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(54) **COMPACT ELECTRIC SPRING ENERGIZED DESKTOP STAPLER**

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(63) Continuation of application No. 13/943,644, filed on Jul. 16, 2013, now Pat. No. 9,522,463.
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B25C 5/15 (2006.01)
B25C 5/02 (2006.01)
B25C 5/00 (2006.01)

(52) **U.S. Cl.**
CPC ***B25C 5/15*** (2013.01); ***B25C 5/00*** (2013.01); ***B25C 5/0228*** (2013.01)

(58) **Field of Classification Search**
CPC B25C 5/15; B25C 5/0228; B25C 5/00; B25C 5/10; G03G 2215/00827
See application file for complete search history.

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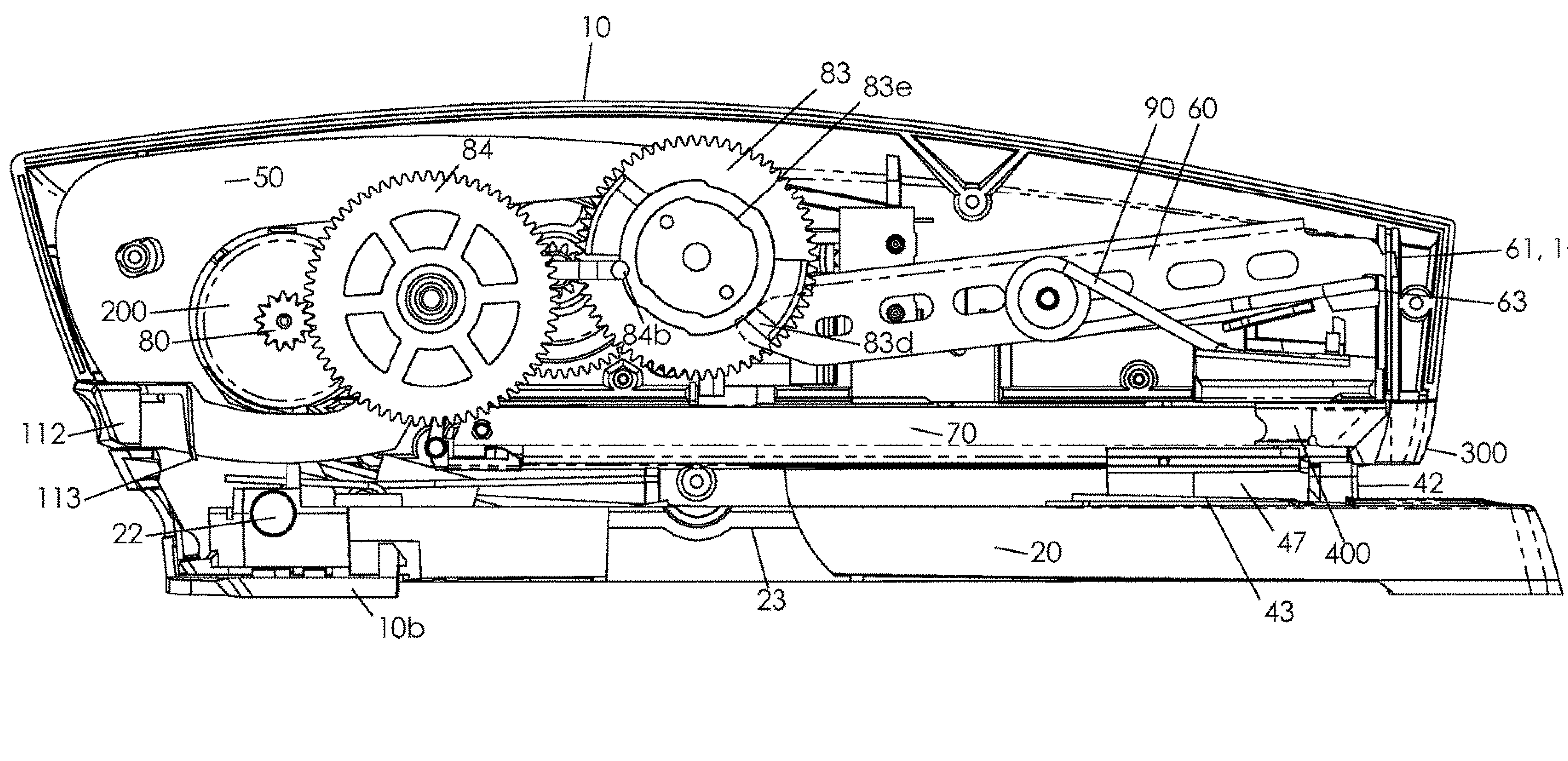
(57) **ABSTRACT**

A compact, electric, spring energized desktop stapler having a unitized housing providing both an external movable enclosure and a support frame for internal parts is disclosed. The internal power train is preferably elongated with the motor at the rear, a gear set toward the center, and low profile lever and power spring assembly at the front. The lever engages a striker with a normal upper rest position where the power spring is deflected and energized. A cam roller mounted to a final gear holds down the rear of the lever until the system is activated when the final gear rotates and the cam roller rolls off the end of the lever. In the unitized body, the base is pivotally attached to the body at the rear. A base lever selectively links to a cam roller or equivalent structure to move the body downward toward the base during a cycle.

24 Claims, 8 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 61/675,648, filed on Jul. 25, 2012.

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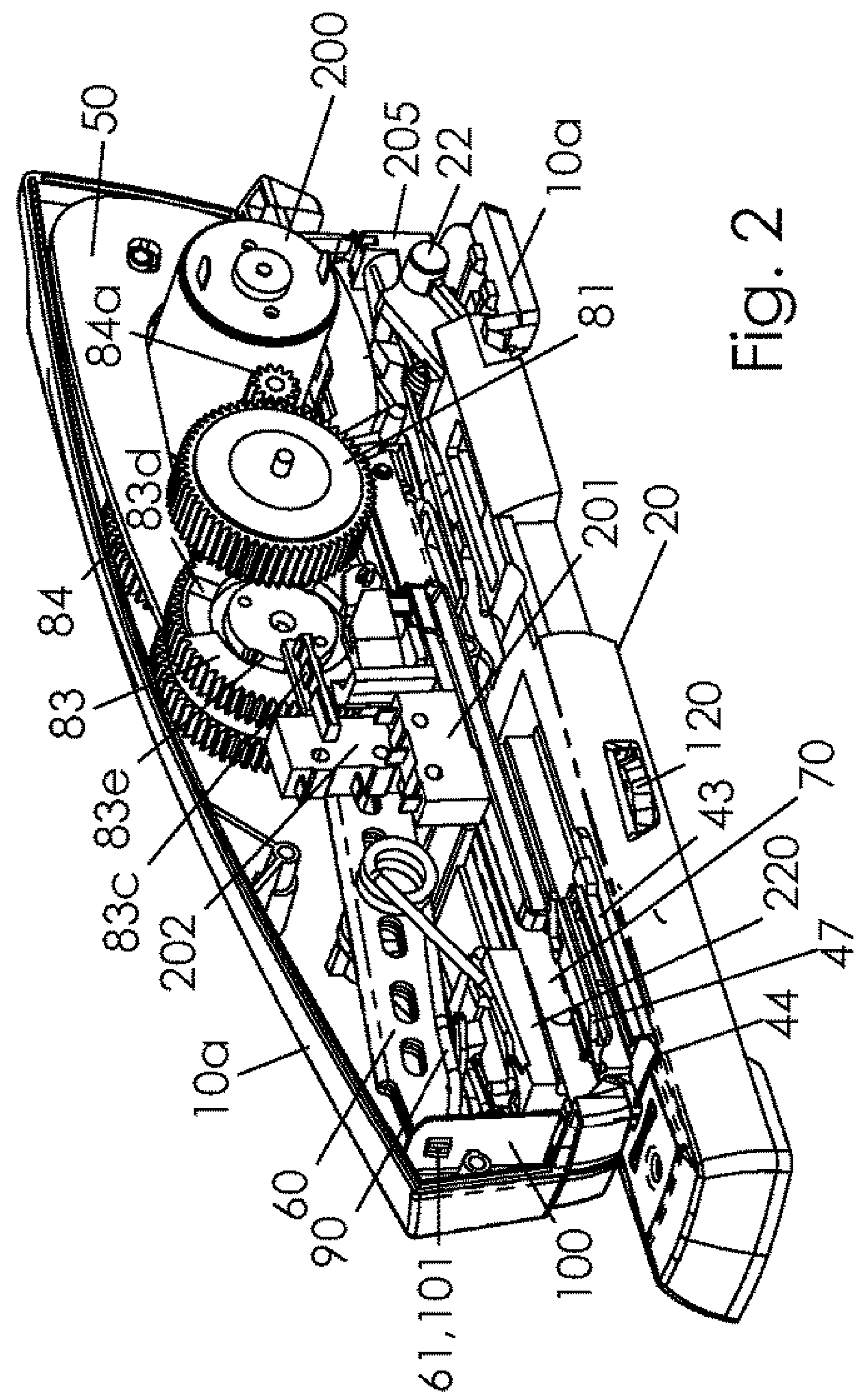

Fig. 2

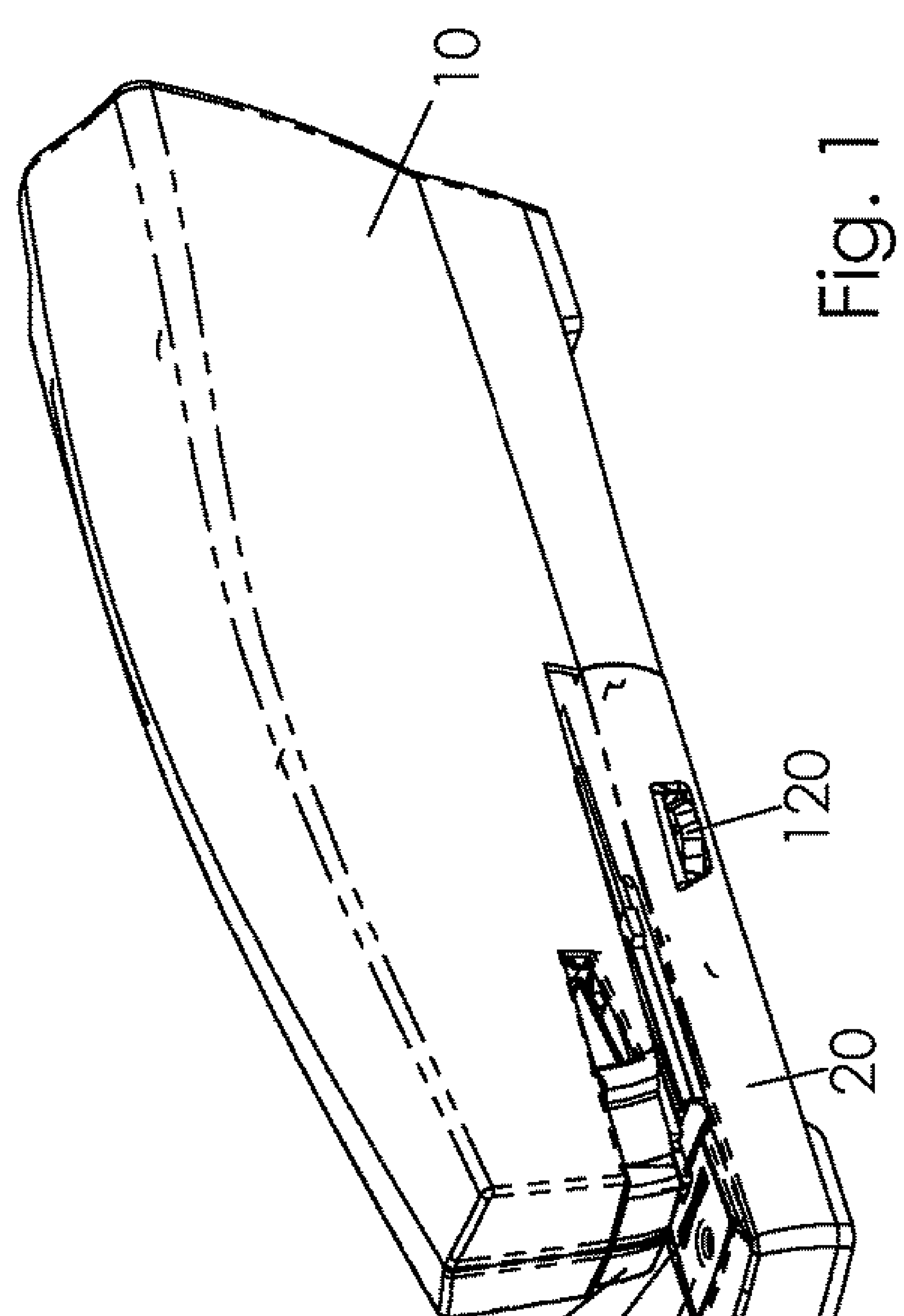

Fig. 1

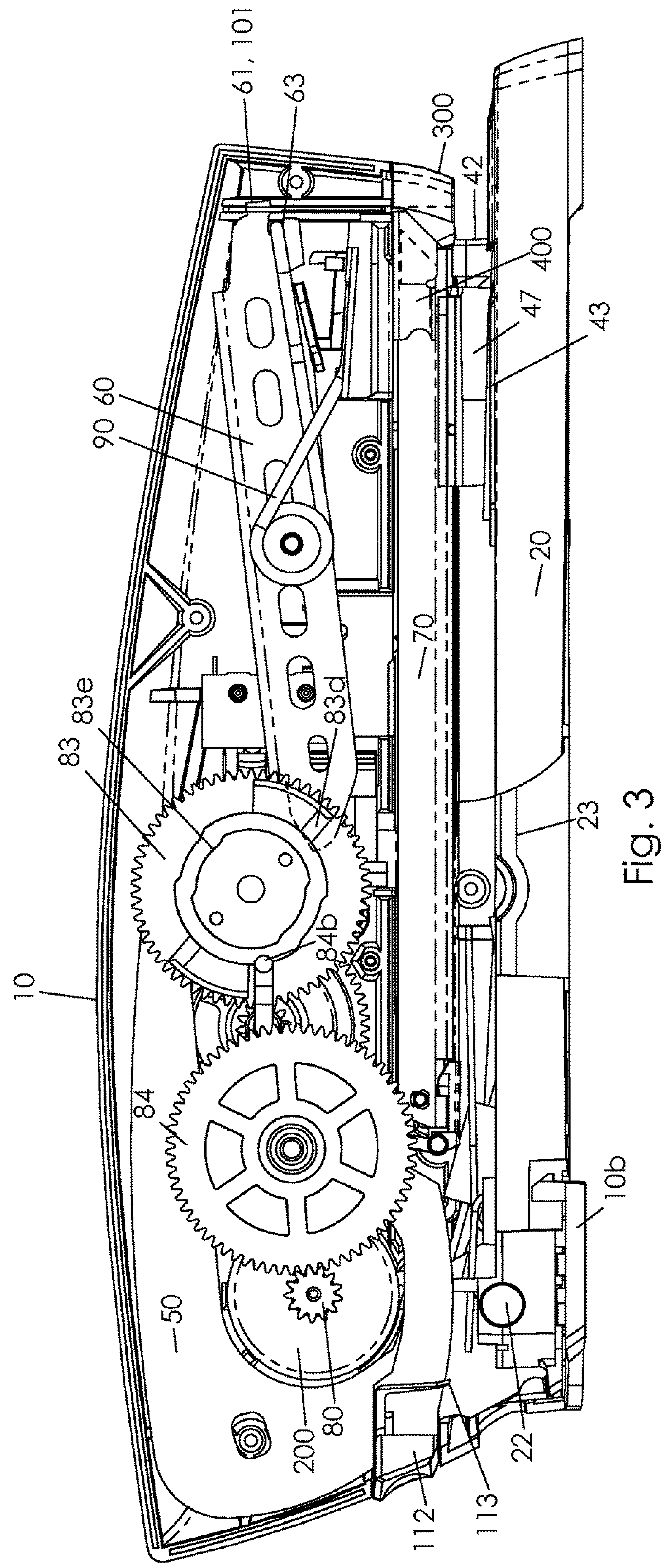

Fig. 3

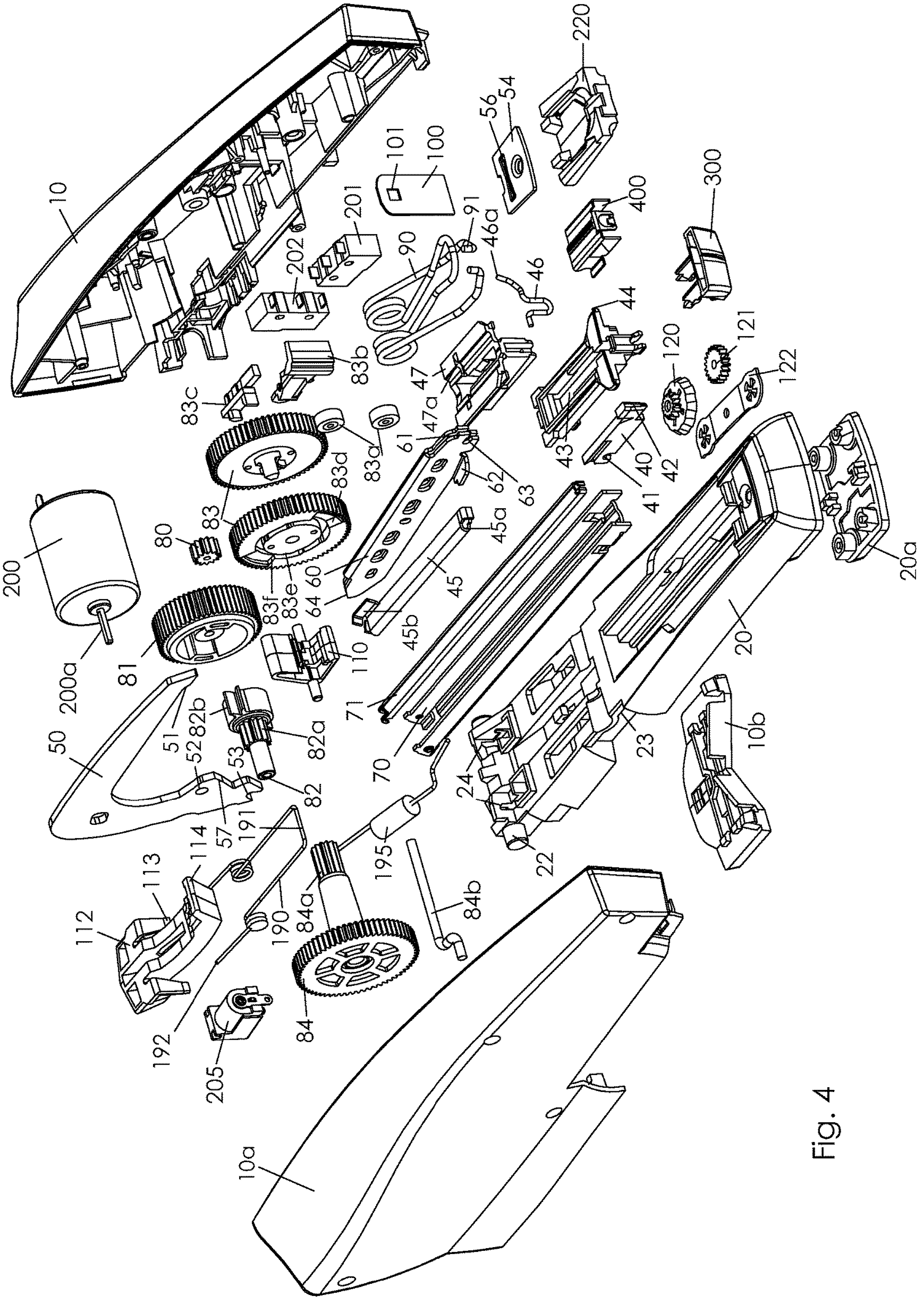
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Fig. 4

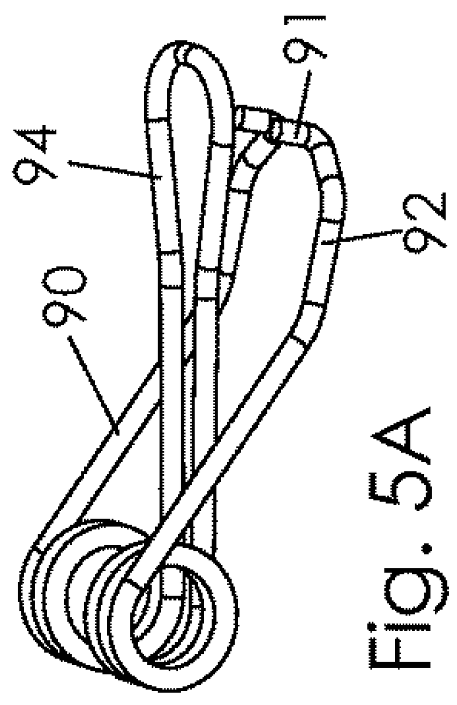


Fig. 5A

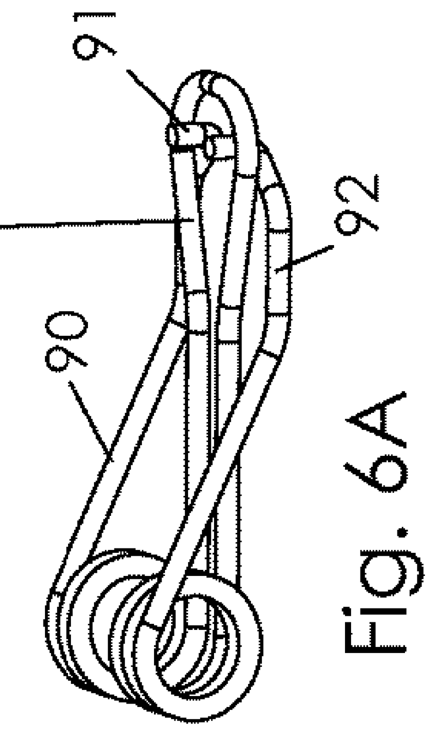
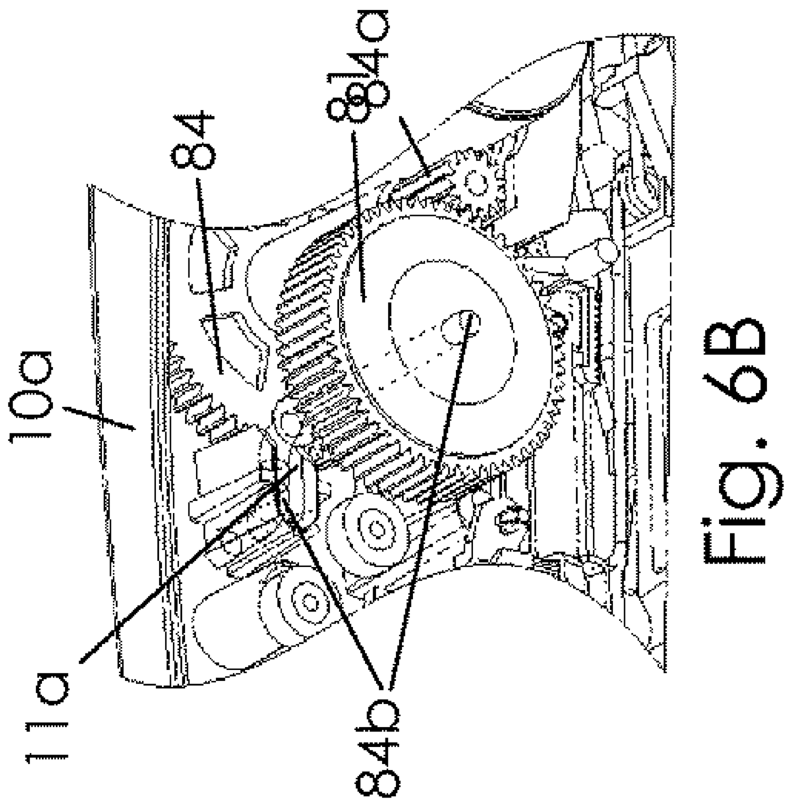


Fig. 6A



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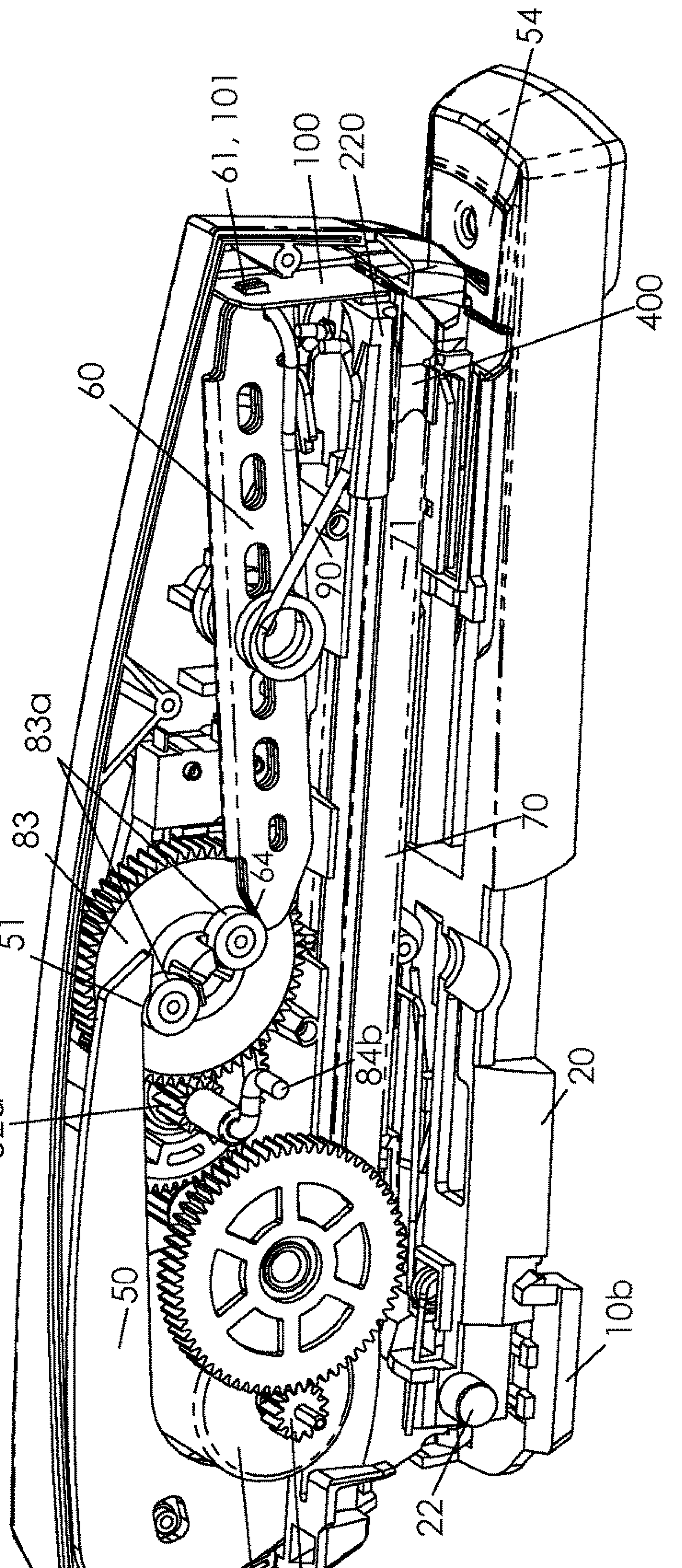
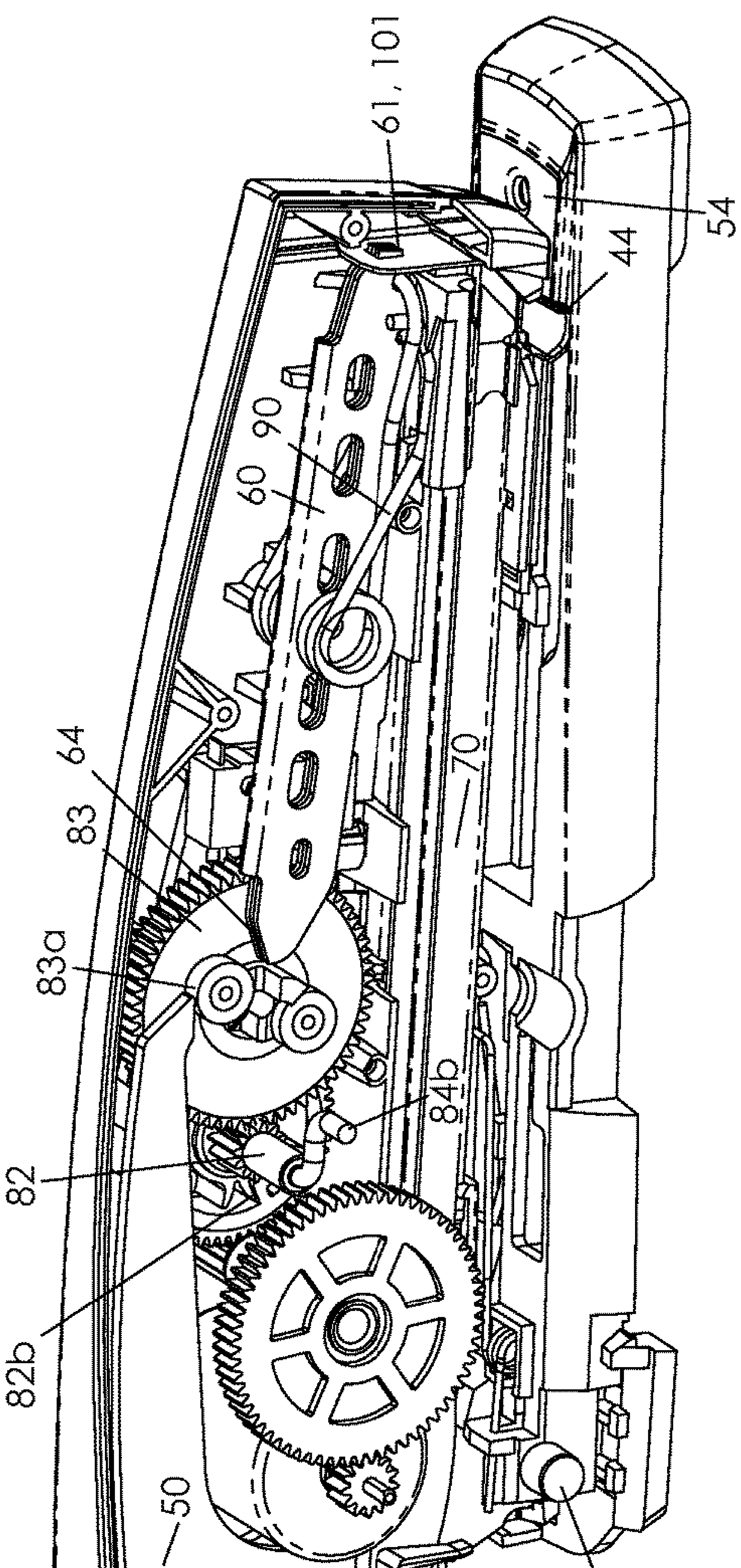


Fig. 5



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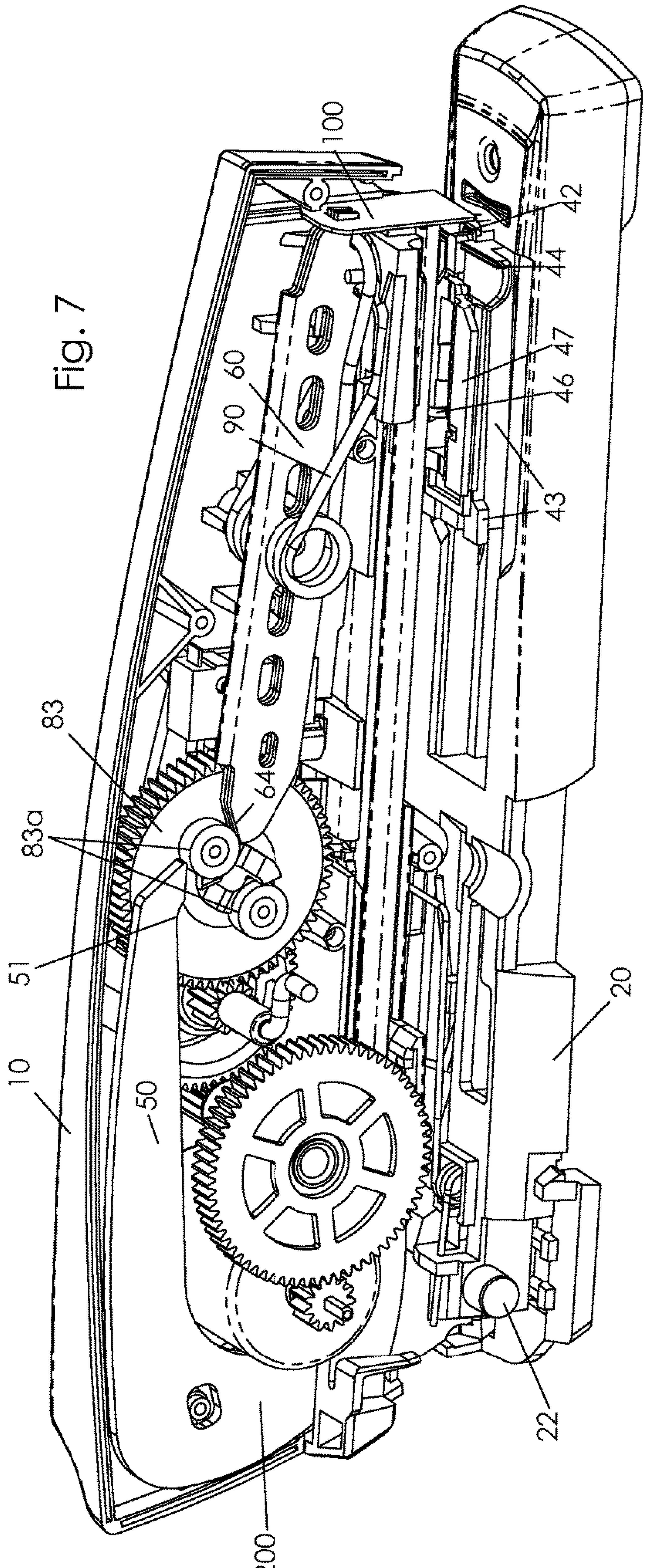
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Fig. 7

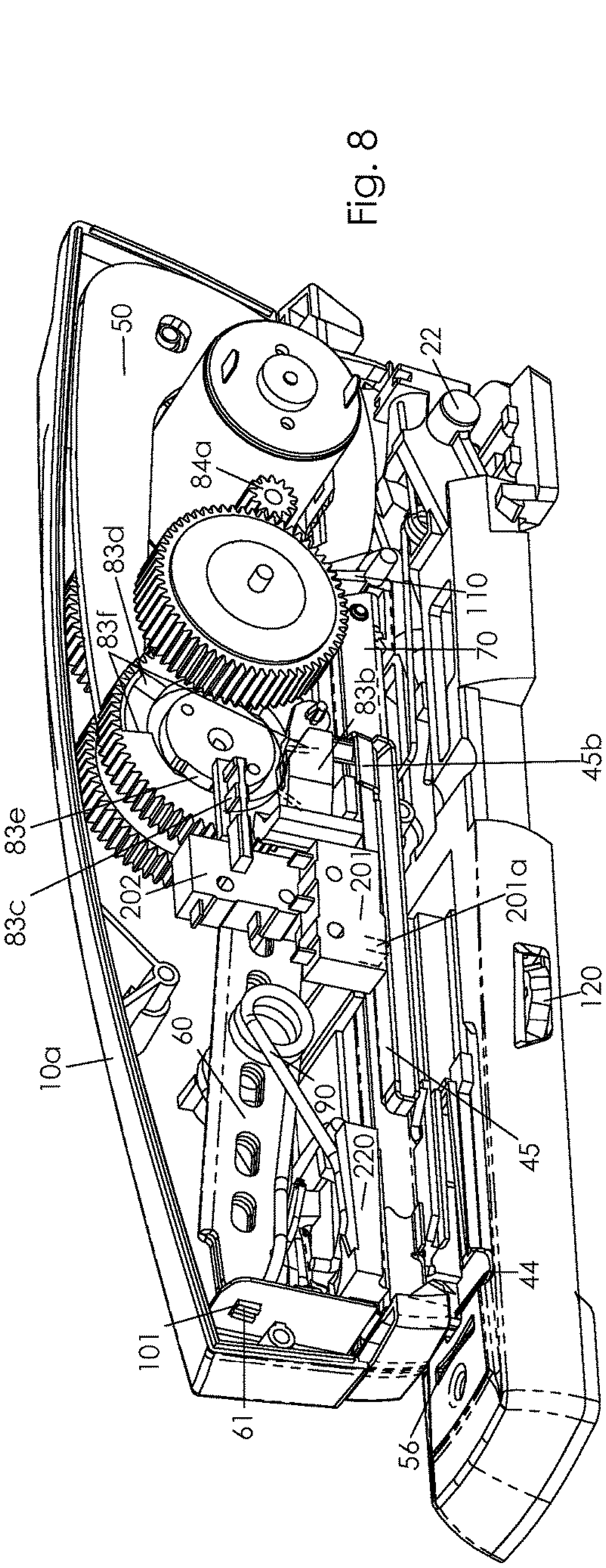
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Fig. 8

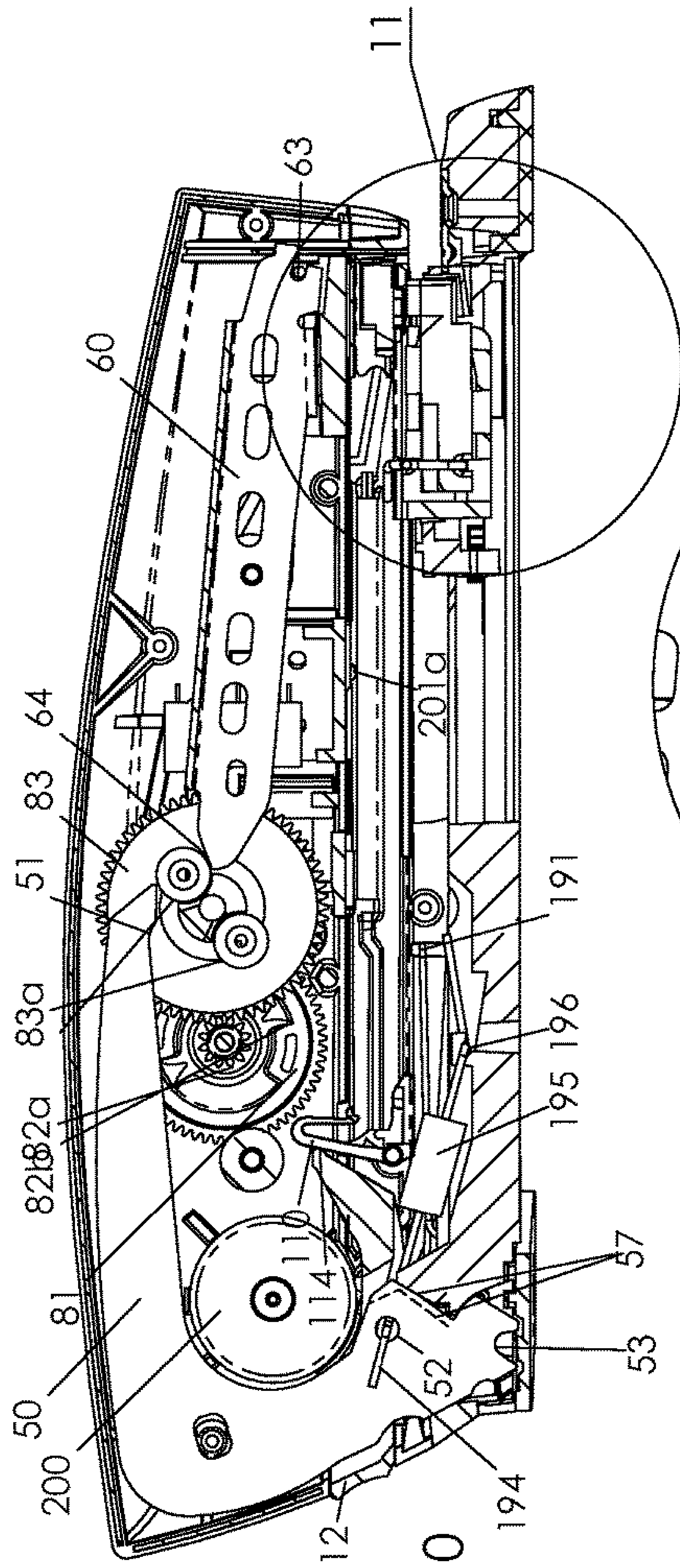


Fig. 10

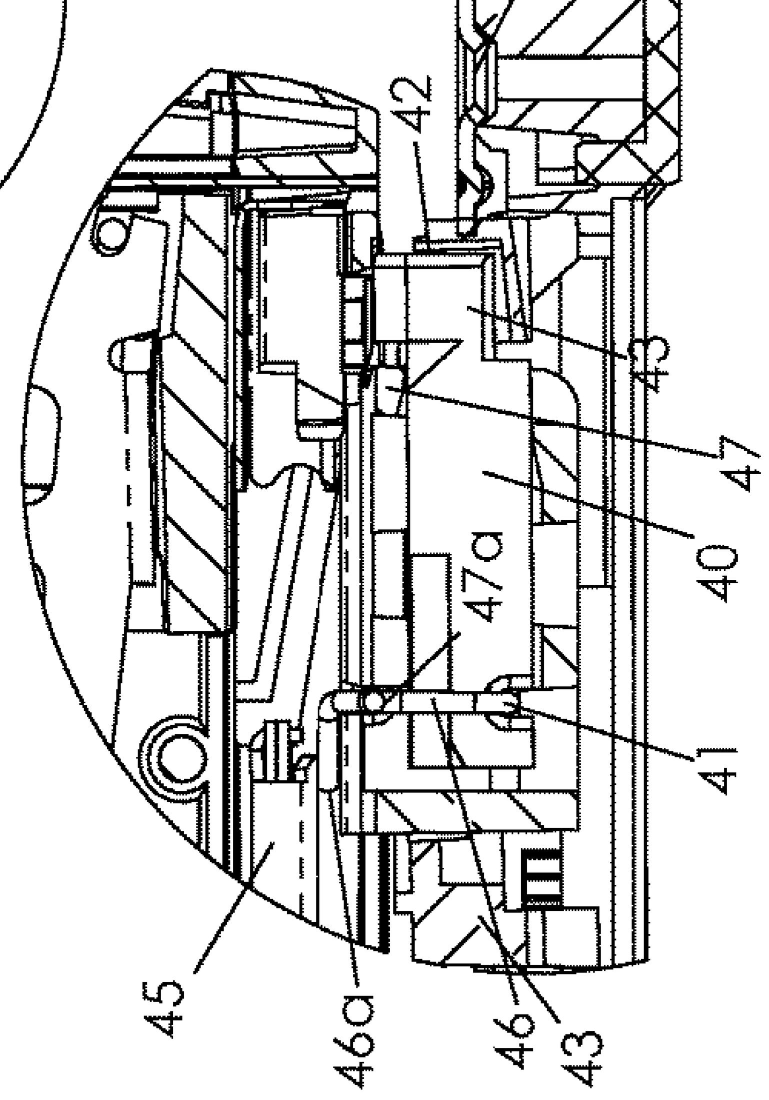


Fig. 11A

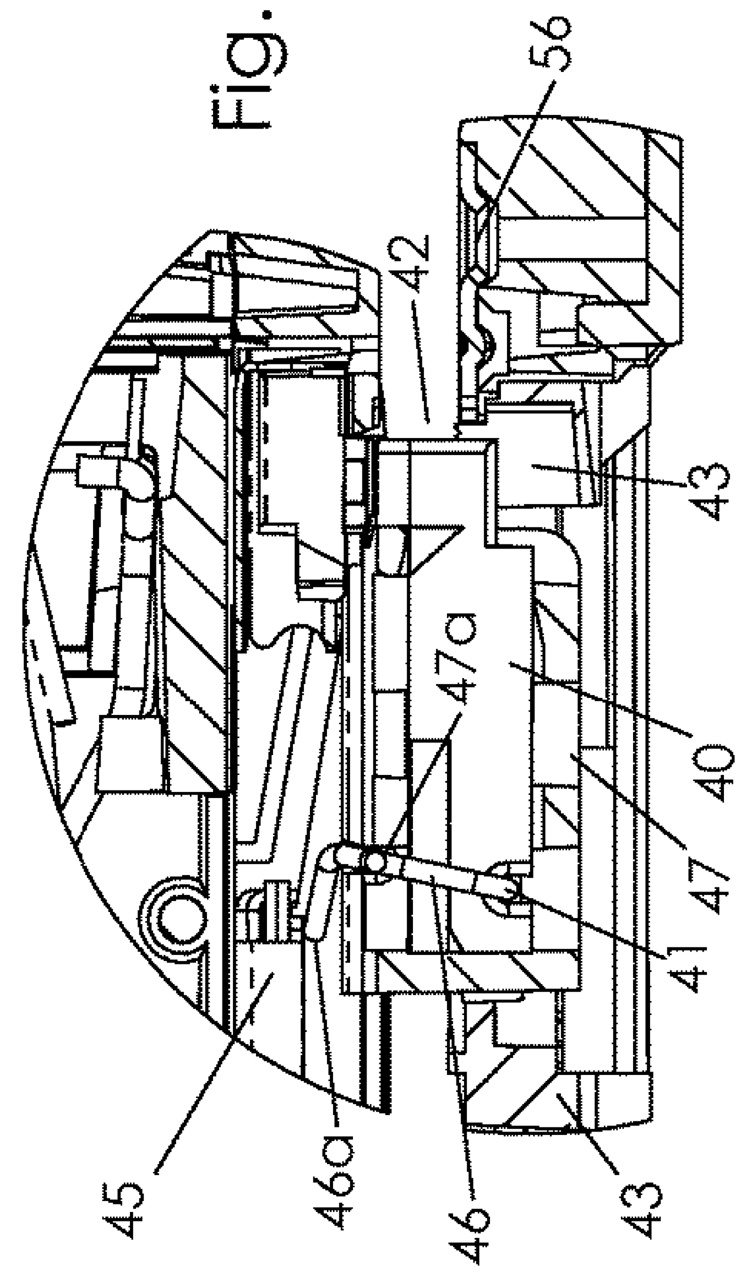


Fig. 11B

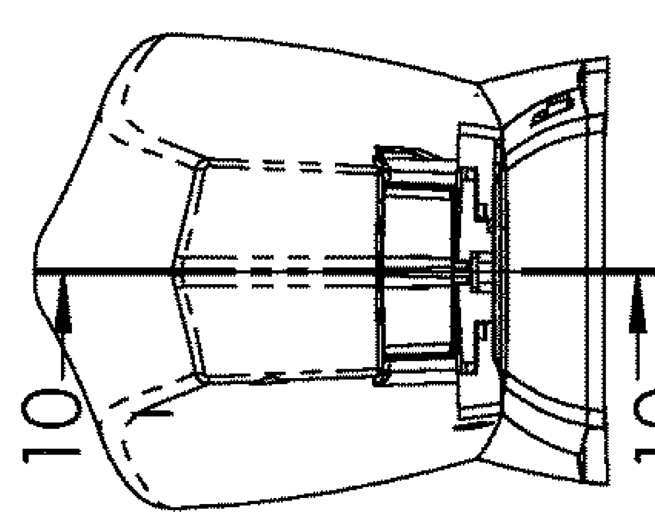


Fig. 9

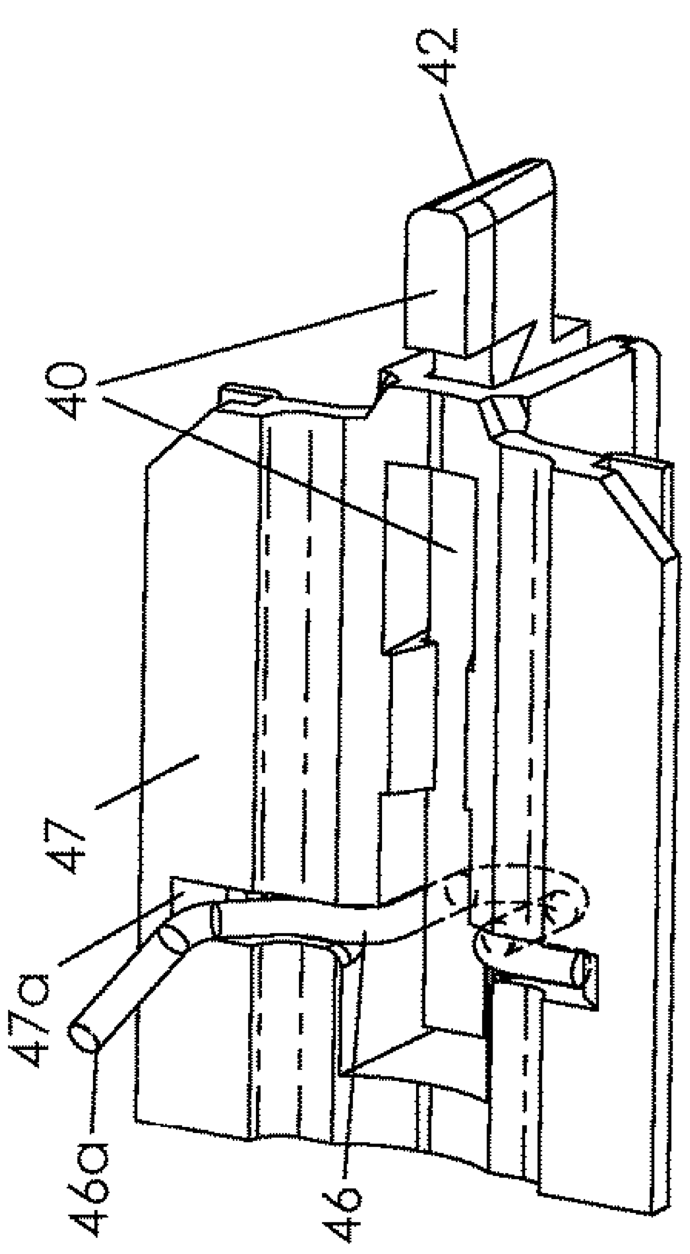


Fig. 12A

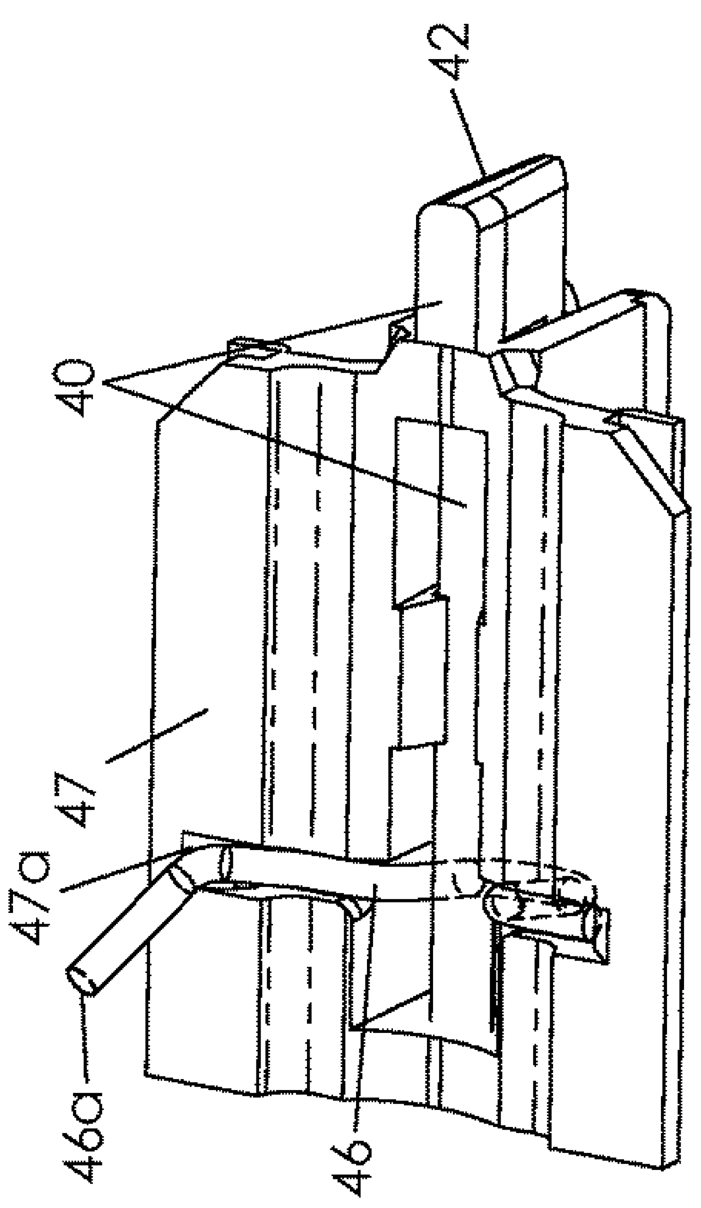


Fig. 12B

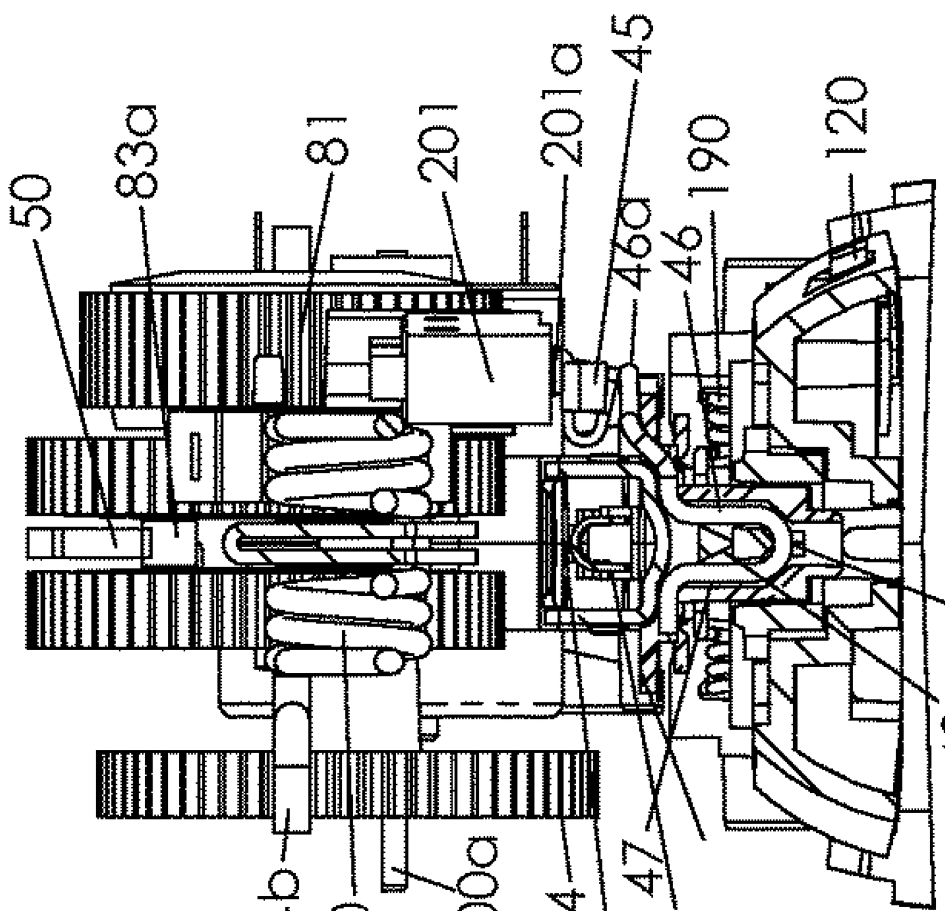


Fig. 13A

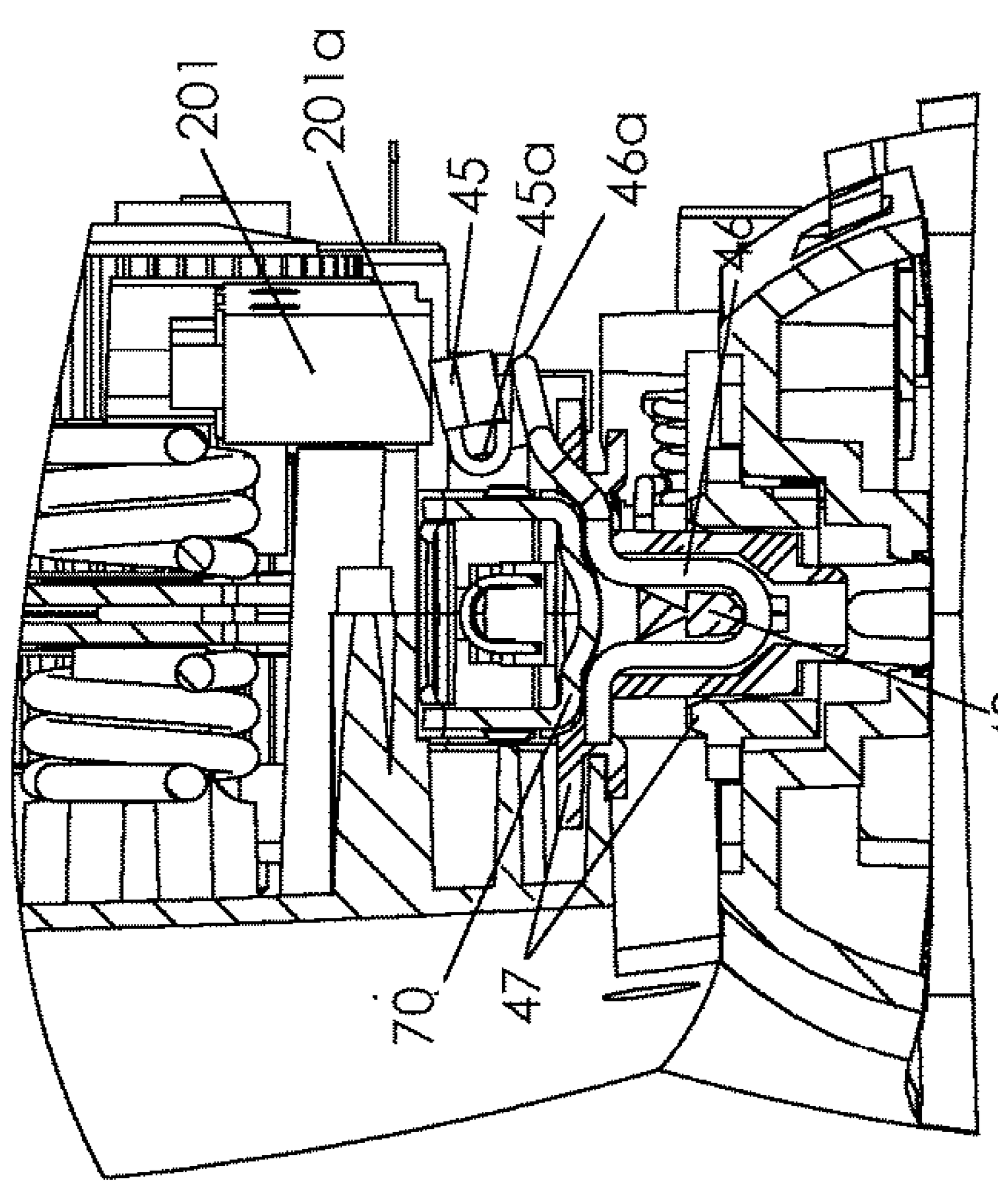


Fig. 13B

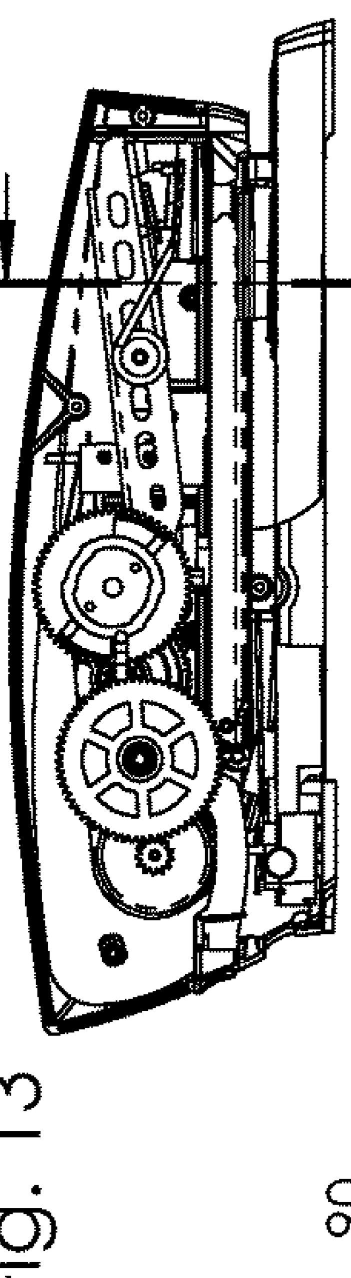


Fig. 13

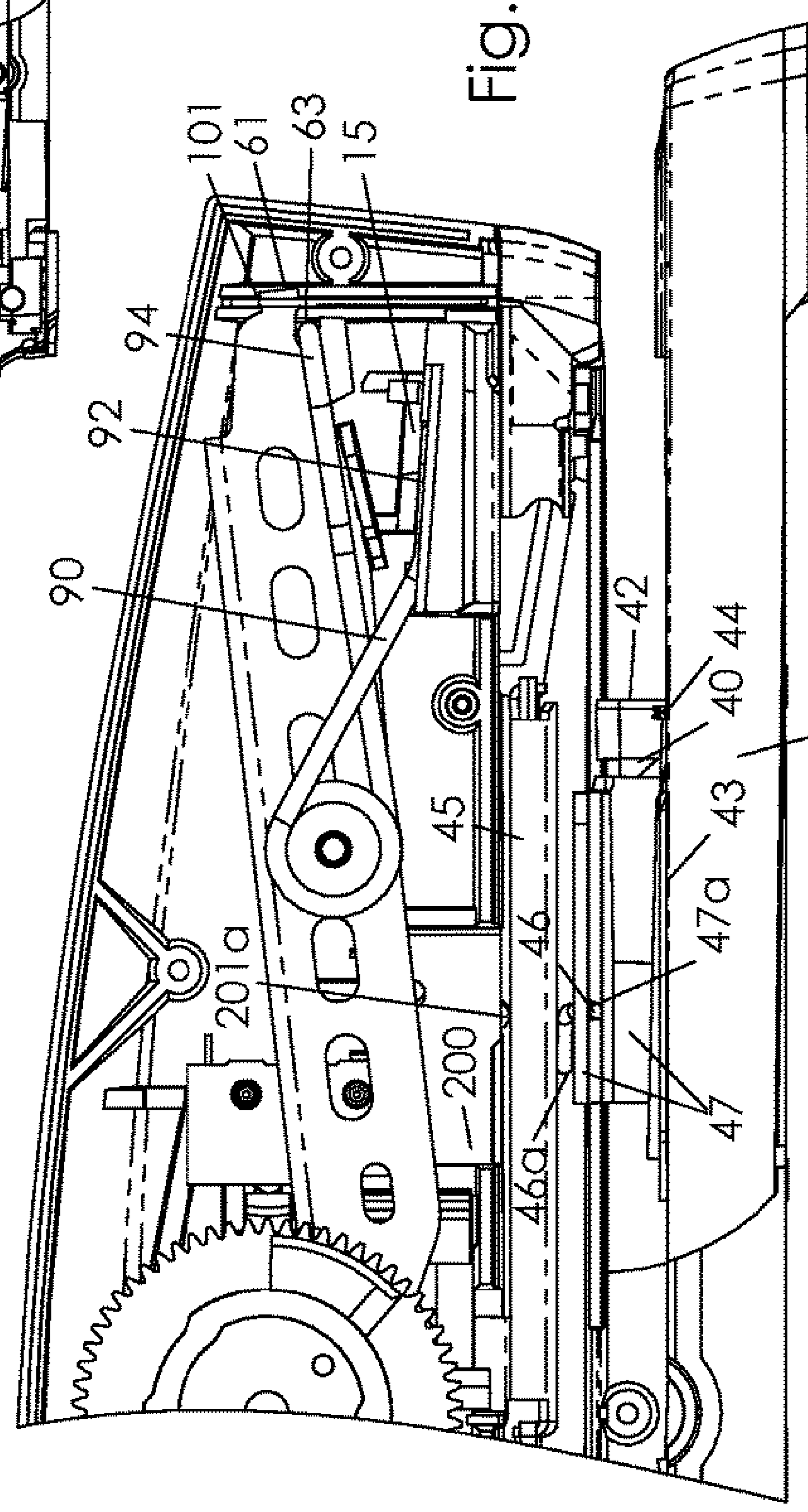


Fig. 14

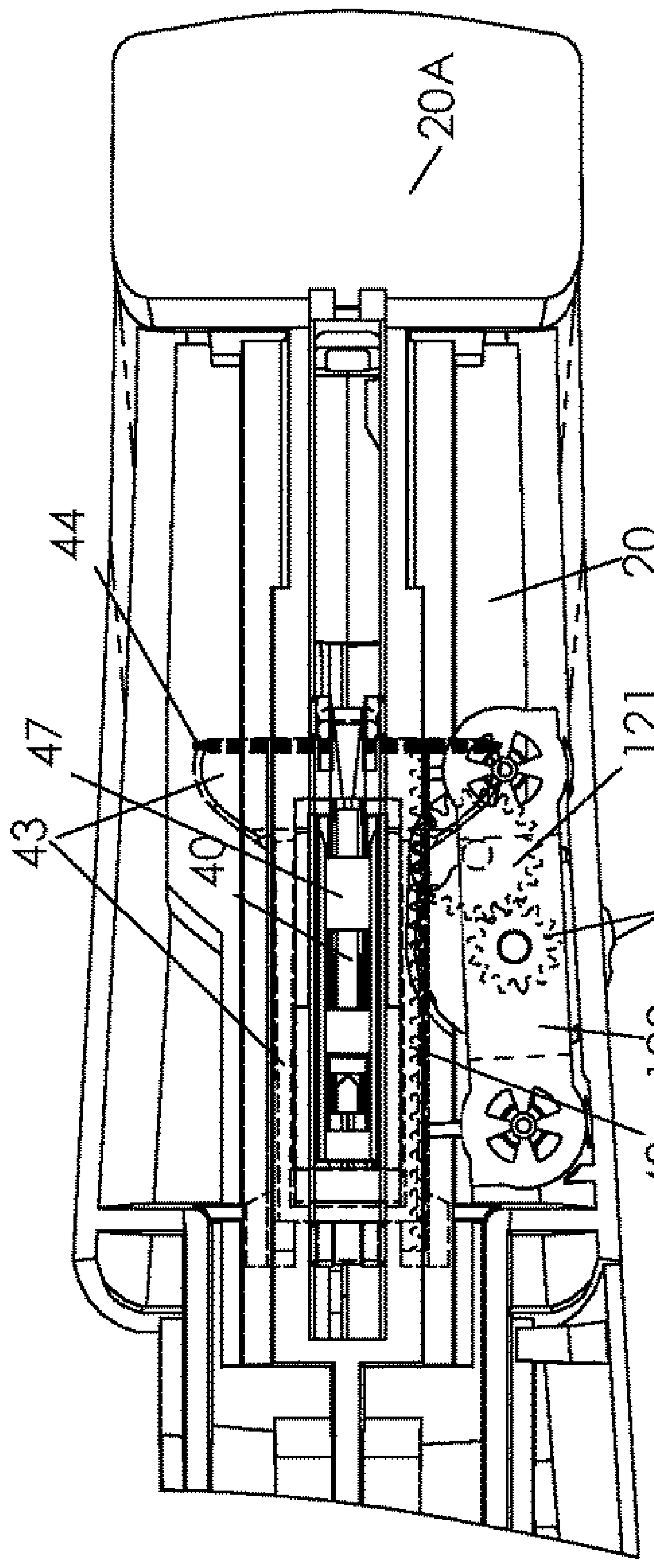


Fig. 15

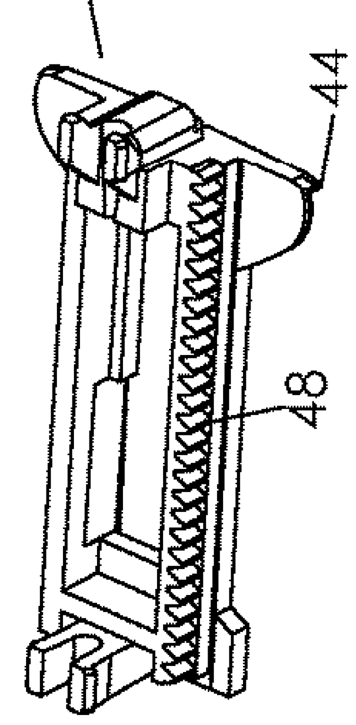


Fig. 16

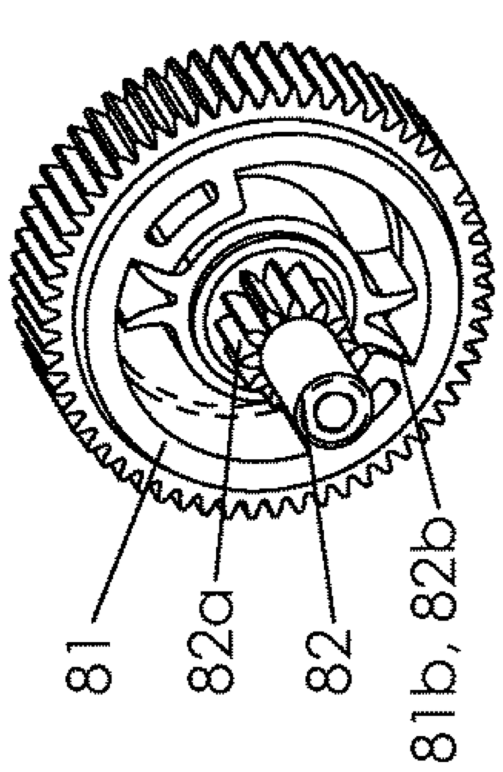


Fig. 17A

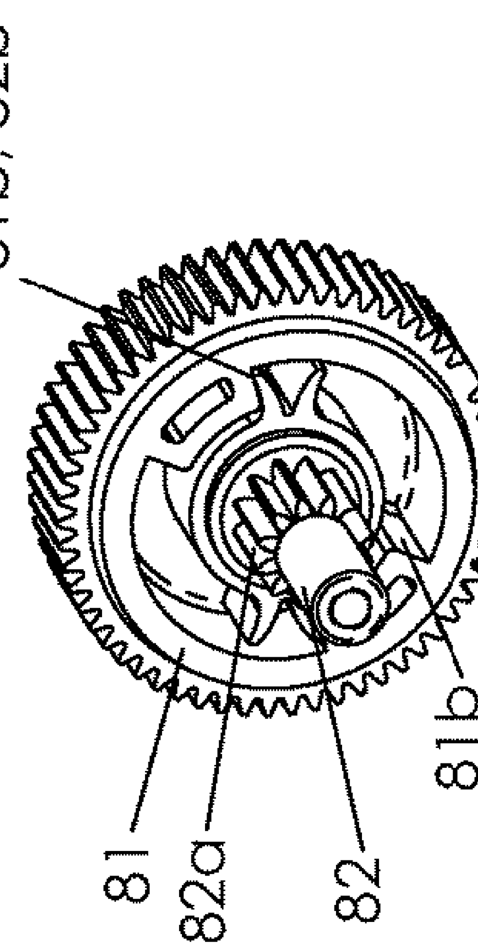


Fig. 17B

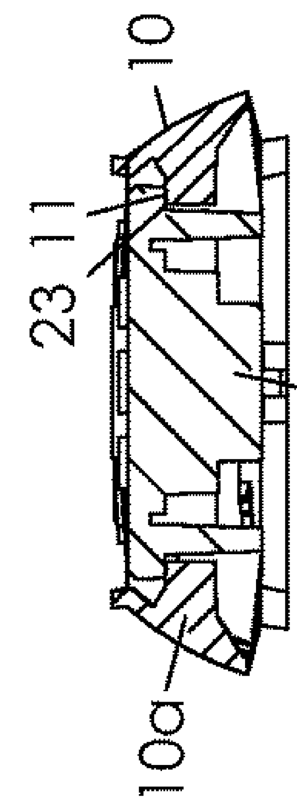


Fig. 20

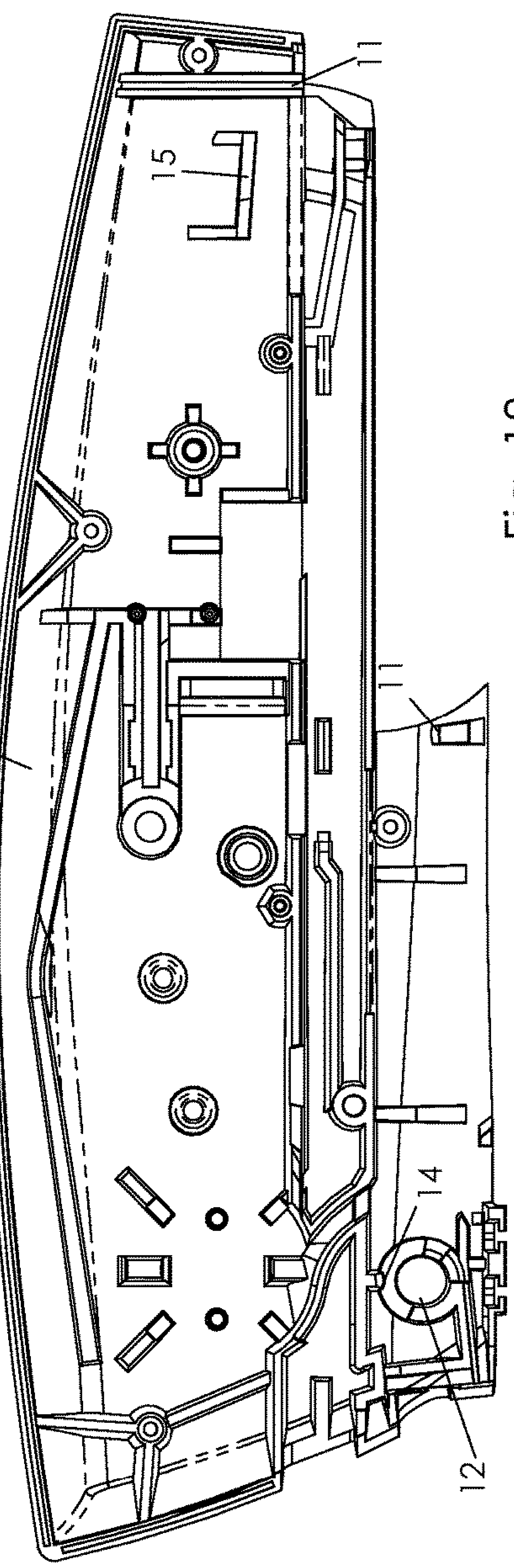


Fig. 18

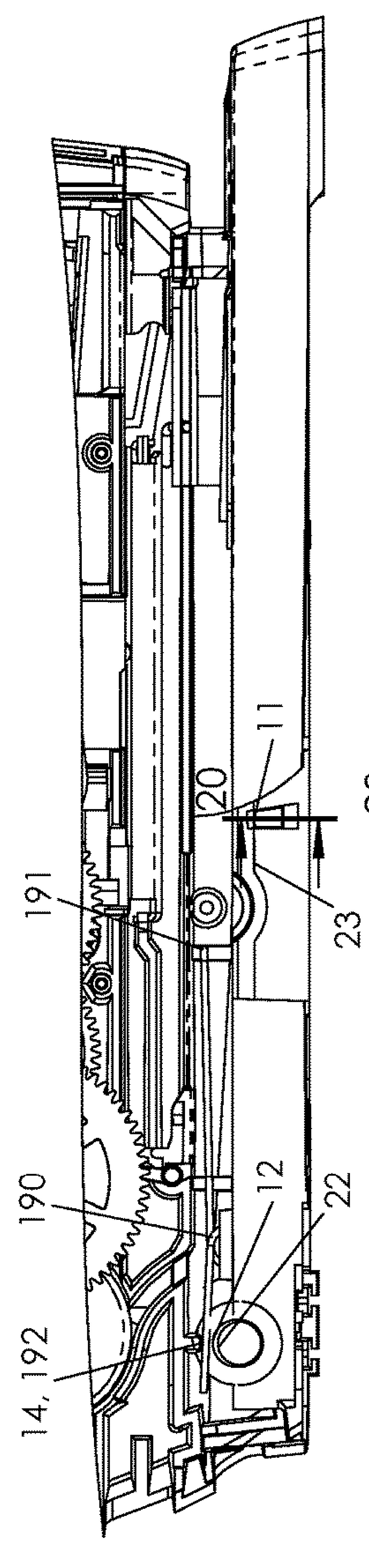


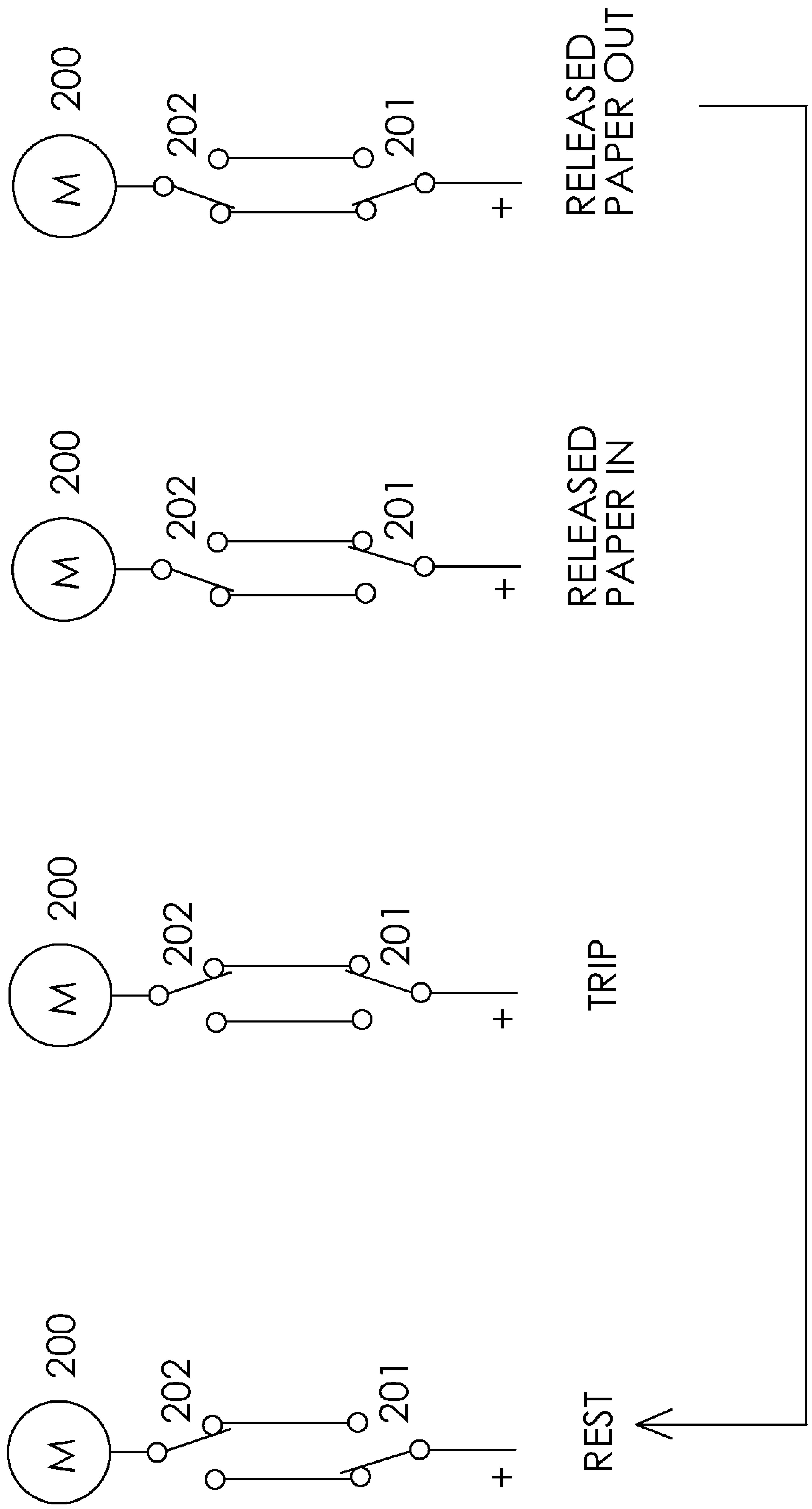
Fig. 19

FIG. 21A

FIG. 21B

FIG. 21C

FIG. 21D



COMPACT ELECTRIC SPRING ENERGIZED DESKTOP STAPLER

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. Provisional Application No. 61/675,648 filed Jul. 25, 2012, and from co-pending parent application Ser. No. 13/943,644, filed Jul. 16, 2013, by the same inventor, the contents of which are incorporated by reference.

FIELD OF THE INVENTION

The present invention relates to an electrically energized stapler, and in particular, a compact spring energized desktop electric stapler.

BACKGROUND

Power operated staplers are known in the form of pneumatic and electrically powered devices. Such staplers are used for fastening in construction tools, and in the case of office type staplers, for binding papers. Powered office staplers are normally of the electric variety. Within the electric category common types are reduction gear driven by a motor, and impact driven through a solenoid. Gear driven types usually operate relatively slowly through cam or lever means. The slow operation allows a low peak electric current, for example through battery power or an alternate source of DC power from a line powered low voltage adaptor. An impact system through solenoid operates quickly, but requires high peak power, sometimes high enough to dim lights in an office setting. Further, the solenoid is expensive and bulky, including a large heavy copper winding. A further type of gear operated stapler uses the motor power to store energy in a spring, whereby the spring drives a staple by impact blow. However, these have required bulky structures.

In gear driven types, the amount of gear reduction required relates to the available power of the motor and the stapling energy required. A further important variable is the efficiency of the design. In some known prior designs there is substantial friction. Also in a design without spring energy storage the motor must drive through large changes in torque as the stapling cycle proceeds. As a minimum the gear reduction or motor size must allow for the peak forces of the cycle. This necessarily means the motor will operate well outside its peak efficiency loads or speeds for much of the cycle. A common such stapler may have four gear reduction stages to drive through such a cycle. A gear reduction device is also relatively slow typically requiring most of a full cycle to complete before the fastener is ejected. Further, the slow action makes such designs ill suited for use in construction tools since there is no anvil to press; the staple ejects too slowly to penetrate a wood or like surface.

In desktop use, pressing paper against or actuating a switch, or equivalent sensor, near the front of the stapler normally actuates the stapler. Commonly, the switch is to one side of the stapler. This facilitates manufacture of the device but leads to a loss of function—the actuation becomes sensitive to the angle in which papers are inserted. If the papers are angled toward the side with the switch, then the staple is installed too close to the edge of the page. If the angle is away from the switch, whereby the paper edge contacts an edge of the device opposite the switch, there may be no staple operation at all since the papers are obstructed from moving against the switch. The above-described behavior is a source of familiar unpredictability of operating electric staplers.

Some electric staplers allow for moving the position of the switch to change the location of the staple relative to the paper edge. The conventional side mounted switch is a known method to provide an adjustable switch position since it is known how to fit it beside the staple track in the various positions.

A common structure for an electric stapler includes an internal metal support frame and a separate external housing to form at least in part a double walled construction. With the support and enclosure functions separate, the overall size necessarily is large. For example, it is common that the external housing remains stationary while the internal frame moves down toward the anvil during a cycle. This requires ever more bulk to provide such movable mountings. Such a structure is complex and expensive. The very large housing is necessarily plastic to keep cost and weight reasonable. But such a large plastic structure often feels of low quality and amplifies noise.

SUMMARY OF THE INVENTION

The present invention provides improvements including size, efficiency, cost and usability to an electric stapler. In various preferred embodiments, it is of a gear motor type, with spring energy storage. The size in an exemplary 25 sheet capacity version is only slightly larger than that of a conventional manual stapler. A unitized housing provides both an external movable enclosure and a support frame for internal parts. The housing may be of either metal or plastic; if metal, such as die cast, is selected the support frame will be sturdy, the external size will be especially compact and noise transmission is minimized But plastic is a practical material also if desired. In either case the housing also normally provides the external appearance of the device.

The power train is preferably elongated with the motor at the rear, a gear set toward the center, and a low profile lever and an elongated power spring assembly at the front. The motor, gear set, lever and power spring are all preferably at a same or similar vertical level, being aligned in sequence along a length of the tool housing. Such alignment preferably includes the power spring and lever, with the power spring being largely remote from the front of the tool. One or both of the power spring and lever form a torque arm that is cantilevered from a pivot axis to the front of the tool. With the structure as described, the tool can be compact vertically along its full length and further it can be narrow in width at the front since there is minimal power spring structure at the front.

The lever engages a striker with a normal upper rest position. In this rest position, the power spring is deflected and energized. A cam roller mounted to a final gear holds down the rear of the lever until the system is activated. Upon activation the final gear rotates and the cam roller rolls off the end of the lever. The cam roller link is preferred over a non-rotating post since it will be of substantially greater efficiency without the sliding action of a post. However, a wheel is most useful when it is relatively large in diameter compared to a simple post. But with a larger diameter wheel, the wheel may release the end of the lever slowly as it rolls off the rear most corner of the lever. To reduce this effect, there may be a compliant link in the gear train to allow limited back motion between gear elements.

In accordance with a preferred embodiment unitized body, the base is pivotally attached to the body at the rear in a desktop configuration. This is consistent with a compact device that is minimally larger than a familiar desktop stapler. A base lever selectively links to a cam roller or equivalent structure to move the body downward toward the base during a cycle. There is no need for a stationary external shell although stationary elements may be included if desired.

In a preferred embodiment, the power spring is a double torsion type with arms extending forward from a common mounting. Optionally, an elongated wire or flat spring may be used. With the elongated spring, the spring structure, the lever and the power spring both extend rearward from the striker. They both remain substantially behind the striker so that the front end of the stapler can be preferably no larger than required to fit the striker, with respect to a front view.

The stapler of the present invention preferably includes an adjustable sensor switch. This sensor is activated upon contact or sense of a paper edge. The sensor is positioned at or near the center of the stapler body, with respect to a front view, just below the staple track. Being on center removes dependency on the angle of the paper. In contrast, for example, a conventional right side mounted sensor will trigger early if the paper is inserted with an angle further in on the right side. With the on center sensor, the stapling operation is closer to a user's expectations.

Along with the center mounted sensor the present invention preferably includes an adjustable sensor position along a length of the body. This allows a range of positions for a staple from the paper edge. A preferred embodiment sensor structure translates along the body and communicates with an elongated sensor bar in the body. Pressing anywhere by the sensor structure along the length of the bar actuates an electrical switch within the body. Therefore, the switch can be fixed in the body so that the connecting wires do not need to flex as in other adjustable switches. An adjusting wheel, rather than a detent slide, for example, moves the sensor for improved control of the sensor position.

In a preferred embodiment, the internal parts of the body all mount into one side. In this way there are no wires or connectors and minimal links to cross to the opposed side. This simplifies assembly and improves reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top, front, left side perspective view of a preferred embodiment electric stapler according to the present invention.

FIG. **2** is the stapler of FIG. **1** with a left housing omitted to expose internal components.

FIG. **3** is a right side elevation view of the electric stapler with the right housing omitted.

FIG. **4** is an exploded view of the components of the electric stapler.

FIG. **5** is a top, right side perspective view of the electric stapler with the right housing omitted to show a rest condition of the components.

FIG. **5**A is a power spring in an energized rest condition corresponding to its position in FIG. **5**.

FIG. **6** is the stapler of FIG. **5** in a condition immediately after release of the striker to eject a staple.

FIG. **6**A is the power spring in a released and preloaded condition corresponding to its position in FIG. **6**.

FIG. **6**B is a detail view of the stapler toward the right housing showing an offset gear axle.

FIG. **7** is the stapler of FIG. **5** in a pre-energized condition.

FIG. **8** is a top, left side perspective view of the stapler.

FIG. **9** is a front elevation view of the stapler.

FIG. **10** is a cross-sectional view of FIG. **9** taken along line **10-10** with the stapler in the pre-energized condition of FIG. **7**.

FIG. **11**A is a detail view from FIG. **10** showing the paper sensor in a normal position.

FIG. **11**B is the view of FIG. **11**A with the paper sensor in a pressed position.

FIG. **12**A is a top perspective view of a paper sensor subassembly in the normal position of FIG. **11**A.

FIG. **12**B is the view of FIG. **12**A with the paper sensor in the pressed position.

FIG. **13** is a reduced size view of FIG. **3** for cross-reference with FIGS. **13**A and **13**B.

FIG. **13**A is a cross-sectional view of the stapler of FIG. **13** taken along line **13**A-**13**A, viewed from the front, showing the paper sensor in the normal position, with the housings omitted.

FIG. **13**B is a cropped, cross-sectional view of the stapler of FIG. **13** taken along line **13**B-**13**B, showing the paper sensor in the pressed position, with one housing half omitted.

FIG. **14** is a detail view of FIG. **3** with the paper sensor subassembly adjusted to a rearward position.

FIG. **15** is a bottom view of the stapler of FIG. **14** showing sensor position adjusting elements.

FIG. **16** is a bottom perspective view of a depth pointer.

FIG. **17**A is a perspective view of a gear and clutch subassembly in a drive condition.

FIG. **17**B is the same view as FIG. **17**A, but with the clutch in a post-release condition.

FIG. **18** is an internal side elevation view of a left housing of the stapler.

FIG. **19** is a detail view of an attachment of a base to the body of the stapler.

FIG. **20** is a cross-sectional view of FIG. **19** taken along line **20-20** showing a base stop limit rib.

FIGS. **21**A-D are electrical schematic views of switch states for an operating cycle.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is directed to a compact, spring-energized, electric stapler shown in the preferred embodiment of FIG. **1**. FIG. **4** provides an exploded view of the major internal components of the stapler shown in FIG. **1**.

FIG. **5** shows some of the components of the preferred embodiment electric stapler of the present invention. Power spring **90** is in a deflected rest position as seen in the isolated view of FIG. **5**A. Gear wheel **83** links to rear end **64** of lever **60** at the lower cam roller **83**a. In the illustrated embodiment, there are two identical opposed gear wheels **83** to reduce the number of unique parts. However, the detailed features are fully used only in the left side gear, the gear shown for example in FIGS. **5** and **6**. The right side gear provides support for axles (not shown) for cam rollers **83**a, and optionally as a second mating gear for gear **82**a. If the axles are of sufficient strength the right side gear may be omitted.

Gear wheel **83**, or the first gear, is stationary in the normal rest condition of FIGS. **2**, **3** and **5** whereby the power spring **90** is deflected and energized before a firing cycle. Ratchet detent **83**b is movably attached to housing **10** to selectively engage catch rib **83**f of gear wheel **83** (FIG. **8**) to prevent backward rotation of the gear wheel from the rest position. Rib **83**f of gear **83** is shown as a termination of a recess in a face of the gear. There are preferably two such recesses in the gear face, FIG. **4**. Ratchet detent **83**b remains proximate to rib **83**f within the recess so that gear wheel **83** cannot reverse, counterclockwise in FIG. **5**. Ramp **83**d of the recess in gear wheel **83**, FIGS. **4** and **8**, allows detent **83**b to ride smoothly out of the recess when gear wheel **83** turns in its normal direction.

Gear **83** or other linked element should be stopped in a consistent rest orientation without over spinning to an unstable toggle position that causes unintentional firing. This unstable condition is also discussed below in the context of gear link **82**. As seen in FIGS. **3** and **5**, roller **83**a presses lever end **64** at an angle before its perpendicular relationship to the lever end, the toggle position. The two small circles on gear **83** correspond to the roller positions, while the rollers are not directly shown in FIG. **3**. Described another way gear **83** rotates until roller **83**a causes lever **60** to pivot near to but not entirely at its corresponding highest striker position. In this position, the force from power spring **90** causes a reverse rotational bias acting on gear **83**, counterclockwise in the view of FIG. **3**. Therefore, the electric motor controllers, discussed below, stop gear **83** sufficiently before the toggle position to ensure the gear does not over spin and cause firing of striker **100**. Accordingly, the rotational position of detent **83**b on gear **83**, or equivalent structure, is such that lever **60** holds striker **100** near but not at its upper most possible position. The reverse bias on gear **83** against detent **83** then holds the assembly stable in the rest condition. Gear **83** may rotate in reverse slightly from the stop position to its rest orientation against the detent. It is then a short portion of the operating cycle to move the gear to the toggle and then release position. Preferably, there are two detent positions on gear **83** or equivalent structure as shown. Since gear **83** rotates one half turn per cycle each such detent corresponds to a single predetermined vertical position of striker **100** in each operating cycle. Optionally, more than two detents may be included.

As an operating cycle begins, gear wheel **83** turns clockwise in FIG. **5** and cam roller **83**a rolls off rear edge **64** of lever **60**. The lever **60** is free to move and energized power spring **90** forces or urges striker **100** downward to eject a staple (not shown) from track **70** by impact blow. Staple pusher **400** biases the staples or like fasteners to move toward striker **100**. Pusher bar **71**, FIG. **13**A, supports a compression spring (not shown) that provides the spring bias to move pusher **400**. Tabs **62** of lever **60** normally contact absorber **220** in the striker lowest position. Nosepiece **300** provides a front terminus to the track **70** and a guide channel for staples and striker **100**.

Cam roller **83**a is of sufficiently large diameter to usefully roll about a small axle (not shown) fitted to gear wheel **83**. Alternatively, a post or sharp-edged hard rib of gear wheel **83** may be used to engage the rear of the lever **60**. But using a roller provides substantially reduced friction between gear wheel **83** and lever **60**. In using a relatively large cam roller, it will tend to roll off of lever end **64** slowly until the two are separated. After separation, the normal energy release and striker motion occur. But during separation there can be lost performance since lever **60** will be released slowly during the roll-off process. An analogy is a car tire rolling slowly off a curb. If the tire is reasonably large in diameter, the car can move downward slowly without damage. But in the case of a power spring, it is desirable to cause damage in the form of holes in the paper being stapled. If a small part of the lever motion is gradual, some of the potential energy in the spring is not available for impact action.

To provide a low friction roller but maintain a sudden release, there can be free play or a compliant link in the system. Then the cam rollers can "flick" away from lever end **64**. For example, the cam rollers may be loosely or slidably mounted to gear wheel **83**. In the preferred embodiment, the free play is in the mated gear subassembly of FIGS. **17**A and **17**B. Gear link **82** includes gear **82**a and stop ribs **82**b, fitted into a recess of second gear **81**. In the normal drive condition, second gear **81** rotates counterclockwise. Stop ribs **82**b press recess ribs **81**b of gear **81**. Second gear **81** can thus drive gear **82**a. This position of the subassembly is normally maintained in the rest condition of FIG. **5** as well as the moving drive condition. As cam roller **83**a moves toward the lever distal end at **64** it becomes unstable. The action briefly reverses so that gear wheel **83** briefly drives gear **82**a. Gear link **82** can freely move a predetermined angle within second gear **81**. Forces within the gear subassembly of FIG. **17**A then reverse to cause this angular motion to the position of FIG. **17**B. Second gear **81** does not make any sudden motion, but inner gear link **82** and gear wheel **83** both move suddenly with gear wheel **83** moving clockwise to about the position of FIG. **6**. In effect, cam gear **83** briefly overshoots the gear train driven by motor **200**. The result of the above interaction is cam roller **83**a does its roll-off instantly. Optional stop ribs **82**b may be resilient extensions as shown, or equivalent absorbing structures in the gear subassembly, to cushion any impact of the sudden reversing motion. In an alternative embodiment roller design, a post or rib of gear wheel **83** may engage a roller fitted at end **64** of lever **60**. The compliant link retains the same advantage.

Next, back in the gear train is third gear assembly **84** and **84**a. Fourth gear **80** mates to motor **200** on shaft **200**a. The gears are preferably made from molded plastic such as acetal or nylon. Other materials may also be used such as other plastics, ceramic, steel, die cast zinc, or machine cut bronze, or any combination thereof. In the preferred embodiment, there are three gear reduction stages for a reduction ratio of between about 100 to 120, including both outer limits and all values therebetween. In contrast, a conventional direct drive device with higher friction and large torque variations may require a ratio of over 150 to allow a practical size and motor. Using spring energy storage keeps the required motor torque relatively constant since the motor is used to deflect a spring rather than directly drive a staple. The motor can then operate near its peak efficiency through most of a cycle.

Power spring **90** includes upper loop **94** and lower arms **92**. At the end of the lower arms is bent tip **91**, FIGS. **5**A, **6**A. FIG. **5**A corresponds to the rest condition of the stapler where the spring is deflected and energized. In FIG. **6**A the spring is non-deflected in a preloaded condition. Arm tips **91** extend within loop **94** to hold the preloaded condition stable. By holding a deflected rest condition the stapler is prepared to operate immediately upon activation. There is no need to wait for wind up or cycling through an operation. Rib **15**, FIGS. **14** and **18**, holds lower spring arm **92** against upward forces so that spring arm **92** remains substantially stationary in the housing.

Spring loop **94** fits to slot **63** of lever **60**, FIG. **14**. Lever tip **61** extends through opening **101** of striker **100**, FIG. **8**. Therefore, the striker and the lever move along with spring loop **94**. The striker is held loosely on the lever tip as the striker moves up when spring **90** is energized, being gently guided by channel **11**, FIG. **18**. As a result there is minimal friction in a re-set energizing stroke as lever **60** lifts striker **100** against the downward bias from power spring **90**. Alternatively, the lever and spring can engage the striker at separate locations of the striker. But then there will be sliding friction under force as the spring and lever oppose each other on the striker and are in and out of striker openings.

As seen in the drawing figures, lever **60** is elongated rearward from striker **100**. Lever **60** pivots about a side to side or lateral axis, preferably but not necessarily at an axis concentric with a coil of power spring **90**. In FIG. **3**, the pivot axis goes into the page. Such orientation allows lever **60** to be elongated with minimal sliding at its arcuate engagement to striker **100**. In FIG. **3**, it is seen that the pivot axis is vertically coincident or aligned with gear **83** or other gears of the gear set. As discussed above, the lever **60** is preferably biased by power spring **90** or other type of spring. The lever **60** in turn drives striker **100**. According to this structure as illustrated in the drawing figures, lever **60** has a spring energized torque applied to impart a vertical downward bias on striker **100**. The torque is generated or applied substantially from rearward of the striker, at the coil of the power spring in the illustrated embodiment. The lever, spring, or spring through the lever, is cantilevered toward the striker to convert the torque to a downward force on the striker. More generally, striker **100** is driven downward in majority by a torque arm, in contrast to direct application of compressive or extensive spring force immediately at the striker location. The torque arm is the lever **60** or may include a further component, such as the power spring **90**, near to the lever. In the example earlier, with the power spring directly engaging the striker, such engagement preferably remains nearest to or substantially vertically coincident with the lever at the striker location to maintain the vertically compact features of the preferred embodiment. Alternatively, the torque may be applied to the lever through the cantilever by an extension or compression spring linked to the lever and located rearward of the striker, or through a flat spring.

Housing **10** is compact at the front where the lever front end is adjacent to an interior ceiling of the housing in the rest condition, as seen in FIG. **3**. The striker **100** is just tall enough to provide opening **101** to receive lever tip **61** for actuating the striker acceleration to eject a staple, yet still fitting within the compact front of housing **10**. With the torque arm positioned as illustrated in the drawing figures between the motor and the striker, with all being at a similar vertical position, the operating elements are elongated and compact both vertically and laterally.

In a paper fastening type stapler, as a staple is ejected, the staple exit end must be pressed toward the base as in FIG. **6**. In a conventional electric stapler, the base and body are a single unit where the staple exit end moves downward internally within a housing. In the preferred embodiment of the present invention, the body and base motion are external. The body is a unitized construction with a single housing **10** and **10**a providing both an exterior shell and the internal frame to support the working parts. The base **20** is preferably a discrete or separate element pivoted to the housing **10** and moves independently, separately from the housing. The preferred embodiment base **20** is substantially exposed outside the housing **10**, **10**a at least about the base sides, top and bottom near a front portion of the base. As illustrated, about half the base **20** is so exposed. This construction allows the design to be compact since the main structures are all single walled, i.e., without an internal frame or nested base. Base **20** includes foot **20**a. A rear foot **10**a is attached to housing **10** and moves with the housing.

According to the preceding discussion, base **20** includes pivot post **22** to fit recess **12** of housing **10**, FIGS. **18** and **19**. Base link **50** is attached to base **20**, discussed in further detail below. Pressing upward at cam **51** of link **50** causes base **20** to move toward housing **10**. Base **20** can therefore close against the paper sheets to be stapled (not shown). In FIG. **5**, one of the cam rollers **83**a is positioned next to cam **51** but has not yet pressed it. Base **20** remains in its rest position spaced from housing **10**. As gear wheel **83** rotates clockwise from FIG. **5** toward and including its position in FIG. **6**, cam roller **83**a forces link cam **51** upward. In FIG. **6** it is seen that housing **10** is moved against base **20**. This action corresponds to just before and after the roll-off of lower cam roller **83**a that leads to ejecting a staple.

Normally there are papers (not shown) situated between the housing and base. In FIG. **6**, the stack height would be zero since the base **20** and housing **10** are in contact. In fact, the stack height may be, for example, 0.10 inch for 25 sheets of typical paper. To allow for this height, link **50** is able to move relative to base **20** to avoid excess force on a rigid structure. Base link **50**, FIG. **10**, is pivotally mounted to base **20** at recess **53**. Base spring **195** pulls the link at opening **52** so that edge **57** normally contacts a rearward face of base **20**. Base spring **195** attaches at front end **196** to the base. Base link **50** and base **20** therefore can pivot together on housing **10** about pivot **22**. But when there is an obstruction, such as a paper stack, base **20** can stop moving toward the housing and link **50** can continue to rotate counterclockwise in FIG. **10** under the force from cam roller **83**a. The configuration of FIG. **10** would not actually cause the base to move since it shows a condition after a stapling operation just before the spring is energized. However, FIG. **10** shows a clear view of base link **50**. FIG. **6** shows the closed base position, so if there were an obstruction to the base motion toward the closed position, there would be a space in front of link edge **57**, as seen in FIG. **10**, as link **50** rotates relative to the no-longer-moving base.

To provide an upper limit stop for housing **10** moving away from base **20**, rib **11** of housing **10** selectively engages rib **23** of base **20**, as seen in FIGS. **4**, **18**, **19** and **20**. Base bias spring **190** holds the housing spaced a normal distance above the base by pressing upward at front end **191**.

To remedy a jam, it can be useful to pull the base **20** open beyond its normal distance. For example, a malformed staple leg may get stuck in anvil **56**, especially when stapling thick paper stacks. An optional feature of the present invention allows that the housing-base opening can be temporarily increased. Accordingly, recess **12** preferably is a slightly vertically elongated opening, FIG. **18**, whereby post **22** is movable vertically within the recess. Normally, rear end **192** of the bias spring presses upward on rib **14** of housing **10** to hold post **22** pivotally at a bottom of recess **12**. If base **20** is forcibly opened from its normal position, base rib **23** pivots slightly about a fulcrum of housing rib **11**. Post **22** moves upward (not shown) in elongated recess **12** whereby the front of the base **20** moves away from the housing **10**. Rib

24 of the base 20, FIG. 4, limits the position of spring rear end 192 to a preloaded condition in base 20.

The present invention in various preferred embodiments further contemplates improvements to a paper sensing system. A preferred embodiment sensor subassembly is shown in FIGS. 12A and 12B. Adjusting slide 47 is movable in a channel or equivalent structure along a length of housing 10. See also FIGS. 11A, 11B, 13A, and 13B. Sensor button 40 moves within slide 47 between a normal position (FIG. 12A) and a pressed position. These button positions are operable for any position of slide 47 along housing 10. In FIGS. 11A and 11B, slide 47 is in a forward most position. This corresponds to installing a staple closest to an edge of the paper. Sensor wire 46 is pivotally mounted to slide 47 at pivot 47a, and at a bottom to button 40 at recess 41, FIGS. 11A, B. The button is loosely held at its front within slide 47. Button 40 thereby moves easily within slide 47. The button 40 and supporting slide 47 are immediately adjacent and below track 70 rather than the conventional position of a switch beside the track. In the normal position, wire 46 is substantially vertical with end 46a being horizontal, FIG. 11A. As button 40 is pressed at button front 42, wire end 46a rotates upward, FIG. 11B. Sensor flap 45 is pivotally mounted to housing 10 at pivot 45a, FIG. 4. Wire end 46a causes flap 45 to rotate upward, FIG. 13B. Flap 45 selectively engages contact 201a of switch 201 to trip switch 201. See also FIG. 7 for the relative positions of flat 45 and contact 201a.

FIG. 14 shows a rearward position of slide 47. This corresponds to installing a staple farther from an edge of the page. The relationship between slide 47 and each of button 40, sensor wire 46, and flap 45 remains functionally unchanged for any selected slide position. Pressing paper against button front 42 creates the same result as for the forward slide position of FIG. 10. Specifically, pressing the button causes flap 45 and contact 201a to move as described above. With this structure thus described a paper sensor is on-center in the stapler and is also adjustable for depth.

Adjusting slide 47 may be directly moved within housing 10 to select a stapling position. For example, a tab of slide 47 may extend externally from a side of housing 10 (not shown) to allow a user to move the slide. In the preferred embodiment, depth pointer 43 surrounds or links to slide 47 whereby moving pointer 43 causes slide 47 to move. These components are visible together in FIG. 7 where the track and related components are removed for clarity. Also see FIG. 4 where slide 47 is directly above its operative position nested within pointer 43. Slide 47 can slide along housing 10 but is largely fixed lengthwise in pointer 43. Pointer 43 is slidable along the length of base 20 while slide 47 can move vertically in pointer 43 as base 20 moves to and away from housing 10. So slide 47 is slidably fixed to housing 10 while pointer 43 is slidably fixed to base 20. As pointer 43 is moved, it contacts slide 47 to cause the slide to move. As housing 10 pivots toward base 20, slide 47 moves downward into pointer 43. Pointer 43 includes its namesake indicator 44 to show where the paper edge will be when the stapler is activated.

As with slide 47, pointer 43 may be directly moved along the base by pushing at or near indicator 44 or other location. This may compromise the appearance and be difficult to control. Further, it can create asymmetric binding forces on the pointer unless the pointer is pushed from both sides. Although the above compromises do not preclude those options in the preferred embodiment, adjusting wheel 120 links to pointer 43 to allow moving the pointer. As seen in FIGS. 15 and 16, adjusting wheel 120 links to gear rack 48 of pointer 43 through gear 121. Retaining plate 122 holds the gear assembly in place in base 20. Adjusting wheel 120, or a linked component, preferably includes detent recesses or equivalent structures to engage base 20. For example, four recesses in a top face of adjusting wheel 120 can be seen in FIG. 4. Such detents provide tactile feedback to a user and hold a position for slide 47. Retaining plate 122 is flexible to provide some resilient vertical motion of the adjusting wheel to allow effective function of the detent action. A resilient detent may engage this system in other places or directions, for example, upon a side of pointer 43. By using a wheel with detents it is easy to accurately adjust the sensor position.

Pointer 43 is biased lengthwise by gear 121 relatively near a centerline of the stapler. This limits twisting and binding forces on pointer 43—such forces being in rotation with respect to the view of FIG. 16. In contrast, a tab of pointer 43 extending, for example, to the lowest position of adjusting wheel 120 in FIG. 16 would tend to twist and bind pointer 43 in its track on base 20. Optionally, an exposed sliding tab on base 20 is separate from pointer 43 to engage pointer 43; this would also reduce the torque arm on pointer 43 that causes binding.

Normally the sensor system is biased toward the normal positions of FIGS. 11A and 13A, with respect to the sensor flap, wire and button. The bias results from the spring force of contact 201a of switch 201 and the weight of flap 45. In the case that an obstruction or other abnormal event occurs, ratchet detent 83b discussed earlier preferably includes a further function to ensure re-set of the sensor system. Sensor flap 45 has a tab 45b, FIGS. 4 and 8. An extension of detent 83b selectively presses tab 45b as gear wheel 83 turns. Specifically, ramp 83d of the gear wheel drives ratchet detent 83b away from the gear wheel. Tab 45b is forced to move to rotate sensor flap 45 to its lowered rest position of FIG. 13A. In turn, sensor wire 46 and button 40 are forced or at least firmly biased to move to the normal positions shown in FIG. 11A. This back up system prevents improper continuous cycling in the event of sensor jams. But as noted previously, flap 45 with tab 45b is normally moved instead from the switch return bias and weight forces.

For control of the operating cycle, a second switch 202 (FIG. 8) is fitted. Gear wheel 83 includes cam track 83e. Switch link 83c moves according to the profile of cam track 83e of gear wheel 83, which in turn corresponds to the cycle positions of cam rollers 83a and lever 60. Switches 201 and 202 may be single pole double throw types. FIGS. 21A to D show switch states for switches 201 and 202 through the operating cycle. According to the function described, the stapler operates primarily or entirely by electromechanical switching without a need for electronic circuits, microprocessors, or components. This reduces manufacturing cost, component expense, and improves reliability. However, such components may be included if it is appropriate.

FIG. 21A shows the rest state. This corresponds to the condition in FIG. 5. Motor 200 is isolated from power. FIG. 21B is the rest condition but with button 40 pressed by paper sheets to trip switch 201 and close the circuit to motor 200. FIG. 21C is the released condition of FIG. 6. The paper is still in place immediately after ejecting the staple. Cam track 83e has rotated to a position to trip switch 202 to open the circuit and stop the gear motions. In FIG. 21D the user has removed the paper. Switch 201 moves to its normal position closing the circuit until cam track 83e advances to the original rest position to open switch 202 and stop the motion.

The switches are shown as mechanical contact type. Optionally, they may be in the form of proximity type, for example, magnetic or optical. Electric socket **205** is fitted tightly within housing **10**.

Most of the gears and rollers preferably rotate upon simple posts or axles (not shown). For second gear **81**, axle **84**b may include an offset end as seen in FIGS. **6** and **6**B. A straight axle would require a smaller diameter third gear **84** to clear the axle, reducing the available gear reduction. With the offset, axle **84**b goes around third gear **84**. The offset portion fits into slot **11**a of housing **10**a to stabilize the axle in the vertical direction, while the end fits into a round recess within the slot to hold the horizontal direction. The assembly of gears **84** and **84**a extends substantially across the width of the body of the stapler with the respective gears at opposed ends. This provides clearance for various components and allows room for the offset of axle **84**b.

Track **70** extends forward (not shown) to load staples. To extend the track release **110** is pressed forward by release button **112**. Tip **114** presses the track release to rotate the track release and free the track. Release button **112** preferably includes integrated spring tabs **113** to hold the button in its normal rearward position in housing **10**. Release button **112** preferably includes a relieved upper face to clear motor **200**, visible in FIGS. **4** and **8**.

In the disclosure there are references to housing **10**. Where applicable this more generally refers to the body comprising housing halves **10** and **10**a.

While particular forms of the invention have been illustrated and described, it will be apparent that various modifications can be made without departing from the spirit and scope of the invention. Furthermore, it is contemplated that features of one embodiment may be combined or used in another embodiment.

What is claimed is:

1. A compact, motorized fastening tool, comprising:
- a body including a front, rear, top, bottom and sides;
- a fastener guide track extending along the bottom of the body;
- a striker at the front of the body including an upper striker position above the track and a lower striker position in front of the track;
- a base pivotally attached to the rear of the body, the base extending forward under the body from the pivotal attachment to the front of the body;
- a gear set disposed along a length of the body above the base, the gear set including a motor and gears linked thereto, the gear set supported within the body with gear set supports being substantially fixed in position on the body in relation to the fastener guide track through a normal operating cycle;
- the body including an upper rest position with the front of the body spaced above a front of the base, and a closed base position of the body wherein the body is rotated downward toward the base;
- a base link selectively engaging the gear set at a base link first end, the first end being within the body, a second end of the base link engaging the base; and
- the gear set including at least the motor thereof, the body, and the guide track all pivoting together in relation to the base to reach the closed base position.

2. The motorized fastening tool of claim **1**, wherein the base is discrete and separate from the body and substantially exposed to move outside the body.

3. The motorized fastening tool of claim **1**, wherein **[**a**]** *the* top of the body is largely externally exposed, and to assume the closed base position, the exposed body top moves downward toward the base.

4. The motorized fastening tool of claim **3**, wherein the body comprises both of an outermost shell and an internal support frame, and wherein the outermost shell with the internal support frame move downward toward the base.

5. The motorized fastening tool of claim **1**, wherein the base link partly surrounds the gear set within the body, and an upper arm of the base link extends to the first end above the gear set and a rear arm of the base link extends downward to the second end rearward of the gear set.

6. The motorized fastening tool of claim **5**, wherein the rear arm passes rearward of the fastener guide track.

7. The motorized fastening tool of claim **1**, wherein the base link includes a resilient connection between the body and the base wherein the body can be normally, forcibly moved away from the base by deflection of the resilient connection.

8. The motorized fastening tool of claim **1**, wherein a final gear of the gear set includes cam features, and the cam features selectively engage the base link first end.

9. The motorized fastening tool of claim **8**, wherein the cam features engage both the base link first end and a striker actuation lever wherein a timing of striker motion and body-to-base motion is coordinated.

10. The motorized fastening tool of claim **9**, wherein the cam features include rollers fitted to the final gear.

11. The motorized fastening tool of claim **10**, wherein the final gear includes two attached, diametrically opposed rollers, and at a predetermined rotational position of the final gear, a first roller presses the base link first end to pivot the body on the base and a second roller actuates the striker to move within the body.

12. A compact, motorized fastening tool, comprising:
- a body with a front, rear, top, bottom, and sides;
- a fastener guide track disposed along the bottom of the body;
- a striker disposed at the front of the body including an upper striker position above the track and a lower striker position in front of the track;
- a motor supported on the body toward the rear of the body;
- a gear set engaging the motor, the gear set mounted and supported by the body;
- a pivotal attachment of the base to the to the rear of the body, the base extending forward under the body from the pivotal attachment to the front of the body; and
- the base and body having separately movable external structures of the fastening tool wherein each of the motor, the gear set, and the body moves in the same manner together about the pivotal attachment toward the base during a normal operating cycle.

13. The motorized fastening tool of claim **12**, wherein *the body is* a unitized body *that* provides both an external shell enclosure and a support frame for internal parts including internal structures to guide and support the gear set and motor, the internal parts moving together with the external body shell toward the base about the pivotal attachment during the normal operating cycle.

14. The motorized fastening tool of claim **12**, wherein the body along with the striker is driven toward the base during the normal operating cycle, and with the body held in a closest position against the base, the striker is pushed downward in a channel of the body toward the base.

15. The motorized fastening tool of claim **13**, wherein the guide track normally remains fixed in position on the body through a full operational cycle.

16. The motorized fastening tool of claim **12**, wherein a base link selectively links the body to the base to cause the body to move toward the base, and a final gear of the gear set includes two attached, diametrically opposed cam rollers, and at a predetermined rotational position of the final gear, a first roller presses a base link first end and a second roller actuates the striker to move within the body.

17. The motorized fastening tool of claim **16**, wherein the base link includes an upper arm extending to the base link first end over the gear set and motor, a rear arm extends downward behind the gear set, and the base link includes a resilient connection to the base wherein the base, in its position nearest the body, is normally forcible away from the body by deflection of the resilient connection.

18. The motorized fastening tool of claim **17**, wherein the rear arm extends downward behind the guide track.

19. The motorized fastening tool of claim **12**, wherein the base is substantially entirely externally exposed at a front portion, and the body normally moves downward toward the exposed front portion, and the base lies substantially entirely below the guide track.

20. A spring assembly of a fastening tool, comprising:

a housing with a front, rear, top, bottom and sides;

a fastener guide track along the bottom of the housing;

a striker at the front of the housing including an upper striker position above the track and a lower striker position in front of the track;

a lever and power spring disposed at a front of the housing, wherein the lever is elongated rearward along a length of the housing, the power spring being a torsion type acting on the striker in majority through a torsional connection to cause a downward bias on the striker;

the power spring including a first spring end movable with respect to the housing, the first spring end linked to the striker to move with the striker, a second spring end, and a structure of the power spring disposed between the first and second spring ends extending substantially behind the striker;

the power spring being elongated including a first arm extending forward from a coil of the power spring to the first spring end adjacent to the striker, a second arm of the power spring extends from the coil to the second spring end;

the first spring arm being above the second arm in a deflected energized condition of the tool, and the spring is not deflected in a released condition of the tool wherein the first arm is moved down to be adjacent to the second arm; and

the second spring arm including a segment angled with respect to the first spring arm wherein the angled segment passes under the first spring arm, the angled segment being adjacent to the first spring arm whereby the spring is preloaded in the released condition, and the angled segment being moved away from the first arm under a bias from the lever in the deflected energized condition.

21. The spring assembly of claim 20, wherein the first spring arm is below the second spring arm adjacent to the coil, and the first spring arm passes beside the second spring arm to be above the second spring arm at distal portions of the arms further away from the coil.

22. The spring assembly of claim 20, wherein the second spring end includes a vertically extending portion adjacent to the first spring arm, the vertically extending portion passing beside the first spring arm to extend upward from below the first spring arm in the released condition of the tool.

23. The spring assembly of claim 22, wherein the second spring end includes a bent tip, and the tip includes the vertically extending portion.

24. The spring assembly of claim 20, wherein the first spring arm directly engages the striker.

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