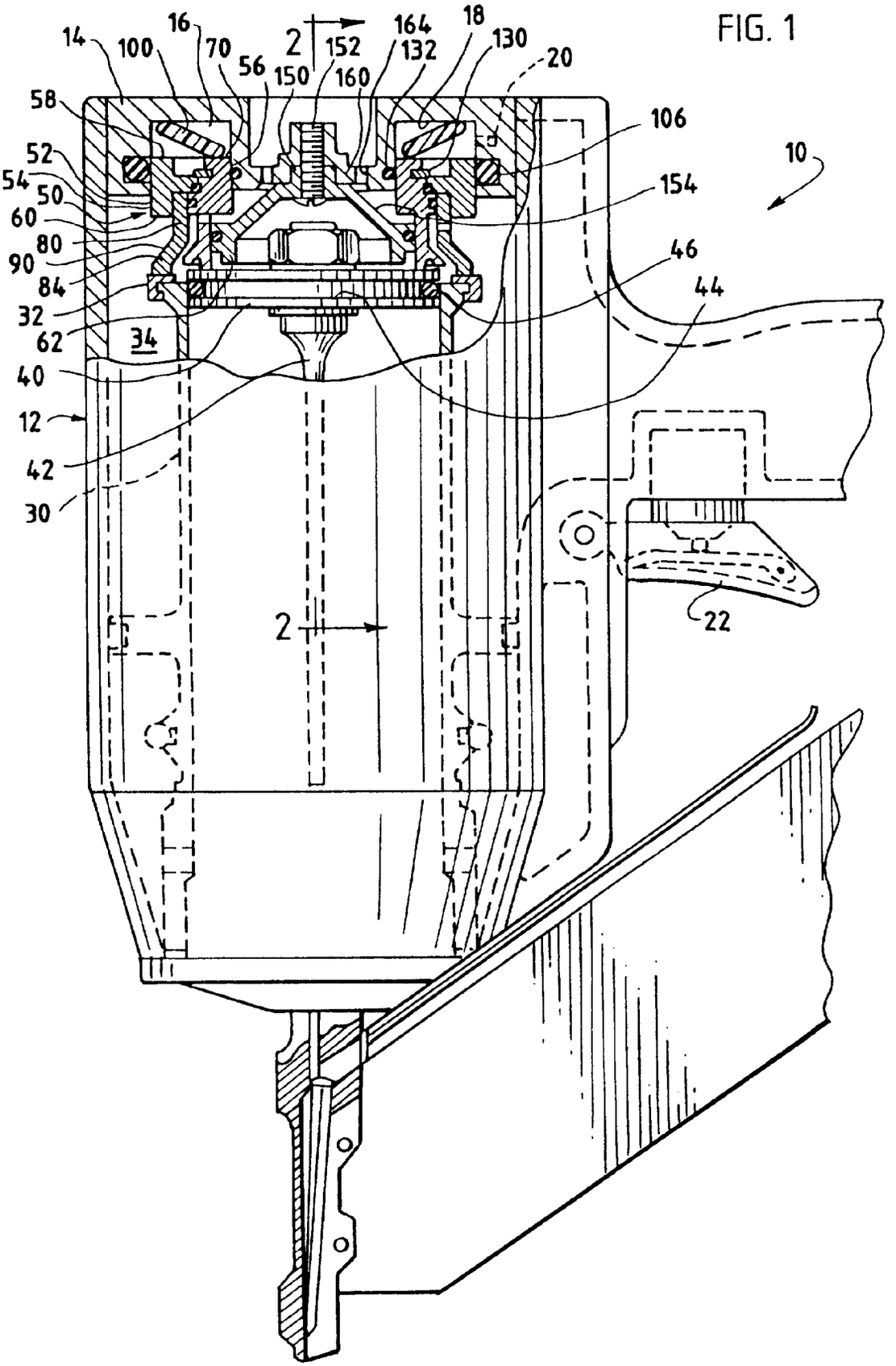

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FIG. 2

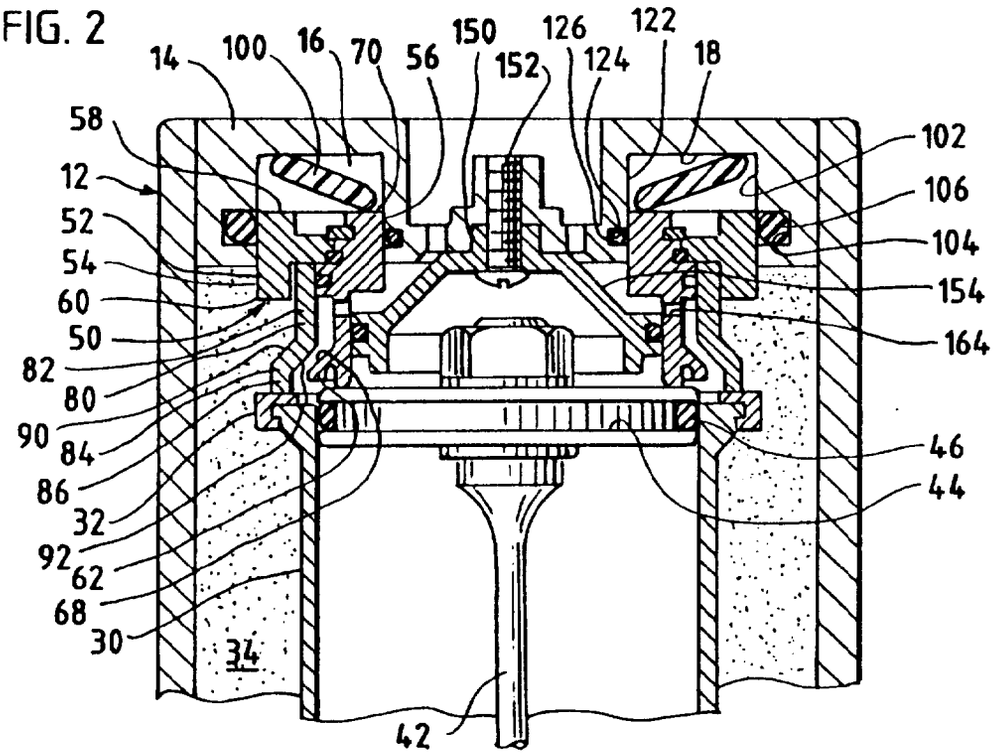

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FIG. 3

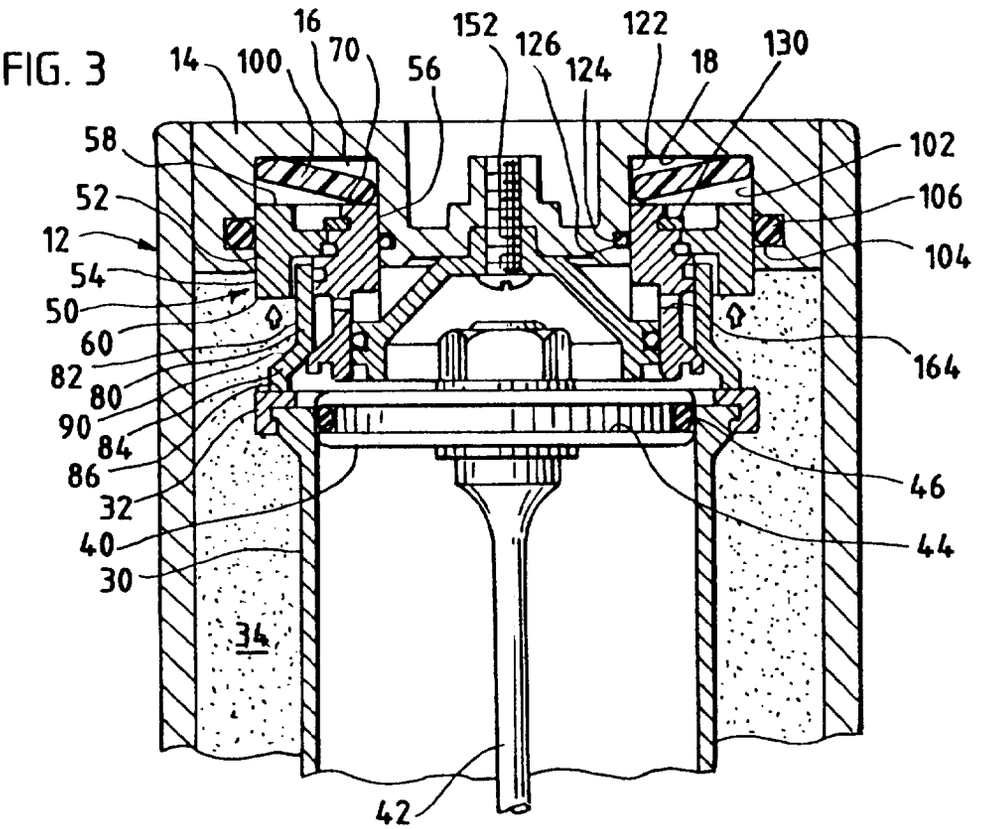

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FIG. 4

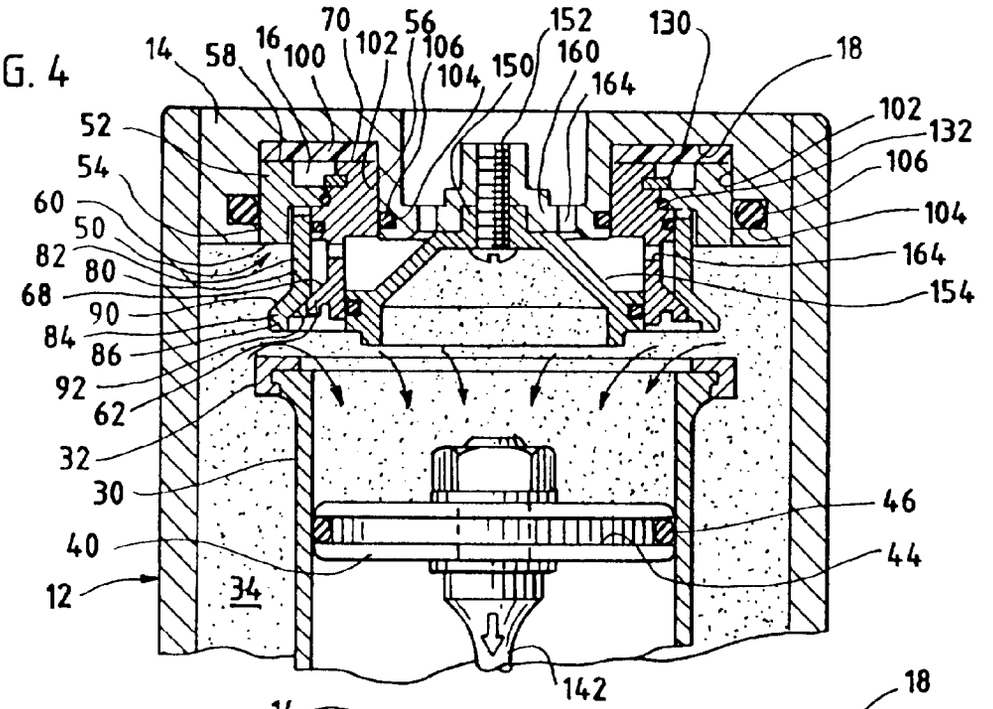
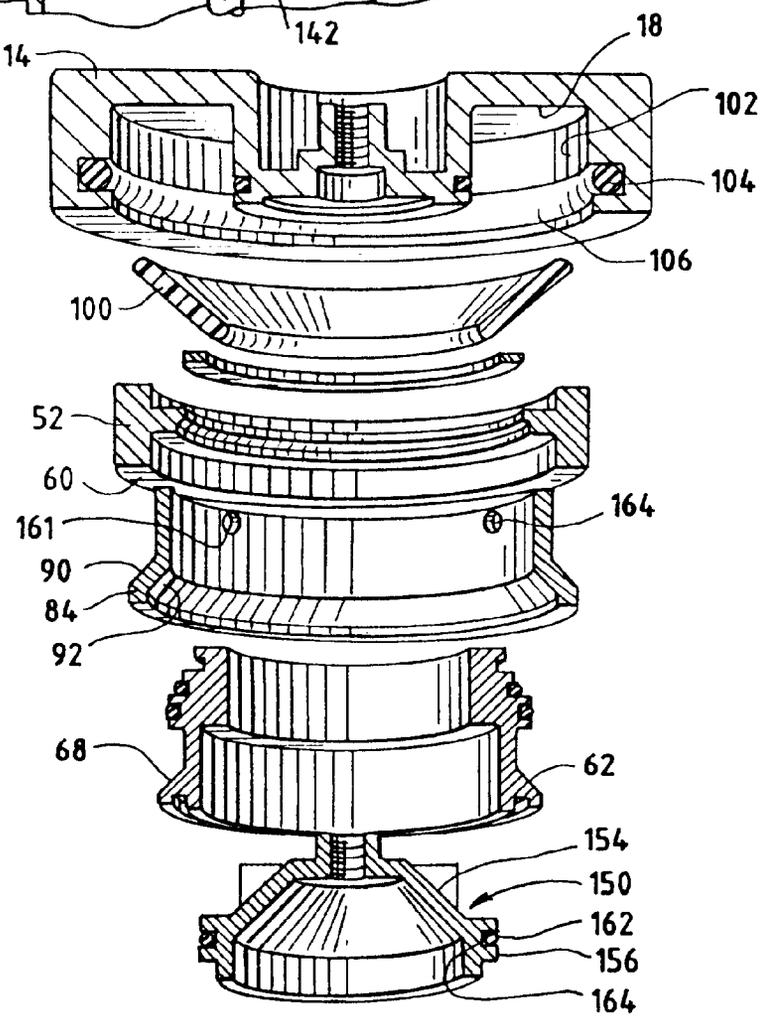

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FIG. 5


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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 6808

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	EP-A-0 359 974 (HAUBOLD-KIHLBERG GMBH) * column 5, line 8-57; claims 7,8; figures 1-5 *	1 2,3	B25C1/04
Y	DE-A-22 23 999 (DIETER HAUBOLD INDUSTRIELLLE NAGELGERÄTE) * figures 4,5 *	2,3	
A	EP-A-0 584 394 (MONACELLI) * column 10, line 4-7; figures 1-3 *	2,5	
A	US-A-3 392 632 (VOLKMANN) * column 3, line 16-21; figure 1 *	3,5	
A	EP-A-0 205 633 (JOH.FRIEDRICH BEHRENS AG) * figures 1-3 *	4	
A	EP-A-0 584 395 (MONACELLI)		
A	FR-A-2 661 353 (SOFRAGRAF INDUSTRIES)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B25C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 February 1996	M. Petersson

CATEGORY OF CITED DOCUMENTS

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