



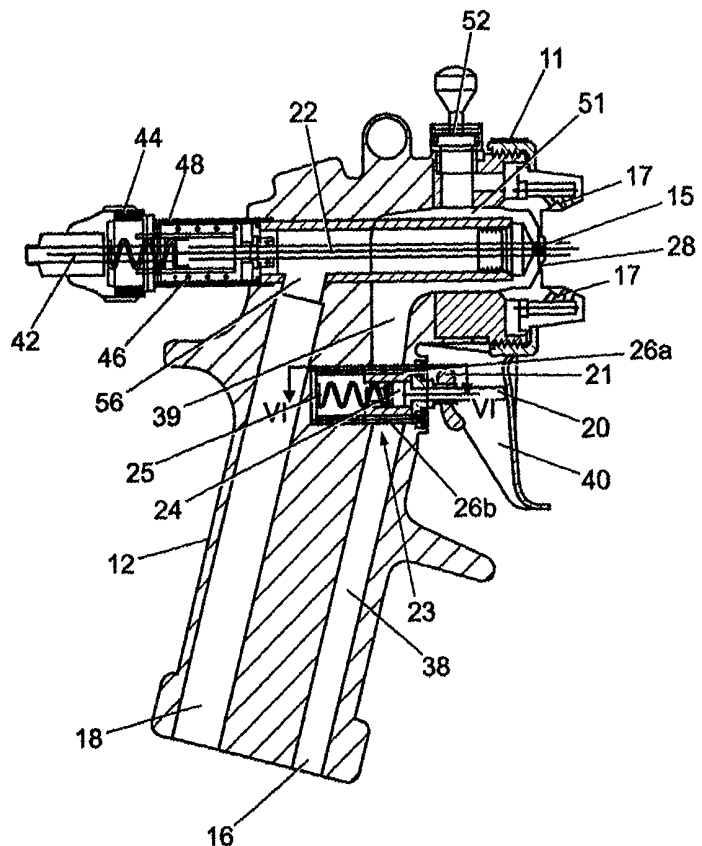
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/GB99/03476</p> <p>(22) International Filing Date: 20 October 1999 (20.10.99)</p> <p>(30) Priority Data: 9823032.9 22 October 1998 (22.10.98) GB</p> <p>(71) Applicant (for all designated States except US): JIM LINDSAY LIMITED [GB/GB]; 13 Hill Street, Ardrossan KA22 8HE (GB).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): LINDSAY, James [GB/GB]; 25 Ardrossan Road, Saltcoats KA21 5BP (GB). ROBINSON, George, Walter [GB/GB]; 15 Shire Avenue, Spalding PE11 1FN (GB).</p> <p>(74) Agent: MURGITROYD &amp; COMPANY; 373 Scotland Street, Glasgow G5 8QA (GB).</p>		<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> Without international search report and to be republished upon receipt of that report.</p>

(54) Title: METHOD AND APPARATUS FOR SPRAYING

(57) Abstract

A low volume-low pressure spray gun (10) for spraying a fluid has a housing (12), a gas input (16), a trigger valve mechanism, and a nozzle (14). The gun (10) has lower and upper air passages (38, 39) which connect the gas input (16) to the trigger valve mechanism (23), and the trigger valve mechanism to the nozzle (14), respectively. The upper passage (39) is offset from the lower passage (38) and is substantially conical in shape, the layout of the passages (38, 39) producing a gas vortex in the upper passage (39) which creates a gas acceleration to compensate for the low pressure of the gas entering the gas input (16). The trigger valve mechanism comprises a piston valve (23), a liquid control needle valve (22), and a trigger (40). The piston valve (23) may include inner and outer apertured sleeves (26a, 26b), the sleeves being co-axial with the inner sleeve (26a) located inside the outer sleeve (26b). The inner sleeve (26a) is rotatably adjustable relative to the outer sleeve (26b) so that the apertures (61, 62) of the sleeves (26a, 26b) may be aligned, partially aligned, or closed, thus permitting adjustment of the gas vortex.



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1     METHOD AND APPARATUS FOR SPRAYING

2  
3     The present invention relates to a method and apparatus  
4     for low air pressure spraying. Particularly, but not  
5     exclusively, the invention is applicable to spray guns  
6     for the application of paint and like material surface  
7     treatments, particularly water-based paints.

8  
9     The use of spray guns for application of paints is well  
10    known. However, it has been found that when water-  
11    based, high gloss paints are sprayed through a high  
12    pressure or conventional spray gun, the level of gloss  
13    is reduced. This is also true of the high volume-low  
14    pressure type of spray gun which operate at only 10psi  
15    air cap pressure.

16  
17    Tests carried out at various pressures have shown that  
18    the loss of gloss is due to air bubbles rising to the  
19    surface of the paint as it dries. It has been found  
20    that the greater the pressure used to spray the paint,  
21    the more air bubbles appear. The cause of the bubbles  
22    is that dissolved air is being released from the water  
23    as the paint dries. The greater the air pressure when  
24    the paint is sprayed, the greater the volume of  
25    dissolved air and the greater the number of bubbles.

1 If the air pressure is low but the volume is high,  
2 gloss levels are reduced. To achieve the desired gloss  
3 levels with this type of paint it is necessary to  
4 design a spray gun that will operate at very low air  
5 pressures and very low air volumes. It must achieve  
6 acceptable levels of atomization, have sufficient  
7 energy to transfer the paint at an acceptable rate to  
8 the surface of the target, and expand the natural cone  
9 of spray into a useful fan pattern.

10

11 In the past, spray guns have used air pressures between  
12 40 and 90 psi, and these high pressures cause a cushion  
13 of air to be formed on the surface of the product being  
14 treated. This cushion causes some of the sprayed  
15 material to bounce back and be displaced laterally by  
16 the following airflow to be lost in the surrounding  
17 air.

18

19 Accordingly, this type of spray gun is very  
20 inefficient. Rarely are transfer efficiencies greater  
21 than 40% and more often nearer 30%. The waste paint  
22 material produces unacceptable emissions of volatile  
23 organic compounds and leaves a solid residue which can  
24 remain floating in the air for some time. These can be  
25 highly toxic and damaging to the atmosphere and health.  
26 To overcome these problems, it is necessary to reduce  
27 the air pressure and air volume used in such guns.  
28 Therefore, the environmental requirements for an  
29 acceptable spray gun are similar to those required for  
30 achieving a good gloss in water-based paints.

31

32 If the air pressure is reduced on a spray gun that was  
33 originally designed for high pressure use, the  
34 turbulence and restrictions in internal air passages  
35 and the air cap cause a loss of air speed and a  
36 reduction in air volume. The result of this is low

1 paint transfer rates, poor atomization and an inferior  
2 paint finish. However, transfer efficiency is  
3 improved. If the air volume is increased while keeping  
4 the pressure low, the ratio of air to paint increases  
5 and the problems experienced with high pressure will  
6 return depending on the increase in volume.

7  
8 Existing high pressure spray guns have been modified to  
9 operate at low pressures, but the complexity of the  
10 designs and the intricate interconnecting drilled  
11 passages do not permit good air flow. In an effort to  
12 overcome the poor performance, air cap ring gaps were  
13 increased, resulting in a substantial increase in air  
14 consumption. This type of spray gun has become known  
15 as the high volume-low pressure (HVLP) gun.

16  
17 More specifically, in HVLP spray guns the means for  
18 actuating the control valves within the gun have had  
19 considerable shortcomings. For example, it is  
20 commonplace for the stem of the needle valve and its  
21 associated compression spring and housing to extend  
22 through the main air flow passage to the nozzle,  
23 thereby leading to significant restrictions in the air  
24 flow path.

25  
26 Likewise, in order to provide a convenient means for  
27 actuating the stem of the air flow and fluid needle  
28 valves, the main nozzle of the apparatus is mounted on  
29 a forward projection of the apparatus so as to leave a  
30 free space to accommodate the arc of movement of the  
31 valve control trigger.

32  
33 Moreover, since the same trigger operates both the  
34 liquid and air control valves, the progressive control  
35 from on to off operating characteristics of the air  
36 control valve can be restricted in certain operating

1 conditions where the liquid control valve has been  
2 manually adjusted to such a point that it affects the  
3 ability of the trigger to operate both valves  
4 simultaneously through the full range of movement.

5  
6 The object of the present invention is to provide a  
7 method and apparatus for spraying paint and other  
8 surface treatment liquids, offering improvements in  
9 relation to one or more of the matters discussed above,  
10 or generally.

11  
12 According to a first aspect of the invention there is  
13 provided an apparatus for spraying liquid surface  
14 treatment material, said apparatus having a housing, a  
15 liquid inlet for supply of the liquid surface treatment  
16 material, a gas inlet for supply of pressurised gas to  
17 be mixed with the liquid surface treatment material, an  
18 outlet nozzle through which the gas and liquid surface  
19 treatment material is sprayed, a control valve adapted  
20 to regulate the supply of the liquid surface treatment  
21 material to the outlet nozzle, a gas valve operable  
22 between an open position and a closed position, a first  
23 communicating passageway connecting said gas inlet to  
24 said gas valve, and a second communicating passageway  
25 connecting said gas valve to said outlet nozzle;  
26 wherein said second passageway is provided with a  
27 stepped portion therein so that a gas vortex is created  
28 therethrough.

29  
30 Preferably, said second passageway is offset from said  
31 first passageway. Preferably, said second passageway  
32 is substantially conical in shape. Preferably, said  
33 second passageway includes an inlet and an outlet,  
34 wherein said passageway is tapered from said inlet to  
35 said outlet. Preferably, said taper is between 1 and  
36 15°.

1 Preferably, said stepped portion of said second  
2 passageway comprises a ledge whose width tapers up to a  
3 maximum of 10% of the radius of said second passageway  
4 at the level of the stepped portion.

5  
6 Preferably, said second passageway has a radius of  
7 curvature at said outlet so as to provide gas to the  
8 nozzle in a substantially horizontal direction.

9  
10 Preferably, the longitudinal axis of said outlet nozzle  
11 extends across said second passageway. Preferably, the  
12 axis of symmetry of said ledge is offset from said  
13 longitudinal axis of said outlet nozzle, thereby  
14 inducing a vortex in the air flowing through said  
15 passageway.

16  
17 According to a second aspect of the invention there is  
18 provided an apparatus for spraying liquid surface  
19 treatment material, said apparatus having a housing, a  
20 liquid inlet for supply of the liquid surface treatment  
21 material, a gas inlet for supply of pressurised gas to  
22 be mixed with the liquid surface treatment material, an  
23 outlet nozzle through which the gas and liquid surface  
24 treatment material is sprayed, a control valve adapted  
25 to regulate the supply of the liquid surface treatment  
26 material to the outlet nozzle, a gas valve operable  
27 between an open position and a closed position, a first  
28 communicating passageway connecting said gas inlet to  
29 said gas valve, and a second communicating passageway  
30 connecting said gas valve to said outlet nozzle;  
31 wherein said second passageway is axially offset from  
32 said first passageway and is substantially conical in  
33 shape, and wherein said second passageway includes an  
34 inlet and an outlet and is tapered from said inlet to  
35 said outlet at an angle of taper of between 1 and 15°.  
36

1 Preferably the apparatus further comprises a trigger  
2 means, whereby said trigger means is adapted to operate  
3 both of said control valve and said gas valve.

4  
5 Preferably, said gas valve is an axially-sliding piston  
6 valve. Preferably, said control valve is a liquid  
7 control needle valve.

8  
9 Preferably, said outlet nozzle is controlled by said  
10 liquid control needle valve.

11  
12 Preferably, said piston valve produces an annular air  
13 jet in said second passageway. The piston valve may be  
14 tapered or parallel. In addition, an air control valve  
15 stem is provided which is connected to the piston valve  
16 and operated by said trigger means.

17  
18 Preferably, said piston valve comprises inner and outer  
19 co-axial apertured sleeves, wherein said inner sleeve  
20 is located within said outer sleeve and is rotatably  
21 adjustable relative to said outer sleeve.

22  
23 Preferably, the liquid control needle valve is  
24 controlled by said trigger means via an axially-sliding  
25 sleeve or slipper member situated on a rearward portion  
26 of the housing. Preferably, it is also provided with a  
27 rotational flow adjustment means to adjust the flow  
28 rate of the liquid.

29  
30 Preferably, said flow adjustment means comprises a stem  
31 member, a rotational adjuster, and a return spring,  
32 said stem member being threaded at its rearmost  
33 extremity to accept the rotational adjuster.

34 Preferably, said stem member is actuated externally by  
35 the trigger means, and is returned to its initial  
36 position by a return spring.

1 Preferably, the apparatus further comprises a  
2 regulating valve and a pair of side jets, whereby the  
3 spray pattern of the outlet nozzle is regulated by said  
4 regulating valve, and said side jets are utilised to  
5 regulate said spray pattern.

6  
7 Preferably, the needle valve is supplied with the paint  
8 or material surface treatment liquid by a pressurized  
9 material supply connector which distributes the  
10 material via a radial port to said needle valve.

11 Alternatively, the material may be introduced to the  
12 apparatus from a gravity liquid reservoir fitted to the  
13 uppermost aspect of the apparatus via a radial port.

14  
15 According to a third aspect of the present invention,  
16 there is provided a method of spraying a fluid onto a  
17 surface, said method comprising the steps of:

18 supplying a liquid to be sprayed into a liquid  
19 inlet of a spray apparatus;

20 supplying a pressurised gaseous propellant into a  
21 gas inlet of said spray apparatus;

22 passing said gaseous propellant through a  
23 communicating passageway from said gas inlet to an  
24 outlet nozzle;

25 accelerating said gaseous propellant by creating a  
26 gas vortex as said propellant passes through said  
27 communicating passageway;

28 passing said accelerated propellant through an  
29 outwardly tapering portion of the communicating  
30 passageway to further accelerate the vortex and supply  
31 the propellant to the outlet nozzle in the form of an  
32 annular gas jet; and

33 spraying said liquid onto a surface by mixing said  
34 liquid and said annular gas jet at said nozzle.

35  
36 Preferably, said passageway comprises an upper portion

1 and a lower portion, wherein said upper portion is  
2 axially offset from said lower portion and is  
3 substantially conical in shape. Preferably, said upper  
4 portion of said passageway includes an inlet and an  
5 outlet and is tapered from said inlet to said outlet at  
6 an angle of taper of between 1 and 15°.

7  
8 Preferably, the mixing of said liquid and said annular  
9 gas jet is controlled by a trigger valve mechanism on  
10 said spray apparatus. Preferably, said trigger valve  
11 mechanism comprises:

12 a gas valve operable between an open position and  
13 a closed position;

14 a control valve adapted to regulate the supply of  
15 the liquid to be sprayed; and

16 a trigger means;

17 whereby said trigger means is adapted to operate  
18 both of said gas and control valves.

19  
20 Preferably, said control valve is a liquid control  
21 needle valve. Preferably, said gas valve is an  
22 axially-sliding piston valve. Preferably said piston  
23 valve comprises an inner apertured sleeve and an outer  
24 apertured sleeve, said inner and outer sleeves being  
25 co-axial, and wherein said inner sleeve is located  
26 within said outer sleeve and is rotatably adjustable  
27 relative to said outer sleeve.

28  
29 Embodiments of the invention will now be described by  
30 way of example with reference to the accompanying  
31 drawings in which :-

32  
33 Figure 1 shows a first embodiment of a spray gun  
34 according to the present invention;

35  
36 Figure 2 shows a section through the spray gun of

1 Figure 1 having pressure feed and offset air passages;

2

3 Figure 3 shows a second embodiment of a spray gun  
4 according to the present invention;

5

6 Figure 4(a) shows a section through the spray gun of  
7 Figure 3 having offset air passages and a tapered upper  
8 air passage;

9

10 Figure 4(b) is a sectional view along line "A-A" of  
11 Figure 4(a);

12

13 Figure 4(c) is a sectional view along line "B-B" of  
14 Figure 4(a), showing the stepped portion of the upper  
15 air passage;

16

17 Figure 5 shows a third embodiment of a spray gun  
18 according to the present invention;

19

20 Figure 6(a) shows a section through the spray gun of  
21 Figure 5;

22

23 Figure 6(b) shows the component parts of the piston  
24 valve of the spray gun of Figures 5 and 6(a); and

25

26 Figure 6(c) shows a sectional view along line "VI-VI"  
27 of Figure 6(a).

28

29 As shown in Fig 1, a first embodiment of a spray  
30 apparatus 10 comprises a body or housing 12 having a  
31 nozzle 14, an operating trigger 40, and a regulating  
32 valve 52. Nozzle 14 is secured to the housing 12 by a  
33 threaded ring 11.

34

35 Figure 2 shows a section view through the spray gun  
36 which shows the components of the apparatus 10 in more

1 detail. The apparatus 10 has an air supply connection  
2 16, a pressurized material supply connection 18, an air  
3 control valve stem 20, and a liquid control valve 22.  
4 It will be noticed that in this embodiment, and each of  
5 the subsequent embodiments described herein, the air  
6 supply connection 16 and material supply connection 18  
7 and their respective supply passages are located in the  
8 handle portion of the apparatus 10. By locating both  
9 supply connections 16,18 in the handle portion, the  
10 apparatus 10 can be packaged in a more compact manner  
11 than prior art apparatus. Furthermore, by being  
12 located in the handle the supply passages are free from  
13 the internal restrictions which can hamper the  
14 performance of known apparatus.

15  
16 A tapered piston valve 23 controls the supply of air to  
17 the nozzle 14 in order to regulate the spray pattern.  
18 The nozzle 14 provides a central jet 15 controlled by  
19 the liquid control needle valve 22, and an annular air  
20 jet 28 controlled by the piston valve 23. The air  
21 control valve stem 20 connects to an axially-sliding  
22 piston 24 to effect progressive throttling of the air  
23 flow. The stem 20 is pushed by an operating trigger  
24 40.

25  
26 The air supply connection 16 is coupled to a compressor  
27 (not shown) which provides air under pressure to the  
28 air supply connection 16. Connection 18 is supplied by  
29 a reservoir (not shown) containing paint or like  
30 material to be sprayed.

31  
32 The liquid control needle valve 22 has a rotational  
33 adjuster 44 and is controlled by the trigger 40 through  
34 a sleeve member 46 which slides on a rearward portion  
35 48 of the housing 12. The trigger 40 acts on the  
36 sleeve 46 by way of a flange (not shown) on the sleeve

1 46, thereby opening the needle valve 22 to allow liquid  
2 to pass through.

3  
4 A regulating valve 52 is positioned whereby the jet 15  
5 produced by nozzle 14 is regulated from a natural cone  
6 to a fan pattern by air from side jets 17.

7  
8 The air passage 38 connects the air supply connection  
9 16 with the piston valve 23. The air control valve  
10 stem 20 controls the air flow through a pair of offset  
11 passages 38 and 39, where the lower passage 38 and the  
12 upper passage 39 are offset to create a vortex within  
13 the upper passage 39, thereby accelerating the gas flow  
14 through said upper passage 39. A return spring 25 is  
15 also provided in order to return the piston 24 and stem  
16 20 to their extended position when released. The  
17 piston valve 23 has two apertured rotational sleeves 26  
18 which can be adjusted by a lever 21 to either line up,  
19 close off or partially close the apertures, thereby  
20 increasing or decreasing the vortex in the passage 39.  
21 Thus, the pressure in the gun can be regulated to offer  
22 variable pressure sprays. A more detailed description  
23 of the operation of the piston valve 23 is given later.

24  
25 The liquid control valve needle 22 has a stem member 42  
26 which passes through sleeve member 46 and is threaded  
27 at its rearmost extremity to accept the rotational  
28 adjuster 44. The rotational adjuster 44 allows fine  
29 position adjustment of the fluid control needle 22.  
30 Trigger 40 actuates the needle member 22 externally of  
31 the housing 12. An internal return spring (not shown)  
32 returns the needle 22 to its rest position. Liquid to  
33 be sprayed is fed to the needle valve 22 from  
34 connection 18 via a radial port 56.

35  
36 Figure 3 shows a second embodiment of a spray gun

1 apparatus 10 according to the present invention.  
2 Externally, the second embodiment appears similar to  
3 the apparatus of the first embodiment. However, the  
4 sectional views of Figures 4(a)-(c) highlight the  
5 difference between the two embodiments.

6  
7 Figures 4(a)-(c) show views of the second embodiment of  
8 the spray gun 10 in which upper air passage 39 has been  
9 modified to assist the creation of the vortex within  
10 the upper passage 39. Figure 4(b) shows the tapering  
11 of the upper passage 39 to assist the acceleration of  
12 the gas therein. The best acceleration results have  
13 been produced when the tapering is between 0 and 10°.  
14 Figure 4(c) shows the cross-section B-B of the upper  
15 passage 39 at its inlet, wherein a stepped portion 50  
16 is provided. For the most effective vortex, the  
17 stepped portion 50 should encompass approximately 10%  
18 of the circumference of the upper passage 39.

19  
20 The vortex is created in the upper passage 39 as the  
21 gas passes through the inlet of upper passage 39 over  
22 the stepped portion 50, which can be best seen in Fig  
23 4(b). As the gas passes over the stepped portion 50,  
24 the increased area causes the gas to swirl in the  
25 passage, thereby creating the vortex which produces a  
26 gas acceleration upwards through the upper passage 39.  
27 The tapering of the upper passage 39 ensures that the  
28 vortex is sustained until it reaches the outlet of the  
29 upper passage 39 at nozzle 14.

30  
31 As with each of the embodiments described herein, the  
32 liquid control valve needle 22 passes through the  
33 uppermost chamber 51 of the upper passage 39. This is  
34 best seen in Figure 4(b), where the valve 22 passes  
35 directly through the chamber 51 in such a way as to not  
36 hinder the vortex created in the upper passage 39.

1 Thus, the vortex flows through the chamber 51  
2 relatively unhindered by the valve 22 as the gas flows  
3 around the outside of the valve 22, and the vortex is  
4 not destroyed by the valve 22.

5  
6 Aside from the amendments to the passage 39, this  
7 embodiment of the spray gun 10 is constructed and  
8 operated substantially in the same manner as the spray  
9 gun 10 of figure 1.

10  
11 The third and final of the preferred embodiments  
12 described is shown in Figures 5 and 6(a)-(c). Again,  
13 externally, the spray gun 10 is similar in appearance  
14 to the other embodiments, with the majority of the  
15 components previously described above being used.  
16 However, the third embodiment differs in the operation  
17 of the piston valve assembly 23 which produces the  
18 vortex.

19  
20 The use of a pair of apertured sleeves 26a,26b within  
21 the piston valve assembly 23 was first discussed in the  
22 description of the first embodiment above. However,  
23 the individual components of the piston valve assembly  
24 23 are best seen in Figure 6(b). The valve assembly 23  
25 consists of an apertured outer sleeve 26b and an  
26 apertured inner sleeve 26a, and each of the sleeves  
27 26a,26b has a pair of apertures 61,62. On each sleeve  
28 26a,26b, the apertures 61,62 are located diametrically  
29 opposite one another, thereby permitting gas to pass  
30 through the sleeves 26a,26b unhindered.

31  
32 Figure 6(a) shows the manner in which the various  
33 components of the valve assembly 23 co-operate. The  
34 inner sleeve 26a is located inside the outer sleeve  
35 26b, with the apertures 61,62 of the two sleeves  
36 26a,26b being axially aligned to allow gas to pass

1 directly through the sleeves 26a,26b. The inner sleeve  
2 26a is fitted with a lever 21 so that the inner sleeve  
3 26a may be rotated relative to the outer sleeve 26b. A  
4 return spring 25 is located within the sleeves 26a,26b  
5 with a piston 24 positioned thereon. The piston 24  
6 receives the spring 25 on one end 24a and an air  
7 control valve stem 20 on the other end 24b. The stem  
8 20 has a flange 20a which locates in the second end 24b  
9 of the piston so that the stem 20 may act on the piston  
10 24.

11  
12 Thus, in order to operate the piston valve assembly 23,  
13 the trigger 40 is pulled towards the housing 12 of the  
14 apparatus 10. As the trigger 40 is pulled, it acts on  
15 the valve stem 20 which in turn acts on the piston 24.  
16 The action of the trigger 40 thus pushes the piston 24  
17 away from the air passages, thereby permitting the gas  
18 to pass through the valve assembly 23 by way of the  
19 aligned apertures 61,62 in the inner and outer sleeves  
20 26a,26b. When the trigger 40 is released, the spring  
21 25 pushes the piston 24, stem 20, and trigger 40 back  
22 to their original positions, and gas can therefore no  
23 longer pass through the valve assembly 23.

24  
25 Figure 6(c) shows how the alignment of the apertures  
26 61,62 on the inner and outer sleeves 26a,26b can be  
27 varied to improve the vortex generation in the upper  
28 air passage 39. The lever 21 can be rotatably adjusted  
29 in order to rotate the inner sleeve 26a relative to the  
30 fixed outer sleeve 26b. Thus, as is seen in Figure  
31 6(c), the apertures 61,62 can be offset from each  
32 other. This offsetting of the apertures 61,62 creates  
33 a lip portion 63, where a portion of the inner sleeve  
34 26a partly blocks the aperture 61 of the outer sleeve  
35 26b. Thus, the gas flowing through the valve assembly  
36 23 is disrupted thereby creating the vortex in the

1 upper passage 39 of the apparatus 10.

2

3 In use, each of the embodiments is operated as follows:

4 The reservoir of material to be sprayed delivers the  
5 material to central jet 15 under the control of needle  
6 valve 22 where it is mixed with air delivered via air  
7 passages 38 and 39. The operation of the gun is  
8 initiated by trigger 40 operating air control valve  
9 stem 20 and liquid control valve 22.

10

11 The present invention provides a method and apparatus  
12 for spraying that addresses the limitations and  
13 inefficiencies of prior spray guns. As it may operate  
14 at pressures as low as 1.5psi in the air cap and at air  
15 volumes as low as 4cfm, energy savings are achieved.  
16 The very low pressures allow a very high transfer  
17 efficiency to be achieved which is an added advantage  
18 when used with paints containing volatile organic  
19 compounds.

20

21 The present invention permits the trigger 40 to operate  
22 the air control valve 23 and the fluid control valve 22  
23 simultaneously, without restricting the operation of  
24 either, regardless of the adjustment of the other. The  
25 stems of both the fluid control needle valve 22 and air  
26 control piston valve 23 operate in parallel to each  
27 other, yet independently of each other.

28

29 The above permits a straight, unobstructed, large  
30 diameter air passage 38 to the air valve 23 while also  
31 permitting a short, straight air passage 39 to the air  
32 cap 52 and a large diameter fluid passage.

33

34 In addition, by offsetting the air passages 38,39, gas  
35 acceleration may be achieved by means of a vortex  
36 created by the gas passing through these passages

1 38,39. With gas acceleration in the head portion of  
2 the apparatus 10, the increased speed of the gas  
3 created by the vortex leads to an increase in air speed  
4 at the nozzle 14 and thereby an increase in material  
5 sprayed by the gun. Therefore, although gas is  
6 introduced to the apparatus 10 from a compressor at  
7 relatively low pressure, by having the air passages  
8 38,39 arranged in the offset position a gas  
9 acceleration is achieved with a consequential increase  
10 in efficiency at the nozzle 14. Moreover, the gas  
11 acceleration is further improved by the provision of a  
12 pair of adjustable, apertured sleeves 26a,26b which can  
13 either increase or decrease gas flow into the vortex  
14 from the air valve 23 depending on the alignment of the  
15 apertures 61,62.

16

17 The features of the present invention:

- 18 i) reduce the compressed air volume required;  
19 ii) reduce the pressure of said compressed air;  
20 iii) reduce energy losses;  
21 iv) improve exit air speed;  
22 v) increase depression at the fluid nozzle; and  
23 vi) reduce resistance to fluid flow.

24

25 The internal surface area of the air passages is  
26 approximately 50% less than a representative selection  
27 of spray guns currently available.

28

29 The trigger to air cap air passage length is 75% less  
30 than with the representative selection.

31

32 Total air passage length is approximately 40% less than  
33 with the representative selection.

34

35 Input air pressure is 75% lower than the average of the  
36 representative selection.

1 Air volume required is approximately 50% lower than the  
2 average of the representative selection.

3

4 Depression at the fluid nozzle is approximately 30%  
5 greater than the representative selection.

6

7 These and other improvements and modifications can be  
8 incorporated without departing from the scope of the  
9 invention.

1       **CLAIMS:**

2

3       1.    An apparatus for spraying liquid surface treatment  
4       material, said apparatus comprising:

5           a housing;

6           a liquid inlet for supply of the liquid surface  
7       treatment material;

8           a gas inlet for supply of pressurised gas to be  
9       mixed with the liquid surface treatment material;

10          an outlet nozzle through which the gas and liquid  
11       surface treatment material is sprayed;

12          a control valve adapted to regulate the supply of  
13       the liquid surface treatment material to the outlet  
14       nozzle;

15          a gas valve operable between an open position and  
16       a closed position;

17          a first communicating passageway connecting said  
18       gas inlet to said gas valve; and

19          a second communicating passageway connecting said  
20       gas valve to said outlet nozzle;

21          wherein said second passageway is provided with a  
22       stepped portion therein so that a gas vortex is created  
23       therethrough.

24

25       2.    An apparatus according to Claim 1, wherein said  
26       second passageway is offset from said first passageway.

27

28       3.    An apparatus according to either Claim 1 or Claim  
29       2, wherein said second passageway is substantially  
30       conical in shape.

31

32       4.    An apparatus according to any preceding claim,  
33       wherein said second passageway includes an inlet and an  
34       outlet, wherein said second passageway is tapered from  
35       said inlet to said outlet.

36

- 1     5.    An apparatus according to Claim 4, wherein said  
2     taper is between 1 to 15°.  
3
- 4     6.    An apparatus according to either Claim 4 or Claim  
5     5, wherein said second passageway has a radius of  
6     curvature at said outlet so as to provide gas to the  
7     outlet nozzle in a substantially horizontal direction.  
8
- 9     7.    An apparatus according to any preceding claim,  
10    wherein said stepped portion of said second passageway  
11    comprises a ledge whose width tapers up to a maximum of  
12    10% of the radius of said second passageway at the  
13    level of the stepped portion.  
14
- 15    8.    An apparatus according to Claim 7, wherein the  
16    longitudinal axis of said outlet nozzle extends across  
17    said second passageway.  
18
- 19    9.    An apparatus according to Claim 8, wherein the  
20    axis of symmetry of said ledge is offset from said  
21    longitudinal axis of said outlet nozzle.  
22
- 23    10.   An apparatus for spraying liquid surface treatment  
24    material, said apparatus comprising:  
25        a housing;  
26        a liquid inlet for supply of the liquid surface  
27    treatment material;  
28        a gas inlet for supply of pressurised gas to be  
29    mixed with the liquid surface treatment material;  
30        an outlet nozzle through which the gas and liquid  
31    surface treatment material is sprayed;  
32        a control valve adapted to regulate the supply of  
33    the liquid surface treatment material to the outlet  
34    nozzle;  
35        a gas valve operable between an open position and  
36    a closed position;

1           a first communicating passageway connecting said  
2 gas inlet to said gas valve; and  
3           a second communicating passageway connecting said  
4 gas valve to said outlet nozzle;  
5           wherein said second passageway is axially offset  
6 from said first passageway and is substantially conical  
7 in shape, and wherein said second passageway includes  
8 an inlet and an outlet and is tapered from said inlet  
9 to said outlet at an angle of taper of between 1 and  
10 15°.

11

12 11. An apparatus according to any preceding claim,  
13 further comprising a trigger means;

14           whereby said trigger means is adapted to operate  
15 both of said control valve and said gas valve.

16

17 12. An apparatus according to Claim 11, wherein said  
18 control valve is a liquid control needle valve.

19

20 13. An apparatus according to Claim 12, wherein said  
21 gas valve is an axially-sliding piston valve.

22

23 14. An apparatus according to Claim 13, wherein said  
24 outlet nozzle is controlled by said liquid control  
25 needle valve.

26

27 15. An apparatus according to either Claim 13 or Claim  
28 14, wherein said piston valve produces an annular air  
29 jet in said second passageway.

30

31 16. An apparatus according to any of Claims 13 to 15,  
32 further comprising an air control valve stem which is  
33 connected to said piston valve and operated by said  
34 trigger means.

35

36 17. An apparatus according to any of Claims 13 to 16,

1 wherein said piston valve comprises an inner apertured  
2 sleeve and an outer apertured sleeve, said inner and  
3 outer sleeves being co-axial, and wherein said inner  
4 sleeve is located within said outer sleeve and is  
5 rotatably adjustable relative to said outer sleeve.

6  
7 18. An apparatus according to any of Claims 12 to 17,  
8 wherein the liquid control needle valve is controlled  
9 by said trigger means via an axially-sliding sleeve or  
10 slipper member situated on a rearward portion of said  
11 housing.

12  
13 19. An apparatus according to any of Claims 12 to 18,  
14 wherein said liquid control needle valve is provided  
15 with a rotational flow adjustment means.

16  
17 20. An apparatus according to Claim 19, wherein said  
18 flow adjustment means comprises a stem member, a  
19 rotational adjuster, and a return spring, said stem  
20 member being threaded at its rearmost extremity to  
21 accept said rotational adjuster.

22  
23 21. An apparatus according to Claim 20, wherein said  
24 stem member is actuated externally by said trigger  
25 means, and is returned to its initial position by said  
26 return spring.

27  
28 22. An apparatus according to any of Claims 12 to 21,  
29 wherein said liquid inlet comprises a pressurized  
30 material supply connector, and wherein said needle  
31 valve is supplied with a liquid by said pressurized  
32 material supply connector.

33  
34 23. An apparatus according to any of Claims 12 to 21,  
35 wherein said liquid inlet comprises a gravity feed  
36 liquid reservoir, and wherein said needle valve is

1 supplied with a liquid by said gravity liquid  
2 reservoir.

3

4 24. An apparatus according to any preceding claim,  
5 further comprising a regulating valve and a pair of  
6 side jets, whereby the spray pattern of the outlet  
7 nozzle is regulated by said regulating valve, and said  
8 side jets are utilised to regulate said spray pattern.

9

10 25. A method of spraying a liquid onto a surface, said  
11 method comprising the steps of:

12 supplying a liquid to be sprayed into a liquid  
13 inlet of a spray apparatus;

14 supplying a pressurised gaseous propellant into a  
15 gas inlet of said spray apparatus;

16 passing said gaseous propellant through a  
17 communicating passageway from said gas inlet to an  
18 outlet nozzle;

19 accelerating said gaseous propellant by creating a  
20 gas vortex as said propellant passes through said  
21 communicating passageway;

22 passing said accelerated propellant through an  
23 outwardly tapering portion of the communicating  
24 passageway to further accelerate the vortex and supply  
25 the propellant to the outlet nozzle in the form of an  
26 annular gas jet; and

27 spraying said liquid onto a surface by mixing said  
28 liquid and said annular gas jet at said nozzle.

29

30 26. A method according to Claim 25, wherein said  
31 passageway comprises an upper portion and a lower  
32 portion, wherein said upper portion is axially offset  
33 from said lower portion and is substantially conical in  
34 shape.

35

36 27. A method according to Claim 26 wherein said upper

1 portion of said passageway includes an inlet and an  
2 outlet and is tapered from said inlet to said outlet at  
3 an angle of taper of between 1 and 15°.

4

5 28. A method according to any of Claims 25 to 27,  
6 wherein the mixing of said liquid and said annular gas  
7 jet is controlled by a trigger valve mechanism on said  
8 spray apparatus.

9

10 29. A method according to Claim 28, wherein said  
11 trigger valve mechanism comprises:

12 a gas valve operable between an open position and  
13 a closed position;

14 a control valve adapted to regulate the supply of  
15 the liquid to be sprayed; and

16 a trigger means;

17 whereby said trigger means is adapted to operate  
18 both of said gas and control valves.

19

20 30. A method according to Claim 29, wherein said  
21 control valve is a liquid control needle valve.

22

23 31. A method according to Claim 30, wherein said gas  
24 valve is an axially-sliding piston valve.

25

26 32. A method according to Claim 31, wherein said  
27 piston valve comprises an inner apertured sleeve and an  
28 outer apertured sleeve, said inner and outer sleeves  
29 being co-axial, and wherein said inner sleeve is  
30 located within said outer sleeve and is rotatably  
31 adjustable relative to said outer sleeve.

32

1 / 8

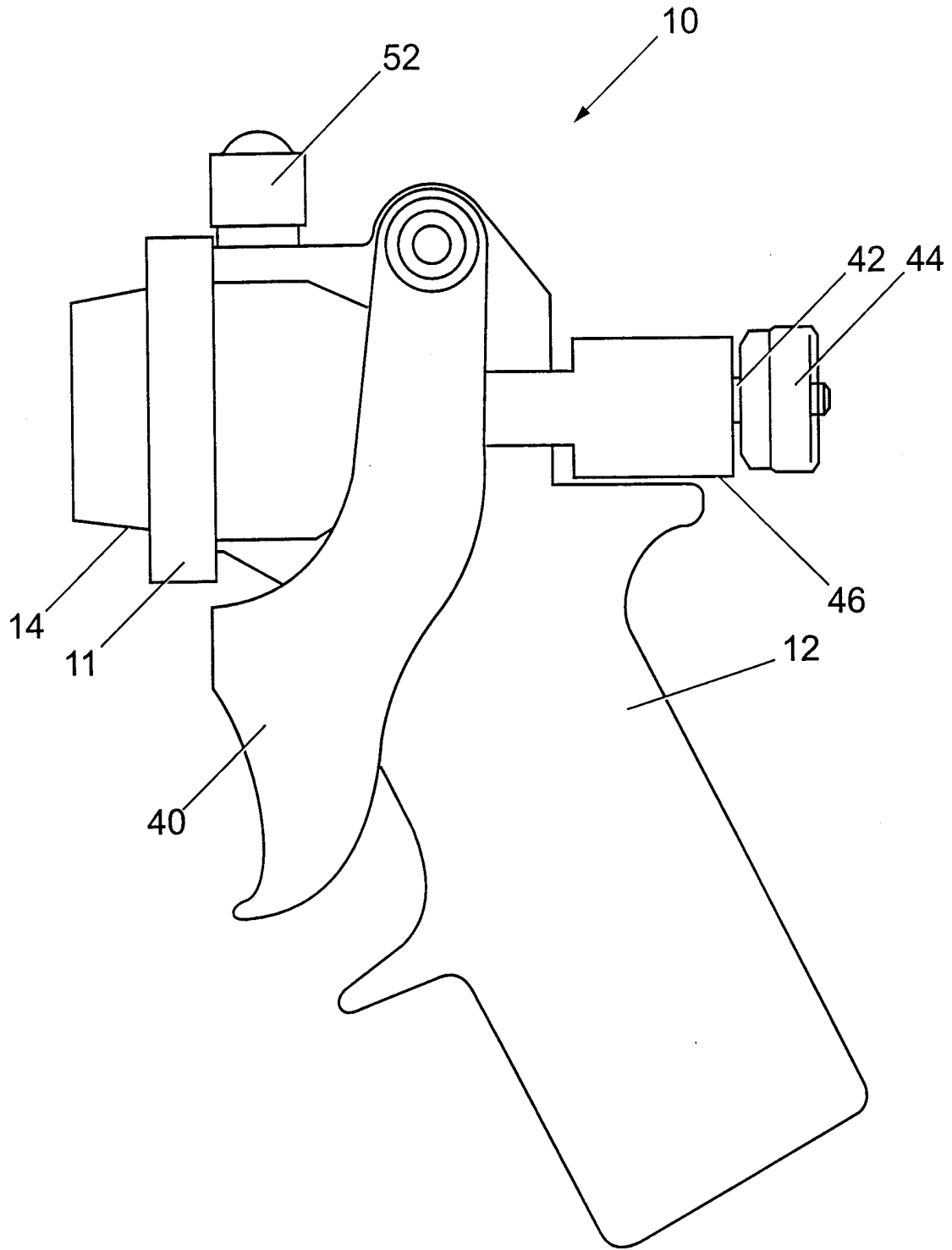


Fig. 1

2 / 8

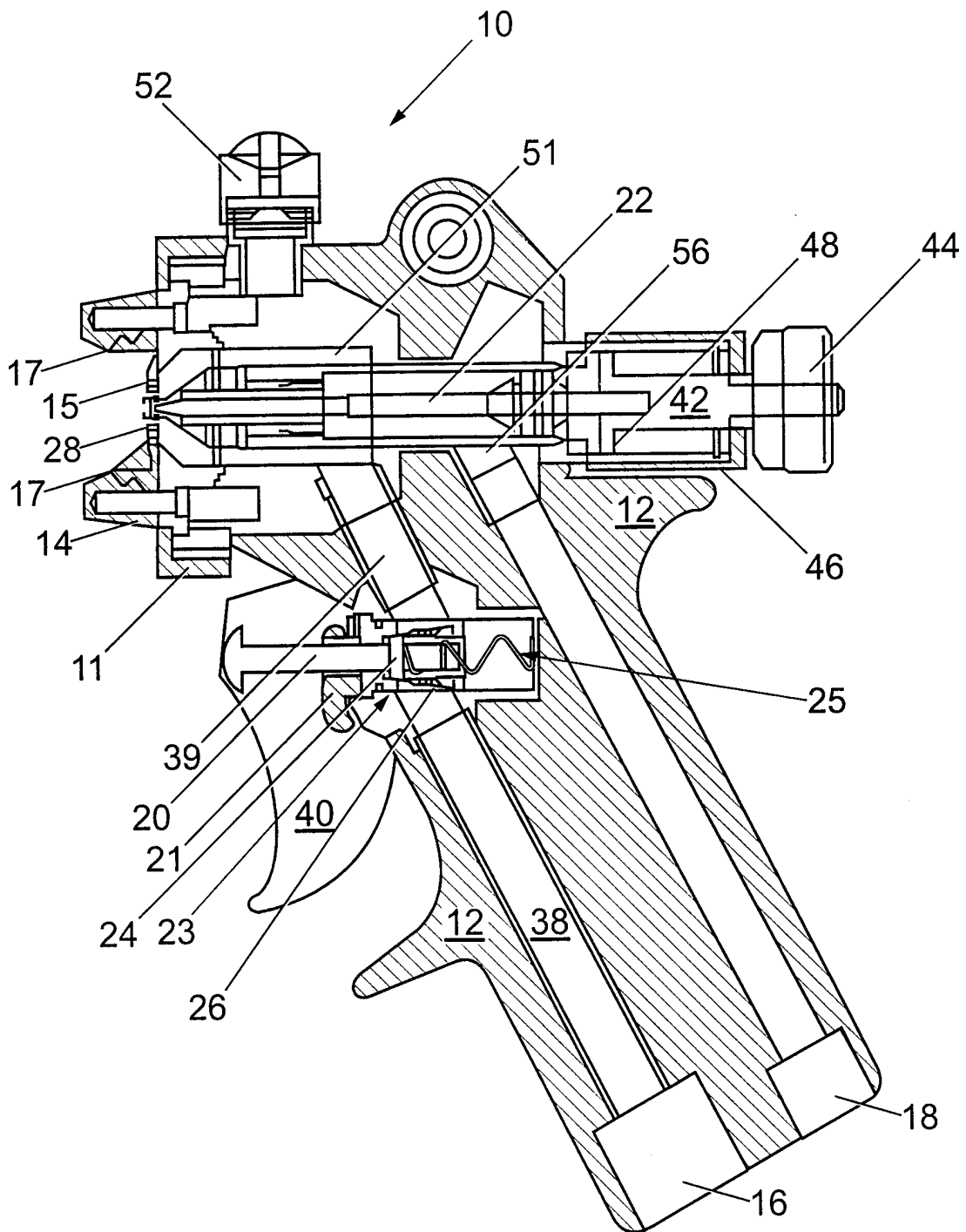


Fig. 2

3 / 8

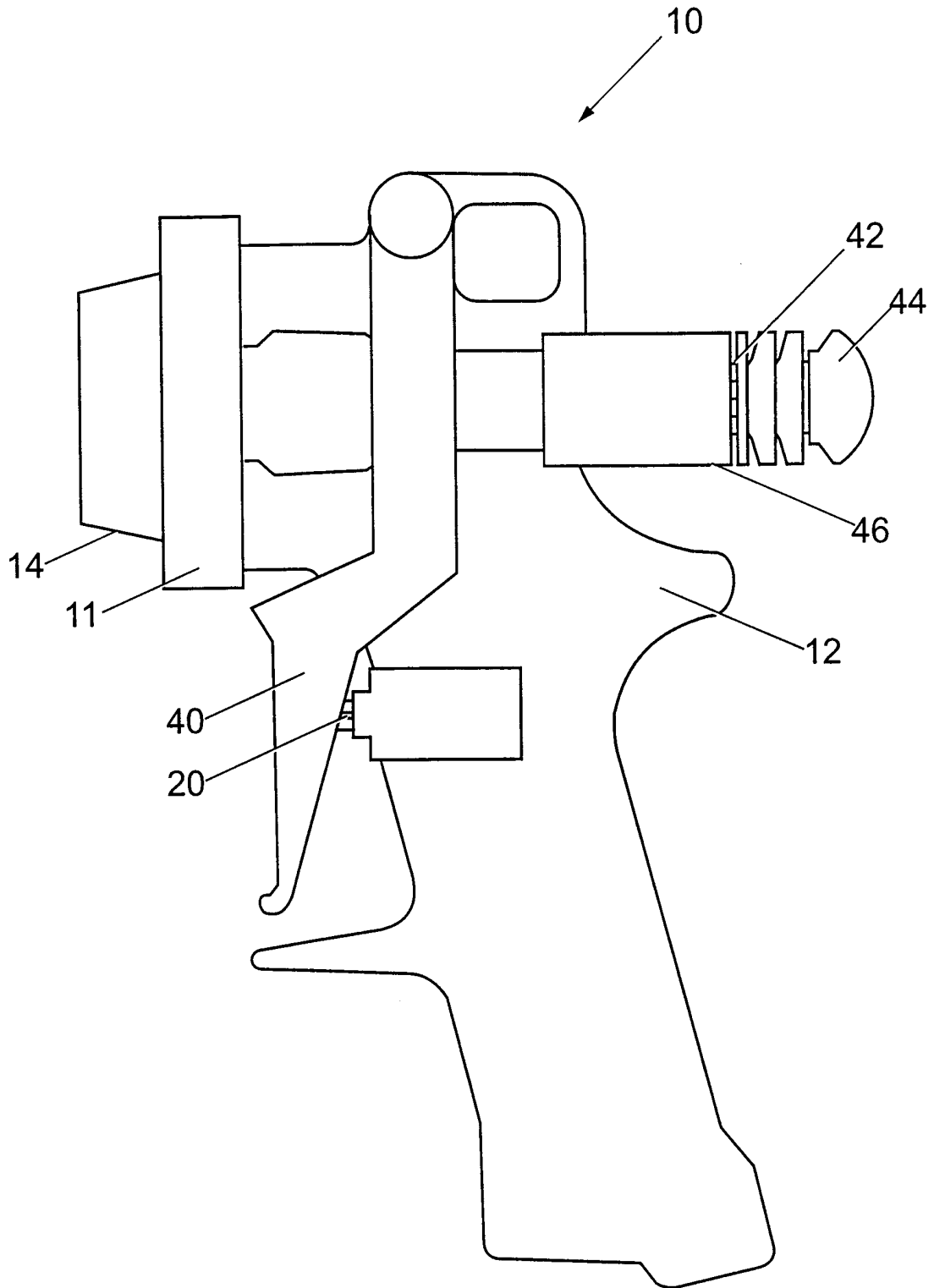


Fig. 3

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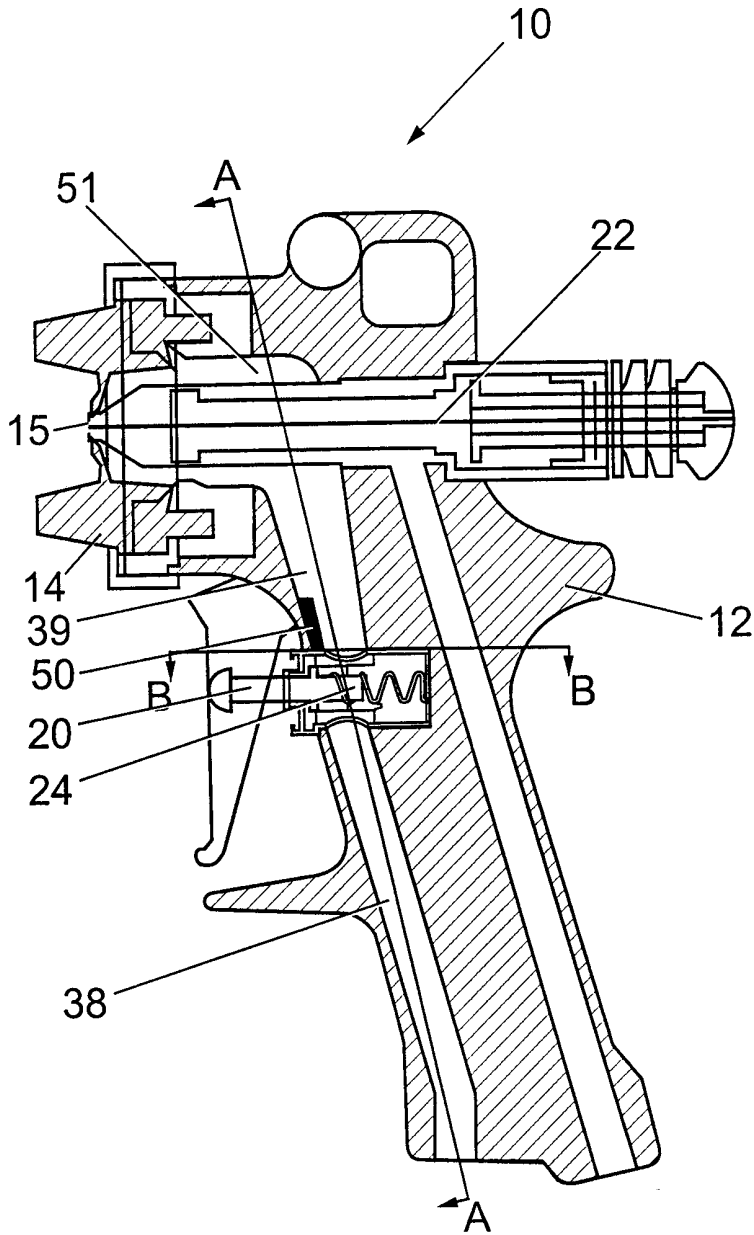


Fig. 4a

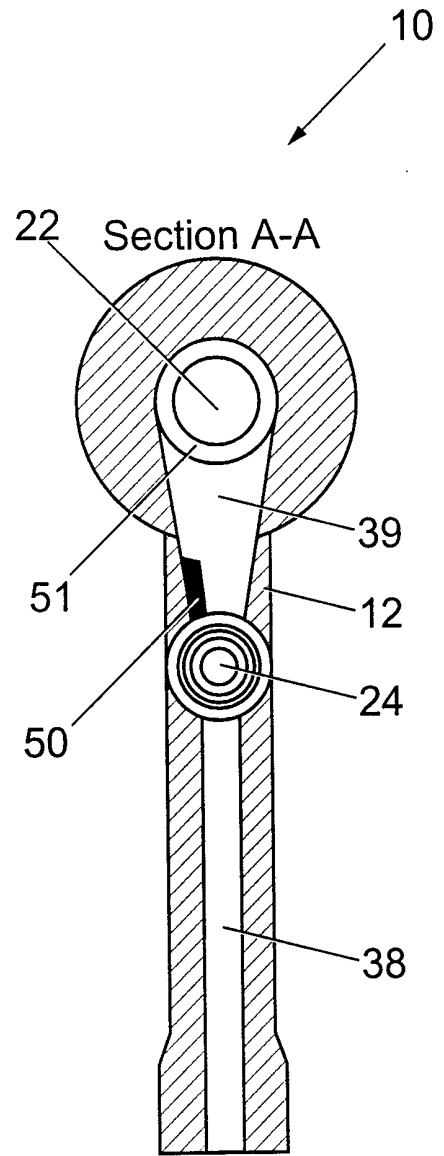
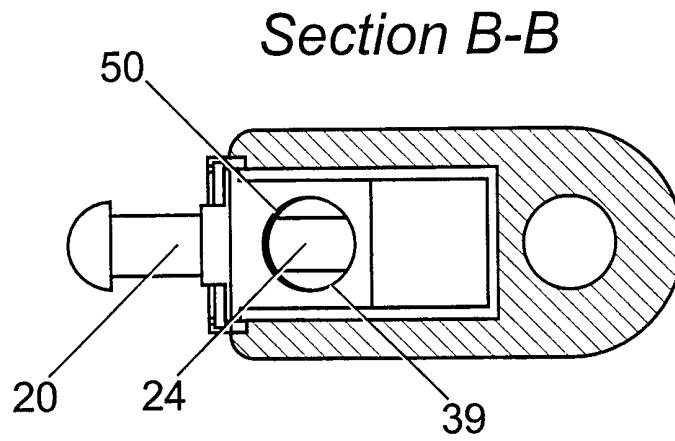


Fig. 4b



*Fig. 4c*

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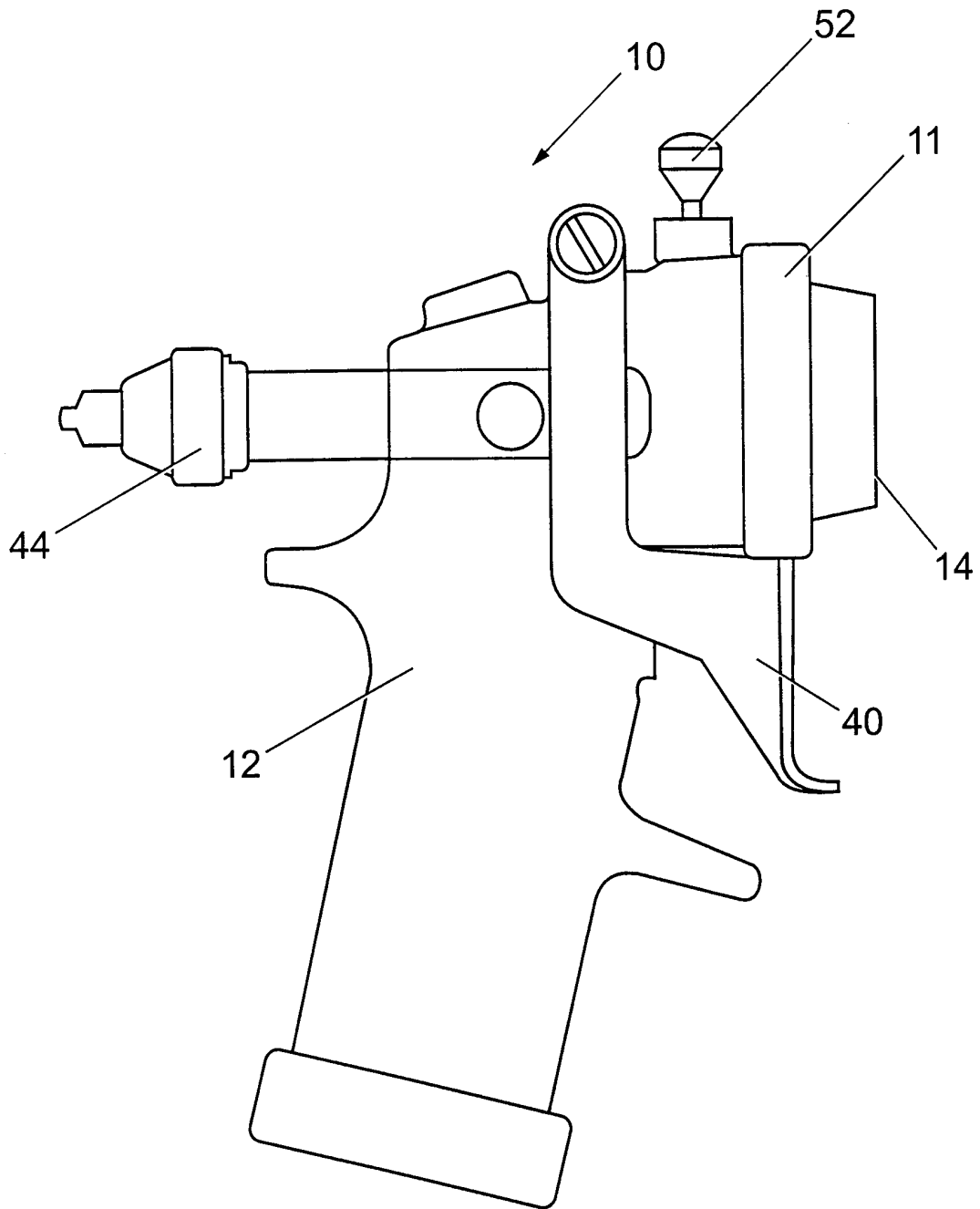


Fig. 5

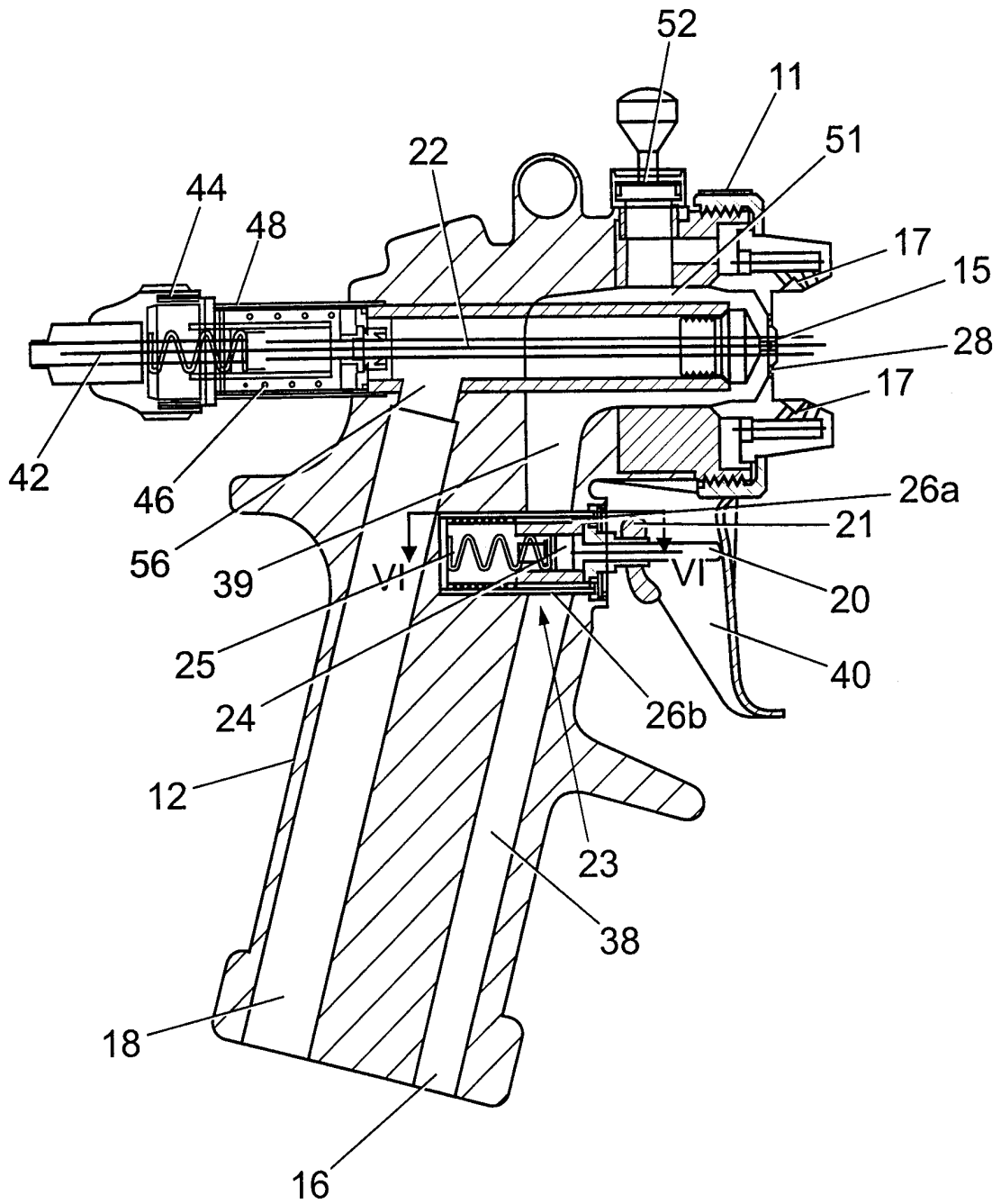


Fig. 6a

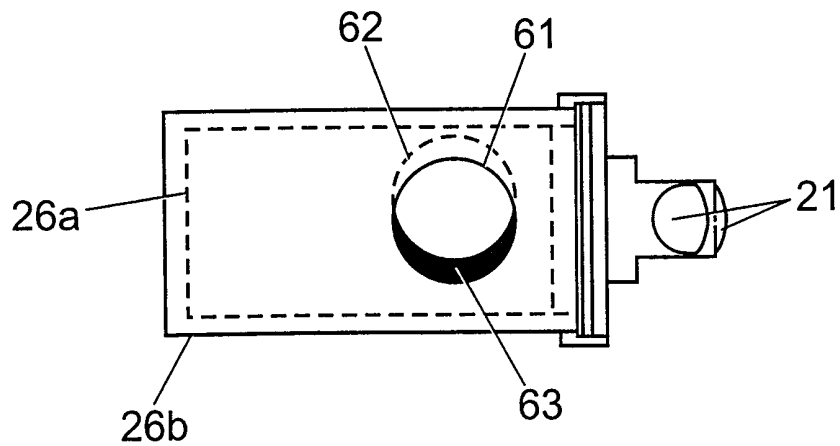
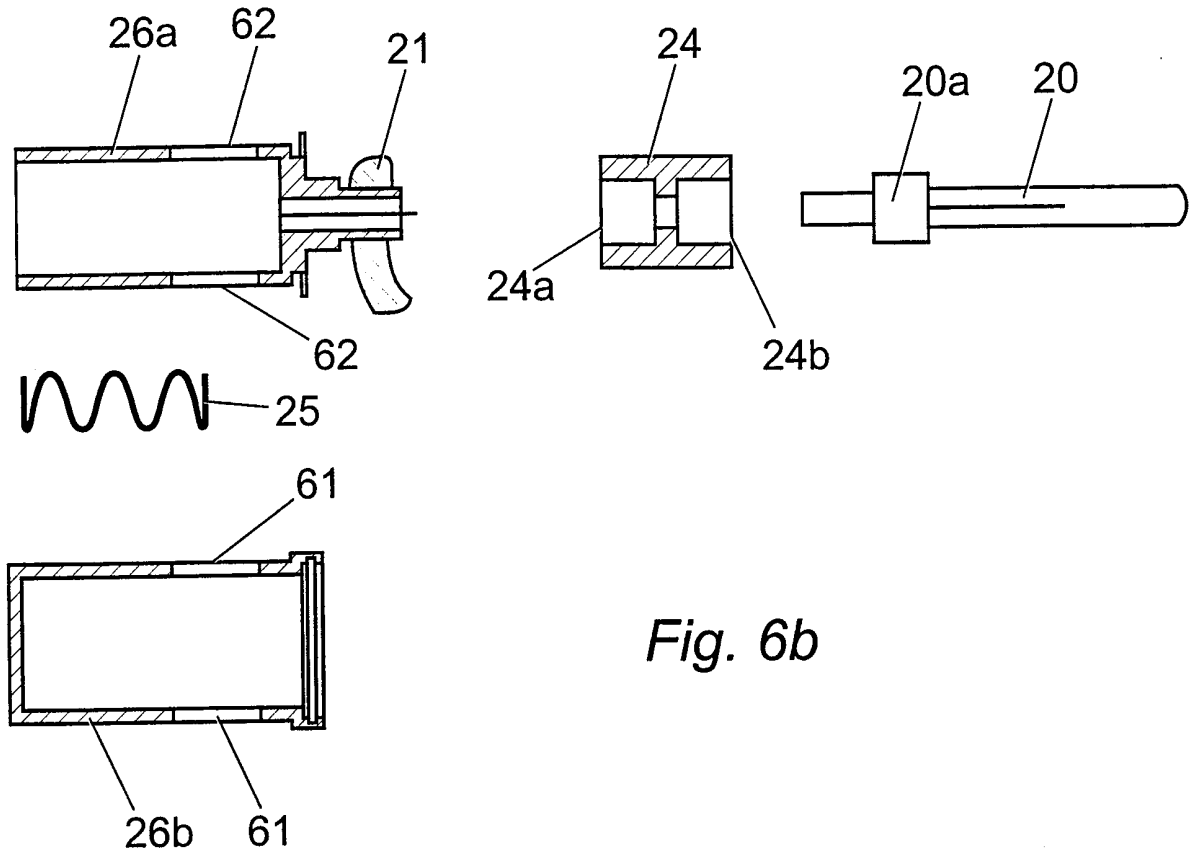


Fig. 6c