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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 August 2014 (14.08.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/123628 A2

(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/US2013/075938

(22) International Filing Date:
18 December 2013 (18.12.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/738,494 18 December 2012 (18.12.2012) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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(54) Title: SEMIAUTOMATIC PISTOL

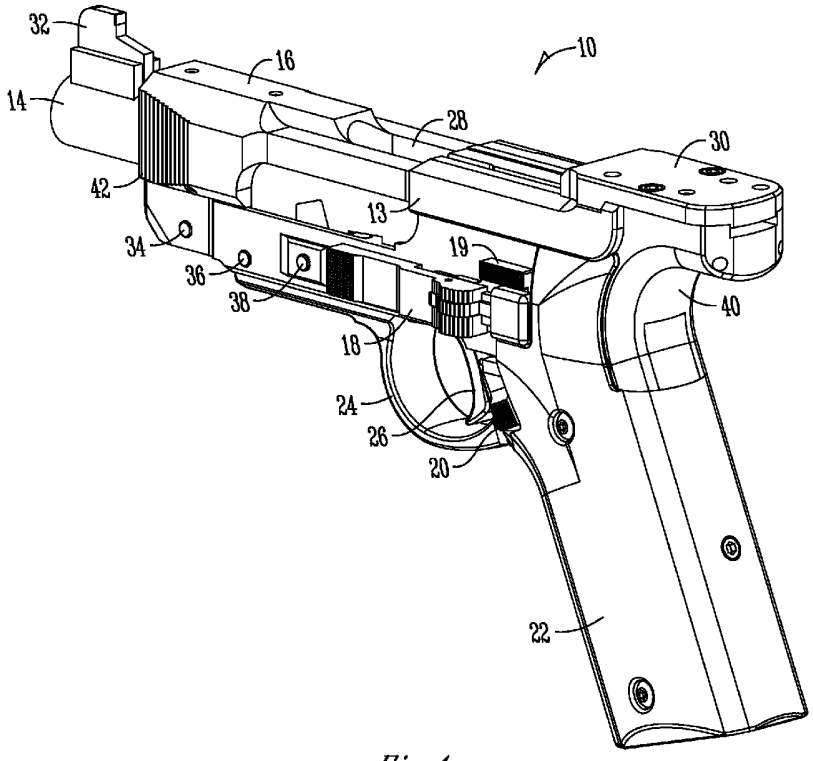

Fig. 1

[Continued on next page]

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(57) Abstract: The present invention is directed to semiautomatic pistols with partially internalized recoil. In an aspect of the invention, the semiautomatic pistol allows for the shooter's grip to be aligned closer to the center-axis of the barrel so that the recoil force is substantially in line with the shooter's grip, thereby reducing and/or preventing muzzle flip. In another aspect of the invention, the semiautomatic pistol is configured to translate the linear recoil movement into rotational movement, which allows internalized recoil.

TITLE: SEMIAUTOMATIC PISTOL

FIELD OF THE INVENTION

The present invention relates to semiautomatic pistols, and more particularly, but not exclusively, to internalized recoil, safety mechanisms, magazine releases, and take-down mechanisms for use with firearms.

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. § 119 to United States application Serial No. 61/738,494 filed December 18, 2012, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

A semiautomatic pistol is a handgun that harnesses the power of a previous discharge to load a new cartridge. It typically includes a single barrel, a magazine, a slide, and a firing mechanism, which includes a trigger mechanism. The trigger mechanism usually includes a trigger, sear, hammer, and firing pin. In some semiautomatic pistols, a sear assembly is the mechanism that facilitates movement of the hammer and firing pin to discharge the ammunition cartridge. In such semiautomatic pistols, when the safety is disengaged, movement of the trigger causes the trigger bar to move within the frame and actuate the sear assembly out of engagement with the hammer, thereby allowing the firing pin to contact an ammunition cartridge loaded in the firing chamber. This causes discharge of the ammunition round. Discharge of the ammunition results in recoil, which typically occurs through the rearward movement of the barrel and/or slide. When the slide has moved to the fullest rearward extent, springs thrust the slide forward to its original position. The slide's rearward and subsequent forward movement is in communication with an upward movement of an ammunition cartridge such that the subsequent cartridge is loaded into the firing chamber by the slide's movement. This results in the discharge of single ammunition round every time the trigger is pulled.

Recoil is a reactive force equal and opposite in energy to the force propelling the ammunition round. The force is longitudinal and in line with the barrel of the gun. The

design of semiautomatic pistols places the grip of the shooter's hand below the recoil axis, which results in an upward and rearward rotation of the gun in the hand of the shooter upon firing of the firearm, sometimes referred to as "muzzle flip." The shooter has less control of the direction of firing due to muzzle flip. The muzzle flip also requires significant realignment of the gun after each shot and can increase the amount of time before the shooter is able to accurately discharge the pistol. This result is counter to the chief purpose of the semiautomatic pistol, which is to provide an ability to rapidly and accurately fire individual shots.

It is particularly important in target shooting applications, where the shooter is judged on the number of shots and accuracy of those shots within a specified time period. Thus, there is a need to provide a semiautomatic pistol structure allowing the shooter to align the upper part of their grip with the center-line axis of the barrel, in order to limit or even prevent upward rotation of the pistol after each discharge so as to facilitate more rapid and accurate discharge of the semiautomatic pistol.

Other attempts to prevent the upward rotation of the pistol during and after recoil have been unsuccessful. One such attempt is exemplified in U.S. Patent No. 2,975,680, which is hereby incorporated in its entirety, where the semiautomatic pistol was designed so that the shooter's grip was raised on the vertical axis of the gun, but the slide still extended over the shooter's hand during recoil. However, this design has many problems, including the following examples: safety concerns due to the slide moving over the shooter's hand toward their arm during recoil movement; continual movement of external parts creates greater concern for break down or wear on those parts; and the sight base is positioned so that it is subject to movement from the slide and thereby loses alignment more quickly.

SUMMARY OF THE INVENTION

Accordingly, it is an object, feature, and/or advantage of the present invention to overcome deficiencies in the art.

It is yet another object, feature, and/or advantage of the invention to provide a semiautomatic pistol where the upper portion of the shooter's grip is aligned closer to the center-axis of the barrel.

It is another object, feature, and/or advantage of the invention to provide a semiautomatic pistol that is capable of more rapid and accurate shooting.

It is another object, feature, and/or advantage of the invention to provide a semiautomatic pistol wherein the rearward movement of components due to recoil does not extend beyond the rear of the pistol.

It is another object, feature, and/or advantage of the invention to provide a semiautomatic pistol wherein the barrel and slide are operably connected and their movement due to recoil takes place internally.

It is another object, feature, and/or advantage of the invention to provide a triple-point sliding safety that simultaneously locks the trigger, sear, and hammer.

It is another object, feature, and/or advantage of the invention to provide a sliding safety that can be operated ambidextrously by the hand gripping the gun or the thumb of the free hand while in a supportive grip position.

It is another object, feature, and/or advantage of the invention to provide a magazine release that is pivotally connected to the frame and grip to compliment a shooter's grip placed higher on the vertical axis of the pistol.

It is another object, feature, and/or advantage of the invention to provide a pivot block that physically restrains rearward movement of the barrel during recoil and can be vertically pivoted to effectively take apart the pistol for cleaning, inspection, and repair.

It is another object, feature, and/or advantage of the invention to provide a configuration that translates linear movement of the barrel and slide due to recoil into rotational movement of a cam around a pin.

These and/or other objects, features, and advantages of the present invention will be apparent to those skilled in the art. The present invention is not to be limited to or by these objects, features, and advantages. No single embodiment need provide each and every object, feature, or advantage.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the semiautomatic pistol of the type embodying the present invention.

FIG. 2A is a side elevation view of the semiautomatic pistol of the type embodying the present invention.

FIG. 2B is a side elevation view of the semiautomatic pistol of the type embodying the present invention in full recoil position.

FIG. 3 is a top plan view of the semiautomatic pistol of FIG. 1 embodying the present invention.

FIG. 4A is a top plan view of an embodiment of a safety of the type embodying the present invention.

FIG. 4B is a perspective view of the safety of FIG. 4A embodying the present invention.

FIG. 4C is an exploded perspective view of the safety of FIG. 4A embodying the present invention.

FIG. 5 is a perspective view of the magazine release embodying the present invention.

FIG. 6 is a perspective view of a slide release lever embodying the present invention.

FIG. 7A is a perspective view of a hammer embodying the present invention.

FIG. 7B is an exploded view of the hammer of FIG. 7A embodying the present invention.

FIG. 8 is a perspective view of the slide embodying the present invention.

FIG. 9A is a side elevation view of the semiautomatic pistol of the type embodying the present invention with some internal components showing.

FIG. 9B is a side elevation view of the semiautomatic pistol of the type embodying the present invention with some internal components showing.

FIG. 9C is an exploded perspective view of the semiautomatic pistol of the type embodying the present invention with some internal components showing.

FIG. 9D is a side elevation view of an upper portion of the frame embodying the present invention with internal components showing.

FIG. 10 is a side elevation perspective view of the frame without the handle embodying the present invention.

FIG. 11 is a perspective view of the pivot block embodying the present invention.

FIG. 12 is a perspective view of a trigger mechanism and disconnector embodying the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiments of this invention are not limited to particular semiautomatic pistols, their components, and methods of use thereof, which can vary and are understood by skilled artisans. It is further to be understood that all terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting in any manner or scope. For example, as used in this specification and the appended claims, the singular forms "a," "an," and "the" can include plural referents unless the content clearly indicates otherwise.

The Figures show a semiautomatic pistol 10, in particular, a locked breech, short recoil, center-fire action semiautomatic pistol 10 with a structure exhibiting internal recoil and permitting a high hand hold on the vertical axis of the pistol 10 so that the upper part of the hand is equal or near equal to the center-line of the barrel 14. Figures 1–2B and 9B–10 show this uppermost grip contour 40. The design is one that provides better accuracy and control for a shooter, as it reduces and/or prevents upward rotation of the pistol 10 due to recoil. Thus, the shooter is able to shoot more rapidly and accurately, as the upward rotation is reduced and thereby the movement and readjusting required for retargeting is lessened, if not completely reduced.

Internal recoil is achieved by use of a translating pin 38 and a cam 48. The cam 48 is operably connected to the barrel 14, which is operably connected to the frame 12. The barrel 14 and slide 16 are operably connected to the frame 12 and move in communication with one another. The barrel 14 is rounded and the slide 16 has a complimentary concave cutout, such that the barrel 14 can travel under the slide 16 and such that the slide 16 can travel over the barrel 14 without the need for rails, internal notches, or other known methods of accomplishing slide or barrel movement. Furthermore, the slide 16 contains a cam cutout 82, for which an embodiment is exemplified in Figure 8. The cam cutout 82 compliments the shape of the upper part of the cam 48. The translating pin 38 is removable and horizontally pierces the frame 12 through the translating pinholes 62 transverse to the barrel 14 and slide 16. The translating pin 38 is designed with a width

and length in relation to the translating pinholes 62, such that the pin is fixed and free from movement. Alternatively, the translating pin 38 may be non-removable and permanently fixed to the frame 12.

During recoil, the barrel 14 and slide 16 move rearward in a longitudinal and linear motion. The cam 48, which is operably connected to the barrel 14, contacts the translating pin 38, whereby the cam 48 translates the linear longitudinal motion due to recoil into rotational movement around the translating pin 38.

According to another aspect of the invention, a pivot block 46 is positioned at the front of the frame 12. The frame 12 contains a forward pivot block pinhole 58 and a rear pivot block pinhole 60, as shown in Figure 10. The pivot block 46 contains complimentary pinholes such that a forward pivot block pin 34 and rear pivot block pin 36 may horizontally pierce the frame 12 and pivot block 46 transverse to the barrel 14 and slide 16 as exemplified in Figure 9C. An embodiment of the pivot block 46 is also illustrated in Figure 11. The pivot block 46 stops rearward and forward movement of the barrel 14 due to recoil and recoil spring 56 extension. Thus, the pivot block 46 takes the force of these movements away from the cam 48 and translating pin 38.

According to another aspect of the invention, the rotational movement of the cam 48 around the translating pin 38 unlatches the slide 16 so that it can continue in linear rearward recoil movement and as the slide 16 continues in rearward recoil movement the case ejection port 28 passes over the firing chamber 84.

The slide 16 contains upper slide cutouts 76, lateral slide cutouts 78, and lower slide cutouts 80, which are shown in Figures 3 and 8. During rearward movement of the slide 16 due to recoil, the slide 16 is able to move within the frame casing 13. Thus, rearward movement due to recoil is internal and there is no extension beyond the rear end or surface of the pistol 10. The top of the slide 16 also contains a case ejection port 28, which can be best seen in Figures 1, 3, and 8. As the slide 16 moves rearwardly during recoil, the case ejection port 28 passes over the firing chamber 84 and the ammunition cartridge is ejected vertically through the case ejection port 28. The slide 16 contains a small tapered projection at the rear center of the slide protruding from the concave cutout. This small tapered projection supports the bottom rim of the cartridge casing thereby holding the casing firmly against the spring loaded extractor 27 until the cartridge is

expelled through the case ejection port 28. In an embodiment of the invention, dual ejectors can be timed to eject the casing straight up through the case ejection port 28 so that no part of the casing contacts any part of the slide 16. This embodiment reduces and/or even prevents damage to the empty casing, so that it is in a condition for reuse.

Within the frame casing 13 are two recoil springs 56, shown in Figures 9A–9C, one on each lateral side of the pistol, which extend longitudinally and linearly to the rear of the pistol 10 in alignment with the sides of the slide 16. The recoil springs 56 are held in place by guide rods 74. A non-limiting example of the guide rods 74 and the recoil springs 56 can be seen in Figures 9A and 9B. Alternatively, other methods of holding the springs in place may be used and are known to those skilled in the art. In an embodiment of the invention, as the slide 16 moves rearwardly during recoil, the rearward movement can be stopped by a vertical slide stop 55 connected to the frame 12 or the frame casing 13. In an embodiment, the slide stop 55 is comprised of nylon. When the pistol 10 is in full recoil (*see* Figure 2B), that is, when the barrel 14 and slide 16 have full rearward extension, the recoil springs 56, are compressed and necessarily extend thereby forcing the slide 16 forward to the position it was in prior to discharge of the pistol 10. As the slide 16 moves in communication with the barrel 14, the barrel 14 also moves forward during the extension of the recoil springs 56. The magazine 108 is housed within the handle 44 of the frame 12 as understood by those of skill in the art. As well-known by those of skill in the art, the magazine 108 contains a spring, which exerts an upward vertical force on the cartridges such that one is pushed up into the firing chamber 84 after rearward recoil movement. In an embodiment, the slide 16 catches the cartridge being pushed up by the magazine spring and is pushed into the firing chamber 84. The tapering projection 114 serves to push the cartridges into a horizontal position parallel to the barrel 14 while being loaded.

In an embodiment of the invention, the slide 16 is angled to taper toward the front of the slide 16 on both forward lateral sides of the slide 16. The tapering is exemplified at least in Figures 1, 3, 8, and 9C. This tapering permits the shooter to grip the slide 16 so that it can be manually drawn into full recoil position with ease, by necessitating less grip strength. Manual recoil is particularly useful for initially loading a cartridge into the firing chamber 84 before the first discharge. In another aspect of the invention, the slide 16 has

forward slide texturing 42 on both forward lateral sides of the slide 16. The forward slide texturing 42 is exemplified at least in Figures 1–3, 8, and 9A. Texturing may be achieved by any method known to those of skill in the art, including, but not limited to, the addition of grooves, bumps, teeth, notches, or serrations. This forward slide texturing 42 increases the friction between the shooter's hand and the slide 16 so that it can be manually drawn into full recoil position. The pistol 10 may be designed to contain both forward slide texturing 42 and angled tapering toward the front of the slide 16, or either feature individually, so that manual recoil can be accomplished with ease.

According to an aspect of the invention, the pistol 10 includes a slidable two-thumb piece safety 18, which can be operated ambidextrously, and also which can be located on either side of the pistol 10. The safety is a triple-point safety simultaneously locking the hammer 52, sear 50, and trigger 26. The triple-point safety 18, exemplified in Figures 4A–4C, is comprised of a trigger and sear block 90 and a hammer block 92. Thus, the lateral interior of the safety 18 is comprised of these protruding blocks 90 and 92 and further comprises a rear safety slide block 106 at the rear. The frame 12 contains three safety mechanism cutouts 64, 66, 68, which correspond to the trigger and sear block 90, hammer block 92, and rear safety slide block 106. These three safety mechanism cutouts 64, 66, 68 are large enough to accommodate the corresponding rear safety slide block 106, hammer block 92, and the trigger and sear block 90, and allow the sliding of these blocks 90, 92, 106 between two slidable positions. When moved forward, the safety 18 is in an unlocked position and the pistol 10 is capable of discharge. When the trigger is pulled, the disconnector 72 pulls the sear 50. When moved rearward, the safety 18 is in a locked position and the pistol 10 is incapable of discharge. When in a locked position, the trigger and sear block 90 locks the trigger 26 by preventing it from moving enough to cause release of the hammer 52 and thereby discharge of the pistol 10 by positioning the trigger and sear block 90 against the safety locking surface 70. The sear 50 is positioned against the trigger 26, thus when the trigger 26 is locked by the trigger and sear block 90 against the safety locking surface 70, the sear 50 is also locked; and the hammer block 92 is positioned so as to prevent the hammer 52 from moving and contacting the firing pin 54. In an embodiment, when in a locked position the hammer lock notch 86 interlocks with the hammer lock 92 so as to prevent movement of the hammer 52. In many semiautomatic

pistols, the trigger still has a minimal amount of residual movement; however, in an embodiment of the present invention, the trigger 26 is completely unable to move when the safety 18 is in a locked position.

An embodiment of the hammer 52 is illustrated in Figures 7A and 7B. The hammer 52 has holes 51 transverse through the hammer 52 body so that a hammer strut pivot pin 49 can pierce the hammer 52. The hammer struts 53 have complimentary holes 51 so that the hammer strut pivot pin 49 can pierce the hammer struts 53 such that the hammer 52 and hammer struts 53 are operably connected. In an embodiment, the hammer 52 also has hammer pivot pin holes 47 that transversely pierce the hammer 52 so that a hammer pivot pin 45 can pierce the hammer 52, while extending from the sides of the hammer 52, which can allow the hammer 52 to rotate within the pistol 10.

The external lateral surface of the safety 18 can have two raised and textured parts 96, 98. These two raised textured parts 96, 98 can be a first and second thumb piece, of the two-thumb piece slidable safety. The forward-most part of the safety 18 contains the front textured surface 96. Near the rear of the safety 18 is a raised rear textured surface 98. Texturing of the front and rear textured surfaces 96, 98 may be achieved by any method known to those of skill in the art, including, but not limited to, the addition of grooves, bumps, teeth, notches, or serrations. According to an embodiment, the texturing of the front textured surface 96 is different from the texturing of the rear textured surface 98. For example, the front textured surface 96 may be textured by bumps, while the rear textured surface 98 may be textured by vertical grooves. The forward and rear textured surfaces 96, 98 are raised and textured so as to permit ambidextrous use of the safety 18 with the thumb of either the left or right hand. For example, when the pistol 10 is held and discharged using one hand, the shooter can manipulate the safety 18 with the thumb of the grip hand; but the shooter can also attain a firm grip on the pistol 10 with the grip hand in a manner that said grip hand does not touch the safety 18 and the shooter can use their free hand in a supportive grip position and then when aimed toward the target can manipulate the safety 18 to the forward unlocked position with the thumb of the free hand or the shooter can manipulate the safety 18 to the rear locked position with the thumb of the free hand by pushing rearward against the rear textured surface 98. In an embodiment of the present invention, the two-thumb piece slidable safety 18 can be designed to require substantial

force to move the safety 18 to an unlocked position, such as requiring the strength of either thumb, or it can be designed to require less force so that the safety 18 can be operated by the shooter's trigger finger or other non-thumb finger.

According to another aspect of the invention, the safety 18 additionally comprises a locking lever 100, which is horizontally pivotable about a vertical locking lever pin 104, and is horizontally extended from the lateral surface of the safety 18 when the safety is in an unlocked position. On the interior lateral surface of the safety 18 is a spring loaded detent 102. This spring loaded detent 102 is directly opposite to and connected with the locking lever 100. Between the frame 12 and safety 18 is a slide release lever 19, which is in the slidable path of the safety 18 corresponding to the path that the spring loaded detent 102 travels. The slide release lever 19 contains a recess 103, which is designed so that the spring loaded detent 102 extends into the recess 103 while in the locked position. The slide release lever 19 and recess 103 for the spring loaded detent 102 are exemplified in Figure 6. When in an unlocked position the locking lever 100 is horizontally pivoted outward from the rear of the safety 18. This helps ensure that during recoil movement the safety 18 does not slide into the locked position, which would prevent subsequent rapid discharge of the pistol 10. Extension of the locking lever 100 can be best seen in Figures 4A and 4B. The rear safety slide block 106 supports the slide release lever 19 mounted between the safety 18 and the frame 12. The rear safety mechanism cutout 68 allows the slide release lever 19 to protrude through the frame 12. In an embodiment of the invention, when the magazine is empty the magazine follower pushes upward and engages the slide release lever 19, which causes the slide release lever 19 to pivot into a slide stop notch 83 on the slide 16, so as to lock the slide 16 in a full recoil position, thereby indicating that the magazine is empty. In this aspect of the invention, the hammer 52, trigger 26, and slide release lever 19 all pivot on the same pin.

In another aspect of the invention, the frame 12 contains a magazine release 20, which resembles a push button style release, which can be located on either side of the pistol 10. The magazine release 20 is connected to a horizontal pin 21, which is embedded in the handle 44 and protrudes through the grip 22. The horizontal pin 21 permits pivoting of the magazine release 20 about a generally horizontal axis by the application of pressure on the bottom part of the magazine release 20. When pressed, the magazine release 20

releases the magazine 108 from within the handle 44. The magazine release 20 can have a surface that contacts a notched surface 110 of the magazine such that the magazine 108 is held in place in the handle of the pistol 10 until released.

In another aspect of the invention, the pivot block 46 can be vertically pivoted around the forward pivot block pin 34 to remove the barrel 14 and slide 16 from the front of the pistol 10 and subsequently remove the recoil springs 56 and frame casing 13. This process is generally referred to as field stripping or "take-down" and is used to clean, inspect, and/or repair the pistol or its components.

In a further aspect of the invention, atop the frame casing 13 an optional sight base 30 may be placed. This sight base 30 is attached so as to align with the barrel sight 32, which is positioned atop the barrel 14 in a manner known to those of skill in the art. In an additional aspect of the invention, part of the frame 12 is an optional trigger guard 24, for which an embodiment is exemplified in Figures 1–2B and 9A–9C.

In a further aspect of the invention, the firing pin retainer 88 is attached to the pistol 10 as shown in Figure 8. The firing pin retainer 88 keeps the firing pin 54 in place within the slide 16. The firing pin retainer 88 can also serve as a lateral guide for the firing pin 54 when the firing pin 54 is in movement related to discharge of the pistol 10. In an embodiment of the invention, a dust cover 89 can serve to hold the firing pin retainer 88 in place.

The invention has been shown and described above with reference to the preferred embodiments, and it is understood that many modifications, substitutions, and additions may be made which are within the intended spirit and scope of the invention.

What is claimed is:

1. A semiautomatic pistol, comprising:

a frame and a handle extending therefrom;

a barrel and slide operably connected to the frame and in communication with one another such that recoil of the barrel and slide will not extend beyond a rear surface of the pistol; and

a trigger mechanism including a sliding safety movable between a locked position wherein the trigger cannot be moved, and an unlocked position wherein the trigger is operable.

2. The pistol of claim 1 wherein the safety locks the hammer, sear, and trigger at the same time when in a locked position.

3. The pistol of claim 2 wherein the safety is an ambidextrous safety.

4. The pistol of claim 1 further comprising a pivot block operably connected to the frame and configured to receive and restrain movement of the barrel and slide; and wherein, said pivot block can be vertically pivoted to permit take-down of the pistol.

5. The pistol of claim 1 wherein the upper part of the grip is in even alignment with the center line of the barrel.

6. The pistol of claim 1 wherein the recoil of the barrel and slide is internal.

7. The pistol of claim 1 wherein the recoil is longitudinal and linear, and wherein the linear recoil is translated into rotational movement of a cam around a pin.

8. The pistol of claim 1 further comprising a magazine release pivotally connected to the handle and configured to selectively hold and release a magazine within the handle.

9. A semiautomatic pistol with internal recoil, comprising:

a frame including a handle and magazine chamber;

a trigger mechanism operably connected to the frame; and

a barrel and slide operably connected to the frame and in communication with one another such that the recoil of the barrel and slide is internal and does not extend beyond the rear of the pistol;

wherein said barrel is operably connected to a cam; and

wherein said frame includes a pin configured to communicate with said cam to translate linear longitudinal recoil of the barrel and slide into rotational movement.

10. The pistol of claim 9 wherein said pin is removable and horizontally pierces the frame through pinholes transverse to the barrel and slide, so that the pin is fixed and free from movement along the length of the barrel.

11. The pistol of claim 10 wherein said barrel and cam move in communication longitudinally in linear fashion during recoil.

12. The pistol of claim 11 wherein said linear recoil movement of the barrel and slide is translated into rotational movement of the cam around said horizontally fixed pin.

13. The pistol of claim 9 further comprising a safety operably connected to the frame.

14. The pistol of claim 13 wherein said safety comprises a hammer block and a trigger block; and wherein said safety locks the hammer, sear, and trigger at the same time when in a locked position.

15. The pistol of claim 13 wherein the safety is a sliding ambidextrous safety.

16. The pistol of claim 13 wherein the safety is a two-thumb piece slidable safety.

17. The pistol of claim 9 further comprising a magazine release operably connected to the frame.

18. The pistol of claim 17 wherein said magazine release is pivotally connected to the handle and configured to selectively hold and release a magazine within the handle.

19. The pistol of claim 9 further comprising a pivot block operably connected to the frame and configured to receive and restrain movement of the barrel and slide.

20. The pistol of claim 19 wherein said pivot block can be vertically pivoted to permit take down of the pistol.

21. The pistol of claim 9 wherein the upper part of the hand grip is in even alignment with the center line of the barrel.

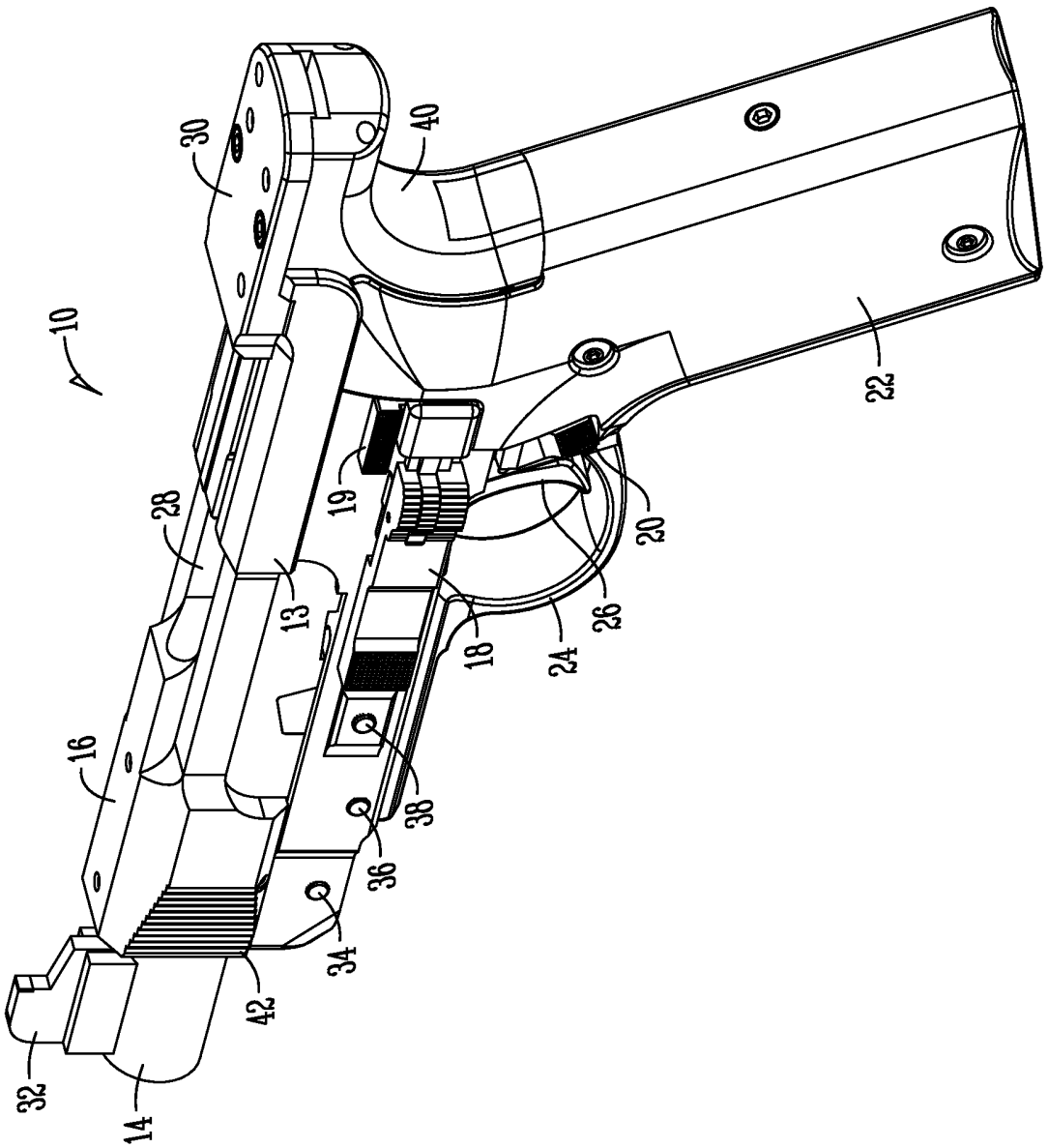

Fig. 1

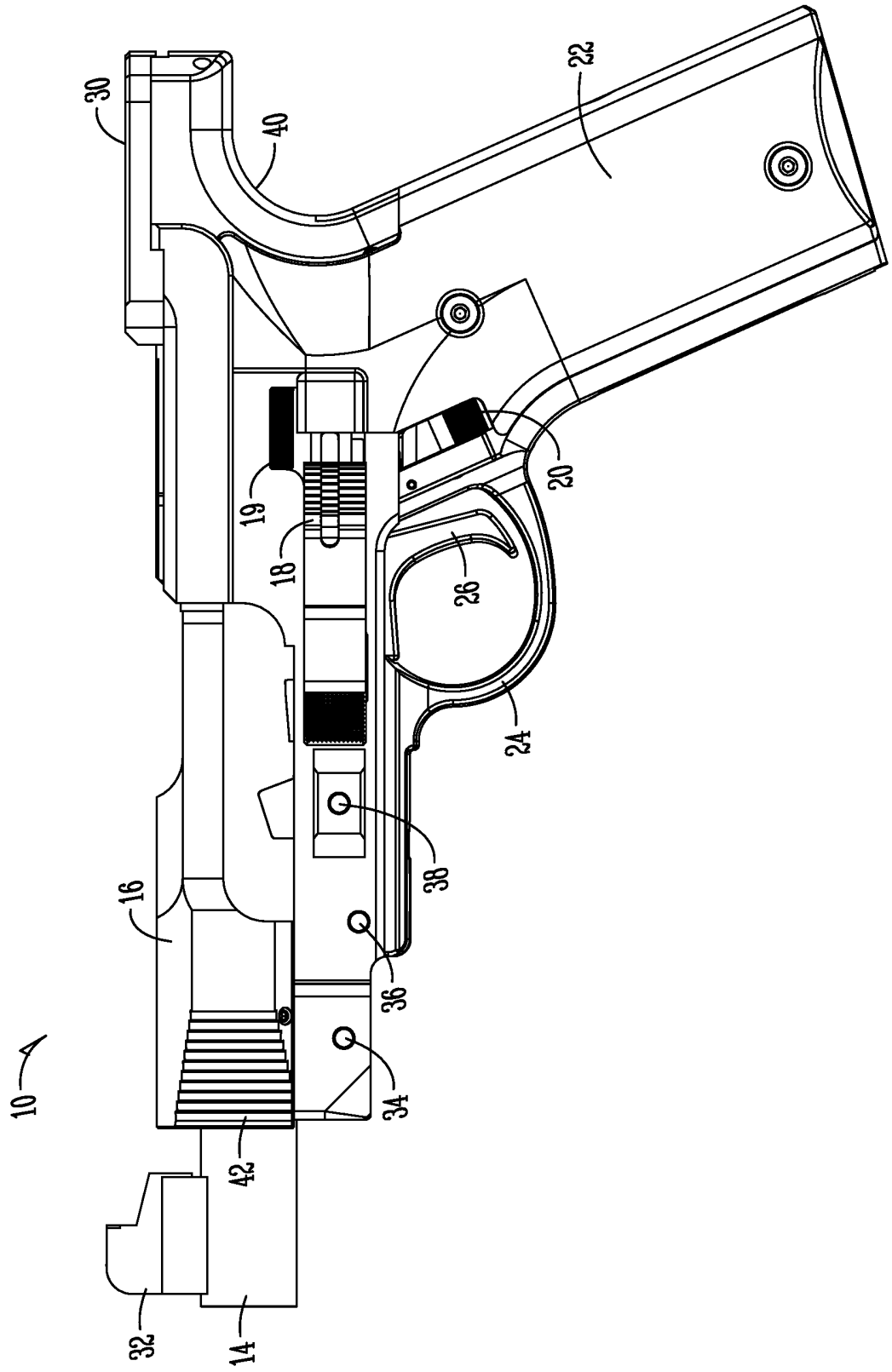

Fig. 2A

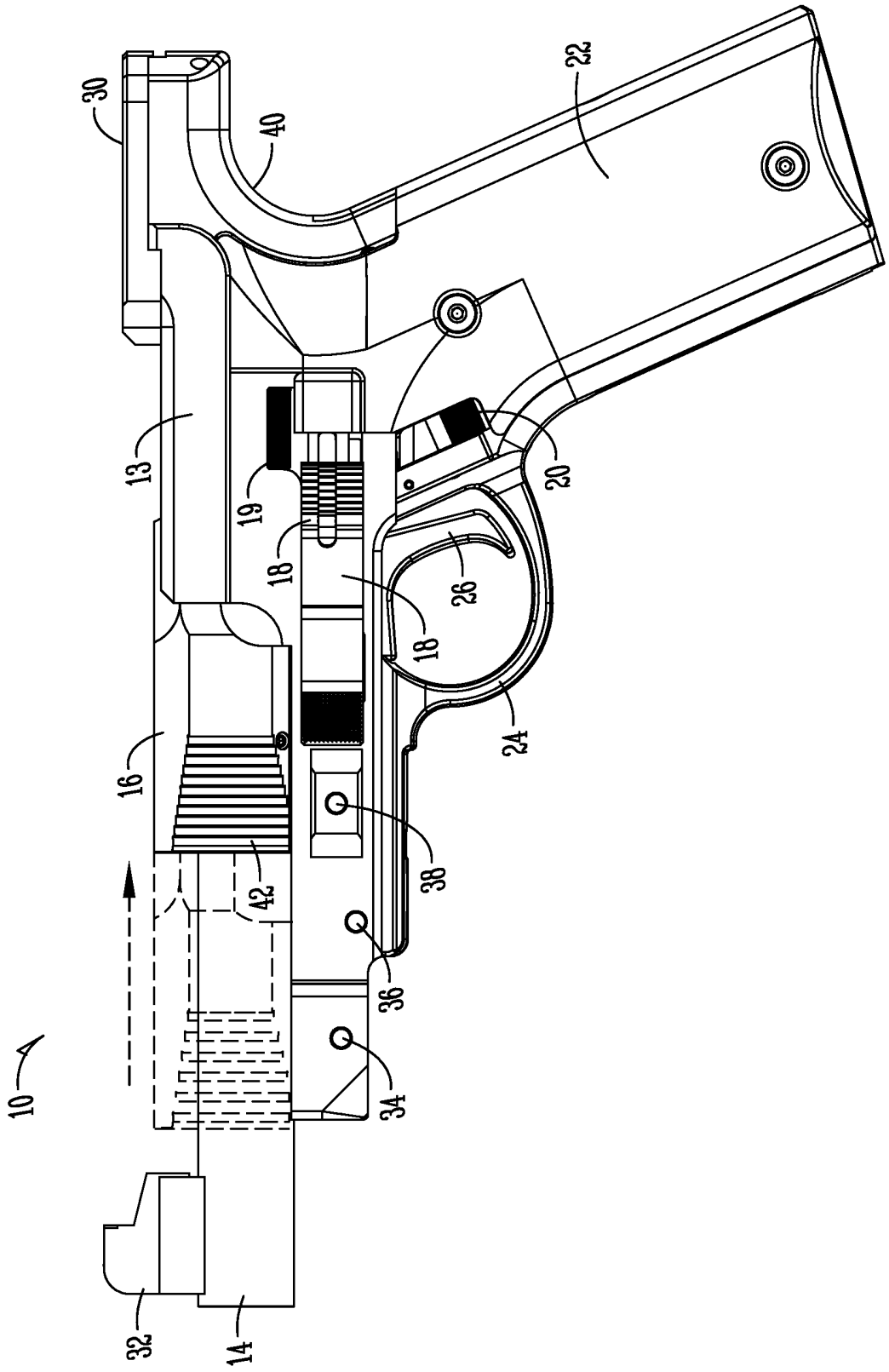

Fig.2B

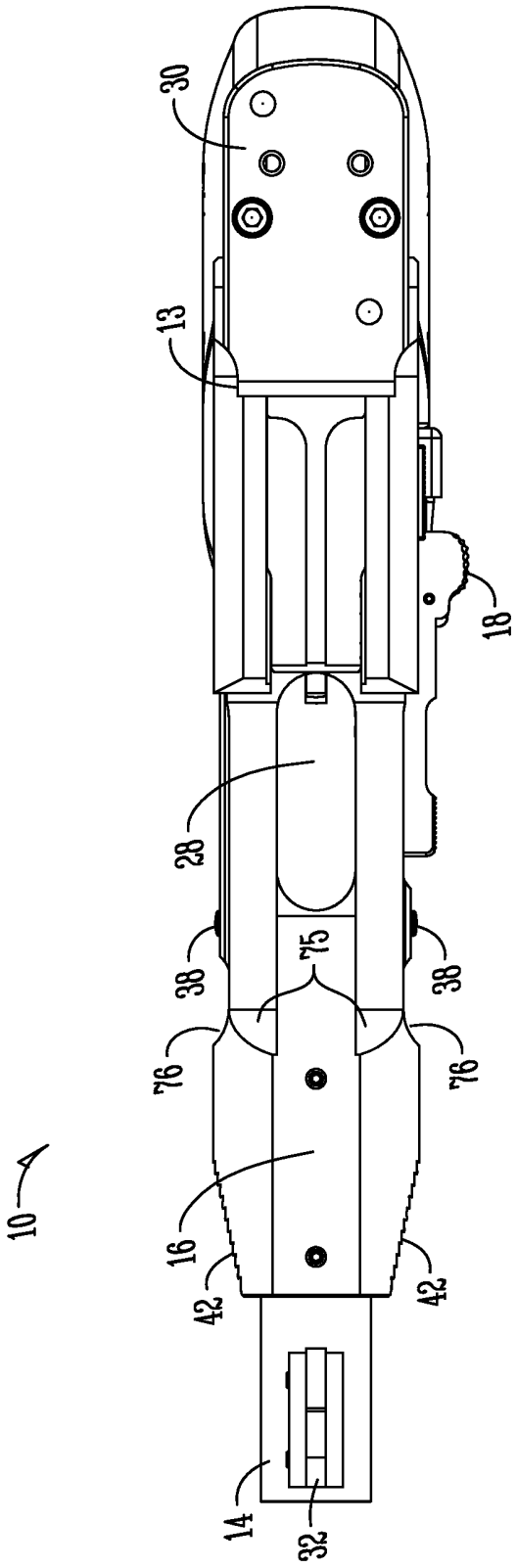

Fig. 3

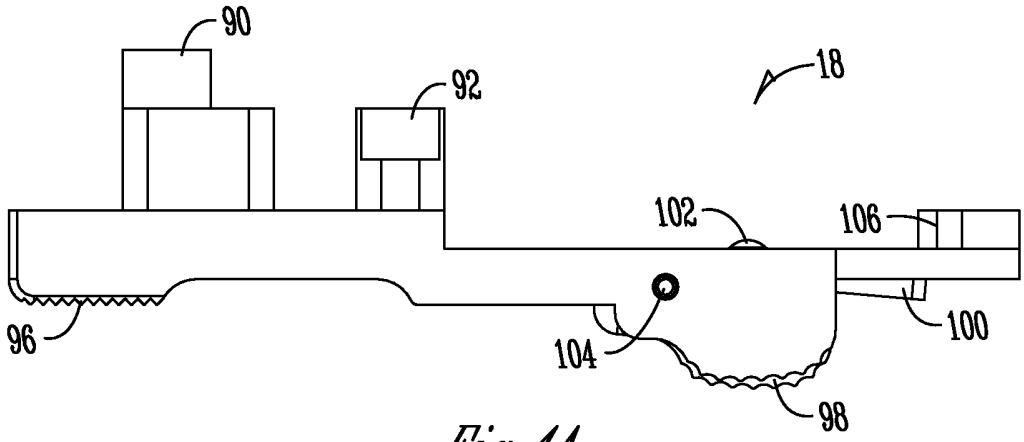

Fig. 4A

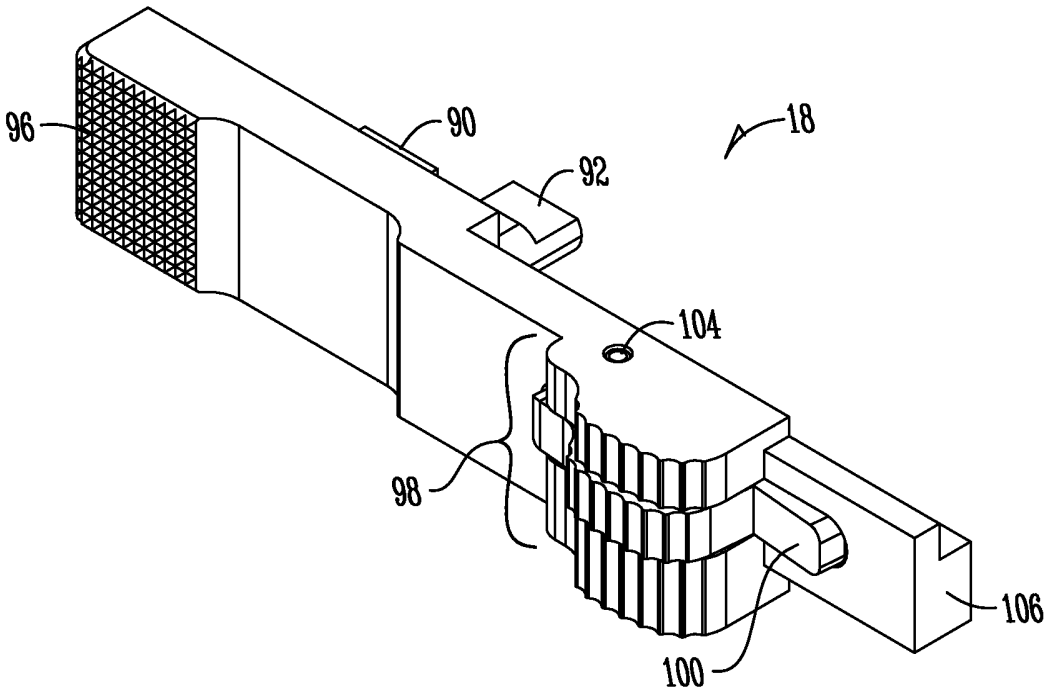

Fig. 4B

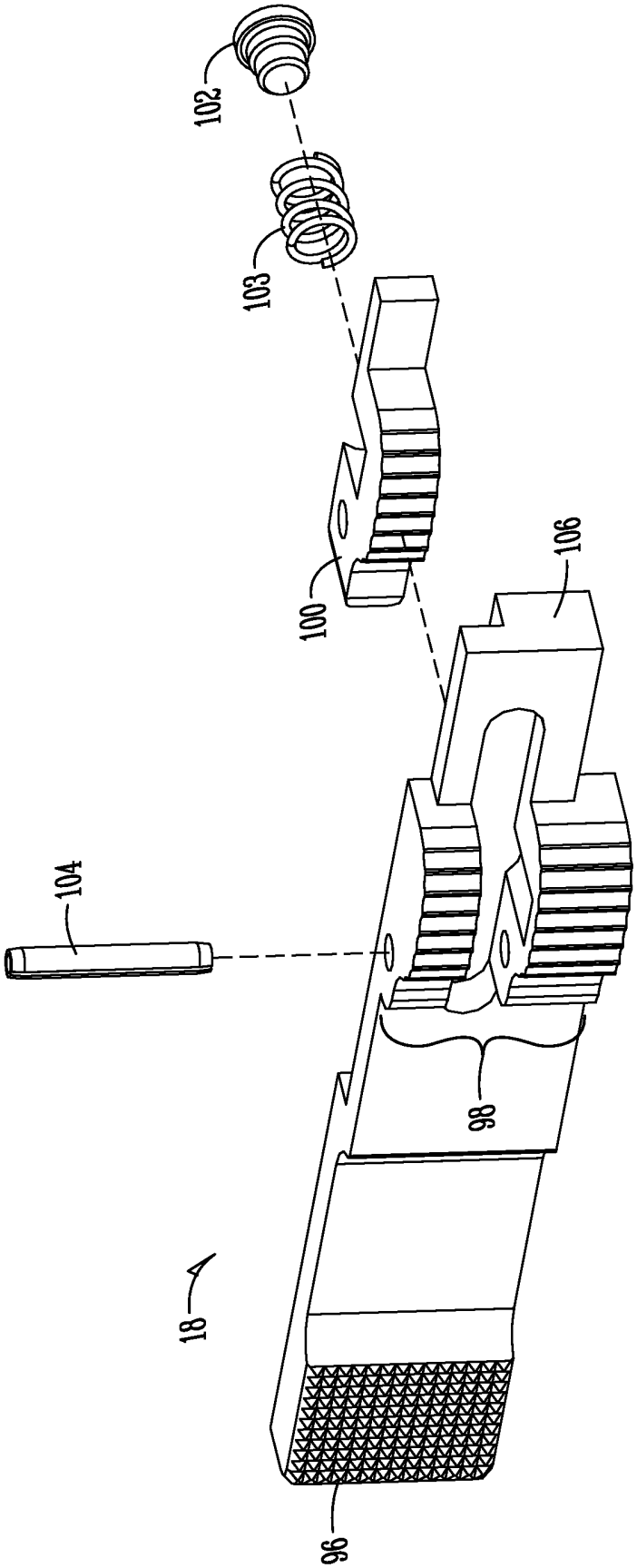

Fig. 4C

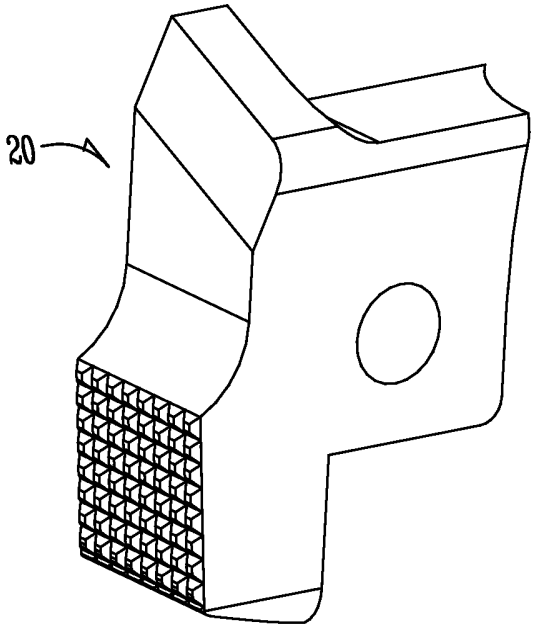

Fig. 5

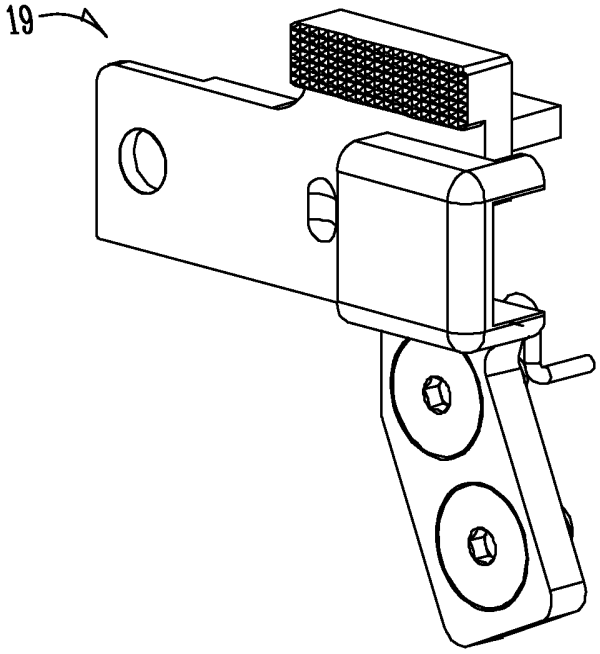

Fig. 6

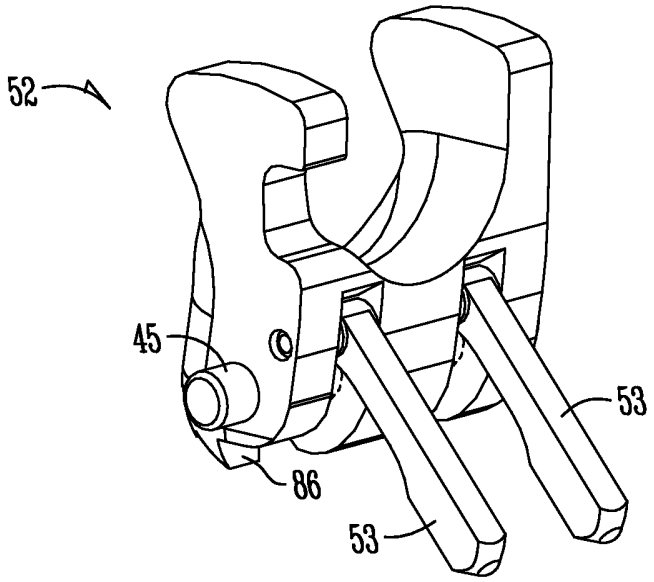

Fig. 7A

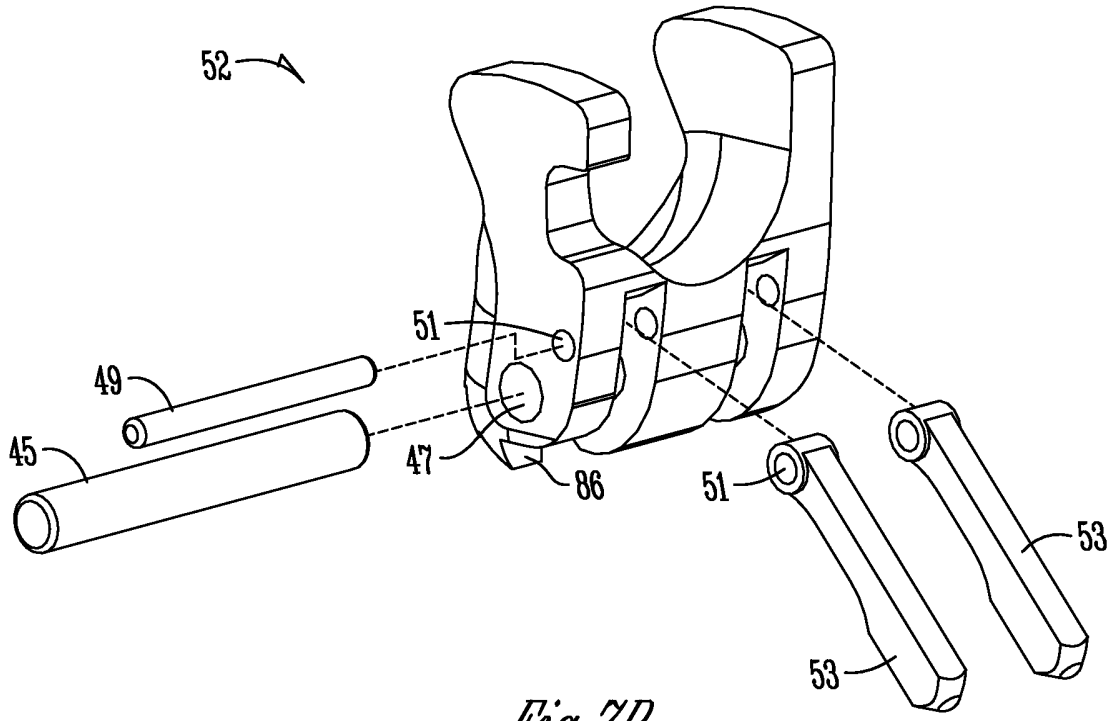

Fig. 7B

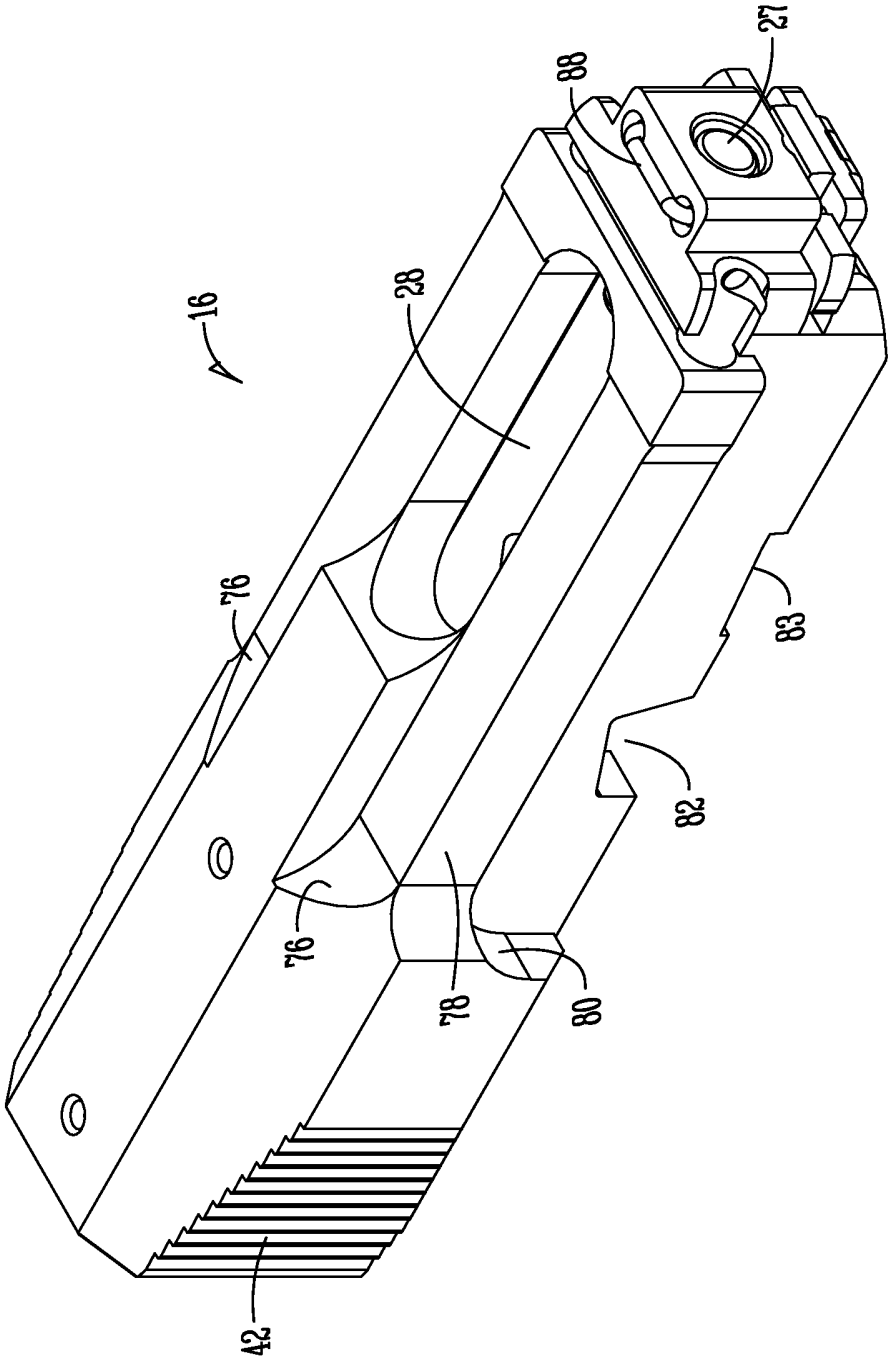

Fig. 8

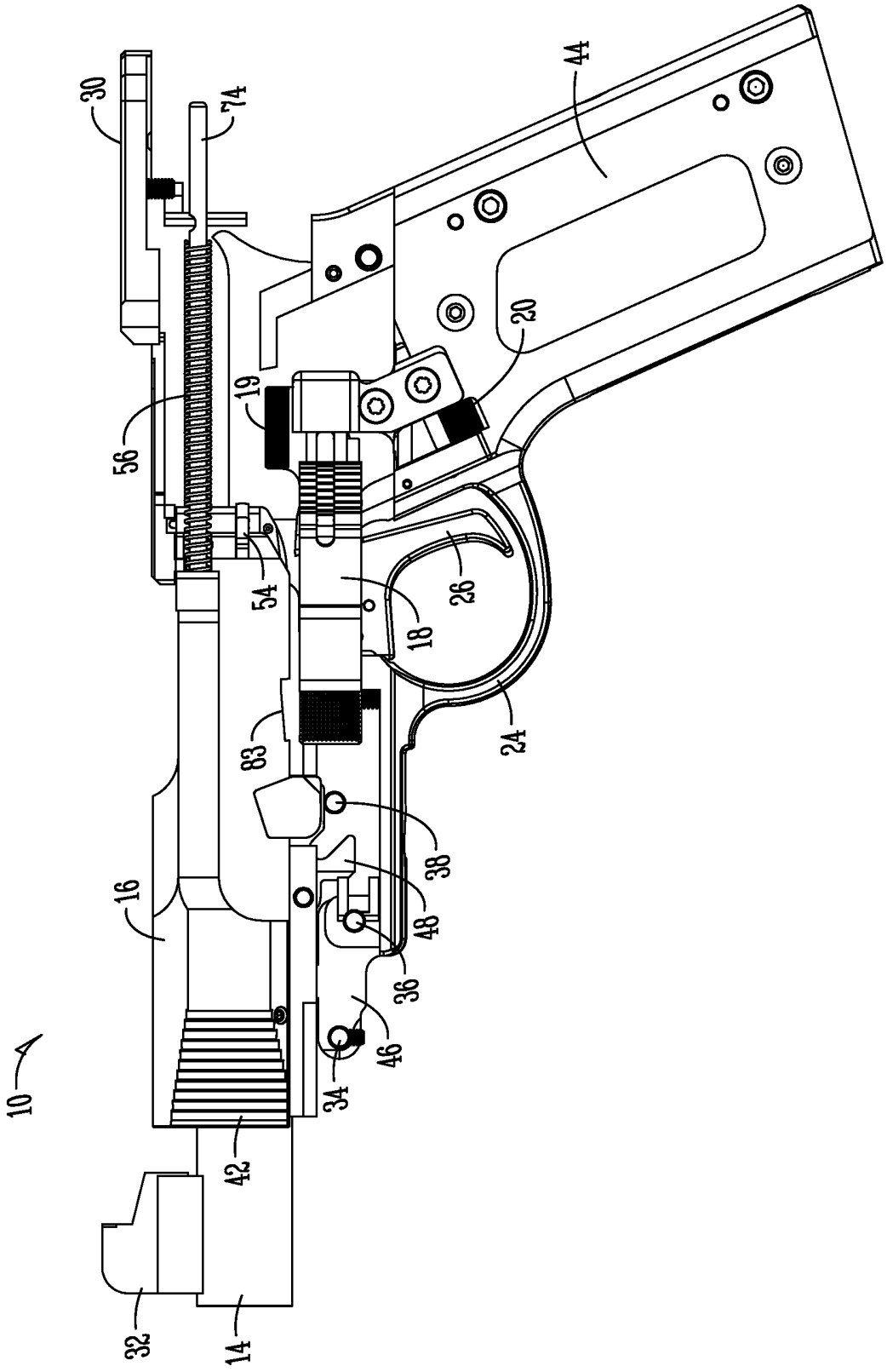

Fig. 9A

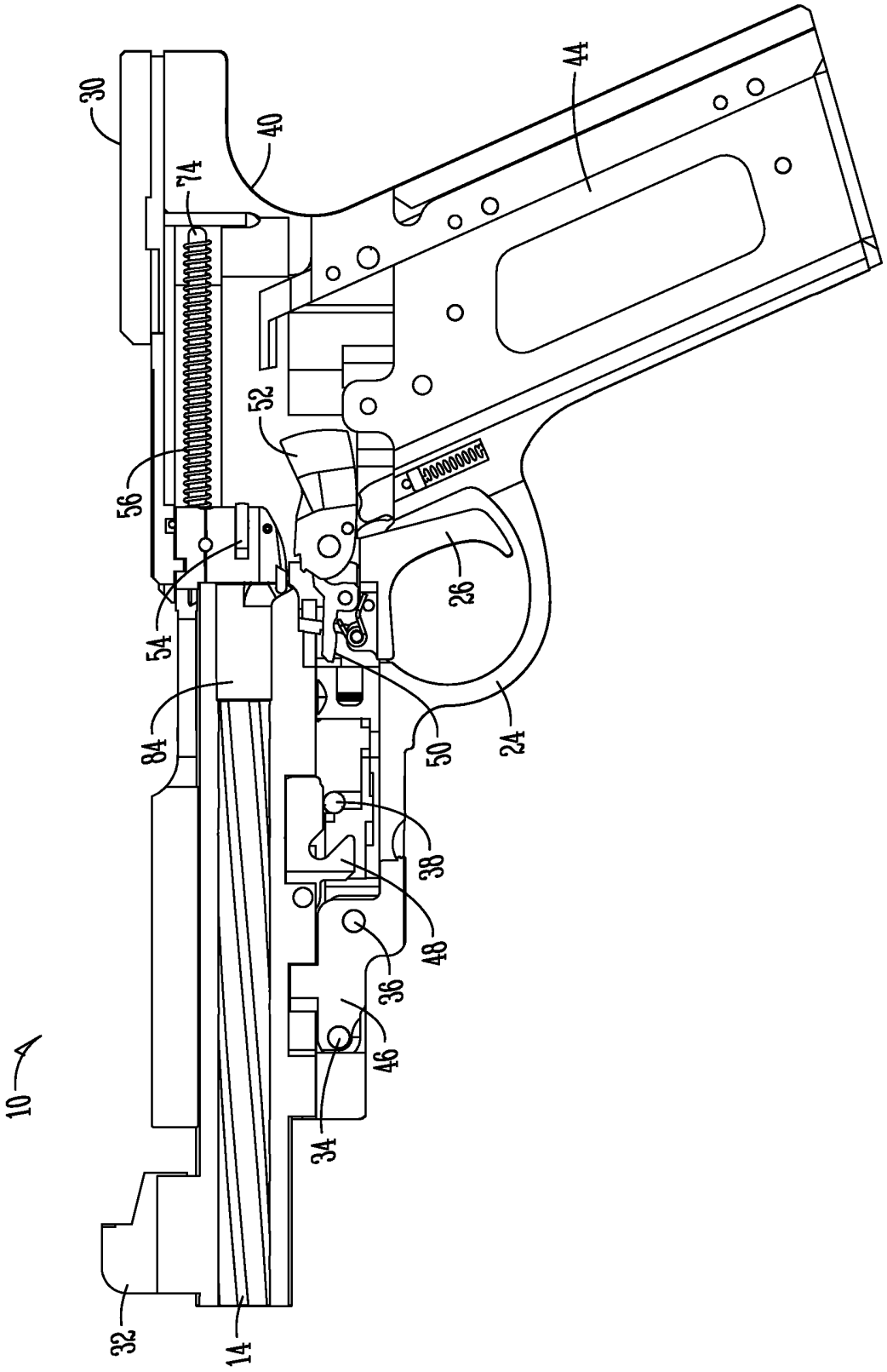

Fig. 9B

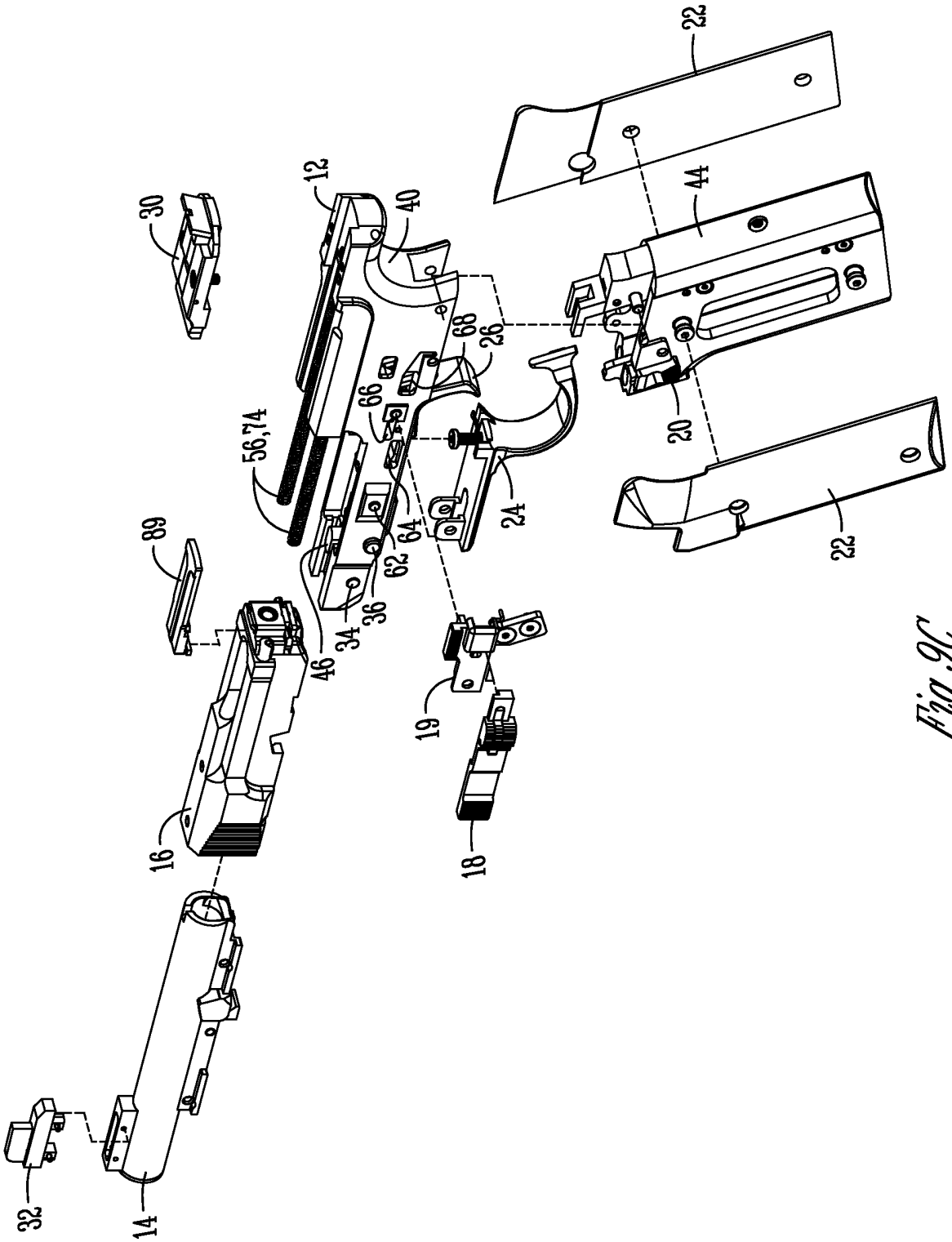

Fig. 9C

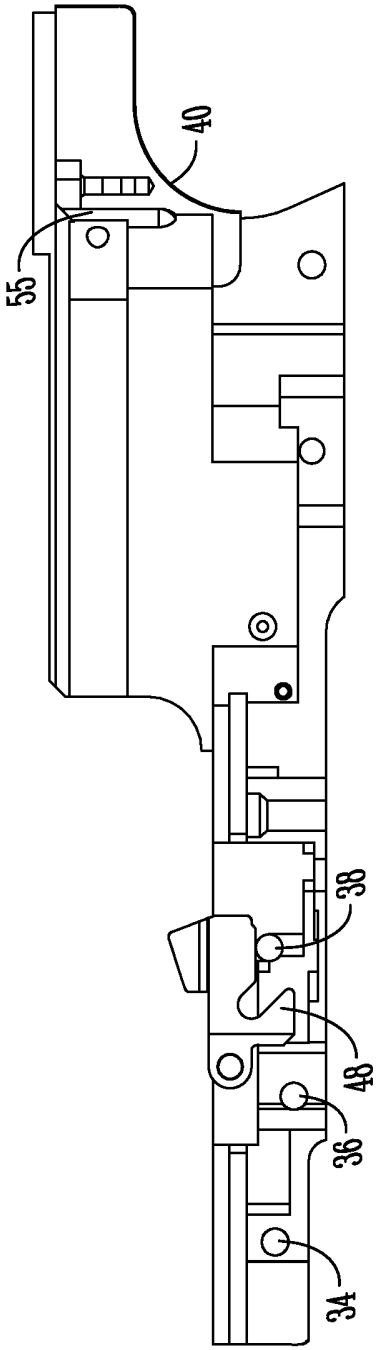

Fig. 9D

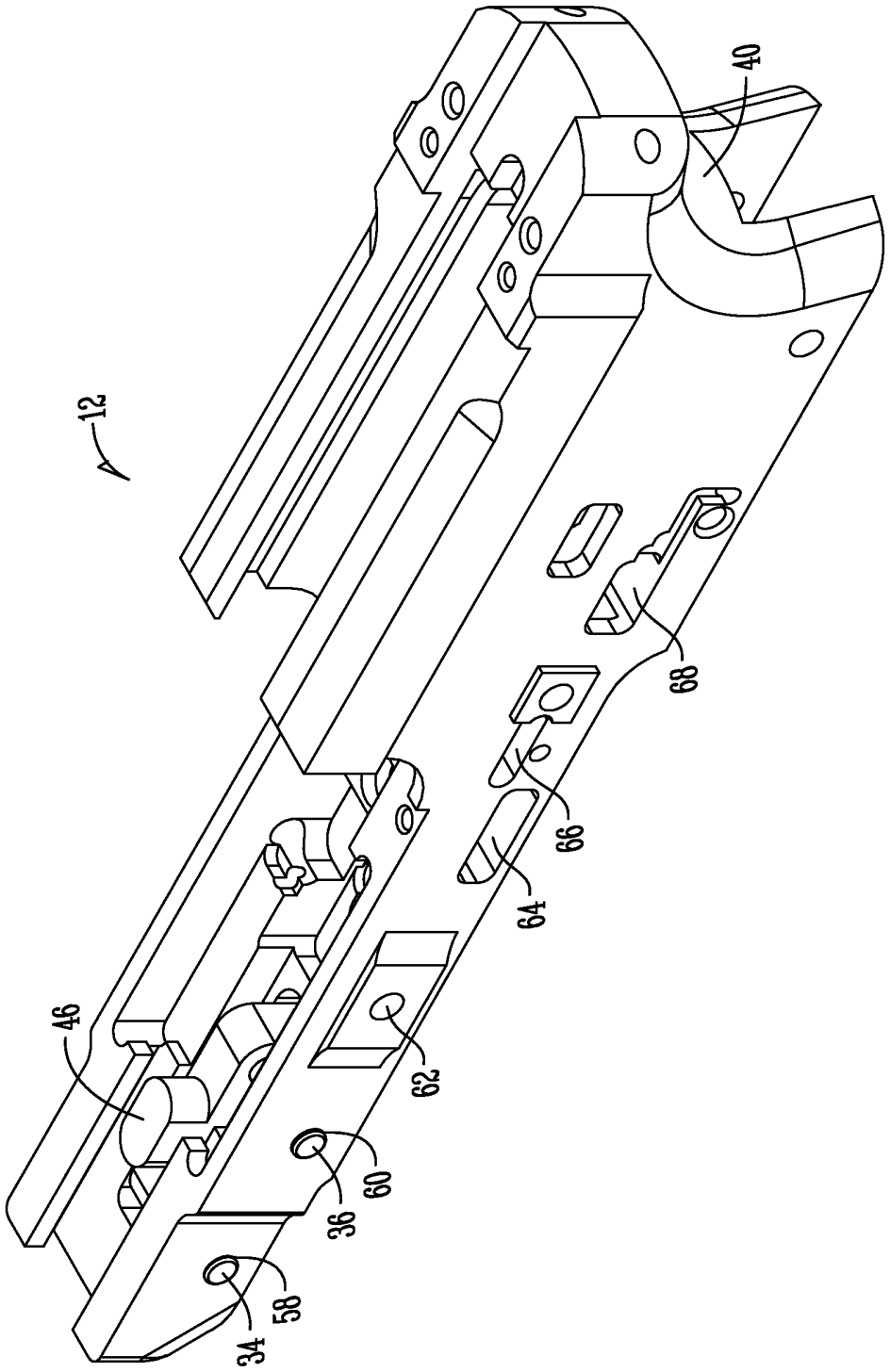

Fig. 10

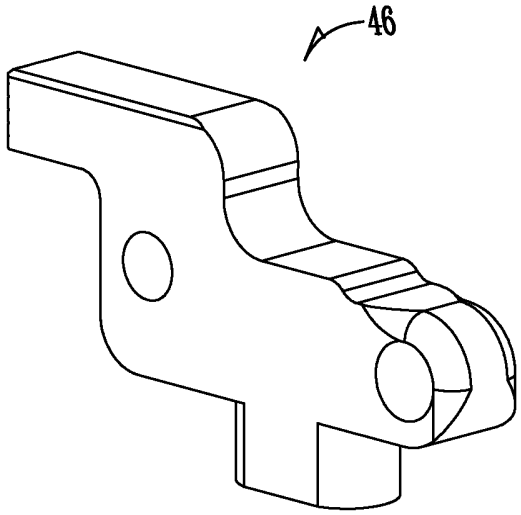

Fig. 11

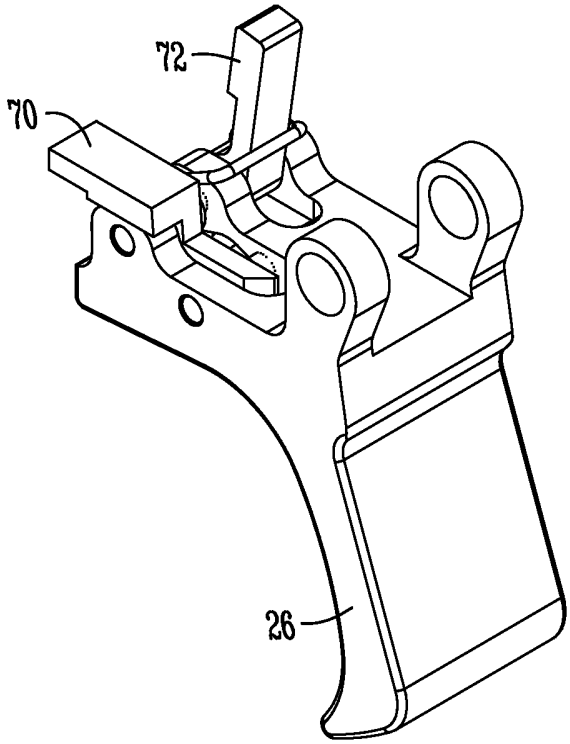

Fig. 12