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(71) **Applicant** *(for all designated States except US):* **KEE ACTION SPORTS I LLC** [US/US]; 570 Mantua Boulevard, Sewell, NJ 08080 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only):* **WOOD, Michael, J.** [US/US]; 16 Springwater Crossing, Newnan, GA 30265 (US). **STEVENS, Simon, Benjamin** [US/US]; 421 Morning Dove Circle, Sewell, NJ 08080 (US).

(74) Agent: FIELITZ, Ellen, E.; Volpe And Koenig, RC, United Plaza, Suite 1600, 30 S. 17th Street, Philadelphia, PA 19103 (US).

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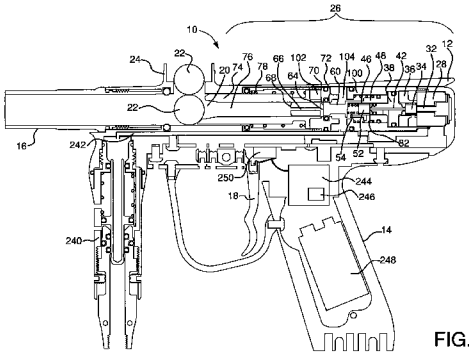

FIG. 1

(57) Abstract: A firing mechanism for a compressed gas gun is provided. The firing mechanism includes a firing chamber having a compressed gas storage chamber and a bolt chamber in communication with the compressed gas storage chamber. A bolt is positioned within the bolt chamber having a bolt passage therethrough, the bolt being moveable by a force of compressed gas from a first position to a second position, and the bolt being biased to the first position by a bolt spring. A solenoid is positioned proximate the firing chamber including a plunger moveable from a first position to a second position. A spool is moveable within the compressed gas storage chamber from a first position to a second position, the spool including a forward portion having a flow passage therethrough. The spool is adapted to selectively control the passage of compressed gas from the compressed gas storage chamber to the bolt chamber.

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[0001] COMPRESSED GAS GUN AND FIRING MECHANISM

[0002] BACKGROUND

[0003] A popular game has developed over the years, paintball, which uses compressed gas guns known as "paintball markers." These guns fire projectiles under the force of compressed gas that may be supplied by a gas tank (such as a CO2 or NO2 tank), or another gas compressed means. Some examples of paintball marker guns are those offered under the brand names 32 DEGREES™, EMPIRE™, DIABLO™, INVERT MINI™, and INDIAN CREEK DESIGNS™, and yet others are shown and described in U.S. Patent Nos. 6,708,685, 4,936,282, 5,497,758, and U.S. Application Nos. 11/183,548, 11/180,506, 11/150,002, 11/064,693, 10/313,465, 10/090,810, the entire contents of which are all incorporated fully herein by reference herein. Players use the paintball guns to shoot projectiles known as paintballs (projectiles and paintballs are used interchangeably herein). These paintballs are spherical, frangible projectiles normally having gelatin or starch-based shells filled with paint (coloring or dye). The shells rupture when impacting a target, allowing the paint within to splatter on the target. The sport of paintball is sometimes played like "capture the flag." A player is eliminated from the game when the player is hit by a paintball fired from an opposing player's marker. When the paintball hits a target such as a player, a mark or "splat" of paint is left on the player.

[0004] The present invention relates generally to the construction of compressed gas guns and more particularly to firing mechanisms for the guns designed to propel a projectile. Older existing compressed gas guns generally utilized a hammer and valve assembly to fire projectiles. When the trigger of such guns is pulled, it depresses the sear mechanism which allows the hammer, under spring or pneumatic pressure, to be driven forward and actuate a poppet-type valve that releases compressed gas through a port in the bolt, which propels a projectile (paintball) from the barrel. Such compressed gas guns generally have

a "two tube" or "stacked bore" arrangement, with an upper tube containing the bolt, and a lower tube containing the hammer and valve mechanisms.

[0005] There are many problems with these arrangements, including increased maintenance, damage after repeated cycles, and a higher amount of force is required to drive the hammer mechanism backwards to be seated on the sear. Also, because the sear and resulting hammer must be made of extremely hard and weighted materials, the overall weight of the gun increases. This is problematic in the sport of paintball, where a player generally requires a very lightweight gun for maneuverability. Such arrangements can produce "kick."

[0006] To overcome the problems of a mechanical sear, other technologies were developed. One technology is the use of a pneumatic cylinder, which uses spring or pneumatic pressure on alternating sides of a piston to first hold a hammer in the rearward position and then drive it forward to actuate a valve holding the compressed gas that is used to fire the projectile. Although the use of a pneumatic cylinder has its advantages, it requires the use of a stacked bore, where generally the pneumatic cylinder is in the lower bore and is linked to the bolt in the upper bore through a mechanical linkage. It also requires increased gas usage, as an independent pneumatic circuit must be utilized to move the piston backwards and forwards. Adjusting this pneumatic circuit can be difficult, because the same pressure of gas is used on both sides of the piston and there is no compensation for adjusting the amount of recock gas, used to drive it backwards, and the amount of velocity gas, which is the amount of force used to drive it forward and strike the valve. This results in erratic velocities, inconsistencies, and shoot-down. In addition, this technology often results in slower cycling times, as three independent operations must take place. First, the piston must be cocked. Second, the piston must be driven forward. Third, a valve is opened to allow compressed gas to enter a port in the bolt and fire a projectile.

[0007] There is the need in the compressed gas gun sports for a compressed gas gun having an in-line, "single tube," or "single bore" arrangement, with a valving system that does not require the use of a hammer and mechanical sear.

[0008] SUMMARY

[0009] The present invention provides a firing mechanism for a compressed gas gun, and a compressed gas gun incorporating the firing mechanism. The firing mechanism includes a firing chamber having a compressed gas storage chamber and a bolt chamber in communication with the compressed gas storage chamber. A bolt is positioned within the bolt chamber having a bolt passage therethrough, the bolt being moveable by a force of compressed gas from a first position to a second position, and the bolt being biased to the first position by a bolt spring. A solenoid is positioned proximate the firing chamber including a plunger moveable from a first position to a second position. A spool is moveable within the compressed gas storage chamber from a first position to a second position, the spool including a forward portion having a flow passage therethrough. The spool is adapted to selectively control the passage of compressed gas from the compressed gas storage chamber to the bolt chamber. The firing mechanism further includes a collection area adjacent the rear of the spool, and a first gas in communication between the compressed gas storage chamber and the collection area. A rod is in communication with the solenoid plunger positioned within the gas passage, the rod moveable from a first position to a second position by movement of the solenoid plunger. The rod includes a forward plug at its forward end and a rearward plug at its rearward end, the solenoid controlling movement of the rod to selectively permit compressed gas to flow through the first gas passage.

[0010] BRIEF DESCRIPTION OF THE DRAWING(S)

[0011] Fig. 1 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the firing components in the "first" or "ready to fire" or "resting" or "waiting" position.

[0012] Fig. 1A is a side sectional view of an embodiment of a compressed gas gun according to the present invention in the "first" or "ready to fire" or "resting" or "waiting" position, illustrating the location of compressed gas in the body of the gun.

[0013] Fig. 1B is a close up side sectional view of an embodiment of a compressed gas gun according to the present invention in the "first" or "ready to fire" or "resting" or "waiting" position.

[0014] Fig. 2 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the trigger initially pulled, activating the solenoid valve.

[0015] Fig. 2A is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the trigger initially pulled, activating the solenoid valve, illustrating the location of compressed gas in the body of the gun.

[0016] Fig. 3 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the spool valve moving forward.

[0017] Fig. 3A is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the spool valve moving forward, illustrating the location of compressed gas in the body of the gun.

[0018] Fig. 4 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the bolt beginning to move forward.

[0019] Fig. 4A is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the bolt beginning to move forward, illustrating the location of compressed gas in the body of the gun.

[0020] Fig. 5 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the bolt continuing to move toward a forward position.

[0021] Fig. 5A is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the bolt continuing to move toward a forward position, illustrating the location of compressed gas in the body of the gun.

[0022] Fig. 6 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the bolt moving further toward a forward position.

[0023] Fig. 6A is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the bolt moving further toward a forward position, illustrating the location of compressed gas in the body of the gun.

[0024] Fig. 7 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the firing components in the projectile launch stage, and the solenoid deactivating.

[0025] Fig. 7A is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the firing components in the projectile launch stage and the solenoid deactivating, illustrating the location of compressed gas in the body of the gun.

[0026] Fig. 8 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with a projectile being fired and the spool returning to its first or rearward position.

[0027] Fig. 8A is a side sectional view of an embodiment of a compressed gas gun according to the present invention with a projectile being fired and the spool returning to its first or rearward position, illustrating the location of compressed gas in the body of the gun.

[0028] Fig. 9 is a side sectional view of an embodiment of a compressed gas gun according to the present invention after a projectile has been fired from the gun with the bolt in the forward position.

[0029] Fig. 9A is a side sectional view of an embodiment of a compressed gas gun according to the present invention after a projectile has been fired from the gun with the bolt in the forward position, illustrating the location of compressed gas in the body of the gun.

[0030] Fig. 10 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the bolt returning to its first or rearward position under spring force, illustrating the location of compressed gas in the body of the gun.

[0031] Fig. 11 is a side sectional view of an embodiment of a compressed gas gun according to the present invention with the firing components returning to the ready to fire position, illustrating the location of compressed gas in the body of the gun.

[0032] Fig. 12 is an alternate embodiment of a firing mechanism for a compressed gas gun according to the present invention.

[0033] Fig. 13 is a side sectional view of another embodiment of a compressed gas gun according to the present invention with the firing components in the "first" or "ready to fire" or "resting" or "waiting" position.

[0034] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0035] For purposes of this detailed description, all reference to direction or orientation refer to the compressed gas gun 10 as oriented in Fig. 1. "Rear" or "rearward" refers to a portion or portions of the gun 10 to the right of Fig. 1, while "forward" refers to a portion or portions of the gun to the left of Fig. 1. In addition, for illustrative purposes only, compressed gas is illustrated in Figs. IA, 2A, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10 and 11, in order to give the reader an idea of the relative distribution of compressed gas within a compressed gas gun and firing mechanism of the present invention. As used herein, the terms "gun" or "marker" are used interchangeably to refer to a compressed gas gun used for sport or game play for firing a projectile. The exemplary projectile shown herein is a paintball.

[0036] Compressed gas guns 10 generally include a gun body 12 housing the inner components of the gun 10, and include a grip 14, barrel 16, and trigger 18, which are shown in Fig. 1. A breech 20 is provided for chambering projectiles 22. An infeed tube 24 is provided for feeding projectiles 22 into the breech 20. A hopper, loader, or magazine is generally provided, as is known in the art, for holding and feeding projectiles 22 into the infeed tube 24.

[0037] A compressed gas gun 10 including a firing mechanism according to the present invention includes a firing chamber 26 (or housing) which is a generally cylindrical space or bore within the body 12 of the gun 10. The gun 10 of the present invention falls into the category of "inline" guns or markers, as the firing components are contained in a single chamber or tube ("single bore"), with compressed gas traveling along a generally longitudinal path through the firing components to fire a projectile 22. The firing chamber 26 may include a first housing portion 100 defining a generally cylindrical space, and a second housing portion 102 forward the first housing portion 100, as shown in Fig. IA.

[0038] A trigger 18 is provided. The trigger 18 is actuated (e.g., pulled) by a user to initiate a firing operation (or sequence). Pulling the trigger 18 may close a trigger switch 250 in electrically operated compressed gas guns. In an electronic compressed gas gun, a signal is sent from the trigger switch 250 either directly to a solenoid 28 or the trigger switch 250 is in communication with a controller 244, which may be circuitry that may include a microprocessor 246. The trigger 18 may also contact or communicate with various other mechanical or electrical switches, which in turn activate or otherwise control a firing operation.

[0039] A solenoid 28 is provided in the firing chamber 26 preferably at the rear of the firing chamber 26. The solenoid 28 includes a solenoid body 30 and a plunger 32 (or "poppet") moveable between a resting, rear, or first position, and an activated or forward or second position. When the gun 10 is in the ready to fire position (as shown in Figs. 1, IA, IB, and 12), the solenoid 28 is not activated. The solenoid plunger 32 may include a tip 34 (or first plug) at its forward end. The tip 34 may be held within a solenoid tip housing 36, positioned within the first housing portion 100.

[0040] A guide body 38 is provided forward of and adjacent the solenoid tip housing 36, within the first housing portion 100, as shown in Figs. IA and IB. The guide body 38 includes a longitudinal channel 40 or first gas passage. The channel 40 provides fluid communication between the first area 90 and the collection area 86 when open at its forward end. A rod 42 is positioned within and moveable within the channel 40, with the rod 42 having a diameter preferably smaller than the channel 40 allowing the passage of gas through the channel 40 around the rod 42. The channel 40 provides a gas flow passage between the compressed gas storage chamber 104 and the collection area 86 to the rear of the spool 46, as described in greater detail below. The rod 42 may comprise or abut a plug 52 forward the rod 42, which is moveable when the rod 42 is moved. The plug 52 seals the forward opening of the channel 40 at its forward or second end in the ready to fire or resting position. The guide body 38 may include an exhaust passage 44 in communication with the channel 40. The diameter of the rod 42 is slightly smaller than the diameter of the channel 40.

[0041] A spool 46 is provided in the firing chamber 26 forward the guide body 38, at least a portion of which is positioned within the first housing portion 100. The spool 46 includes a first or rear portion 48 having an interior passage 50 sized to receive a portion of the rod 42 and the plug 52, as shown in Figs. IA and IB. The spool 46 further includes a rear passage/port 58b through an annular wall of the spool 46 adjacent the first portion 48 of the spool 46. The plug 52 is sized to fit tightly within passage 50, and divide the passage into a first area 90 to the rear of the plug 52, and a second area forward the plug 52.

[0042] A spring 54 may be provided within the passage 50 forward the plug 52, and abutting a forward inner wall 56 of the passage 50. The spring 54 will bias the plug 52 and rod 42 to a rearward position. The spool 46 may be formed to receive a portion of the guide body 38 within the rear part of the passage 50, as shown in Figs. IA and IB. A spool return spring 82 is provided within the forward end of the first housing portion 100 for biasing the spool 46 to a rear or first position. The spool return spring 82 can be positioned at other locations

within the housing portion 100, so long as the spool 46 is biased to a rear or first position.

[0043] The spool 46 includes a gas passage such as formed by ports 58a, 58b in sidewalls of the spool 46, and a hollowed body portion provided as an interior spool passage 50, providing communication between the compressed gas storage chamber and the interior spool passage 50, as shown in Fig. IB. The plug 52 selectively permits or blocks the passage of compressed gas from the compressed gas storage chamber through port 58b into the first area 90. The spool 46 preferably includes a decreased diameter portion 60 in a generally central portion of the spool 46. A forward portion 62 of the spool 46 is provided as an extension having a diameter larger than the diameter of the decreased diameter portion 60. The forward portion 62 includes a gas flow passage that may be formed from at least one sidewall passage 64 (or port) proximate the rear portion of the forward portion 62 of the spool 46. An open longitudinal passage 66 in communication with the sidewall passage 64 is provided in the forward portion 62 and extends toward the forward end 68 of the spool 46 and is open to the forward end of the gun 10. The sidewall passage 64 and longitudinal passage 66 form a flow passage at the forward portion of the spool 46.

[0044] The forward portion 62 of the spool 46 is positioned relative to the second housing portion 102 as shown in Figs. IA and IB, with the second housing portion 102 essentially at least partially coaxially surrounding at least a part of the forward portion 62 of the spool 46. The second housing portion 102 includes an opening 70 sized to receive the forward portion 62 of the spool 46. The second housing portion 102 preferably includes at least one internal o-ring 72 or any similar seal held within the opening 70 to act as a seal for blocking the passage of compressed gas when the firing mechanism is in a first, ready or resting position. The rear portion of the forward portion 62 of the spool 46 (preferably rearward of the sidewall passage 64 (or port)) is positioned within the opening 70 proximate the o-ring 72 when the spool 46 is in the ready to fire or first position, shown in Figs. 1 - IB.

[0045] A bolt 74 having a longitudinal bolt passage 76 is positioned in the forward portion of the firing chamber 26, also referred to as a bolt chamber. The bolt passage 76 is sized to receive at least a portion of the forward portion 62 of the spool 46. As shown in Figs. IA and IB, the bolt 74 coaxially surrounds the forward portion 62 of the spool 46. A seal such as an o-ring may also be provided in order to provide a seal between the bolt and forward portion 62 of the spool 46. A bolt return spring 78 provided within the forward portion of the firing chamber 26 biases the bolt 74 to a rearward position. The bolt 74 preferably includes an enlarged diameter portion 80 proximate its first or rear end 96. The enlarged diameter portion 80 of the bolt 74 is positioned adjacent a forward facing wall of the second housing portion 102 when the bolt is in the ready to fire or resting position. The bolt 74 is moveable within the first portion of the firing chamber 26 from a first, ready to fire or rearward position, to a second, firing or forward position.

[0046] A firing operation of a preferred embodiment of the compressed gas gun 10 and firing mechanism of the present invention will now be described.

[0047] Figs. 1, IA, and IB show the compressed gas gun 10 of the present invention in the ready to fire, start, first, or resting position. The compressed gas initially collects in a compressed gas storage chamber 104, as shown in Fig. IA. A projectile 22 has been chambered in the breech 20 of the gun 10, ready for firing. As shown in Fig. IA, gas under pressure (represented in the figures as dot or speckled patterns for illustration only) from a source of compressed gas flows from a compressed gas source, through a high pressure gas circuit, path, or passage 242 as is known in the art, and initially collects in the compressed gas storage chamber 104, including portions of the interior spool passage 50 in fluid communication with the compressed gas storage chamber 104 via port 58a. Gas flows to the opening in the rear port 58b of the spool 46, as shown in Figs. 1 and IA, and is initially blocked by the plug 52 from entering the first area 90. The gas is sealed in these areas via various o-rings, shown in the figures. The plug 52 prevents the gas from entering the first area 90 to the rear of the plug 52.

[0048] The compressed gas gun 10 further includes a controlled 244 for controlling the operation of the compressed gas gun 10, which may be an selected electronic or electrical circuitry as is known in the art for operating or controlling the operation of compressed gas guns. The controller 244 may include a microprocessor 246, and electronic or electrical circuitry may control operation of the solenoid 28. In an electronic paintball marker, the trigger generally actuates a trigger switch 250 to initiate a firing operation.

[0049] Figs. 2 and 2A show the firing operation upon initial trigger pull. When a user pulls the trigger 18, the solenoid 28 is initially activated. The solenoid 28 may include a plunger 32 having a solenoid tip 34 adapted to close off the rear portion of passage 40. Activation of the solenoid 28 moves the plunger 32 from a first or rear position to a second or forward position. The plunger 32 moves the rod 42 forward, which in turn moves the plug 52 away from the opening in the channel 40, and also away from the opening in the port 58b, allowing compressed gas to flow to the first area 90 behind the plug 52. Solenoid tip 34 closes off the rear of passage 40 so that gas cannot move rearward at this point. Gas is free to flow from the first area 90 behind the plug 52, around the rod 42 and through the channel 40, and to the rear collection area 86 between the annular wall 94 of the guide body 38 and the rear wall of the spool 46. It is appreciated that the plunger 32, tip34, rod 42 and plug 52 may be a single piece arrangement, or may be of a two-piece arrangement (with the plunger and rod or plug and rod as a single piece), or any other arrangement without departing from the present invention.

[0050] The spool 46 has a first effective surface area upon which compressed gas including compressed gas in the collection area 86 can act, with a pressure force being exerted upon the first effective surface area to the left (e.g., toward the forward end of the gun) in the Figures, which is greater than the effective surface of the spool 46 upon which compressed gas acts in the opposing direction, which is a force being exerted to the right in the figures. Due to the pressure differential created by compressed gas acting upon the different effective surface areas, the spool 46 is shifted forward (to the left) as shown in

Figs. 3 and 3A. At this stage of the firing operation, the decreased diameter portion 60 of the spool 46 moves within the o-ring 72 of the opening 70 of the second housing portion 102, opening a gas flow passage between the area to the rear of the second housing portion 102, and the area forward the second housing portion 102. This allows gas from the compressed gas storage chamber rearward of the second housing portion 102 to flow around the decreased diameter portion 60 of the spool 46 and through the opening 70 to the bolt chamber. In addition, the compressed gas will exert a pressure on the rear end 96 of the bolt 74 that is positioned within the opening 70 of the second housing portion 102, and such compressed gas will begin to move the bolt 74 forward in the firing chamber 26. The compressed gas force upon the bolt 74 is should be greater than the force of spring bias from the bolt spring 78 in order for the bolt 74 to be moved forward. The spool 46 has also moved forward relative to the plug 52, whereby gas can no longer flow from the first area 90 though the channel 40 to the collection area 86. Thus, only a limited amount of gas is present in the collection area 86, and the majority of the compressed gas should be used to fire a projectile 22, as further described. As the port 58B passes the plug 52, compressed gas is blocked from entering the first area 90, as shown in Figs. 3 and 3A. Thus, only a discrete amount of compressed gas is used to send the spool 46 forward, and most of the compressed gas in the compressed gas storage chamber 104 is used to fire a projectile from the gun of the present invention.

[0051] When the solenoid 28 is activated, the plunger 32 moves the plug 52 away from the forward opening in the guide body 38, against the bias of spring 54. Compressed gas is permitted to flow from the first area 90, through the channel 40 and into the collection area 86. When the solenoid 28 is deactivated (or activated to move rearwardly), or the plunger 32 is otherwise moved rearwardly, the plug 52 moves rearward under the bias of the spring 54. This closes off the flow passage through the channel 40, preventing fluid communication between the first area 90 and the collection area 86. In the rear position, the tip 34 of the plunger 32 moves rearward of the rear opening in the guide body 38, permitting compressed gas in the collection area 86 to exhaust.

[0052] Figs. 4 and 4A show the continued operation of the firing mechanism. As the spool 46 travels forward to a firing position, gas will further travel through the sidewall passage 64 of the spool 46, as shown in Fig. 4A. The compressed gas continues to exert a pressure on the rear end 96 of the bolt 74, moving the bolt 74 forward against the bias of the bolt return spring 78.

[0053] As shown in Figs. 5 and 5a, compressed gas will travel from the sidewall passage 64 of the spool 46 into and forward through the longitudinal passage 66, and out the opening in the forward end 68 of the spool 46. At the point of operation shown in Figs. 5 and 5A, the rearmost portion of the bolt passage 76 still coaxially surrounds the forward end 68 of the spool 46. Compressed gas continues to move the bolt 74 forward against the bias of the bolt return spring 78, acting on rearwardly facing surface areas of the bolt 74.

[0054] As shown in Figs. 6 and 6A, the bolt 74 continues to move forward under the force of compressed gas. The bolt 74 moves forward beyond the spool 46, which has reached its most forward position. Compressed gas is may flow both through the longitudinal passage 66 of the spool 46, and around the forward end 68 of the spool through the bolt passage 76.

[0055] As shown in Figs. 7 and 7A, the compressed gas flows through the bolt passage 76, to fire the projectile 22 from the barrel 16. The plunger 32 of the solenoid 28 has been retracted to a rearward most position, away from the rear opening in the guide body 38. The compressed gas stored in the collection area 86 is permitted to vent rearwardly through the channel 40, and out the rear of the gun body. Any rearward opening in the gun body in communication with the portion of the firing chamber rear of the channel 40 may provide means to vent the compressed gas to atmosphere.

[0056] The charge of compressed gas propels the projectile 22 out of the barrel 16. As shown in Figs. 8 and 8A, with the compressed gas vented from the collection area 86 rear of the spool 46, the spool 46 moves rearward to its first position under the force of the spool return spring 82. This seals the opening 70 of the second housing portion 102, and compressed gas may again accumulate within the compressed gas storage chamber 104. As shown in Figs. 9 and 9A, the

solenoid plunger 32 again closes the rearward opening of the guide body 38 with the tip 34. Most of the original charge of compressed gas from the compressed gas storage chamber 104 has now exited the barrel to fire the projectile, or has been vented from the rear of the gun.

[0057] As shown in Fig. 10, with no compressed gas to bias the bolt 74 to the firing or forward position, the bolt return spring 78 biases the bolt rearward to its original ready to fire position, and another projectile is chambered in the breech. Fig. 11 shows the gun with a projectile chambered, and with the compressed gas storage chamber 104 charged with compressed gas to begin another firing cycle.

[0058] Another embodiment of a compressed gas gun firing mechanism of the present invention is shown in Fig. 12. This firing mechanism includes a generally tubular housing 200 and a cylinder housing 214 forward the housing 200 as shown in Fig. 12 as an in-line arrangement. The rear of this embodiment is similar to the embodiment described above, including a solenoid 28, with a tip 32, held within a tip housing 36. A guide body 38 including a channel 40 is provided forward the tip housing 36, with a rod 42 moveable within the channel 40. A spool 46 is provided, including an interior passage 50 within a first portion 48. A plug 52 is provided moveable within the passage 50, and biased rearwardly in the passage by a spring 54. A first area 90 is provided between the plug 52 and a forward opening in the guide body 38. The guide body 38 may be provided as a single piece, or a plurality of pieces spaced and positioned within the housing 200. The spool 46 further includes a spool port 210 providing communication with the passage 50 and the compressed gas storage chamber 104. A collection area 86 is provided between the rear of the spool 46 and an annular wall of the guide body 38.

[0059] The first portion 48 of the spool moves within a first spool chamber 202. A spool return spring 82 is provided in the forward portion of the first spool chamber 202, biasing the spool to a first or rearward position.

[0060] Forward the first portion 48 of the spool is a first decreased diameter portion 204, and an annular wall 206 having a diameter larger than the

first decreased diameter portion 204. The annular wall 206 is preferably provided with an o-ring to block the passage of gas. The first decreased diameter portion 204 and annular wall 206 are held within a channel 208 in the housing 200 when the firing mechanism is in a first, resting, or ready to fire state, as shown in Fig. 12.

[0061] Gas under pressure enters the housing 200 via the input port 212. Gas is initially held within a compressed gas storage chamber 104. When the firing mechanism is in the ready to fire or first or resting position, gas is held generally within the compressed gas storage chamber 104 between the first spool chamber 202 and the channel 208. In this position, the annular wall 206 and o-ring prevent gas from passing from the compressed gas storage chamber 104 forward.

[0062] A cylinder housing 214 is provided forward the channel 208 and adjacent the housing 200, defining a cylindrical cavity 218. A forward portion 216 of the spool is provided as a cylindrical projection that extends into the cylindrical cavity 218. Coaxially surrounding the forward portion 216 of the spool is a nozzle or flow tube 220 having an interior through passage 222. The forward portion of the flow tube 220 extends forward beyond the cylinder housing 214, and threadably engages a bolt 224. The bolt 224 may also be formed as a single piece with the flow tube 220. The flow tube 220 is reciprocally moveable in the cylinder housing 214 from a first or ready to fire position to a second or firing position. A flow tube spring 226 positioned within the cylinder housing 214 biases the flow tube 220 and the bolt 224 to a rearward position. The flow tube 220 includes indentations 230 at the first end of the flow tube 220, adjacent the rearward opening in the flow tube 220. The flow tube 220 has a rear enlarged portion 232 that has a diameter smaller than the cylindrical cavity 218.

[0063] In operation, the firing mechanism shown in Fig. 12 is positioned within the firing chamber of a compressed gas gun, such as shown in Figs. 1-11. A regulator 240 (as illustrated in Fig. 1) regulates the gas pressure from a source of pressurized gas, e.g., a compressed gas tank (not shown) and supplies gas to the input port 212. A compressed gas port 242 (illustrated in Fig. 1) provides

communication between the source of gas under pressure and the compressed gas storage chamber 104. Gas from the input port 212 fills the compressed gas storage chamber 104 and the passage 50. When the trigger of the gun is pulled, the solenoid 28 is activated. The plunger 32 of the solenoid 28 pushes rod 42 forward, unseating the plug 52 from the opening in the forward portion of the guide body 38. Compressed gas flows through the channel 40 to collect in the collection area 86.

[0064] The gas in the collection area 86 acts upon a rearwardly facing effective surface area of the spool 46 that is greater than the forwardly facing effective surface area of the spool 46. The gas pressure in the collection area 86 will therefore push the spool 46 forward due to the differential in the gas pressure forces.

[0065] The annular wall 206 of the spool 46 moves forward in the channel 208, contacting and pushing the flow tube 220 forward. At a certain point, the annular wall 206 will pass the forward wall of the housing 200 adjacent the channel 208, allowing compressed gas to flow into the cylindrical cavity 218. Gas will flow into the indentations 230 at the rear of the flow tube 220. The flow tube 220 has a rearwardly facing effective surface area that is greater than the forwardly facing effective surface area of the flow tube 220. Thus, the flow tube 220 will be pushed forward by the pressure of the gas acting on the rearwardly facing effective surface area.

[0066] The spool 46 will reach its forward movement limit. The solenoid plunger 32 may be retracted, moving the tip 34 away from the rearward opening in the guide body 38, and allowing gas to be vented from collection area. The spool 46 will move rearward, biased by the spool return spring 82.

[0067] The flow tube 220 will continue to move forward under the pressure of the compressed gas in the cylindrical cavity 218, until the flow tube 220 moves off of the forward portion 216 of the spool. Compressed gas will rush through the passage 222 in the flow tube 220. The bolt 224 will be in a firing position, having chambered a projectile, and the compressed gas will fire the projectile from the gun.

[0068] Relief of the pressure in the cavity will allow the flow tube spring 226 to return the flow tub 220 to its rear position. Compressed gas will again collect in the compressed gas storage chamber 104, and the firing mechanism is ready to fire again.

[0069] Fig. 13 illustrates another embodiment of a compressed gas gun according to the present invention with the firing components in the "first" or "ready to fire" or "resting" or "waiting" position. The configuration and operation of the compressed gas gun is similar to that of the compressed gas guns described above with reference to Figs. 1- 11, with the following notable differences. The length of the spool 46 of the compressed gas gun extends from the guide housing 38 to the breech 20, within the second housing portion 102 of the firing chamber 26. The spool 46 may include numerous o-rings 310 to seal gas in various areas during operation of the compressed gas gun. An open longitudinal passage 66 is provided in the forward portion 62 and extends toward the forward end 68 of the spool 46. A plastic insert 312 is disposed within the open longitudinal passage 66 in the forward portion 62 of the spool 46. A gas port 314 and the longitudinal passage 66 form a flow passage at the forward portion 62 of the spool 46.

[0070] The bolt 74 comprises a tapered portion 316 extending annularly about an internal surface of the bolt 74, as shown in Fig. 13. This internal tapered portion 316 acts as a rearwardly facing effective surface area 318 upon which compressed gas acts, with a pressure force being exerted to the left in the figure to move the bolt 74 forward in the firing chamber 26. The force of compressed gas exerted on the effective surface area 318 combines with other forces on the bolt 74 to overcome the force of spring bias from the bolt spring 78 to move the bolt 74 forward.

[0071] Having thus described in detail several embodiments the present invention, it is to be appreciated and will be apparent to those skilled in the art that many physical changes, only a few of which are exemplified in the detailed description of the invention, could be made without altering the inventive concepts and principles embodied therein. It is also to be appreciated that numerous embodiments incorporating only part of the preferred embodiment are

possible which do not alter, with respect to those parts, the inventive concepts and principles embodied therein. The present embodiment and optional configurations are therefore to be considered in all respects as exemplary and/or illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all alternate embodiments and changes to this embodiment which come within the meaning and range of equivalency of said claims are therefore to be embraced therein.

* * *

CLAIMS

What is claimed is:

1. A firing mechanism for a compressed gas gun, the firing mechanism comprising:

a firing chamber including a compressed gas storage chamber and a bolt chamber in communication with the compressed gas storage chamber;

a bolt positioned within the bolt chamber having a bolt passage therethrough, the bolt moveable by a force of compressed gas from a first position to a second position, the bolt biased to the first position by a bolt spring;

a solenoid positioned proximate the firing chamber including a plunger moveable from a first position to a second position;

a spool moveable within the compressed gas storage chamber from a first position to a second position, the spool including a forward portion having a flow passage therethrough, the spool adapted to selectively control the passage of compressed gas from the compressed gas storage chamber to the bolt chamber;

a gas collection area adjacent the rear of the spool;

a first gas passage providing communication between the compressed gas storage chamber and the collection area; and,

a rod in communication with the solenoid plunger positioned within the first gas passage, the rod moveable from a first position to a second position by movement of the solenoid plunger, the rod having a forward plug at its forward end and a rearward plug at its rearward end, the solenoid plunger controlling movement of the rod to selectively allow compressed gas to flow through the first gas passage.

2. A firing mechanism for a compressed gas gun, the firing mechanism comprising:

a compressed gas storage chamber adapted to receive compressed gas from a source of compressed gas;

a bolt chamber in fluid communication with the compressed gas storage chamber housing a bolt with a bolt passage therethrough moveable from a first position to a second position under the force of compressed gas;

a solenoid for controlling the movement of a spool by opening a flow passage providing fluid communication between the compressed gas storage chamber and the rear wall of the spool; and,

a spool positioned at least partially within the compressed gas storage chamber and at least partially within the bolt chamber adapted to move from a first position to a second position, the spool including a flow passage proximate its forward end, the spool adapted to selectively allow the passage of compressed gas from the compressed gas storage chamber through the flow passage to the bolt chamber when the spool is moved under the force of compressed gas from a first position to a second position.

3. The firing mechanism of claim 2, further comprising a spool return spring biasing the spool to its first position.

4. The firing mechanism of claim 3, further comprising a bolt spring biasing the bolt to its first position.

5. The firing mechanism of claim 2, wherein a rear portion of the bolt coaxially surrounds a forward portion of the spool.

6. The firing mechanism of claim 2, wherein a rear portion of the bolt coaxially surrounds a forward portion of the spool when in the first position and wherein the bolt moves forward relative to the forward portion of the spool when in the second position.

7. The firing mechanism of claim 2, wherein the spool has a first effective surface area greater than a second effective surface area, wherein selective

activation of the solenoid allows compressed gas in the compressed gas storage chamber to act upon the first effective surface area.

8. The firing mechanism of claim 2, wherein the bolt comprises a first effective surface area greater than a second effective surface area, and wherein compressed gas proximate the first effective surface area biases the bolt from a first position to a second position.

9. The firing mechanism of claim 2, further comprising a trigger adapted to actuate the solenoid.

10. A firing mechanism for a compressed gas gun, the firing mechanism comprising:

a compressed gas storage chamber in fluid communication with a bolt chamber;

a bolt reciprocally moveable within the bolt chamber, the bolt configured to move from a first position to a second position by the application of compressed gas;

a spool reciprocally moveable within the compressed gas storage chamber, the spool selectively allowing compressed gas to flow from the compressed gas storage chamber to the bolt chamber, the spool configured to move from a first position to a second position by the application of compressed gas;

a solenoid adapted to open a gas flow passage for controlling movement of the spool; and,

a trigger for actuating the solenoid.

11. A compressed gas gun comprising:

a gun body including a firing chamber;

a grip;

a trigger;

a barrel;

a compressed gas storage chamber within the firing chamber adapted to receive compressed gas from a source of compressed gas;

a bolt chamber in fluid communication with the compressed gas storage chamber housing a bolt with a bolt passage therethrough moveable from a first position to a second position under the force of compressed gas;

a spool positioned at least partially within the compressed gas storage chamber and at least partially within the bolt chamber adapted to move from a first position to a second position, the spool comprising a flow passage proximate its forward end, the spool adapted to selectively allow the passage of compressed gas from the compressed gas storage chamber through the flow passage to the bolt chamber when the spool is moved under the force of compressed gas from a first position to a second position; and

a solenoid for controlling the movement of the spool.

12. The firing mechanism of claim 11, further comprising a flow passage providing fluid communication between the compressed gas storage chamber and a rear wall of the spool.

13. A method of firing a compressed gas gun, the method comprising the steps of:

(a) providing a compressed gas storage chamber in fluid communication with a bolt chamber;

(b) providing bolt reciprocally moveable within the bolt chamber, the bolt adapted to move from a first position to a second position under the force of compressed gas;

(c) providing a spool moveable within the compressed gas storage chamber adapted to selectively control the passage of compressed gas between the compressed gas storage chamber and the bolt chamber; and,

(e) selectively supplying compressed gas to move the spool from a first position to a second position.

14. The method of claim 13, wherein the spool is adapted to block the passage of compressed gas from the compressed gas storage chamber to the bolt chamber when in a first position, and to permit the passage of compressed gas from the compressed gas storage chamber to the bolt chamber when in a second position.

15. The method of claim 13, wherein compressed gas is selectively supplied to move the spool from a first position to a second position by actuation of a solenoid.

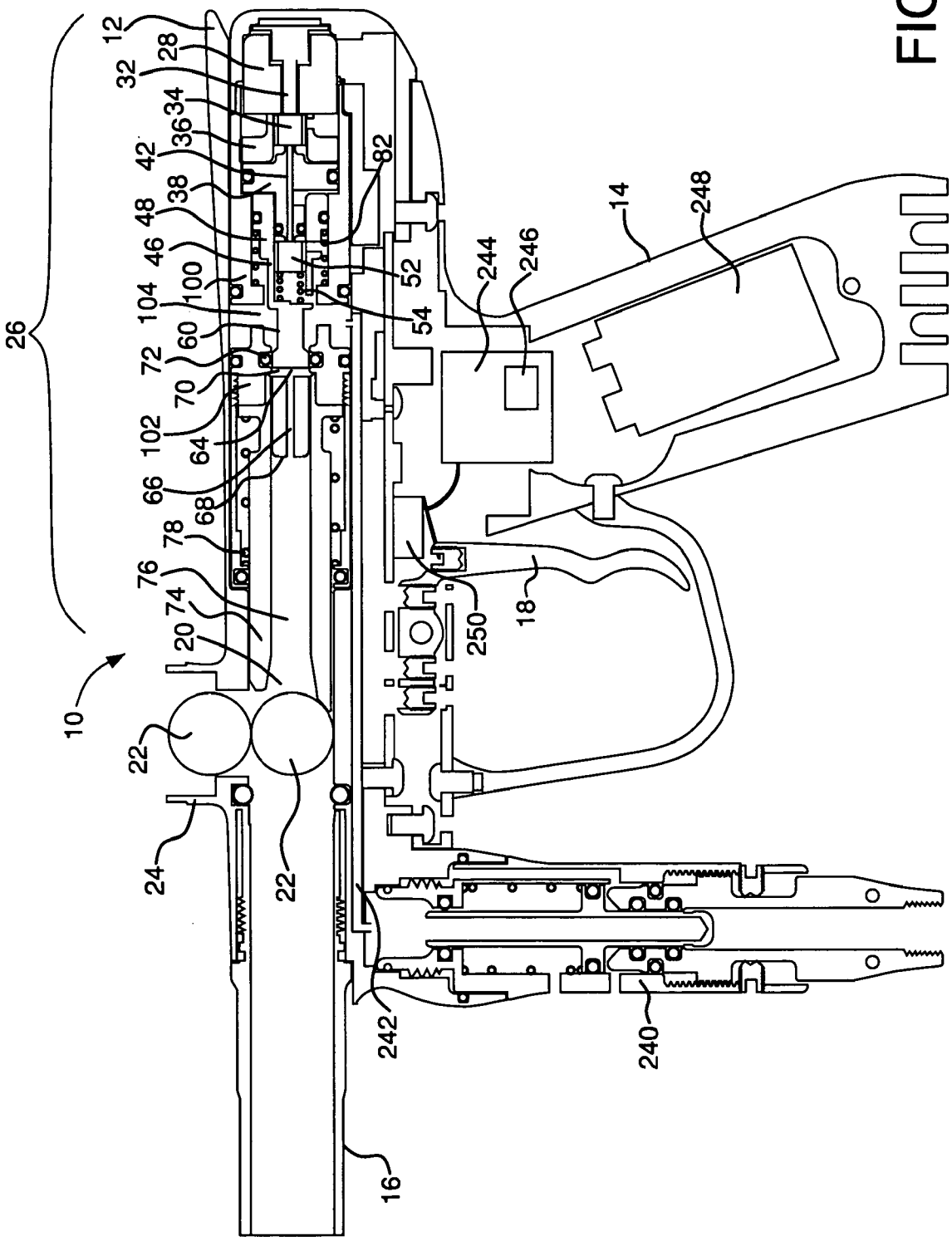
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FIG. 1

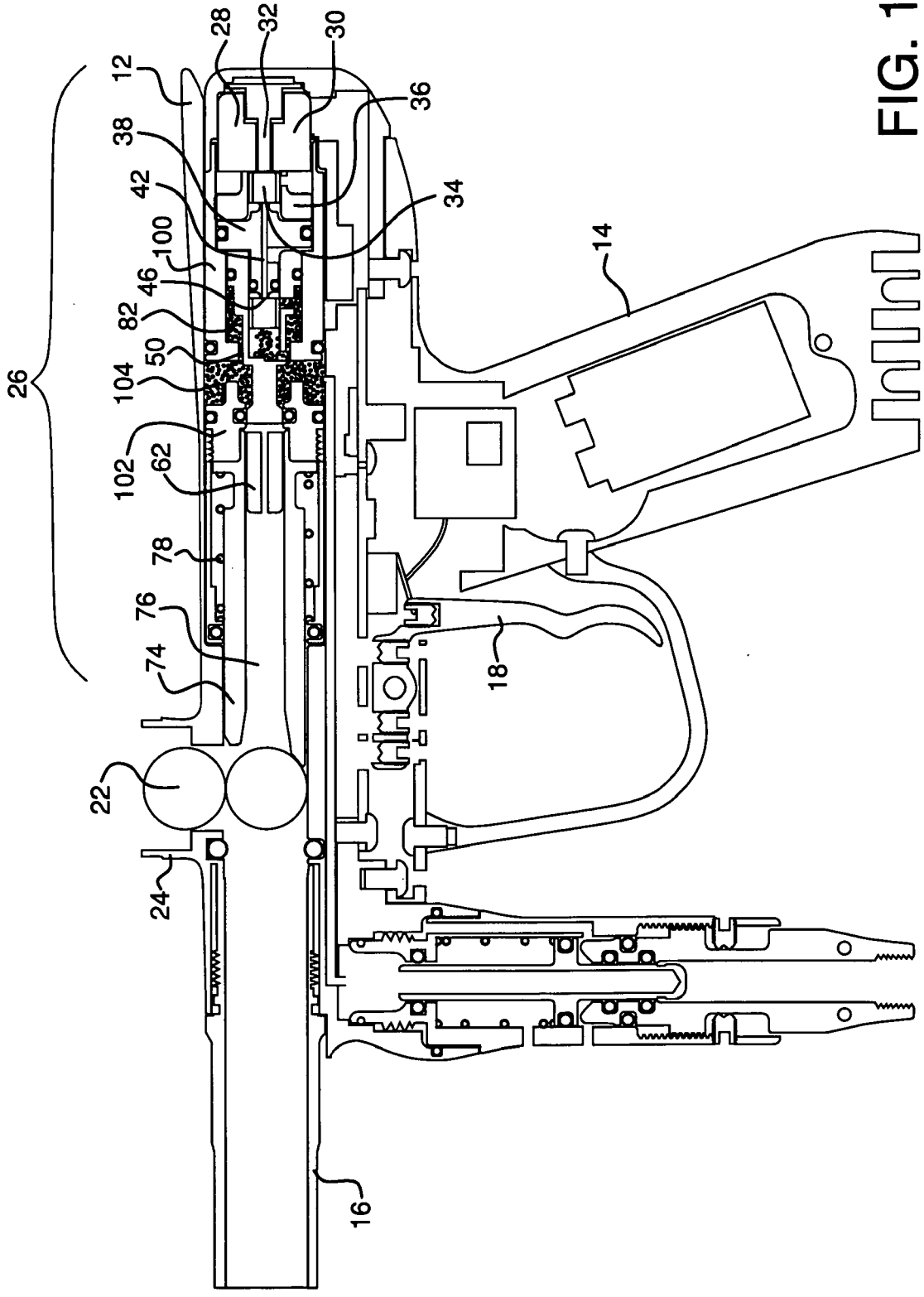
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FIG. 1A

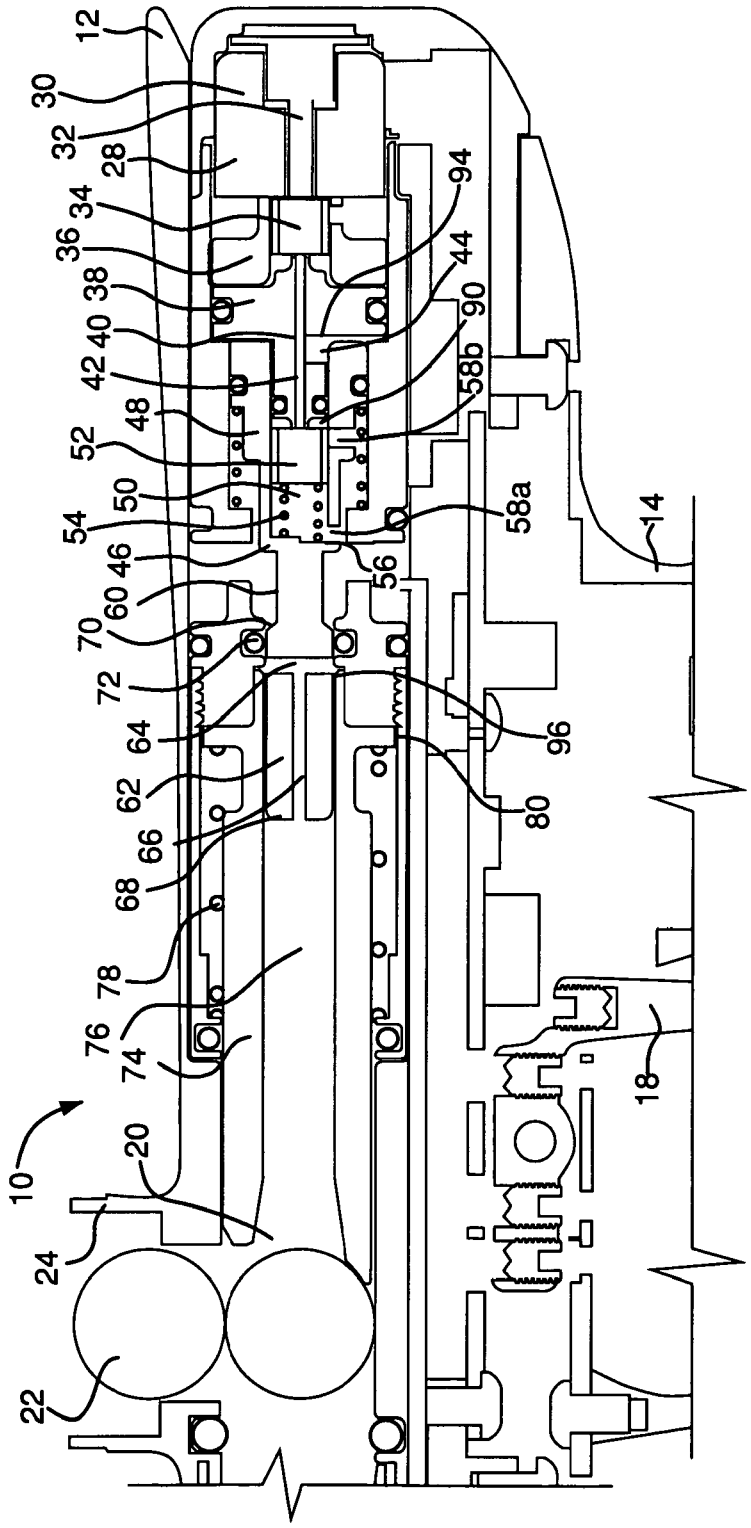
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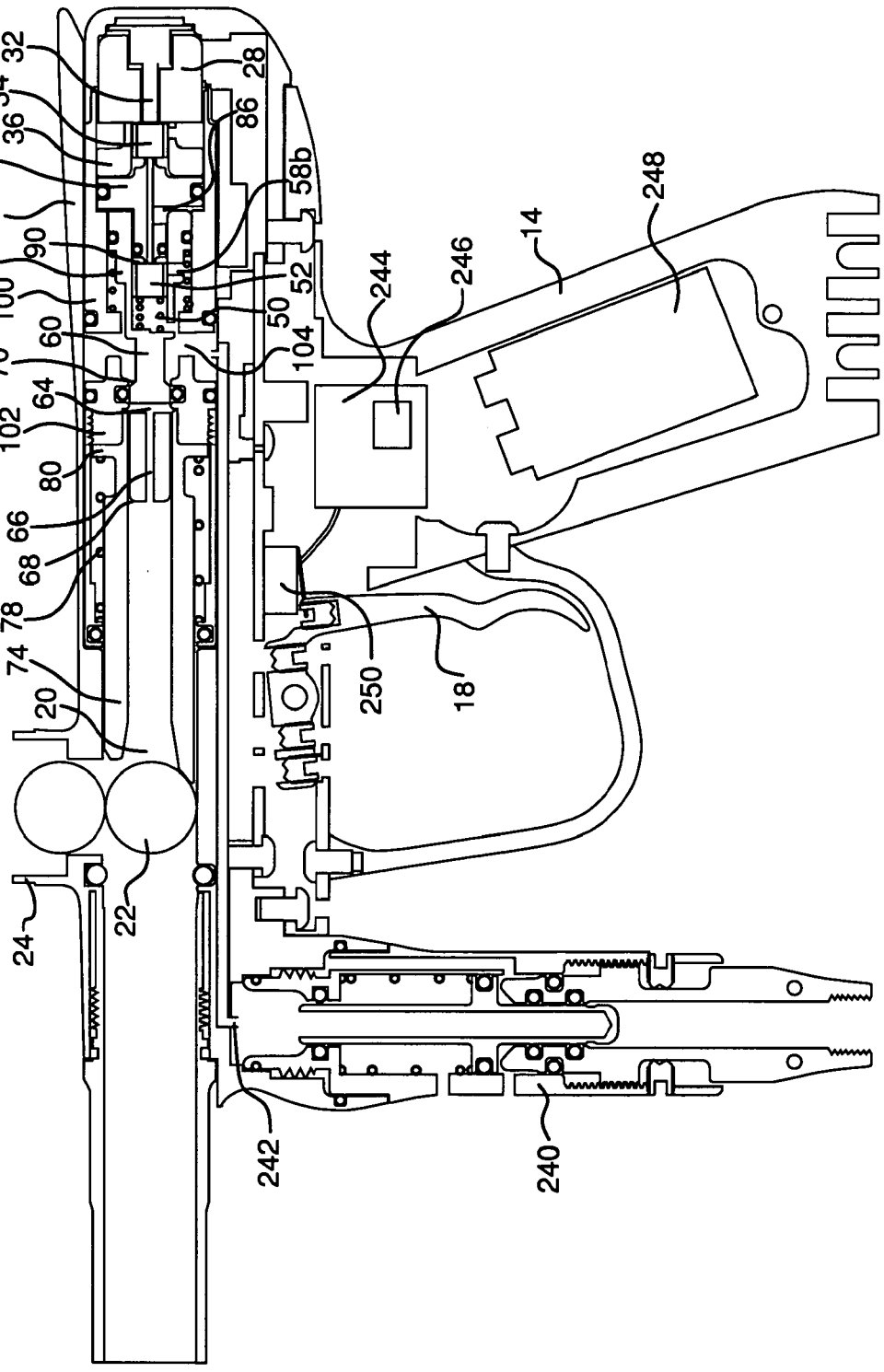
FIG. 1B

FIG.2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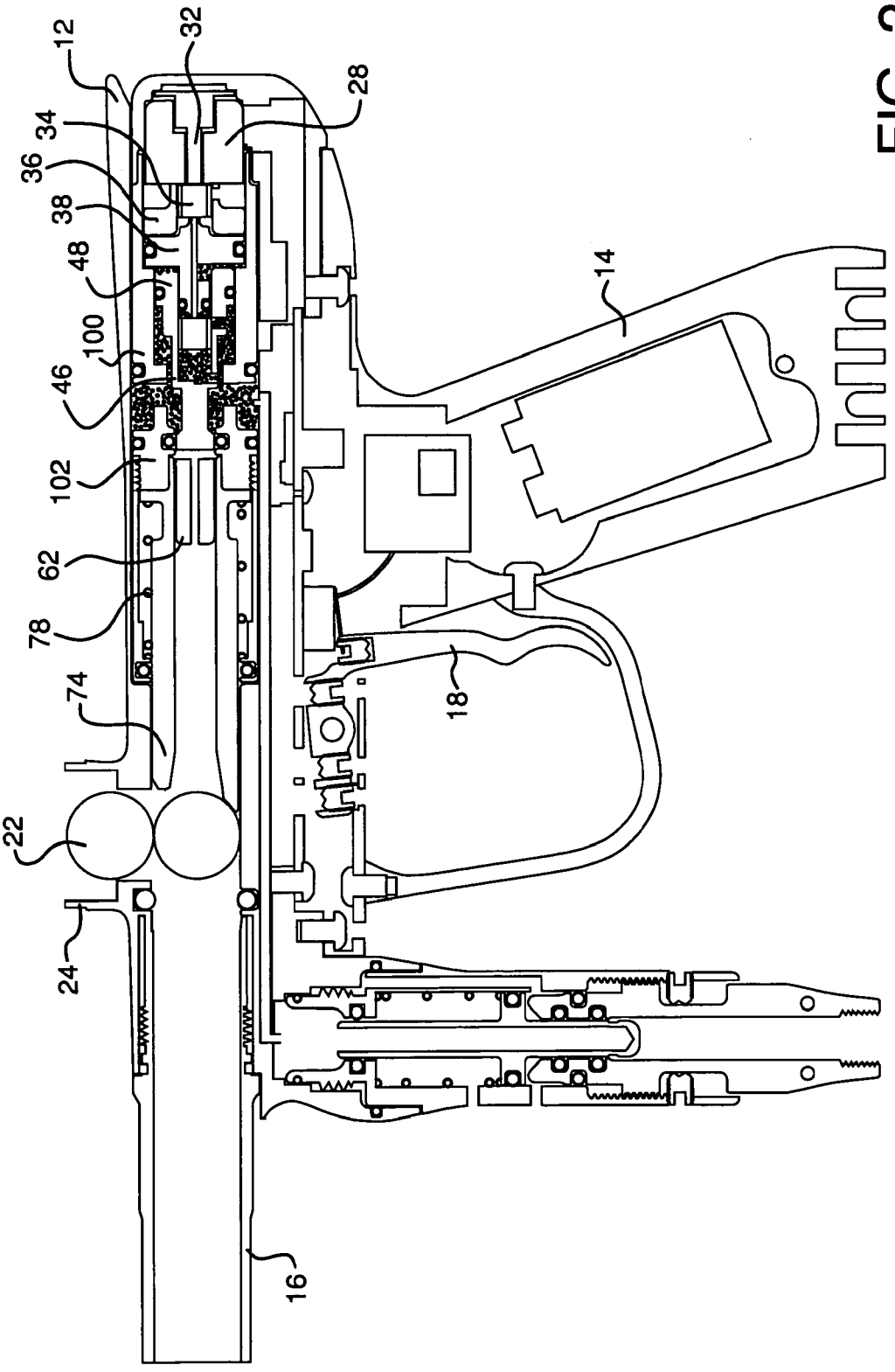
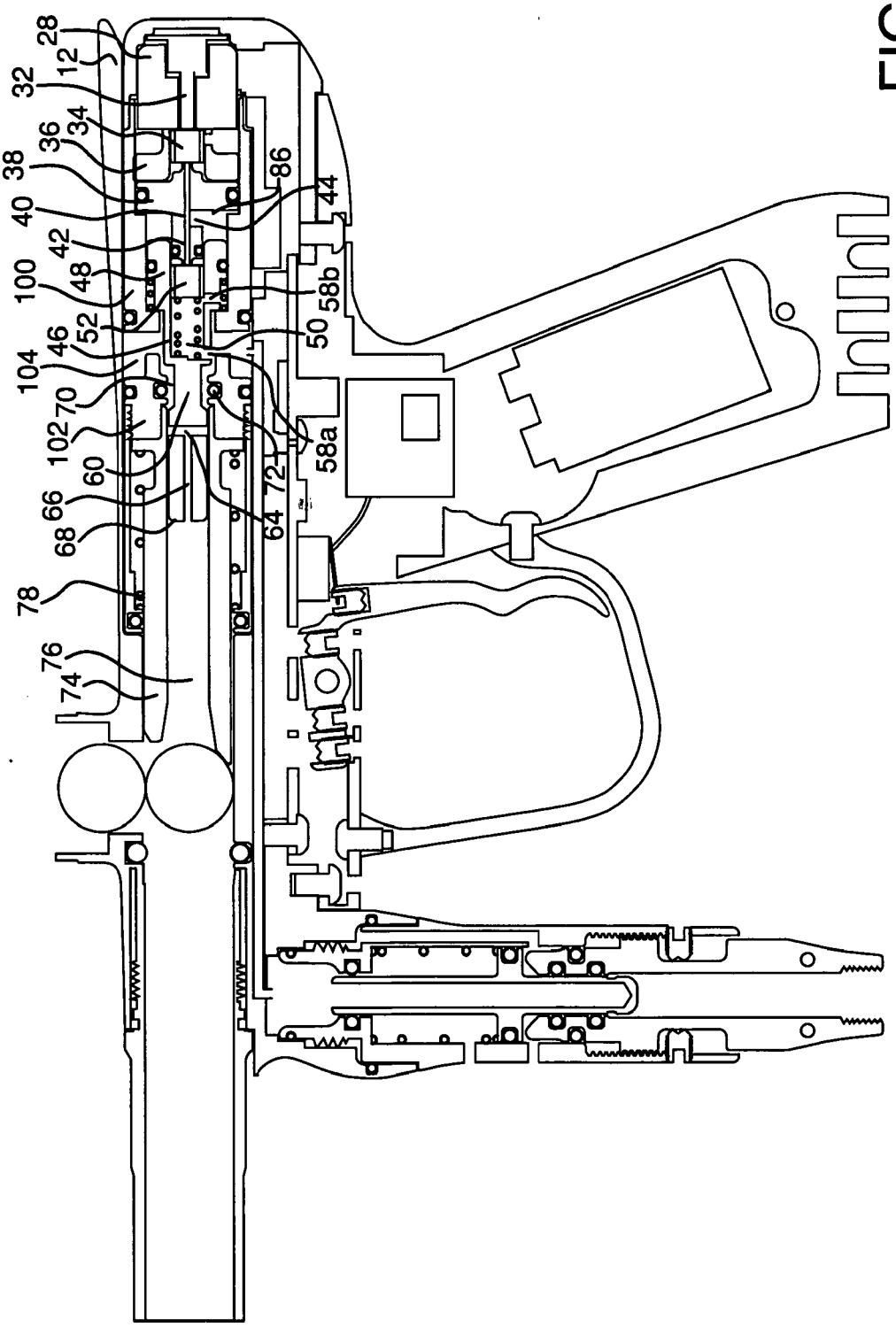


FIG. 2A

FIG. 3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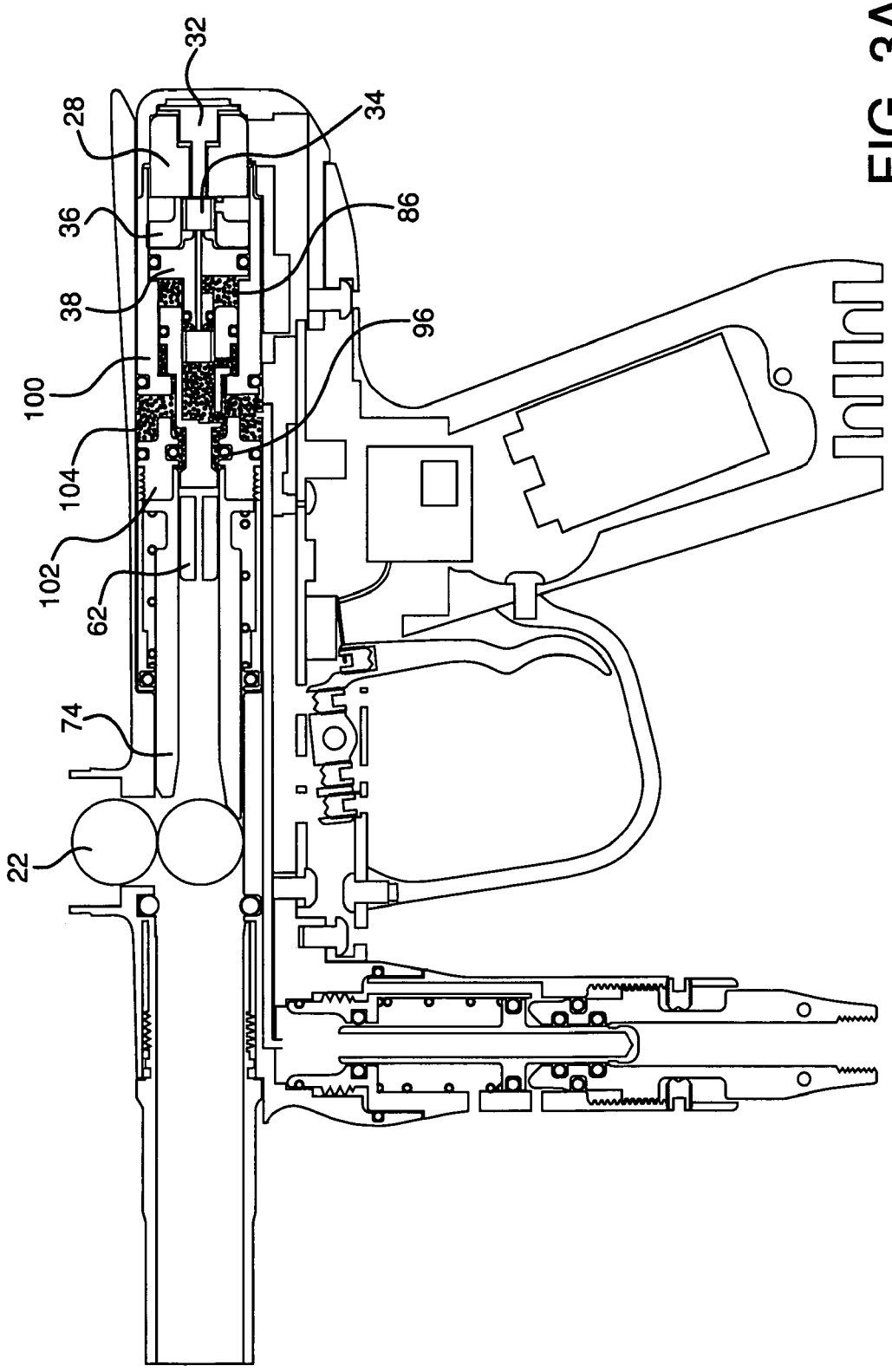
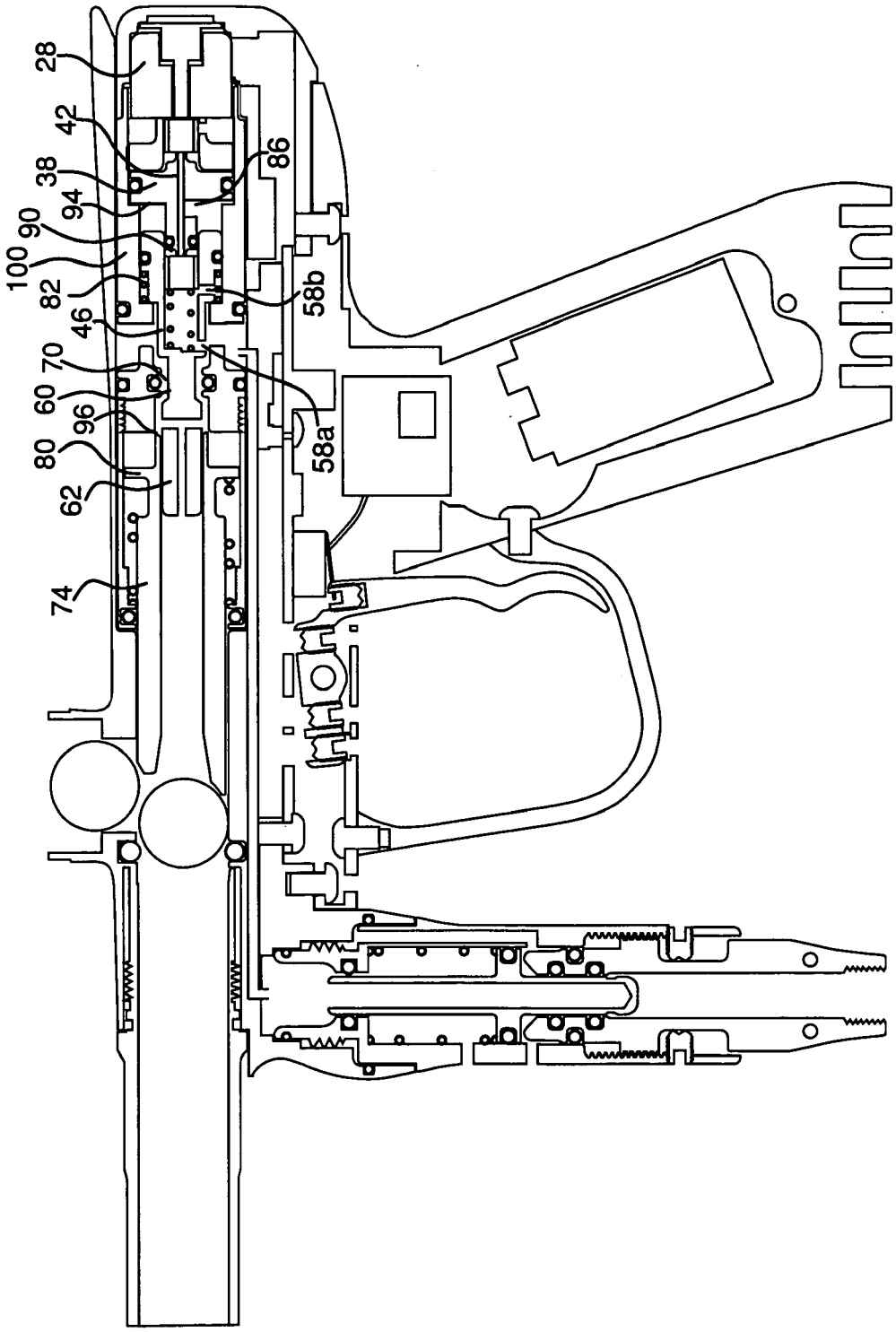


FIG. 3A



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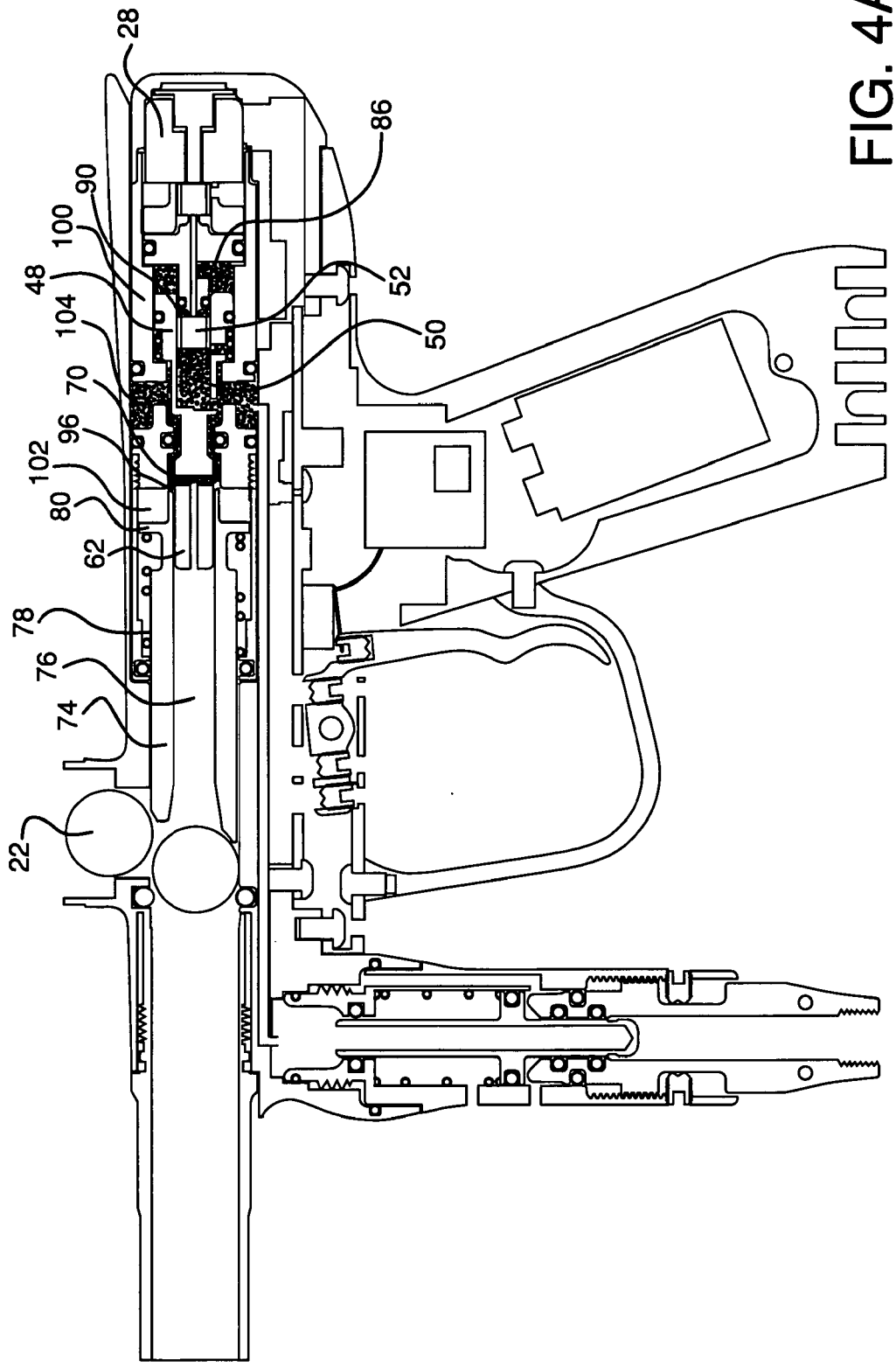


FIG. 4A

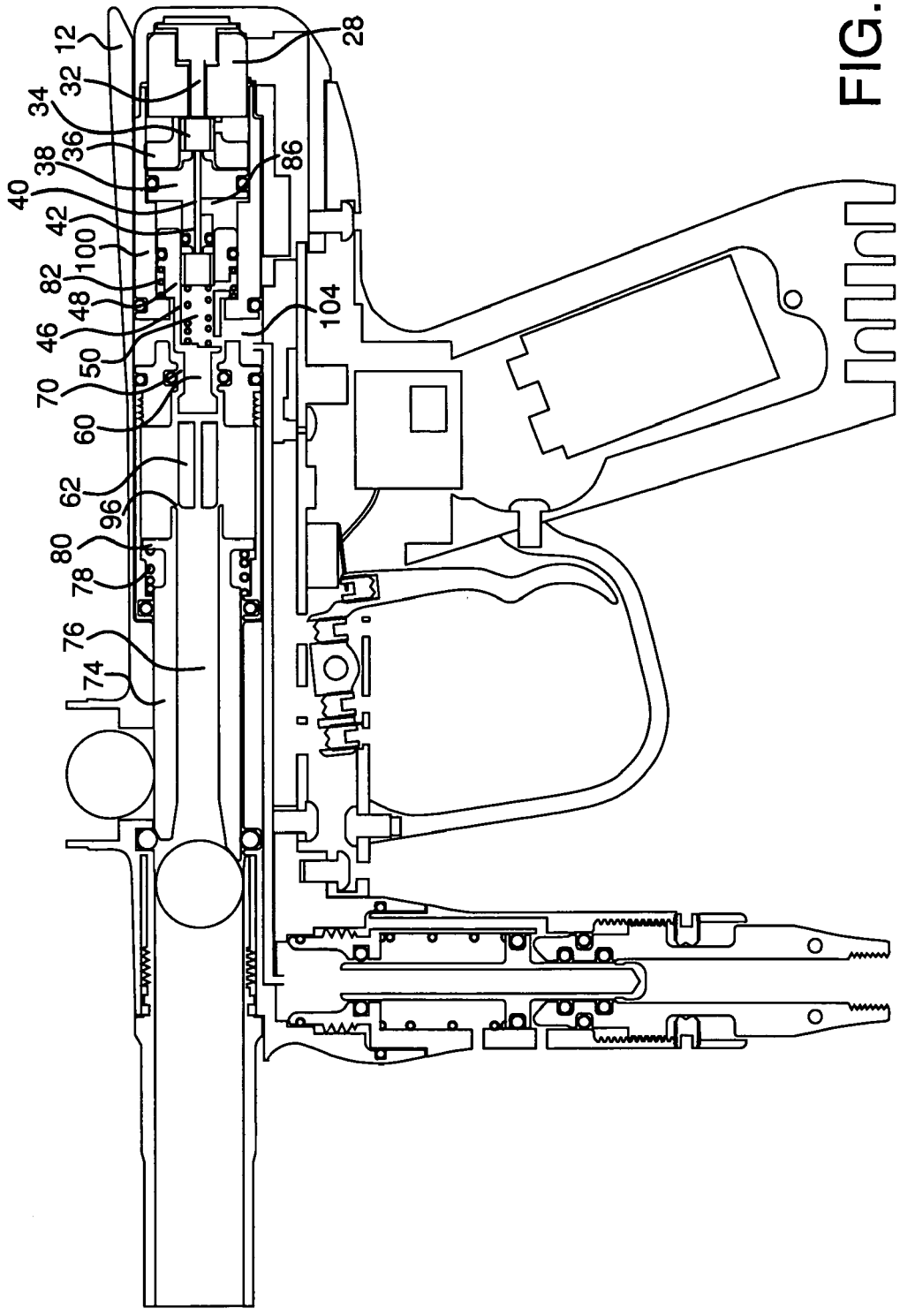


FIG. 5

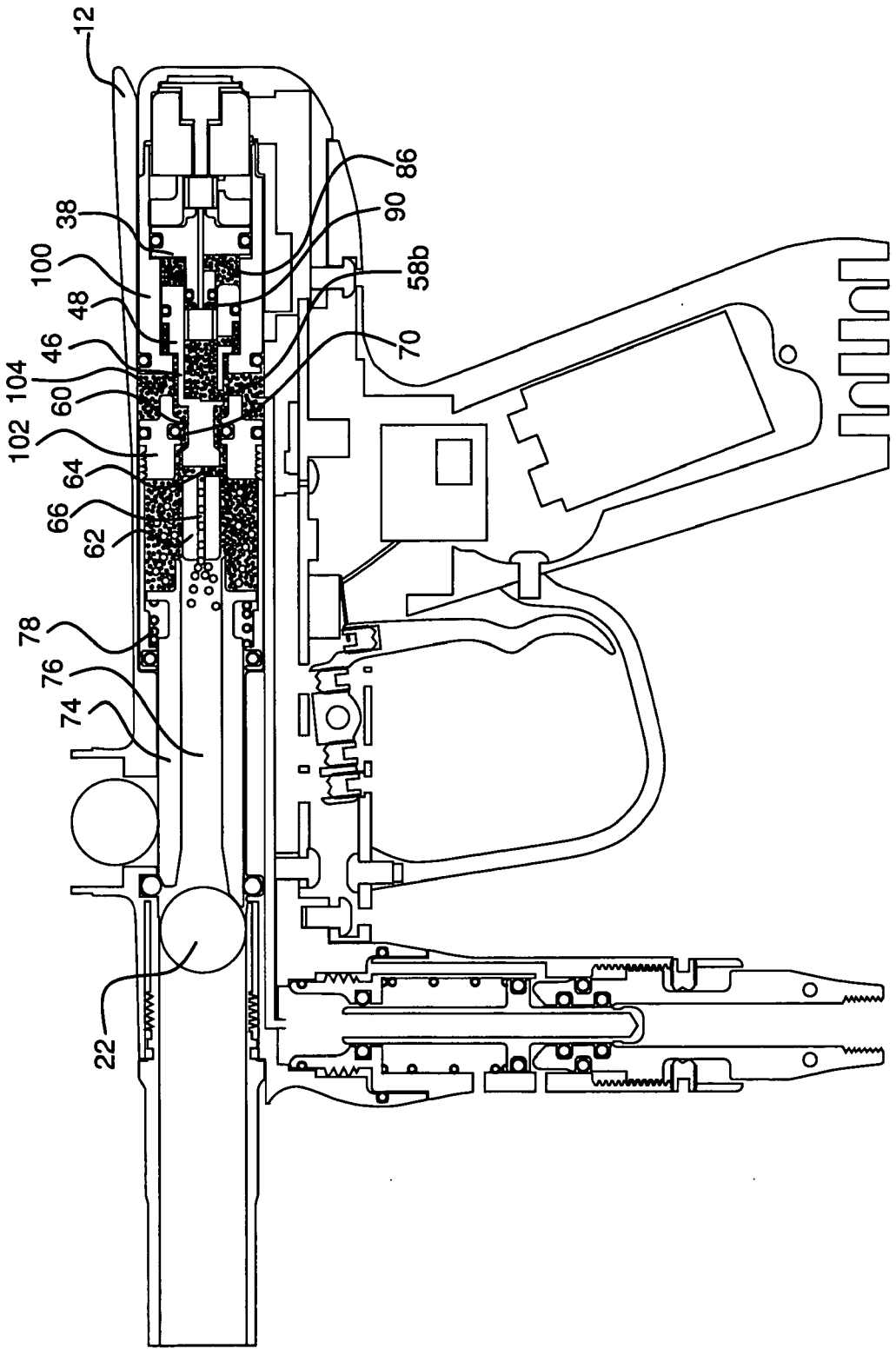
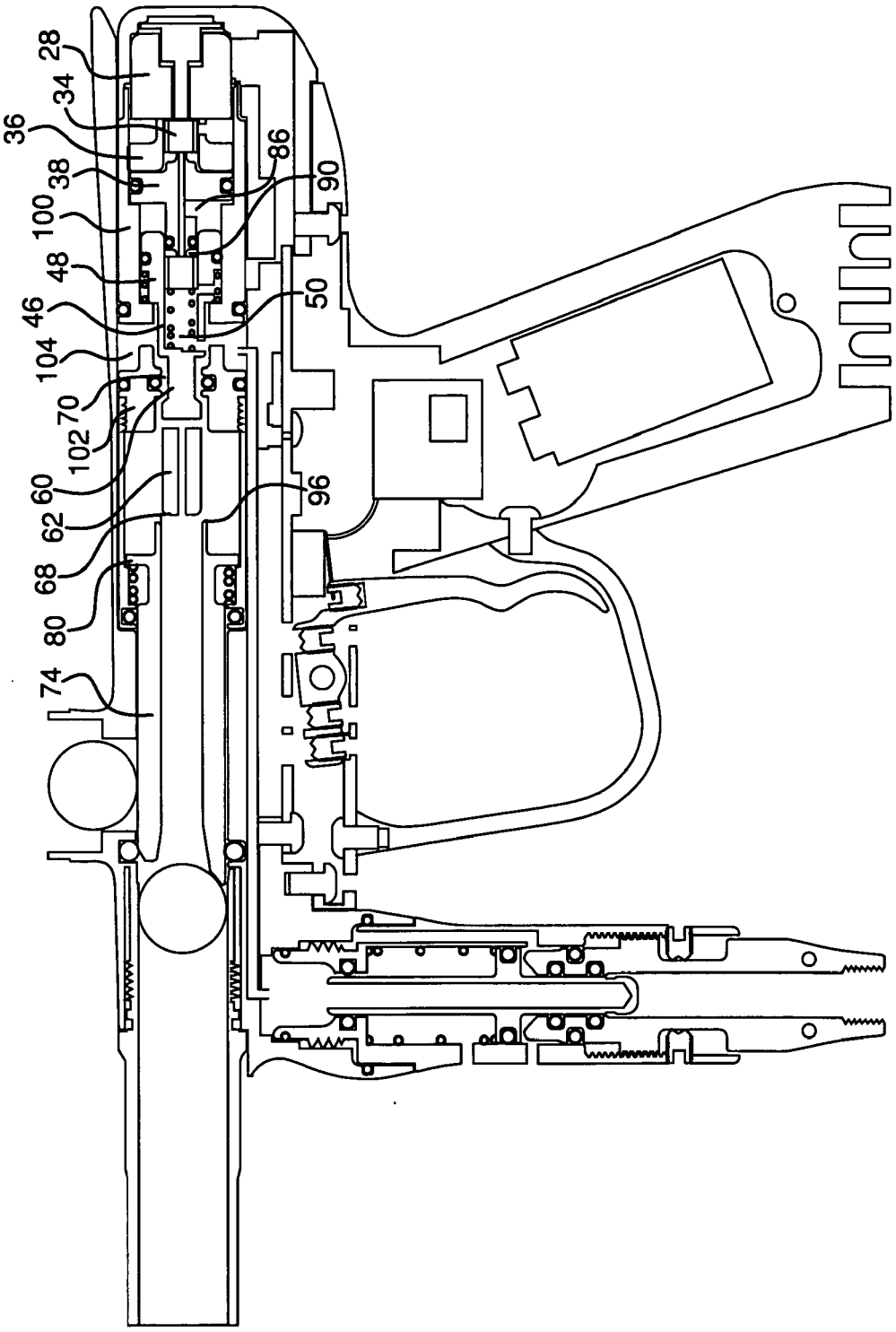


FIG. 5A

FIG. 6



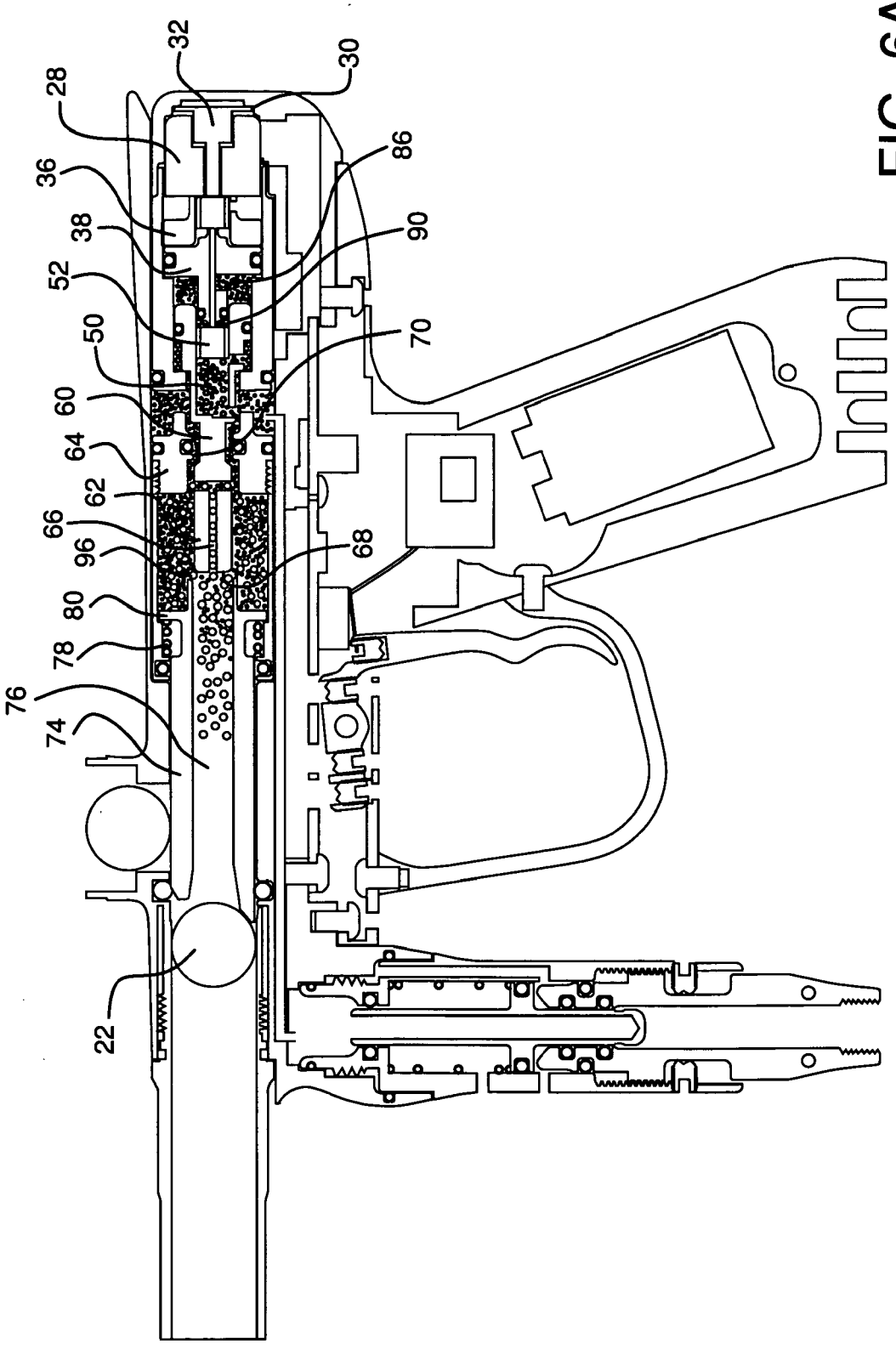
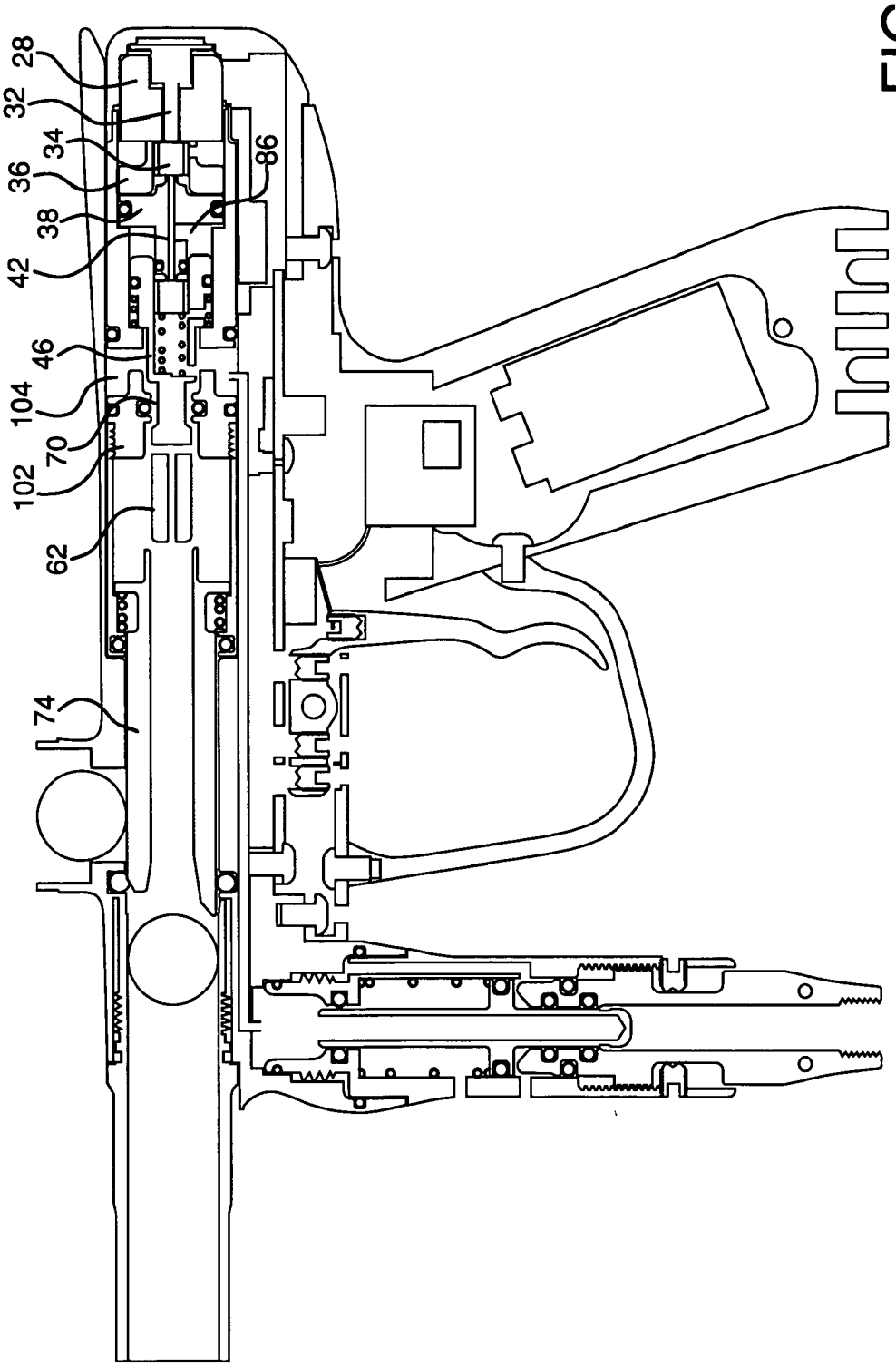


FIG. 6A

FIG. 7



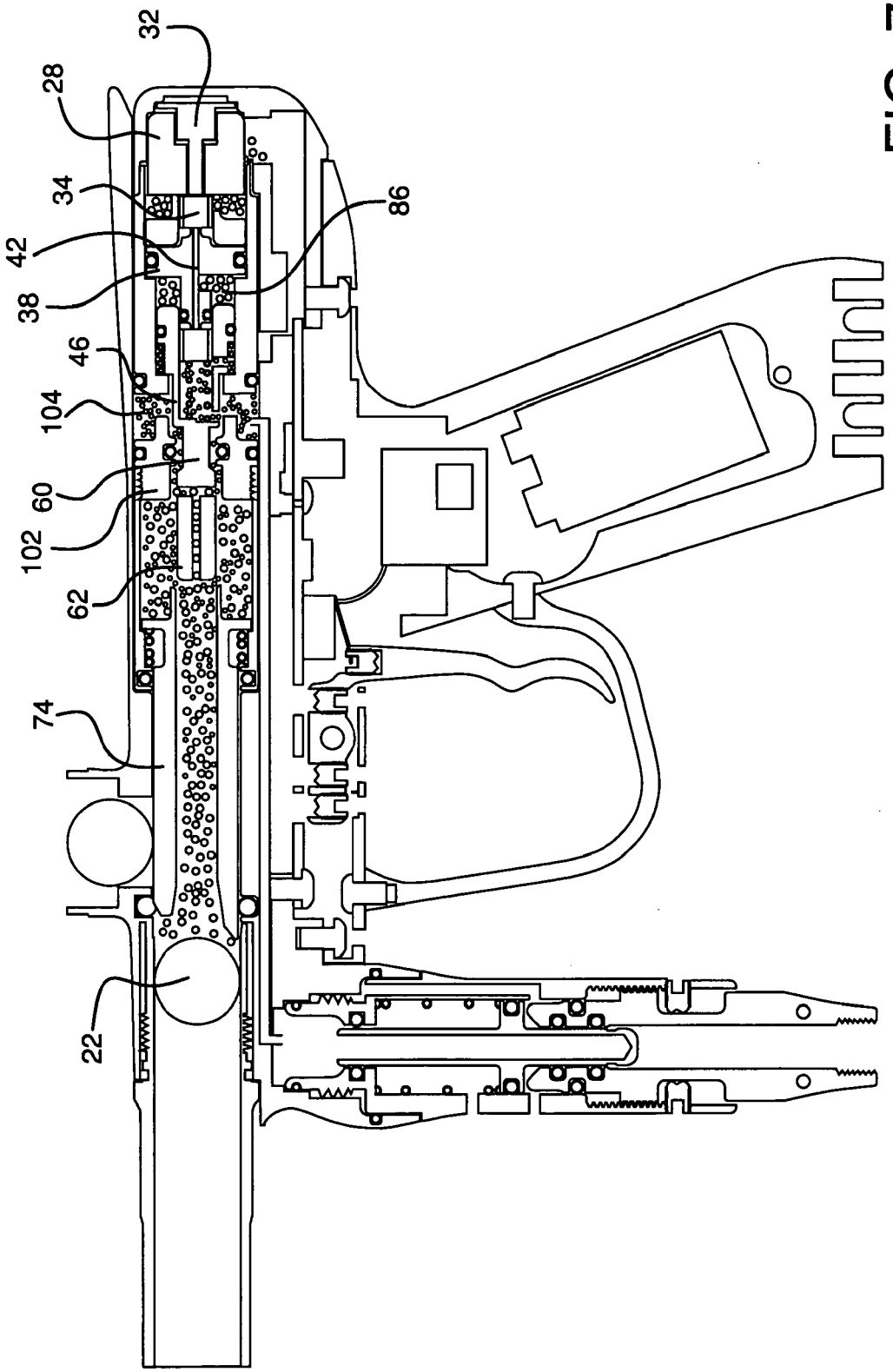


FIG. 7A

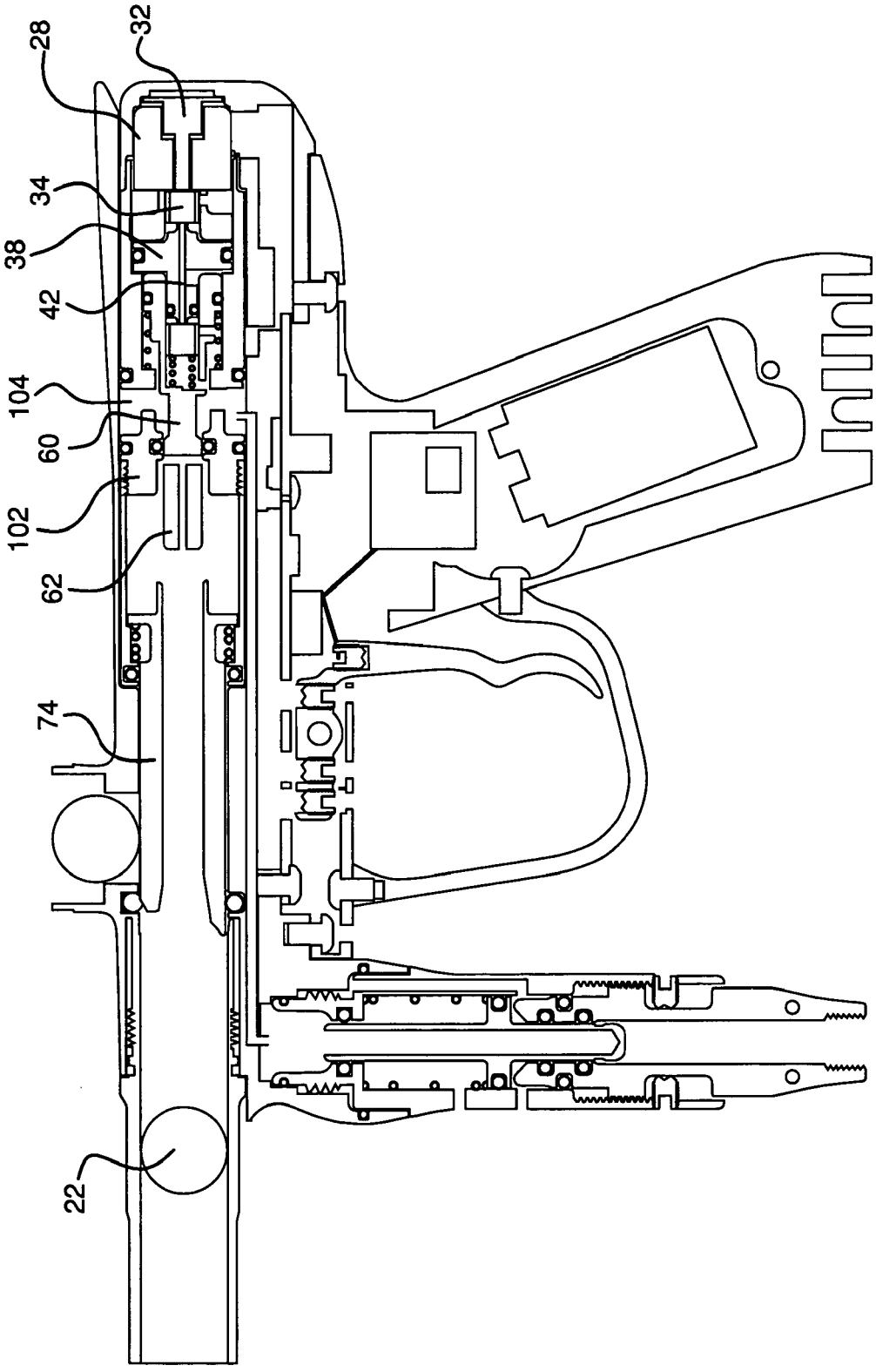


FIG. 8

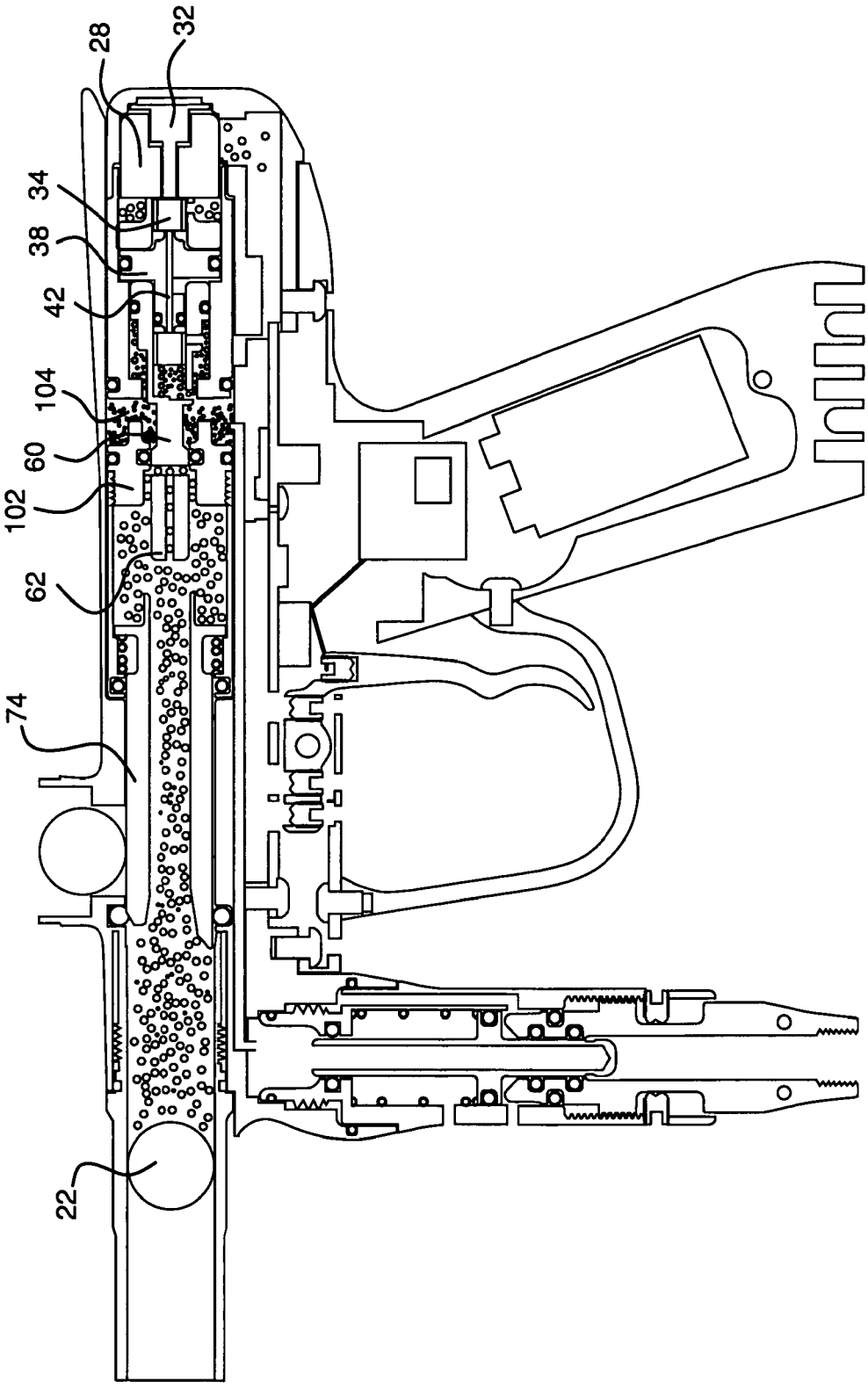
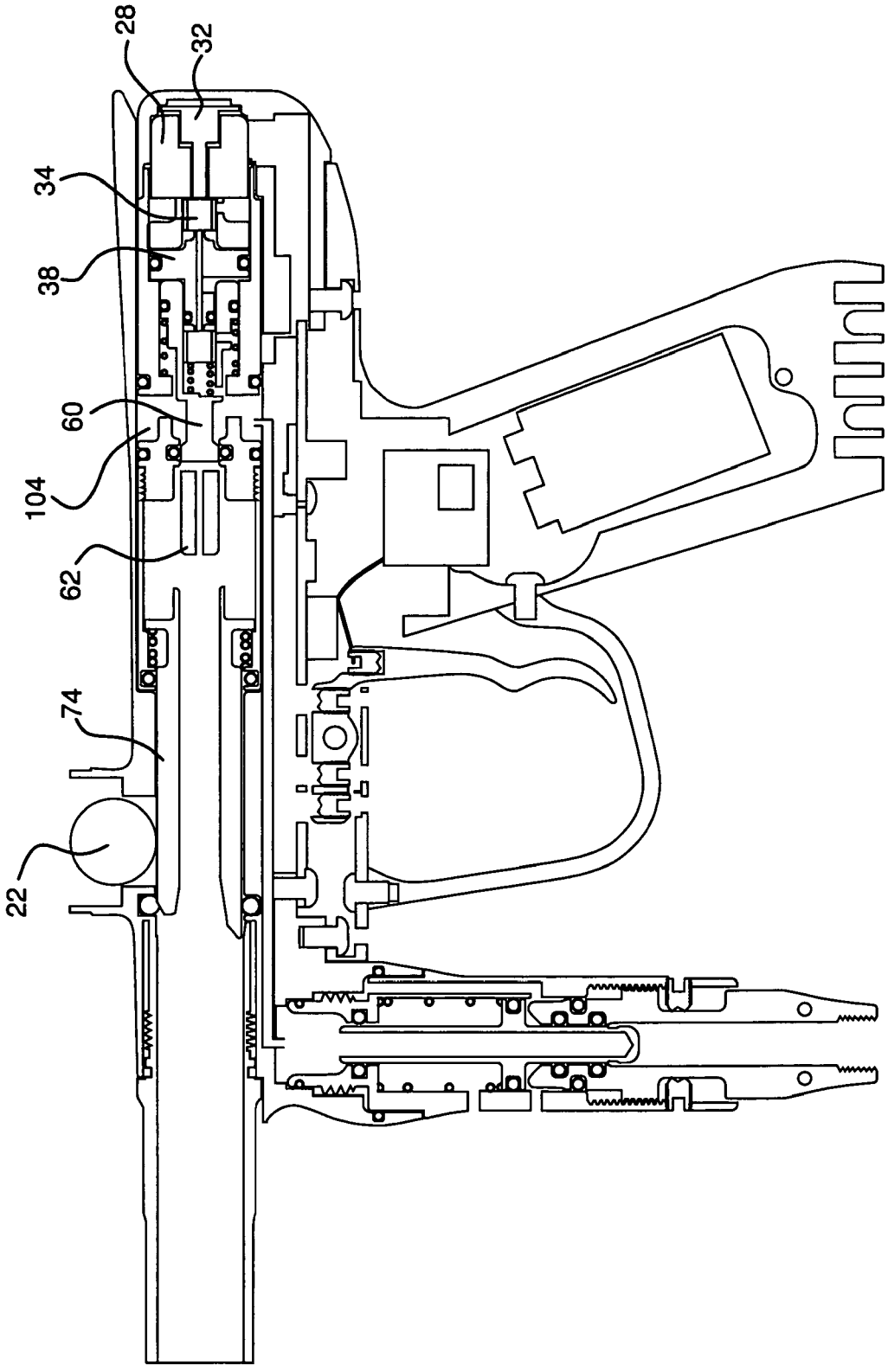


FIG. 8A

FIG. 9



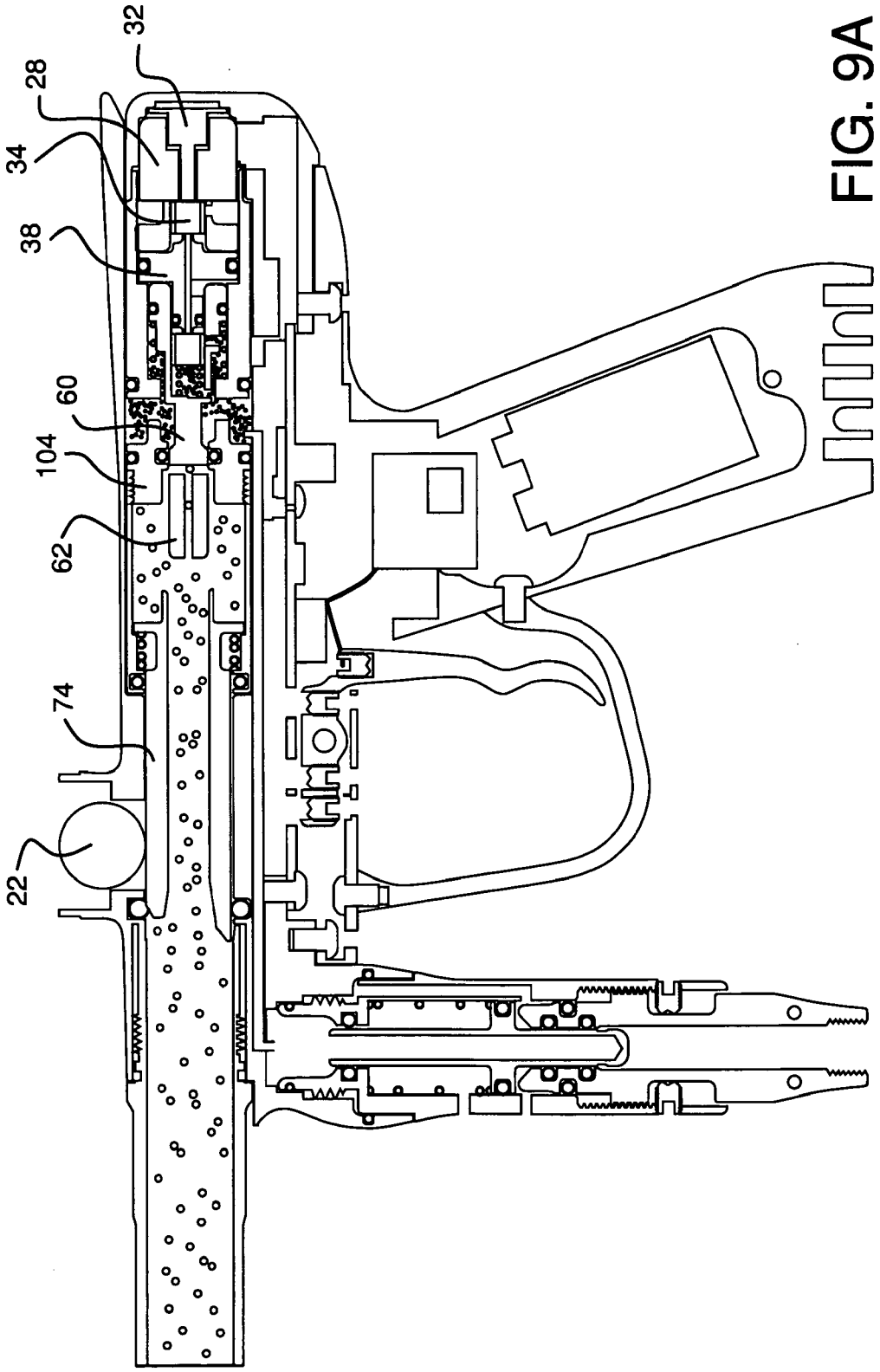
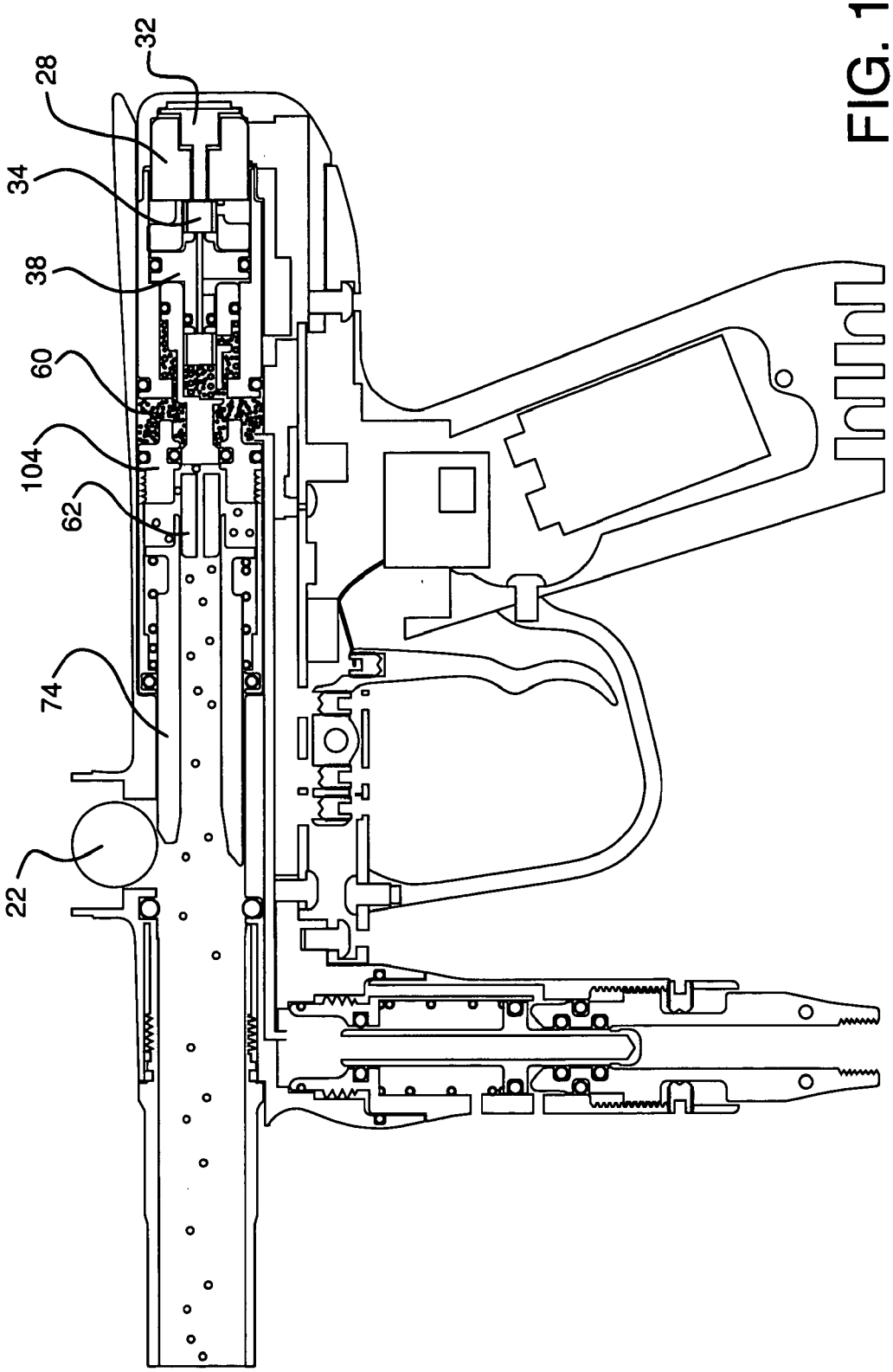


FIG. 9A

FIG. 10



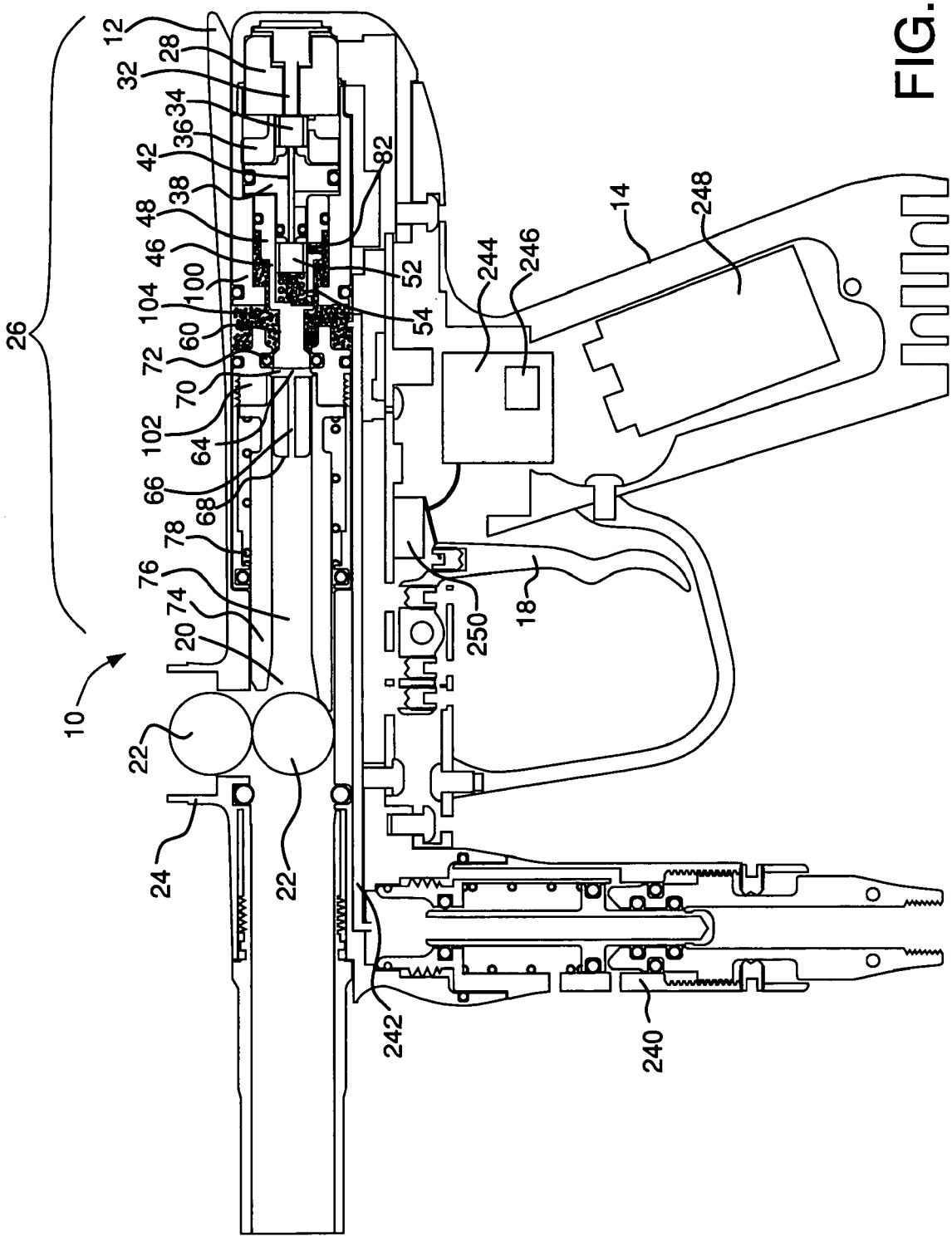

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FIG. 11

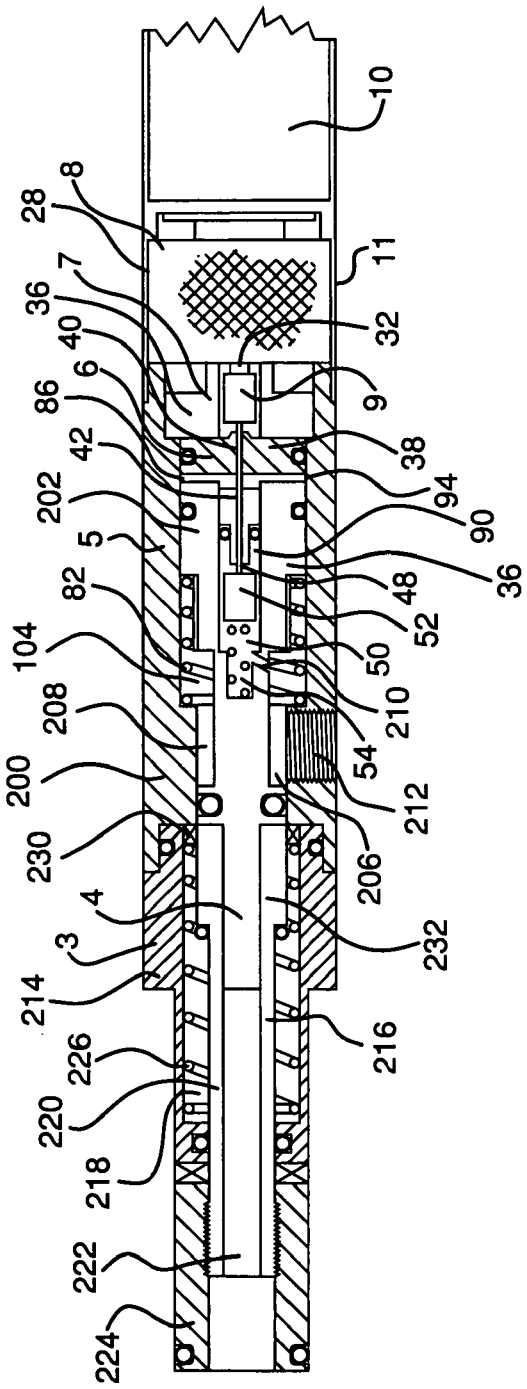
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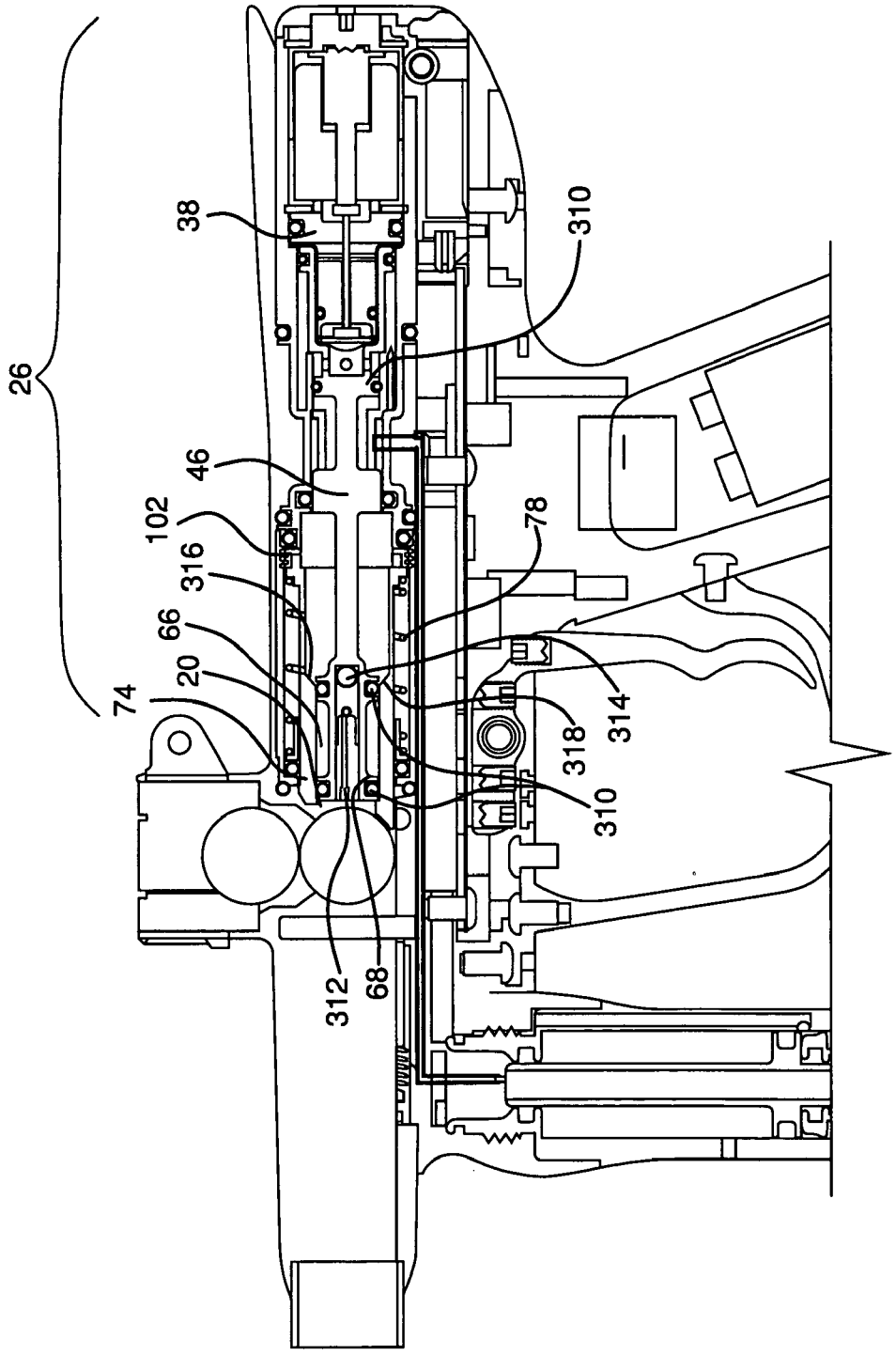
FIG. 12

FIG. 13



INTERNATIONAL SEARCH REPORT

International application No
PCT/US 07/16582

A CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F41 B 11/32 (2008 04)
USPC - 124/73
According to International Patent Classification (IPC) or to both national classification and IPC

B FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - F41B 11/32 (2008 04)
USPC - 124/73

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 124/63,64,65,71 ,73,74, Backward/forward citation searches, Text Search

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WEST (PGPB, USPT, USOCR EPAB, JPAB), Terms (palntball paint ad) ball) and (gun pistol firearm rifle) and spool, Google Cpaintball marker solenoid spoof)

C DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
Y	US 6,708,685 B2 (Masse) 23 Mar 2004 (23 03 2004) figs 8-10, 33-36, col 8, In 55 - col 9, In 20, and col 16, In 50 - col 17, In 35	1-15
Y	US 2006/0037597 A1 (Wood) 23 Feb 2006 (23 02 2006) figs 2-12 and para [0043-0045]	1-15
A	US 2005/0268894 A1 (Styles et al) 08 Dec 2005 (08 12 2005) figs 1-3	1-15

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*** Special categories of cited documents**
'A" document defining the general state of the an which is not considered to be of particular relevance
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"L" document which may throw doubts on priority claim(s) or which is cited lo establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application bul cited to understand the principle or theory underlying the invention
"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 JuI 2008 (30 07 2008)	Of AUP ?nna
Name and mailing address of the ISA/US Mail Stop PCT, Attn ISA/US, Commissioner for Patents P O Box 1450, Alexandria, Virginia 22313-1450 Facsimile No 571-273-3201	Authorized officer Leθ W Young PCT Hβlp-eslc 571-272-4300 PCTOSP 571-272 7774

Form PCT/ISA/210 (second sheet) (April 2007)