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(71) Applicant: **Fulton Group Limited**
Leamington Spa, Warwickshire CV31 1QG (GB)

(72) Inventors:
- **Silverwood, Robert**
  Nuneaton, Warwickshire CV11 6FX (GB)
- **Appleby, Teresa Mary**
  Coventry, Warwickshire CV3 2BX (GB)
- **Pereira, Marcus**
  Leamington Spa, Warwickshire CV32 7DN (GB)
- **Morris, Kenneth David**
  Warwick, Warwickshire CV34 5NE (GB)
- **Kitchen, Bryan John**
  Kenilworth, Warwickshire CV8 2AQ (GB)

(74) Representative:
Dempster, Benjamin John Naftel et al
Withers & Rogers
4 Dyer's Buildings,
Holborn
London EC1N 2JT (GB)

(54) Pneumatic needle gun

(57) A pneumatic needle gun 10 comprises a housing 12, a hollow cylinder 24 in the housing 12 having a piston 30 arranged for sliding reciprocal movement therein. The piston 30 is actuated by gas pressure. The cylinder 24 has a gas inlet for the passage of actuating gas, the gas inlet comprising a bore 36 in the wall of the cylinder 24. The bore 36 has a curved concave mouth 34 to reduce turbulence on entry of gas into the cylinder 24.

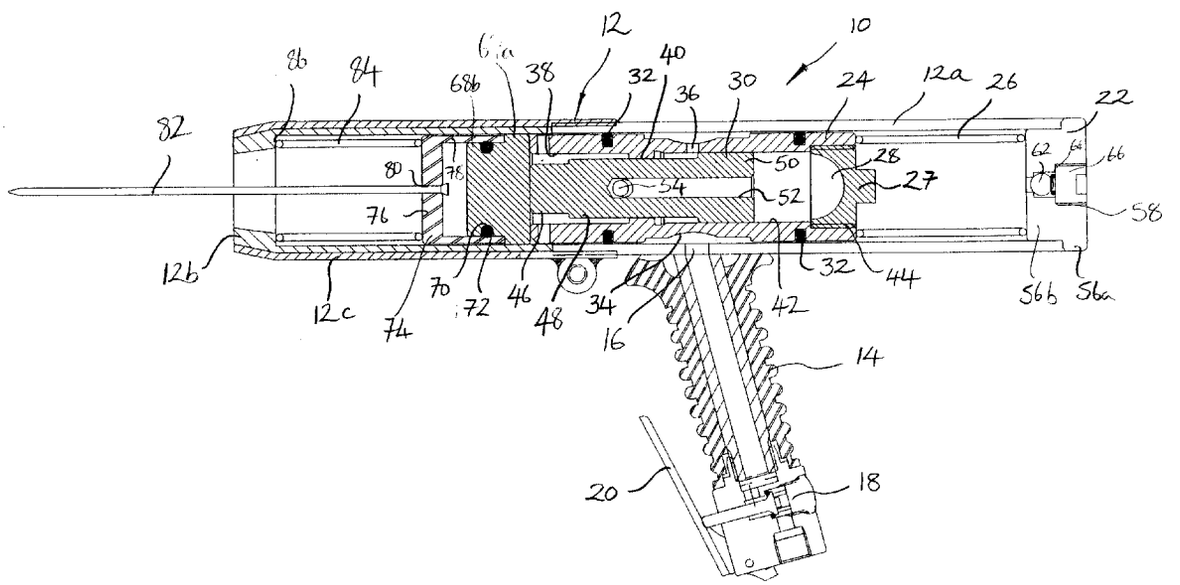

FIG. 1

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Description

This invention relates to a pneumatic needle gun.

Pneumatic needle guns are used for surface preparation including removal of paint and industrial coatings on, for instance, ships, in hard to reach places. Normally pneumatic needle guns comprise a cylinder with a piston slidably located therein and arranged for reciprocal movement therein. The piston is actuated by pneumatic pressure and is spring biased towards one end of the cylinder. By application of a pneumatic pressure the piston is caused to vibrate with a rapid reciprocal movement within the cylinder against a stop which causes vibration of a plurality of needles projecting from one end of the cylinder. The vibrating needles can be used to remove coatings. Conventional needle guns suffer from considerable energy losses in terms of excess vibration and the transmission of vibration to the user is a significant problem. Such guns are also, as a result, very noisy to use.

It is an object of the present invention to provide an improved needle gun with reduced vibration.

According to one aspect of the invention there is provided a pneumatic needle gun comprising a housing, a hollow cylinder in the housing having a piston located therein, the piston being arranged for sliding reciprocal movement, the piston being actuated by gas pressure, the cylinder having a gas inlet for passage of actuating gas, the gas inlet comprising a bore in the wall of the cylinder, the bore having a curved concave mouth to reduce turbulence on entry of gas into the cylinder.

The reduction of turbulence at the intake reduces excess vibration and energy wasted through noise.

According to a second aspect of the invention there is provided a pneumatic needle gun comprising a hollow cylindrical housing, a piston assembly located in the housing and an intake for supply of gas to actuate the piston, a needle arranged so as to protrude from one end of the housing, the housing being closed at the other end by an end closure, the end closure having a pressure regulating valve therein to limit the maximum pressure within the housing.

Closing off the end of the housing causes the closed housing to act as a gas spring which reduces excess vibration. The valve in the end closure prevents the pressure within the cylinder from rising too high which has been found to increase vibration.

According to a third aspect of the invention there is provided a pneumatic needle gun comprising a hollow cylinder, a piston located in the cylinder and arranged for reciprocal sliding movement in the cylinder, the piston being elongate and having a blind longitudinal bore formed therein, the piston having a gas entry bore extending from an outer side surface of the piston into the longitudinal bore, the gas entry bore having a mouth defined by the gas entry bore and a further partially blind bore partially coincident with and spaced longitudinally of the piston from the gas entry bore so as to form a shoulder in the gas entry bore.

In that way gas can begin to enter the piston to cause it to be actuated at an earlier stage in the piston return stroke than in prior art systems. Also, the offset shape of the entrance to the gas entry bore reduces the suddenness of air entry which, in turn, helps to reduce vibration.

In conventional needle guns the needles are mounted in a cup which is loosely received on a slug. In use, the piston impacts the slug to impart vibration to the needles. The cup and slug can be readily separated so that the needles, which are worn down in use, can be readily replaced. However, as the cup and the slug are loosely connected they rattle causing excess vibration.

According to a fourth aspect of the invention there is provided a needle gun comprising a hollow cylindrical housing, a piston assembly mounted in the housing for a reciprocal sliding movement including a piston, a slug mounted within the housing and arranged so as to be impacted by the piston, in use, and a cup carrying one or more needles, one of the cup or slug having a peripheral recess, a ring of resilient material being received in the recess so that the cup is located on the slug by means of a frictional fit between the ring of resilient material and the cup or slug.

In that way the cup and slug are firmly connected which reduces excess vibration and noise.

The cup may be formed from plastic so as to be readily disposable with the needles as a unit.

In conventional needle guns the piston assembly is mounted by O-rings providing a tight fit against the inner wall of the housing and is lubricated by oil. According to a preferred feature of the present invention which is applicable to any of the above aspects the piston assembly may be mounted by a thinner O-ring than conventional needle guns, the O-ring being provided with a band of low friction material around the outside, preferably PTFE. That provides an advantageous arrangement as the piston assembly can be more easily located in the housing which makes manufacture of the gun more straightforward.

A pneumatic needle gun will now be described in detail in accordance with the above aspects of the invention by way of example and with reference to the accompanying drawings in which:

Fig. 1 is a cross section through a pneumatic needle gun in accordance with the above aspects of the invention;

Fig. 2 is an enlarged elevation of the piston shown in the gun of Fig. 1;

Fig. 3 is an enlarged sectional view of part of the piston assembly of the gun of Fig. 1;

Fig. 4 is an enlarged sectional view of the end closure of the gun of Fig. 1; and,

Fig. 5 is an enlarged sectional view of the slug and needle mounting cup of the gun of Fig. 1.

In Fig. 1 a pneumatic needle gun 10 comprises an elongate hollow cylindrical housing 12 and a pistol grip 14. The housing 12 has an aperture 16 through a side wall thereof. The pistol grip 14 is tubular and hollow with a valve 18 at its base for connection to a supply gas under pressure (not shown) and a corrugated rubber jacket to reduce the transmission of vibration. The valve 18 is operable by a trigger 20. By actuating the trigger 20 gas can pass through the grip 14, through the aperture 16 into the interior of the housing 12.

The housing 12 comprises a first cylinder 12a open at one end and closed by an end closure 22 at the other end. The open end of the first cylinder 12a has a threaded portion on its outer surface. A second cylinder 12b extends from adjacent the open end of the first cylinder 12a. The second cylinder 12b is open at both ends and its end spaced from the first cylinder 12a is inwardly tapered. The first and second cylinders 12a, 12b are secured together by means of a shroud 12c which has an inner surface substantially similar in size and shape to the outer surface of the second cylinder 12b. The shroud 12c is screwed onto the threaded portion on the end of the first cylinder 12a.

The cylinder 24 (see Fig. 3) is mounted within the housing 12 for sliding reciprocal movement. A coil spring 26 is mounted between the cylinder 24 and the end closure 22 to bias the cylinder 24 away from the closure 22.

One end of the cylinder 24 is closed off by a stop 27 formed with a concave depression 28 on its inwardly facing surface. A piston 30 is mounted within the cylinder 24 for sliding reciprocal movement therewithin. The cylinder 24 is mounted by two spaced O-rings 32, each having a PTFE band around the outer edge thereof to reduce friction during reciprocal movement of the cylinder 24.

The cylinder 24 is arranged so that the O-rings 32 lie one each side of the aperture 16 in the housing 12 at all times during reciprocal movement of the cylinder 24.

The cylinder 24 has an annular concave depression 34 formed between the O-rings 32. A bore 36 is formed through the wall of the cylinder 24 in the base of the depression 34.

The interior of the cylinder 24 comprises a first axial bore 38, extending from the left hand end of the cylinder 24 (as viewed in Figs. 1 and 3) to an annulus 40. A second axial bore 42 extends from the annulus 40 toward the right hand end of the cylinder 24. The right hand end of the cylinder has a screw-threaded axial bore 44 to accommodate the stop 27.

The piston 30 (see Fig. 2) comprises a first cylindrical body portion 46 having a first diameter, a second cylindrical body portion 48 extending co-axially from the first body portion and having a second diameter greater than the first, and a third cylindrical body portion 50 and having a third diameter greater than the second.

The piston 30 has a blind axial bore 52 extending from the end of the third body portion 50 into the body of the piston 30. Also, a gas entry bore 54 extends radially from the outer surface of the piston 30 into the above-mentioned blind axial bore 52. The mouth of the gas entry bore 54 comprises the bore 54 and a further blind bore 55 partially coincident with the gas entry bore and spaced longitudinally of the piston 30 from the gas entry bore 54.

The end closure 22 (see Fig. 4) is fixed into the closed end of the first cylinder 12a by any suitable fixing means, for instance by welding or by screw-threaded engagement.

The closure 22 comprises a first diameter cylindrical part 56a and a second greater diameter cylindrical part 56b. An axial bore 58 is formed in the closure 22. The bore 58 comprises first, second and third portions 58a, 58b, 58c having progressively increasing diameters.

A radial bore 60 extends from the outer surface of the first diameter part of the body 56 into the second portion 58b of the axial bore 58.

A ball 62 is mounted on an O-ring 64 of resilient material in the second portion 58b of the axial bore 58. The third portion 58c of the axial bore 58 is screw threaded. A plug 66 is located in the third portion 58c in screw-threaded engagement with the screw thread of said third portion 58c.

The plug 66 is located so that the O-ring 64 pushes the ball 62 into sealing engagement with the first portion 58a of the axial bore 58. The ball 62 and O-ring 64 act as a gas-pressure regulating valve. If the pressure within the housing 12 rises too high the ball 62 is pushed against the O-ring 64 which is compressed. The ball 62 is moved out of sealing engagement with the first portion 58a of the bore 58. Gas can then escape from the housing to atmosphere via the bores 58 and 60 until an acceptable pressure level in the housing is reached.

A metal slug 68 is located in the second cylinder 12b of the housing near the end disposed adjacent the first cylinder 12a. The slug 68 comprises a first cylindrical part 68a and a second cylindrical part 68b. The first cylindrical part 68a has a diameter substantially similar to the diameter of the inner wall of the second cylindrical part has a diameter smaller than the first part and has an annular recess 70 formed therein. An O-ring 72 is located in the recess 70.

A cup 74 comprising a circular base 76 and a cylindrical wall 78 is arranged in the second cylinder 12b adjacent the slug 68. The base 76 of the cup has a plurality of apertures 80, through each of which extend respective needles 82. The needles 82 protrude from the open end of the second cylinder 12b. The cup 74 is arranged so that its wall 78 extends around the O-ring 72 on the slug to provide a firm frictional fit between cup 74 and slug 68. The cup 74 and slug 68 are slidably located in the housing 12 with a loose running fit.

A spring 84 extends between the base 76 of the cup 74 and a shoulder 86 on the inner wall of the cylinder 12b.

In use, the operator actuates the trigger 20 which opens the valve 18. Gas under pressure from a pressu-

rised gas supply (not shown) such as a compressor, passes through the tubular grip 14, through the aperture 16 into the housing 12. The gas then passes around the annular depression 34 in the outer wall of the cylinder 24 and through the bore 36 into the interior of the cylinder 24. The annular concave depression 34 reduces turbulence on entry of gas into the cylinder which results in lower energy losses through excess vibration.

The gas pressurizes the part of the interior of the cylinder 24 defined between the third body portion 50 of the piston 30 and the annulus 40 of the cylinder 24. The pressure causes the piston 30 to move to the right (as viewed in Fig. 1).

As the piston 30 moves to the right the gas entry bore 54 moves past the annulus 40 allowing gas to pass through the bore 54 and down the blind axial bore 52 to pressurise the right hand part defined by the right hand end of the piston 30 and the stop 27. The special shape of the mouth of the gas entry bore 54 with the blind bore 55 partially coincident with the main bore 54 allows gas to enter the bore 54 earlier than with a conventional bore. Also, the shape of the entry reduces the suddenness of gas entry into the bore 54. Rather, the gas enters in such a fashion that the acceleration of the piston to the left in Fig. 1 is initially lower than with conventional systems but the piston 30 is accelerated for a longer period of time than conventional systems. That results in a cushioning effect to reduce unwanted vibration as the piston 30 reaches the end of its rightwards stroke. When the pressure in the part between piston 30 and stop 27 exceeds the pressure in the cylinder between the annulus 40 and third body portion of the piston 30, the piston 30 is forced to move to the left (as view in Fig. 1). Gas continues to pressurise the right hand part until the bore 54 moves back past the annulus 40. The piston 30 has sufficient momentum to strike the slug 68. The piston 30 then returns to the right of the cylinder 24 under pressure and the cycle continues as set out above. The repeated impacts of the piston 30 on the slug 68 causes the slug 68, cup 74 and needles 82 to vibrate. The vibrating needles 82 can thus be used to remove coatings such as paint from hard surfaces.

As the piston reciprocates the cylinder 24 will reciprocate in reaction to the piston movement. The cylinder 24 is biased towards the left hand end of the housing 12 by the spring 26. Also, the right hand O-ring 32 of the cylinder 24 provides a gas-tight seal to the space defined between the cylinder 24 and the end closure 22. Thus, the closed off space acts as a gas spring when compressed by movement of the cylinder 24. The gas spring reduces unwanted vibration of the gun 10. If the cylinder is caused to move too far to the right, the gas pressure in the space may rise above an acceptable limit. In that case, the gas pressure acting on the ball 62 will cause the O-ring to be compressed and the ball 62 will move so that a gas flow path through the bore 58 to the radial bore 60 is opened. Excess gas is expelled until the pressure in the space drops to a level which allows the ball 62 to return under the resilient return force of the O-ring 64 into sealing contact with the first part 58a of the bore 58.

On its return stroke under the action of the spring 26, the cylinder 24 impacts the slug 68 to impart additional vibration to the needles 82.

The slug 68 and cup 74 are returned to their initial position after impact by the cylinder 24 or piston 30 by means of the spring 84.

The needle gun 10 operates with substantially less transmitted vibration and noise output than previous guns.

Claims

1. A pneumatic needle gun comprising a housing, a hollow cylinder in the housing having a piston located therein, the piston being arranged for sliding reciprocal movement, the piston being actuated by gas pressure, the cylinder having a gas inlet for passage of actuating gas, the gas inlet comprising a bore in the wall of the cylinder, the bore having a broadening mouth to reduce turbulence on entry of gas into the cylinder.

2. A pneumatic needle gun as claimed in claim 1, wherein the mouth is curved.

3. A pneumatic needle gun as claimed in claim 2, wherein the mouth is concave.

4. A pneumatic needle gun comprising a hollow cylindrical housing, a piston assembly located in the housing and an intake for supply of gas to actuate the piston, a needle arranged so as to protrude from one end of the housing, the housing being closed at the other end and a pressure regulating valve being provided in said other end to limit the maximum pressure within the housing.

5. A pneumatic needle gun as claimed in claim 4, wherein the housing is closed at said other end by an end closure and the valve is provided in the end closure.

6. A pneumatic needle gun as claimed in claim 4 or claim 5, wherein the valve comprises a sphere seated on a resilient O-ring which resiliently urges the sphere to block an opening into the housing.

7. A pneumatic needle gun comprising a hollow cylinder, a piston located in the cylinder and arranged for reciprocal sliding movement in the cylinder, the piston being elongate and having a blind longitudinal bore formed therein, the piston having a gas entry opening extending from an outer side surface of the piston into the longitudinal bore, the rear wall of

the gas entry opening being angled rearwardly.

8. A pneumatic needle gun as claimed in claim 7, wherein the rear wall of the gas entry opening is stepped.

9. A pneumatic needle gun as claimed in claim 8, wherein the gas entry opening comprises a gas entry bore, the gas entry bore having a mouth defined by the gas entry bore and a further partially blind bore partially coincident with and spaced longitudinally of the piston from the gas entry bore so as to form a shoulder in the gas entry bore.

10. A pneumatic needle gun as claimed in claim 9, wherein the partially blind bore is of greater diameter than the gas entry bore.

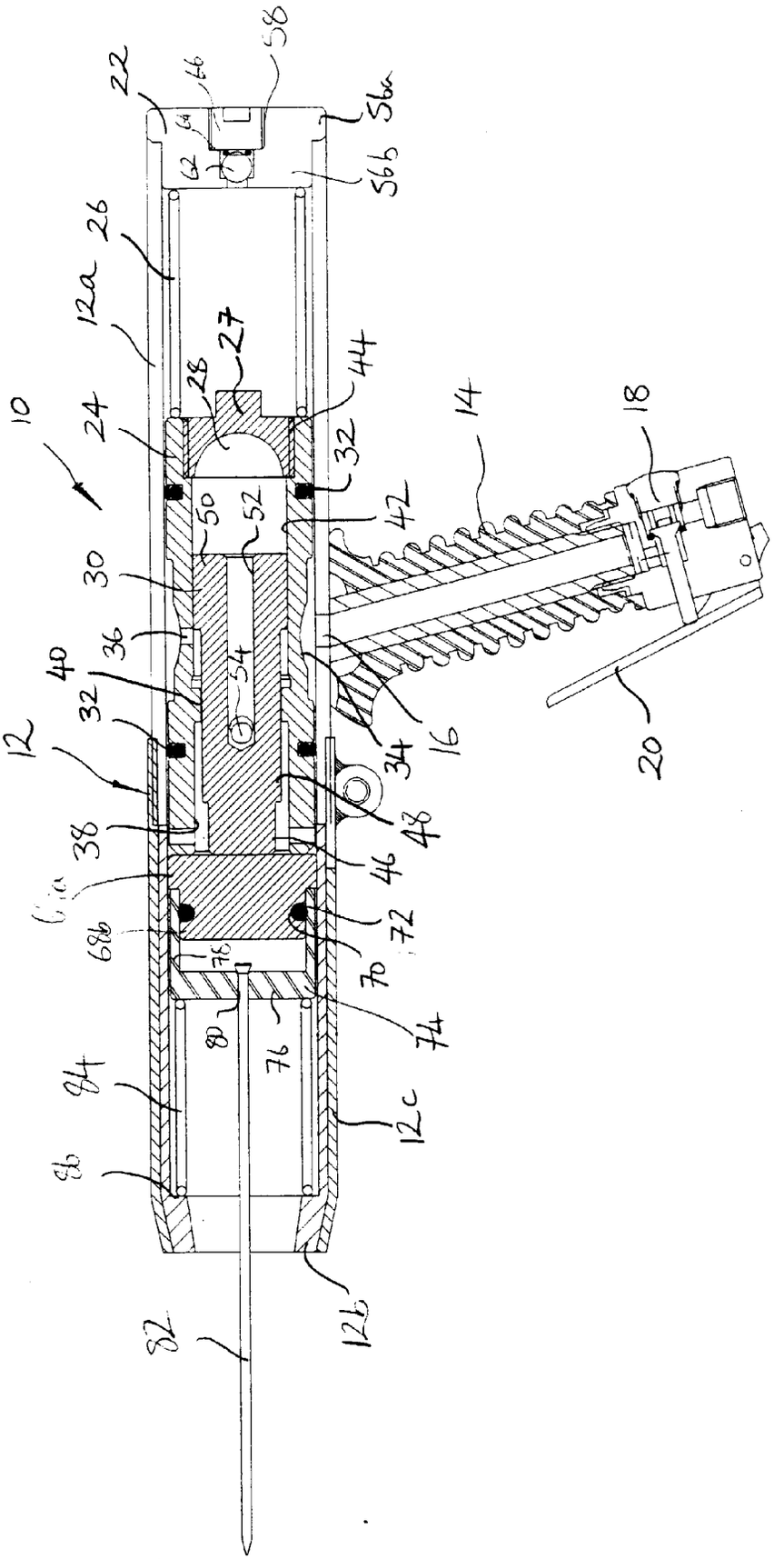
11. A pneumatic needle gun as claimed in claim 9 or claim 10, wherein the offset of the partially blind bore from the gas entry bore is substantially the same as or greater than the depth of the partially blind bore.

12. A needle gun comprising a hollow cylindrical housing, a piston assembly mounted in the housing for a reciprocal sliding movement including a piston, a slug mounted within the housing and arranged so as to be impacted by the piston, in use, and a cup carrying one or more needles, one of the cup or slug having a peripheral recess, a ring of resilient material being received in the recess so that the cup is located on the slug by means of a frictional fit between the ring of resilient material and the cup or slug.

13. A needle gun as claimed in claim 12, wherein the cup is formed from plastic so as to be readily disposable with the needles as a unit.

14. A needle gun as claimed in any preceding claim, wherein the piston assembly is mounted by a relatively thin O-ring, the O-ring being provided with a band of low friction material around the outside.

15. A needle gun as claimed in claim 14, wherein the band is made of PTFE.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12b
12c
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84
86b

FIG. 1

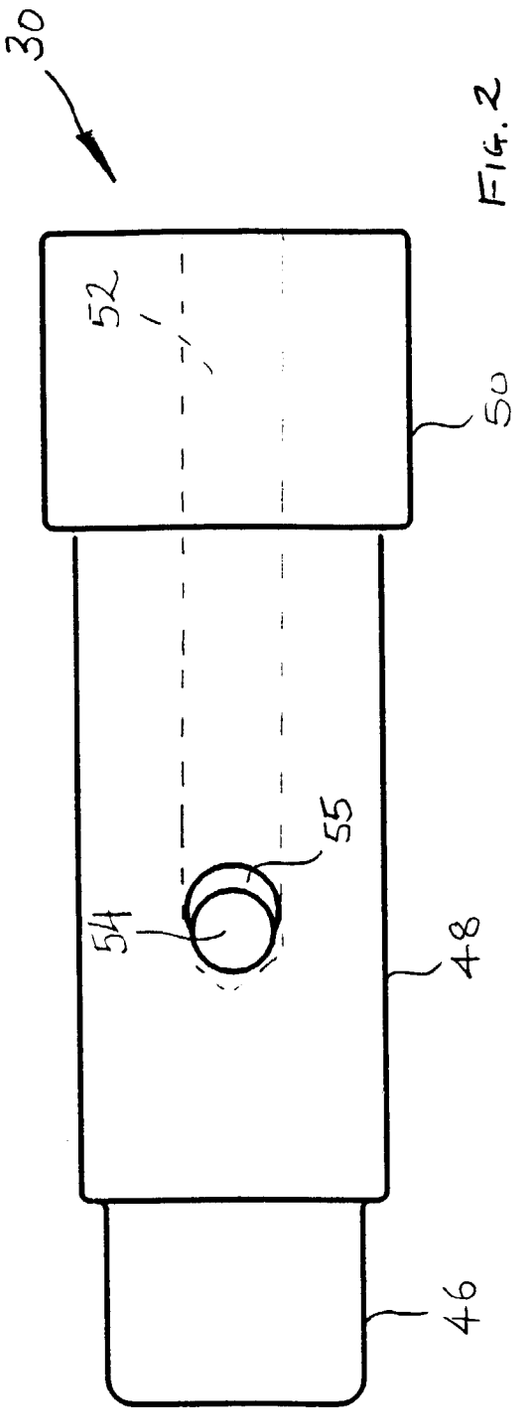

FIG. 2

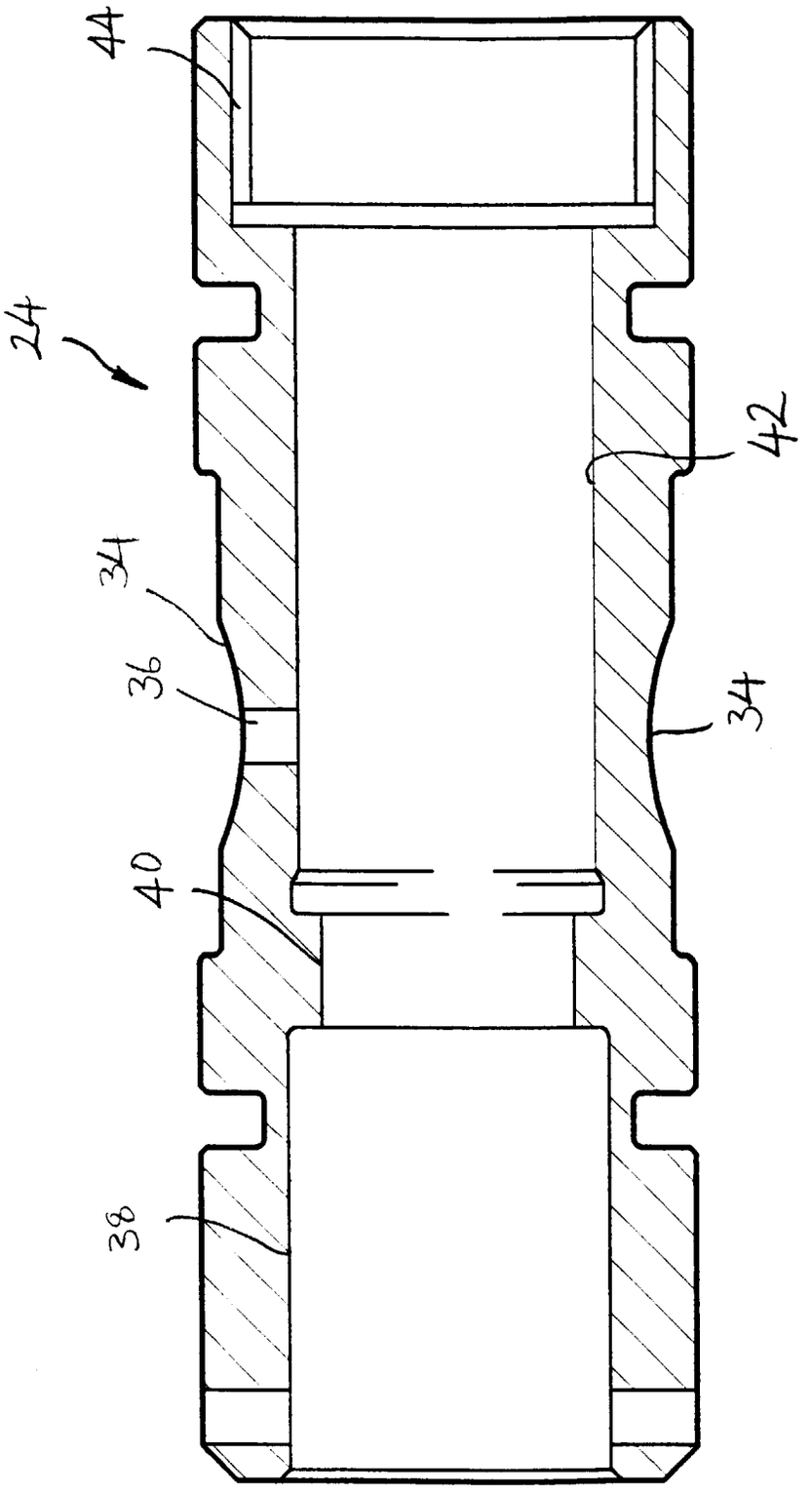

FIG. 3

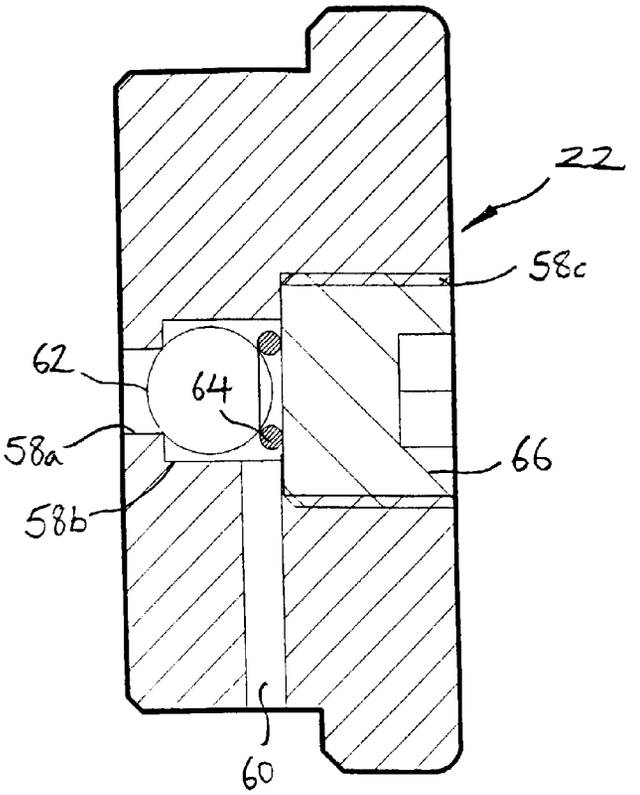

FIG. 4

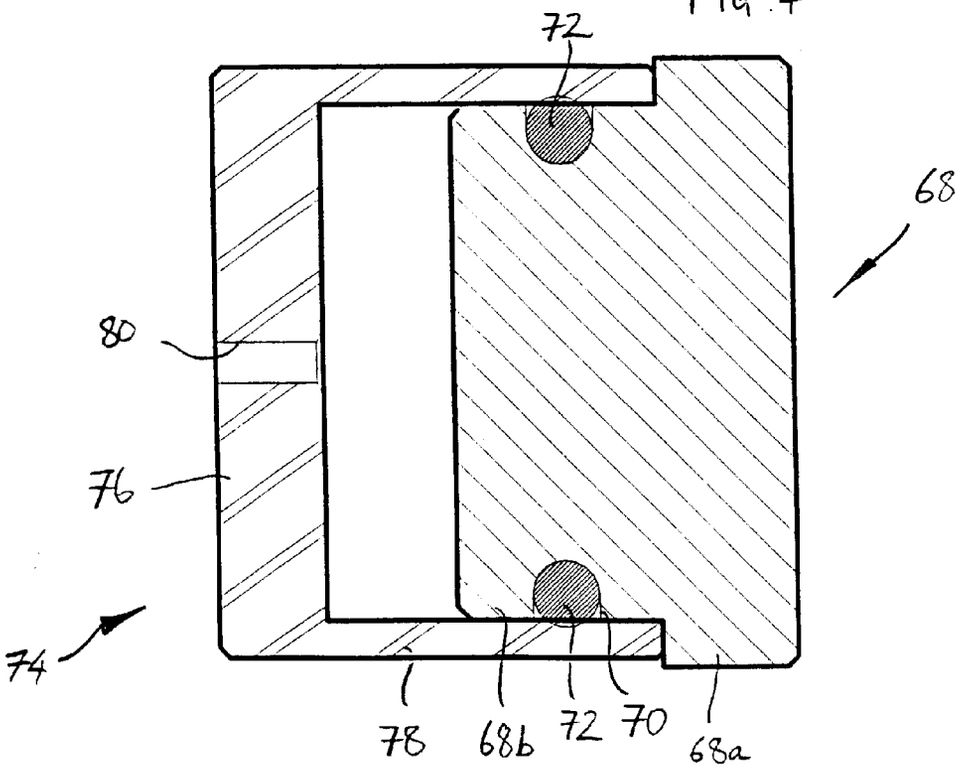

FIG. 5