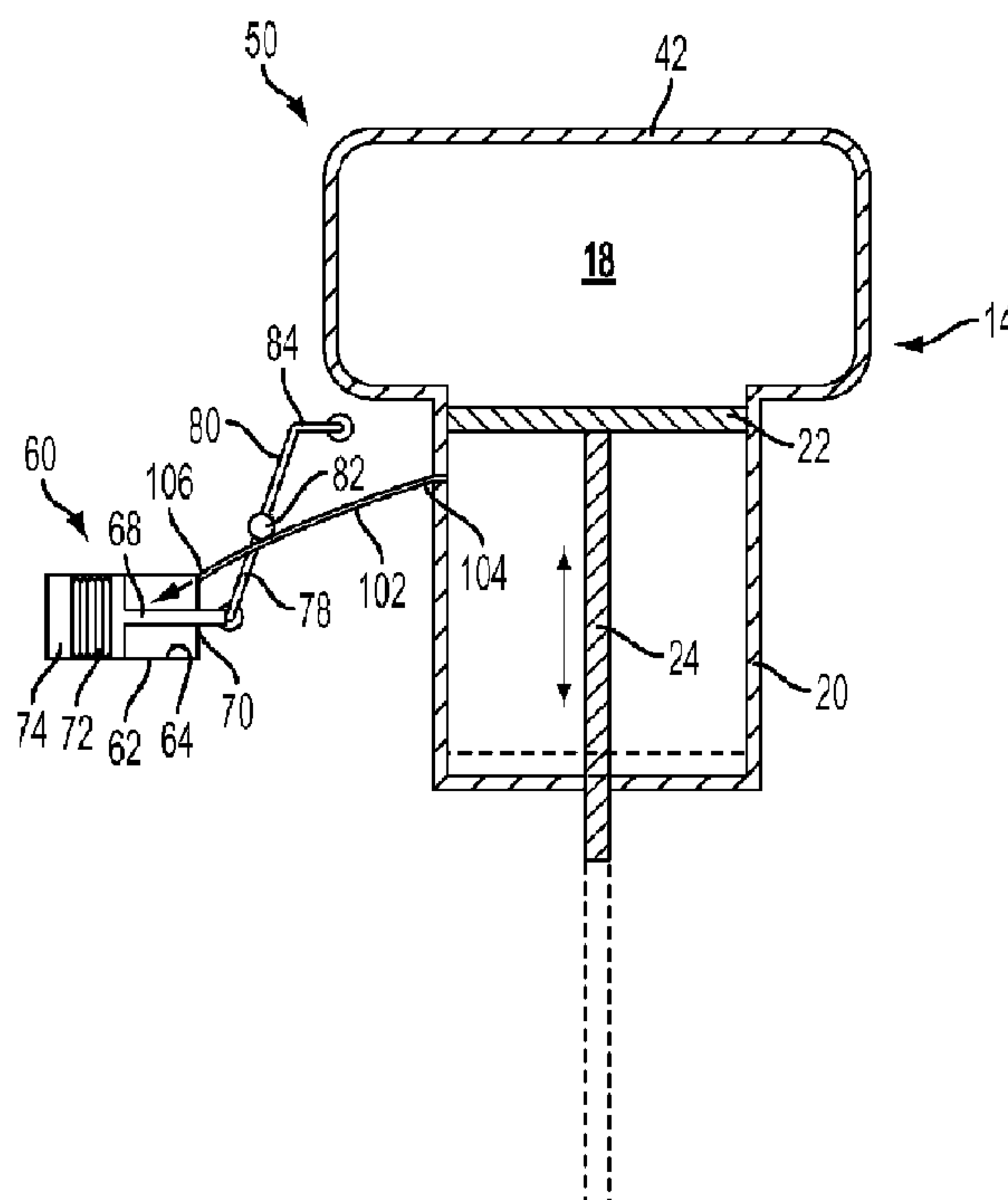




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(72) Inventeurs/Inventors:
ZHAO, HANXIN, US;
PORTH, CHRISTOPHER H., US;
MOORE, STEPHEN P., US
(73) Propriétaire/Owner:
ILLINOIS TOOL WORKS INC., US
(74) Agent: FINLAYSON & SINGLEHURST

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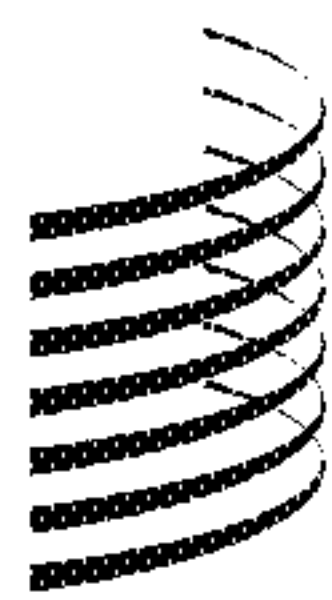


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A combustion-powered fastener-driving tool includes a combustion-powered power source having a combustion chamber, a reciprocating piston and driver blade, and a valve sleeve reciprocable relative to the power source between a rest position and a firing position. The valve sleeve partially defines the combustion chamber. A lockout device is in fluid communication with the combustion power source and includes a reciprocating gas piston connected to a latch in operational proximity to the valve sleeve. The lockout device is configured such that upon combustion in the combustion chamber, gas from the combustion engages the gas piston and moves the latch to an engaged position in which the valve sleeve is prevented from moving to the rest position.

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(71) Applicant: **ILLINOIS TOOL WORKS INC.** [US/US];
155 Harlem Avenue, Glenview, Illinois 60025 (US).

(72) Inventors: **ZHAO, Hanxin**; c/o Illinois Tool Works Inc.,
3600 West Lake Avenue, Glenview, Illinois 60026 (US).
PORTH, Christopher H.; c/o Illinois Tool Works Inc.,
3600 West Lake Avenue, Glenview, Illinois 60026 (US).
MOORE, Stephen P.; c/o Illinois Tool Works Inc., 3600
West Lake Avenue, Glenview, Illinois 60026 (US).

(74) Agent: **HAUPTMAN, Benjamin J.**; LOWE HAUPTMAN
HAM & BERNER, LLP, 2318 Mill Road, Suite 1400, Al-
exandria, Virginia 22314 (US).

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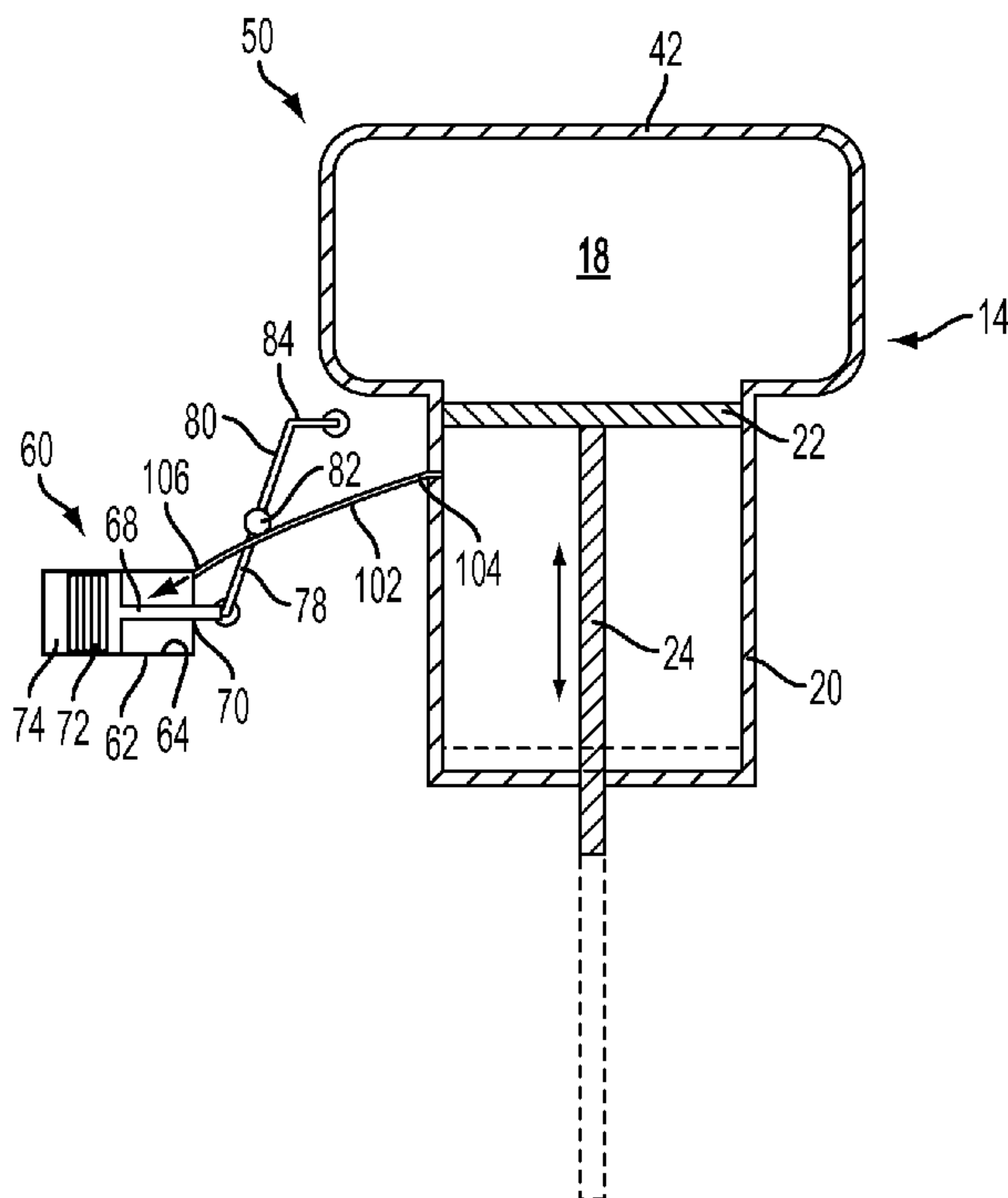


FIG. 7

(57) Abstract: A combustion-powered fastener-driving tool (50) includes a combustion-powered power source (14) having a combustion chamber (18), a reciprocating piston (22) and driver blade (24), and a valve sleeve (36) reciprocable relative to the power source (14) between a rest position and a firing position. The valve sleeve (36) partially defines the combustion chamber (18). A lockout device (60) is in fluid communication with the combustion power source (14) and includes a reciprocating gas piston (66) connected to a latch (80) in operational proximity to the valve sleeve (36). The lockout device (60) is configured such that upon combustion in the combustion chamber (18), gas from the combustion engages the gas piston (66) and moves the latch (80) to an engaged position in which the valve sleeve (36) is prevented from moving to the rest position.

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LOCKOUT FOR FASTENER-DRIVING TOOL

BACKGROUND

The present invention relates generally to fastener-driving tools used to drive fasteners into workpieces, and specifically to pneumatic or combustion-powered fastener-driving tools, also referred to as fastener drivers.

5 Combustion-powered tools are known in the art. Exemplary tools are manufactured by Illinois Tool Works, Inc. of Glenview, Illinois for use in driving fasteners into workpieces, and are described in commonly assigned patents to Nikolich U.S. Pat. Re. No. 32,452, and U.S. Pat. Nos. 4,522,162; 4,483,473; 4,483,474; 4,403,722; 5,133,329; 5,197,646; 5,263,439; 6,145,724
10 and 7,383,974 all of which may be referenced for further details.

Such tools incorporate an external tool housing enclosing a small internal combustion engine. The engine is powered by a canister of pressurized fuel gas, also called a fuel cell. A battery-powered electronic power distribution unit produces a spark for ignition, and a fan located in a combustion chamber
15 provides for both an efficient combustion within the chamber, while facilitating processes ancillary to the combustion operation of the device. Such ancillary processes include: cooling the engine, mixing the fuel and air within the chamber, and removing, or scavenging, combustion by-products. The engine includes a reciprocating piston with an elongated, rigid driver blade disposed
20 within a single cylinder body.

A valve sleeve is axially reciprocable about the cylinder and, through a linkage, moves to close the combustion chamber when a work contact element at the end of the linkage is pressed against a workpiece. This pressing action also triggers a fuel-metering valve to introduce a specified volume of fuel
25 into the closed combustion chamber. This same movement of the tool against the workpiece causes the fan inside the combustion chamber to turn on and mix the fuel with the air inside the combustion chamber.

Upon the pulling of a trigger, which closes a trigger switch, a spark is generated for igniting a charge of gas in the combustion chamber of the
30 engine, the resulting high pressure inside the chamber causes the combined piston and driver blade to be forced downward to impact a positioned fastener and drive it into the workpiece. Just before the piston impacts a resilient bumper at a lower end of the cylinder, the piston passes an exhaust port, through which some of the exhaust gas is vented. Next, the tool valve sleeve and cylinder
35 absorb heat from the combustion to generate vacuum pressure that pulls the piston back to its uppermost position for the next cycle. Fasteners are fed magazine-style into the nosepiece, where they are held in a properly positioned orientation for receiving the impact of the driver blade.

For efficient operation, it is preferred that the combustion chamber
40 remains sealed until the piston returns to its uppermost or pre-firing position. The amount of time that the combustion chamber remains closed is a function of the operator's work rhythm and is often too short when attempting a repetitive cycle operation, where the trigger remains pulled and the workpiece contact

element (WCE) is rapidly pressed upon the workpiece for fastener driving, and
45 then the tool is quickly lifted and moved to the next fastener location.

With combustion-powered tools of the type disclosed in the
aforementioned patents, by firing rate and control of the valve sleeve, the operator
controls the time interval provided for the vacuum-type piston return. The
formation of the vacuum occurs following the combustion of the mixture and the
50 exhausting of the high-pressure burnt gases. With residual high temperature gases
in the tool, the surrounding lower temperature aluminum components cool and
collapse the gases, thereby creating a vacuum. In many cases, such as in trim
applications, the operator's cycle rate is slow enough that vacuum return works
consistently and reliably

55 However, for those cases where a tool is operated at a much higher
cycle rate, the operator can open the combustion chamber during the piston
return cycle by removing the tool from the workpiece. This causes the vacuum
to be lost and piston travel will stop before reaching the top of the cylinder. This
leaves the driver blade in the guide channel of the nosepiece, thereby preventing
60 the nail strip from advancing towards the nose. The net result is no nail in the
firing channel and no nail fired in the next shot.

To assure adequate closed combustion chamber dwell time in the
sequentially-operated combustion tools identified above, a chamber lockout
device is known that is linked to the trigger. This mechanism holds the
65 combustion chamber closed until the operator releases the trigger. This extends
the dwell time (during which the combustion chamber is closed) by taking into

account the operator's relatively slow musculature response time. In other words, the physical release of the trigger consumes enough time of the firing cycle to assure piston return. The mechanism also maintains a closed chamber
70 in the event of a large recoil event created, for example, by firing into hard wood or on top of another nail. It is disadvantageous to maintain the chamber closed longer than the minimum time to return the piston, as cooling and purging of the tool is prevented.

In commonly-assigned US Patent No. 7,383,974, an
75 electromagnetic solenoid controls a pivoting latch for periodically locking the valve sleeve in the closed position. In some cases, electromagnetic force has been found to lack sufficient holding power for retaining the valve sleeve against motion along the main tool axis towards the open position of the valve sleeve.

Thus, there is a need for a combustion-powered fastener-driving
80 tool which is capable of operating in a repetitive cycle mode. There is also a need for a combustion-powered fastener-driving tool which addresses the special needs of delaying the opening of the combustion chamber to achieve complete piston return in a repetitive cycle mode.

SUMMARY

85 The above-listed needs are met or exceeded by the present fastener-driving tool which overcomes the limitations of the current technology. Among other things, the present tool incorporates a combustion chamber lockout that is designed to temporarily lock the valve sleeve in the closed position and

maintain the combustion chamber sealed until the piston can be returned to its pre-
90 firing position. An advantage of the present lockout mechanism is that it is
operative independent of the particular operator work rhythm.

A feature of the present lockout mechanism is a relatively small
gas cylinder enclosing a reciprocating gas piston that is in direct fluid
95 communication with the combustion chamber. A piston rod of the gas piston is
connected at a free end to a pivoting latch. A pivot axis of the latch preferably
extends transversely to a main tool axis, defined by the direction of motion of
the main tool piston and driver blade. The latch reciprocates between a
disengaged position, with the gas piston rod in an extended position relative to
100 the gas cylinder, and an engaged position, with the gas piston rod retracted
relative to the gas cylinder. The gas piston preferably reciprocates transversely
to the main tool axis. A return spring in the gas cylinder biases the gas piston
toward the extended position. In the engaged position, the latch engages a
portion of the valve sleeve such that it cannot move from the closed position to
105 the open position until the latch is disengaged.

During a fastener driving cycle, once combustion occurs in the
combustion chamber, high gas pressure from the combustion chamber is
diverted to the gas cylinder, overcomes the force of the return spring and pushes
the piston within the cylinder so that the latch moves from the disengaged
110 position to the engaged position, where a locking end of the latch engages the
tool valve sleeve and prevents the sleeve from moving in a way that opens the

combustion chamber. Once the latch is in the engaged position, an electromagnet associated with the gas cylinder is energized and holds the gas piston in the retracted position so that the valve sleeve is prevented from opening
115 once the combustion-generated gas pressure decreases.

A tool control system controls the energization of the electromagnet. Once the main piston returns to its pre-firing position, an event determined in a variety of ways, including the expiration of a preset period of time, the electromagnet is deenergized, releasing the hold on the gas piston, so
120 that the return spring pushes the gas piston to the point where the gas piston rod is in the extended position, and the latch is disengaged. Upon disengagement of the latch, the valve sleeve is free to move to the open position, venting the spent combustion gases and allowing the input of a fresh supply of air for the next combustion.

125 More specifically, the present combustion-powered fastener-driving tool includes a combustion-powered power source having a combustion chamber, a reciprocating piston and driver blade, and a valve sleeve reciprocable relative to the power source between a rest position and a firing position. The valve sleeve partially defines the combustion chamber. A lockout device is in
130 fluid communication with the combustion power source and includes a reciprocating gas piston connected to a latch in operational proximity to the valve sleeve. The lockout device is configured such that upon combustion in the combustion chamber, gas from the combustion engages the gas piston and

moves the latch to an engaged position in which the valve sleeve is prevented
135 from moving to the rest position.

In another embodiment, a lockout mechanism is provided for use
with a fastener-driving tool having a reciprocating valve sleeve and a main
piston reciprocating between a pre-firing position and a fastener-driving
position. The mechanism includes a gas cylinder enclosing a gas piston having a
140 piston rod extending from the cylinder and reciprocating within the cylinder
between a first position and a second position. A return spring biases the gas
piston in the first position. An electromagnet is associated with the gas cylinder
such that upon energization of the electromagnet, the gas piston is retained in the
second position. A gas conduit is connected between the gas cylinder and a
145 combustion power source for periodically receiving a supply of compressed gas
for operating the gas piston in a way that overcomes a force of the return spring.
A latch has a first portion connected to the gas piston and a second portion
configured for engaging the valve sleeve, and pivots between a disengaged
position, in which the valve sleeve freely moves between a rest position and a
150 firing position, and an engaged position, in which the valve sleeve is prevented
from moving from the firing position to the rest position.

In still another embodiment, a fastener-driving tool is provided,
including a combustion-powered power source having a combustion chamber,
and main piston and driver blade reciprocating along a main tool axis between a
155 pre-firing position and a fastener driving position. A valve sleeve reciprocates
along the main tool axis relative to the power source between a rest position and a

firing position and partially defines the combustion chamber. A lockout device is in fluid communication with the power source and includes a reciprocating gas piston moving between an extended position and a retracted position. A latch in the lockout device is in operational proximity to the valve sleeve and moves between a disengaged position, in which the valve sleeve moves between the firing position and the rest position, and an engaged position in which the valve sleeve is prevented from moving from the firing position to the rest position. A tool control system is connected to an electromagnet associated with the gas cylinder and is configured for energizing the electromagnet for a preset period of time. The tool is configured such that upon combustion in the combustion chamber, gas from the combustion engages the gas piston and moves the latch to the engaged position in which the valve sleeve is prevented from moving to the rest position, and the control system energizes the electromagnet for retaining the gas piston in the retracted position until the main piston returns to the pre-firing position.

In another embodiment, a fastener-driving tool is provided, having a combustion-powered power source with a housing, a combustion chamber, and a reciprocating piston and driver blade that each move along a main axis; also, a valve sleeve reciprocal relative to the power source between a rest position and a firing position and partially defining the combustion chamber; and also a lockout device in fluid communication with the power source, also included is a reciprocating gas piston connected to a latch in operational

proximity to the valve sleeve, the latch being pivotably connected to the housing and configured such that upon combustion in the combustion chamber, gas from the combustion engages the gas piston and moves the latch to an engaged position in which the valve sleeve is prevented from moving to the rest position. In an embodiment, the fastener-driving tool further includes a tool control system, and an electromagnet connected to the control system and located in operational proximity to the gas piston for holding the gas piston so that the latch is retained in the engaged position for a period determined by the control system.

In another embodiment, a fastener-driving tool is provided, including a combustion-powered power source having a combustion chamber, and a main piston and driver blade reciprocating along a main tool axis between a pre-firing position and a fastener driving position; a valve sleeve reciprocating along said main tool axis relative to said power source between a rest position and a firing position and partially defining said combustion chamber; and a lockout device in fluid communication with said combustion power source and including a reciprocating gas piston moving between an extended position and a retracted position, and a latch pivotally connected to said gas piston and in operational proximity to said valve sleeve and moving between a disengaged position in which said valve sleeve moves between said firing position and said

rest position, and an engaged position in which said valve sleeve is prevented from moving from said firing position to said rest position; a tool control system connected to an electromagnet associated with a gas cylinder and configured for energizing said electromagnet for a pre-set period of time; and said tool configured such that upon combustion in said combustion chamber, gas from said combustion forces said gas piston to said retracted position, moving said latch to said engaged position in which said valve sleeve is prevented from moving to said rest position, and said control system energizes said electromagnet for retaining said gas piston in said retracted position until said main piston returns to said pre-firing position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front perspective view of a prior art fastener-driving tool;

FIG. 2 is a fragmentary vertical cross-section of the tool of FIG. 1 shown in the rest position;

FIG. 3 is a fragmentary vertical cross-section of the present tool, similar to the tool of FIG. 2 but shown in the pre-firing position;

FIG. 4 is a fragmentary side elevation of the present fastener-
 180 driving tool with the lockout in the disengaged position;

FIG. 5 is a fragmentary side elevation of the tool of FIG. 4 with the
 lockout latch in the engaged position, holding the valve sleeve in the closed
 position;

FIG. 6 is a schematic vertical section of the present tool depicting
 185 the internal operation of the gas piston and the latch in the disengaged position;
 and

FIG. 7 is a schematic vertical section of the tool of FIG. 6
 depicting the gas piston and the latch in the engaged position.

DETAILED DESCRIPTION

190 Referring now to FIGs. 1 and 2, a prior art combustion-powered
 fastener-driving tool incorporating the present invention is generally designated 10
 and preferably is of the general type described in detail in the patents listed above
 which may be referenced for further details. As will be seen below, this tool 10 is
 modified as described to incorporate the features of the present lockout system. A
 195 housing 12 of the tool 10 encloses a self-contained internal power source 14 (FIG.
 2) within a housing main chamber 16. As in conventional combustion tools, the
 power source 14 is powered by internal combustion and includes a combustion
 chamber 18 that communicates with a cylinder 20. A piston 22, also referred to as a
 main piston, reciprocally disposed 200 within the cylinder 20 is connected to the
 200 upper end of a driver blade 24.

As shown in FIG. 2, an upper limit of the reciprocal travel of the piston 22 is referred to as a pre-firing position, which occurs just prior to firing, or the ignition of the combustion gases which initiates the downward driving of the driver blade 24 to impact a fastener (not shown) to drive it into a workpiece.

205 Through depression of a trigger 26, an operator induces combustion within the combustion chamber 18, causing the driver blade 24 to be forcefully driven downward through a nosepiece 28 (FIG. 1). The nosepiece 28 guides the driver blade 24 to strike a fastener that had been delivered into the nosepiece via a fastener magazine 30.

210 Included in the nosepiece 28 is a workpiece contact element 32, which is connected, through a linkage or upper probe 34 to a reciprocating valve sleeve 36, an upper end of which partially defines the combustion chamber 18. Depression of the tool housing 12 against the workpiece contact element 32 in a downward direction as seen in FIG. 1 (other operational orientations are
215 contemplated as are known in the art), causes the workpiece contact element 32 to move from a rest position to a firing position. This movement overcomes the normally downward biased orientation of the workpiece contact element 32 caused by a spring 38 (shown hidden in FIG. 1). It is contemplated that the location of the spring 38 may vary to suit the application, and locations displaced
220 farther from the nosepiece 28 are envisioned.

 Through the linkage 34, the workpiece contact element 32 is connected to and reciprocally moves with, the valve sleeve 36. In the rest position (FIG. 2), the combustion chamber 18 is not sealed, since there is an

annular gap 40 separating the valve sleeve 36 and a cylinder head 42, which
225 accommodates a chamber switch 44 and a spark plug 46. Specifically, there is an
upper gap 40U near the cylinder head 42, and a lower gap 40L near the upper end
of the cylinder 20. In the preferred embodiment of the prior art tool 10, the cylinder
head 42 also is the mounting point for a cooling fan 48 and a fan motor 49
powering the cooling fan. The fan 48 and at least a portion of the motor 49 extend
230 into the combustion chamber 18 as is known in the art and described in the
aforementioned patents which may be referenced for further details. In the rest
position depicted in FIG. 2, the tool 10 is disabled from firing because the
combustion chamber 18 is not sealed at the top with the cylinder head 42, and the
chamber switch 44 is open.

235 Referring now to FIGs. 3-5, the combustion tool of the invention is
generally designated 50. Components shared with the tool 10 are designated
with identical reference numbers. Firing is enabled when an operator presses the
workpiece contact element 32 against a workpiece. This action overcomes the
biasing force of the spring 38, causes the valve sleeve 36 to move upward
240 relative to the housing 12, closing the gaps 40U and 40L and sealing the
combustion chamber 18 until the chamber switch 44 is activated. This operation
also induces a measured amount of fuel to be released into the combustion
chamber 18 from a fuel canister 52 (shown in fragment).

Upon a pulling of the trigger 26, the spark plug 46 is energized,
245 igniting the fuel and air mixture in the combustion chamber 18 and sending the
piston 22 and the driver blade 24 downward toward the waiting fastener for

entry into the workpiece. As the piston 22 travels down the cylinder 20, it pushes a rush of air which is exhausted through at least one petal or check valve 54 and at least one vent hole 56 located beyond piston displacement (FIG. 2). At
250 the bottom of the piston stroke or the maximum piston travel distance, the piston 22 impacts a resilient bumper 58 (FIG. 2) as is known in the art. With the piston 22 beyond the exhaust check valve 54, high pressure gasses vent from the cylinder 20 until near atmospheric pressure conditions are obtained and the check valve 54 closes. Due to internal pressure differentials in the cylinder 20,
255 the piston 22 is returned to the pre-firing position shown in FIG. 2.

As described above, one of the issues confronting designers of combustion-powered tools of this type is the need for a rapid return of the piston 22 to pre-firing position and improved control of the chamber 18 prior to the next cycle. This need is especially critical if the tool is to be fired in a repetitive
260 cycle mode, where an ignition occurs each time the workpiece contact element 32 is retracted, and during which time the trigger 26 is continually held in the pulled or squeezed position.

Referring again to FIGs. 3-7, to accommodate these design concerns, the present tool 50 preferably incorporates a lockout device, generally
265 designated 60 and configured for preventing the reciprocation of the valve sleeve 36 from the closed or firing position until the piston 22 returns to the pre-firing position. This holding, delaying or locking function of the lockout device 60 is operational for a specified period of time required for the piston 22 to return to the pre-firing position. Thus, the operator using the tool 50 in a repetitive cycle

270 mode can lift the tool from the workpiece where a fastener was just driven, and begin to reposition the tool for the next firing cycle without risk of prematurely opening the combustion chamber 18.

Due to the shorter firing cycle times inherent with repetitive cycle operation, the lockout device 60 ensures that the combustion chamber 18 will remain sealed, and the differential gas pressures maintained so that the piston 22
275 will be returned before a premature opening of the chamber 18, which would normally interrupt piston return. With the present lockout device 60, the piston 22 return and subsequent opening of the combustion chamber 18 can occur while the tool 10 is being moved toward the next workpiece location.

280 Referring now to FIGs. 4-7, included in the lockout device 60 is a generally cylindrical housing 62 defining an internal cylinder 64 in which reciprocates a gas piston 66 having a gas piston rod 68. FIG. The piston rod 68 projects through an opening 70 in the housing 62. Opposite the piston rod 68, the gas piston 66 is biased towards the opening 70 by a gas return spring 72
285 located within the cylinder 64. Reciprocation of the gas piston 66 within the internal or gas cylinder 64 is between a first or extended position (FIG. 6) and a second or retracted position (FIG. 7), the gas return spring 72 biasing the gas piston to the extended position.

An electromagnet 74 is located within the housing 62 and is
290 associated with the gas cylinder 64, preferably at an opposite end from the opening 70 and the piston rod 68. More specifically, the electromagnet 74 is constructed and arranged for retaining the gas piston 66 in the retracted position.

As seen in FIG. 7, the gas return spring 72 is located in the gas cylinder 64 between the gas piston 66 and the electromagnet 74, and is compressed when the
295 gas piston 66 is in the retracted position. As described below in greater detail, upon energization, the electromagnet 74 is sufficiently powerful for retaining the gas piston 66 in the retracted position for a specified period of time.

Referring now to FIGs. 4 and 5, which depict an exterior of the casting forming the cylinder 20 and the reciprocating valve sleeve 36, a free end
300 76 of the piston rod 68 is connected to a first portion 78 of a generally “S” or dogleg-shaped latch 80 that is configured for pivoting about a pivot axis 82 extending transverse to a main tool axis defined by movement of said driver blade 24. Opposite the first portion 78, the latch 80 has a second portion 84 configured for engaging the valve sleeve 36. While the specific configuration of
305 the second portion 84 may vary to suit the situation, in the preferred embodiment, a small roller 86 is rotatably disposed at a tip 88 of the second portion 84. The second portion 84 is constructed and arranged for engaging the valve sleeve at a ledge 90 located just below the portion partially defining the combustion chamber 18 (FIG. 5).

310 In the preferred embodiment, the pivot axis 82 takes the form of a threaded fastener engaging a boss 92 (FIG. 5) in the cylinder 20. A suitable bearing 94 facilitates the pivoting action of the latch 80 about the axis 82 as is known in the art. Also, the cylindrical housing 62 is similarly attached to the cylinder 20 at a second boss 96, which receives a fastener 98 engaging an eyelet
315 100 attached to the housing.

Referring again to FIGs. 6 and 7, another feature of the present
lockout device 60 is that the lockout device is in fluid communication with the
combustion power source 14 such that a conduit or gas passageway 102 delivers
combustion gas generated during combustion in the combustion chamber 18
320 during the fastener driving cycle. More specifically, the conduit 102 is
constructed and arranged to siphon off a portion of the combustion gas after the
piston 22 has passed the conduit 102 on the way to drive a fastener. Thus, one
end 104 of the conduit 102 is connected to the cylinder 20, and the opposite end
106 is connected to the internal cylinder 64. The siphoned portion of combustion
325 gas traveling through the conduit 102 forces the gas piston 66 to the retracted
position and overcomes the force of the gas return spring 72. The electromagnet
74 retains the gas piston 66 in the retracted position under the control of a tool
control system 108, preferably a control program 110 located in a Central
Processing Unit (CPU) 112, usually located in the tool handle 114 (see FIG. 1),
330 however other locations are contemplated. As is known in the art of
combustion tools, the control system 108 controls energization of the spark plug
46, the operation of the fan motor 49 as well as other functions. In the present
tool 50, the control system 108 also controls the energization of the
electromagnet 74.

335 The main purpose of the electromagnet 74 holding the gas piston
66 in the retracted position is that the latch 80 is held in the engaged position
(FIGs. 5 and 7) which engages the valve sleeve 36 and prevents it from moving
from the closed position of FIG. 3 to the rest position of FIG. 2. Thus, the

combustion chamber 18 remains closed as long as the latch 80 is in the engaged
340 position. This condition is maintained as long as the electromagnet 74 is
energized by the control system 108. While the specific time period of
energization of the electromagnet 74 varies with the application, in the preferred
embodiment, the electromagnet is energized by the control system 108 for
approximately 100 msec. This period is considered sufficient such that enough
345 dwell is provided to satisfy all operating conditions for full piston return. During
this period, the latch 80 is held in the engaged position, thereby preventing the
chamber 18 from opening.

Furthermore, the retention of the gas piston 66 in the retracted
position (FIG. 7) prevents action of the gas return spring 72, which will force the
350 gas piston 66 to the extended position (FIG. 6) upon de-energization of the
electromagnet 74. This de-energization will permit release of the valve sleeve
36 from the latch 80, and the corresponding venting and recharge of the
combustion chamber 18 for the next combustion.

A feature of the present tool 50 is that the control system 108 is
355 configured such that the electromagnet 74 is energized for a time period
sufficient for the main piston 22, shown in a fastener driving position in phantom
in FIG. 7, to return to the pre-firing position (FIG. 2). It is also contemplated
that the lockout device 60 and the latch 80 are potentially configured so that a
reverse sequence of movement of the gas piston 66 (extended v. retracted)
360 triggers the engagement/disengagement of the valve sleeve 36. Another feature
of the present tool 50 is that the combination of pressurized combustion gas used

for retracting the gas cylinder 66, coupled with electromagnetic power of the electromagnet 74 is more effective and consistent in the operation of retaining the valve sleeve 36 in the closed position, than relying solely on
365 electromechanical power, as was done in prior tool lockout devices.

The control program 108 is configured so that once the piston 22 has returned to the pre-firing position; the electromagnet 74 is deenergized, reducing the transversely directed force on the latch 80. As the user lifts the tool 10 from the workpiece, and following timed de-energization of the
370 electromagnet 74, the spring 38 will overcome the force of the gas return spring 72, and will cause the valve sleeve 36 to move to the rest or extended position, opening up the combustion chamber 18 and the gaps 40U, 40L. As is known, the valve sleeve 36 must be moved downwardly away from the fan 48 to open the chamber 18 for exchanging gases in the combustion chamber 18 and for
375 preparing for the next combustion.

While a particular embodiment of the present lockout for a fastener-driving tool has been described herein, it will be appreciated by those skilled in the art that changes and modifications may be made thereto without departing from the invention in its broader aspects and as set forth in the
380 following claims.

CLAIMS

What is Claimed is:

1. A fastener-driving tool, comprising:
 - a combustion-powered power source having a housing, a combustion chamber, and a reciprocating piston and driver blade that each move along a main axis;
 - a valve sleeve reciprocal relative to said power source between a rest position and a firing position and partially defining said combustion chamber; and
 - a lockout device in fluid communication with said power source and including a reciprocating gas piston connected to a latch in operational proximity to said valve sleeve, said latch being pivotably connected to said housing and configured such that upon combustion in said combustion chamber, gas from said combustion engages said gas piston and moves said latch to an engaged position in which said valve sleeve is prevented from moving to said rest position.
2. The tool of claim 1, further including a tool control system, and an electromagnet connected to said control system and located in operational proximity to said gas piston for holding said gas piston so that said latch is retained in said engaged position for a period determined by said control system.
3. The tool of claim 2, wherein said gas piston has a piston rod and reciprocates within a gas cylinder between an extended position and a retracted position, said cylinder being provided with a return spring for biasing said gas piston to said extended position.

4. The tool of claim 3, wherein the electromagnet associated with said gas cylinder is constructed and arranged for retaining said gas piston in said retracted position under control of the tool control system.

5. The tool of claim 3, wherein said return spring is compressed when said gas piston is in said retracted position.

6. The tool of claim 3, wherein said return spring is located in said gas cylinder between said gas piston and said electromagnet.

7. The tool of claim 4, wherein said electromagnet is located at an end of said gas cylinder opposite said gas piston rod.

8. The tool of claim 1, wherein said latch pivots about a pivot axis extending transverse to said main axis and includes a first portion connected to said gas piston, and a second portion configured for engaging said valve sleeve.

9. The tool of claim 8, wherein said first portion of said latch is pivotally connected to a rod of said gas piston.

10. The tool of claim 1, wherein said reciprocating piston moves between a pre-firing position and a driving position, and the tool control system configured for causing said latch to remain in said engaged position after a combustion until said reciprocating piston reaches the pre-firing position.

11. A lockout mechanism for use with a fastener-driving tool having a reciprocating valve sleeve and a combustion power source with a main piston reciprocating between a pre-firing position and a fastener-driving position, said mechanism comprising:

a gas cylinder enclosing a gas piston having a piston rod extending from said cylinder and reciprocating within said cylinder between a first position and a second position, a return spring biasing said gas piston in said first position,

a gas conduit connected between said gas cylinder and the combustion power source for periodically receiving a supply of compressed gas for operating said gas piston in a way that overcomes a force of said return spring; and

a latch having a first portion connected to said gas piston and a second portion configured for engaging the valve sleeve, wherein the lockout mechanism further comprises an electromagnet associated with said gas cylinder such that upon energization of said electromagnet, said gas piston is retained in said second position, and in that said latch pivoting between a disengaged position in which the valve sleeve freely moves between a rest position and a firing position, and an engaged position, in which said valve sleeve is prevented from moving from said firing position to said rest position.

12. The mechanism of claim 11, wherein said return spring is located within said gas cylinder between said gas piston and said electromagnet.

13. The mechanism of claim 11, wherein said latch pivots about a pivot axis extending transversely to a main tool axis.

14. The mechanism of claim 11, wherein said gas piston is connected to said tool.

15. A fastener-driving tool, comprising:

a combustion-powered power source having a combustion chamber, and a main piston and driver blade reciprocating along a main tool axis between a pre-firing position and a fastener driving position;

a valve sleeve reciprocating along said main tool axis relative to said power source between a rest position and a firing position and partially defining said combustion chamber; and

a lockout device in fluid communication with said combustion power source and including a reciprocating gas piston moving between an extended position and a retracted position, and a latch pivotally connected to said gas piston and in operational proximity to said valve sleeve and moving between a disengaged position in which said valve sleeve moves between said firing position and said rest position, and an engaged position in which said valve sleeve is prevented from moving from said firing position to said rest position;

a tool control system connected to an electromagnet associated with a gas cylinder and configured for energizing said electromagnet for a pre-set period of time; and

said tool configured such that upon combustion in said combustion chamber, gas from said combustion forces said gas piston to said retracted position, moving said latch to said engaged position in which said valve sleeve is prevented from moving to said rest position, and said control system energizes said electromagnet for retaining said gas piston in said retracted position until said main piston returns to said pre-firing position.

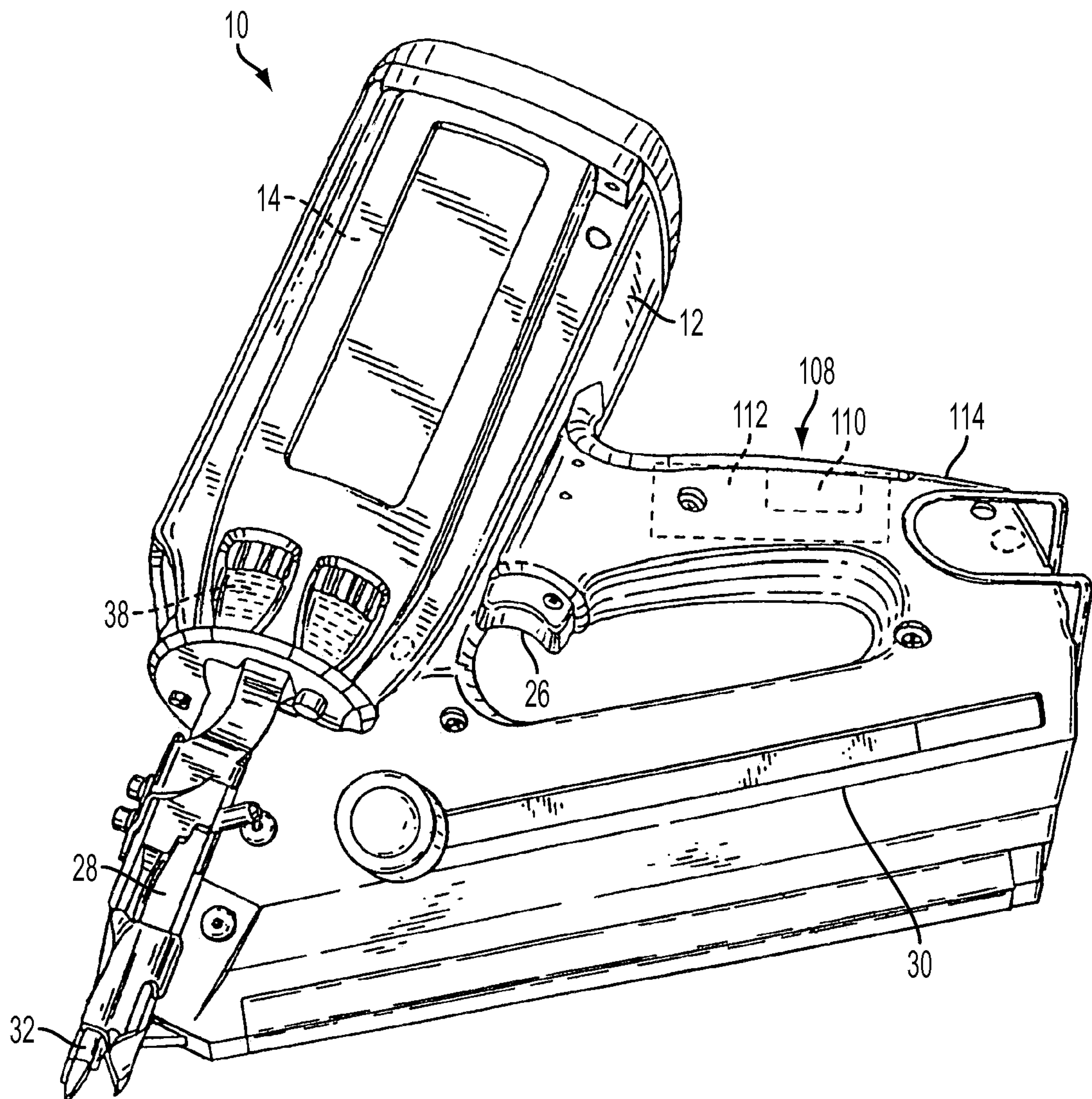


FIG. 1

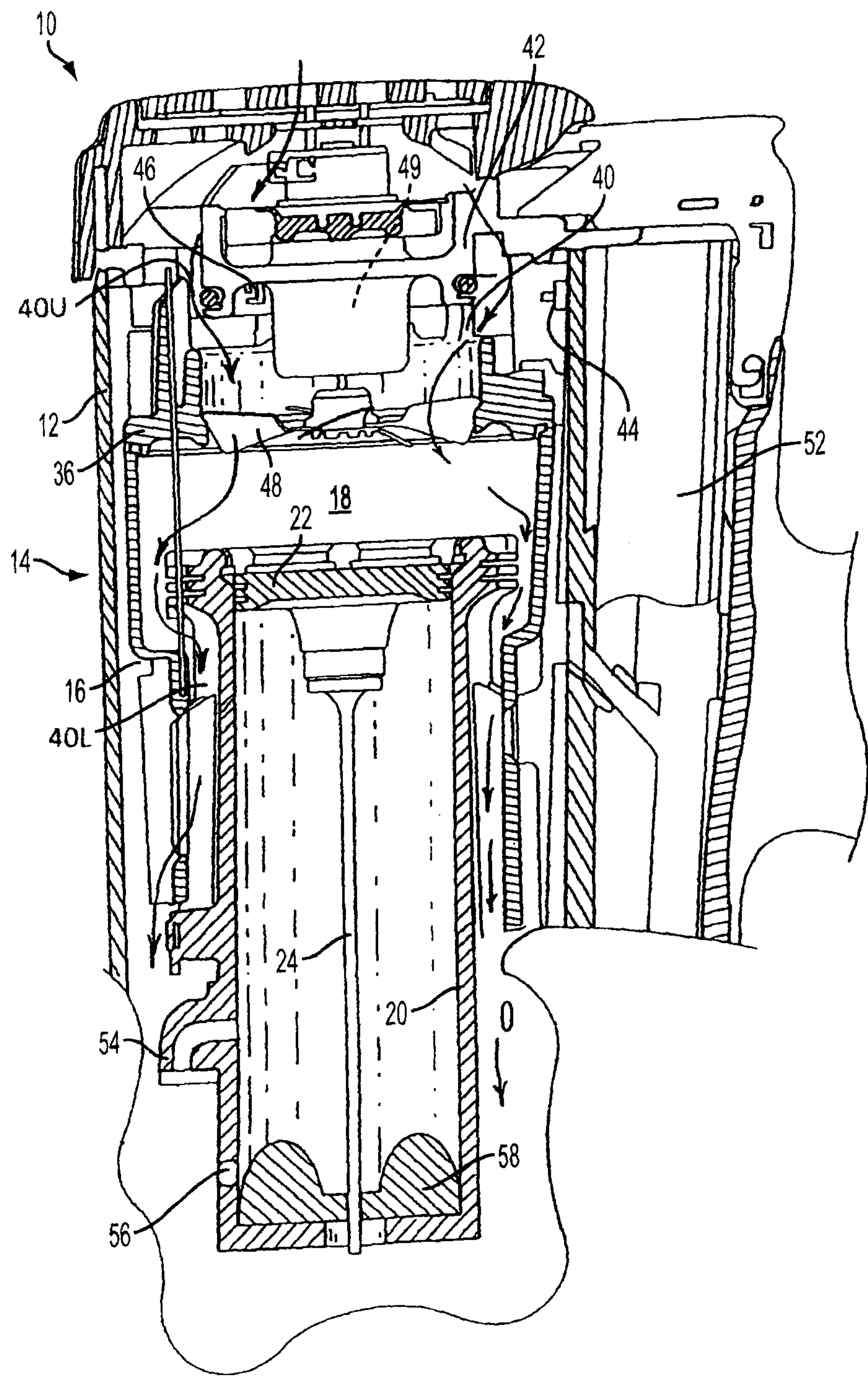


FIG. 2

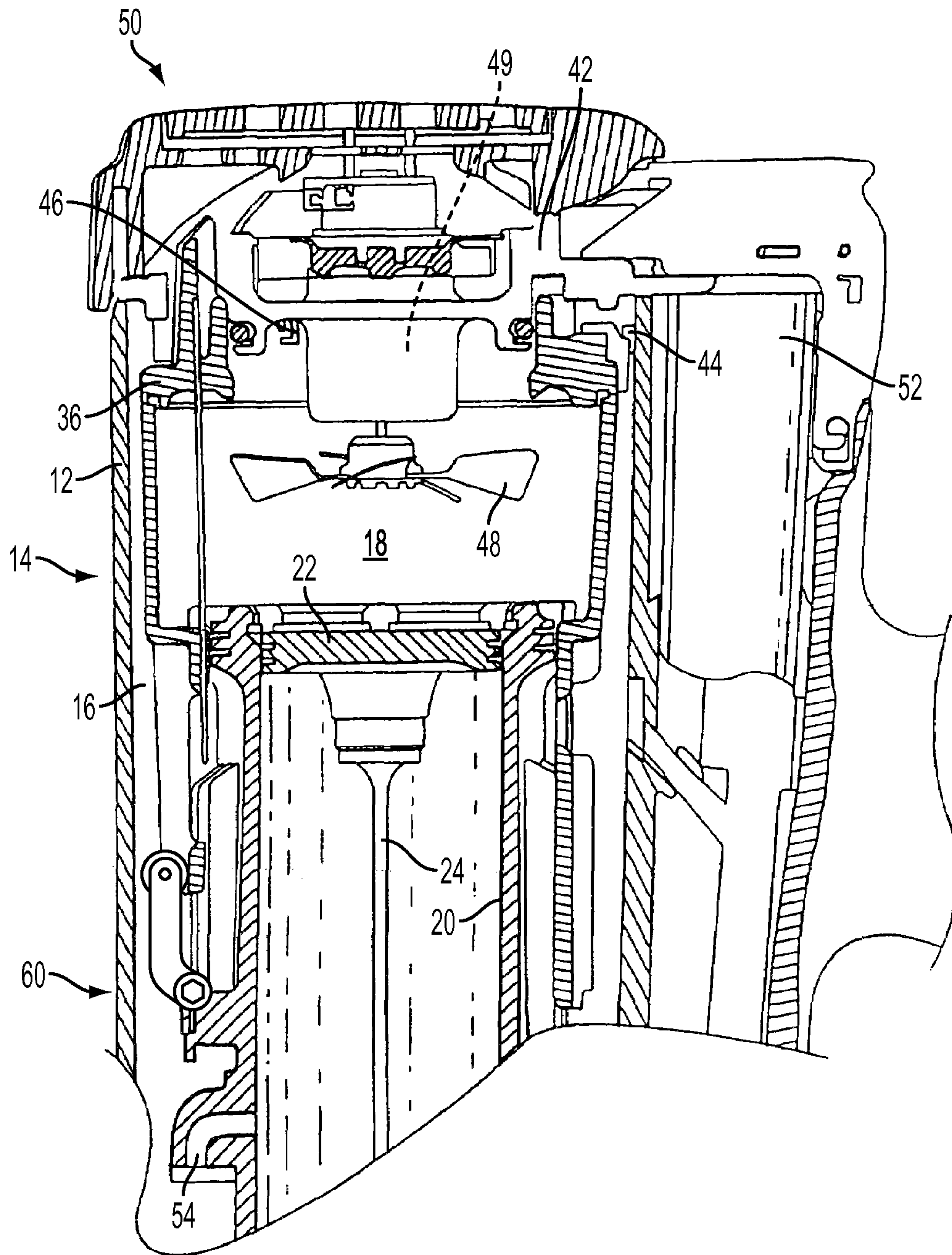


FIG. 3

4/6

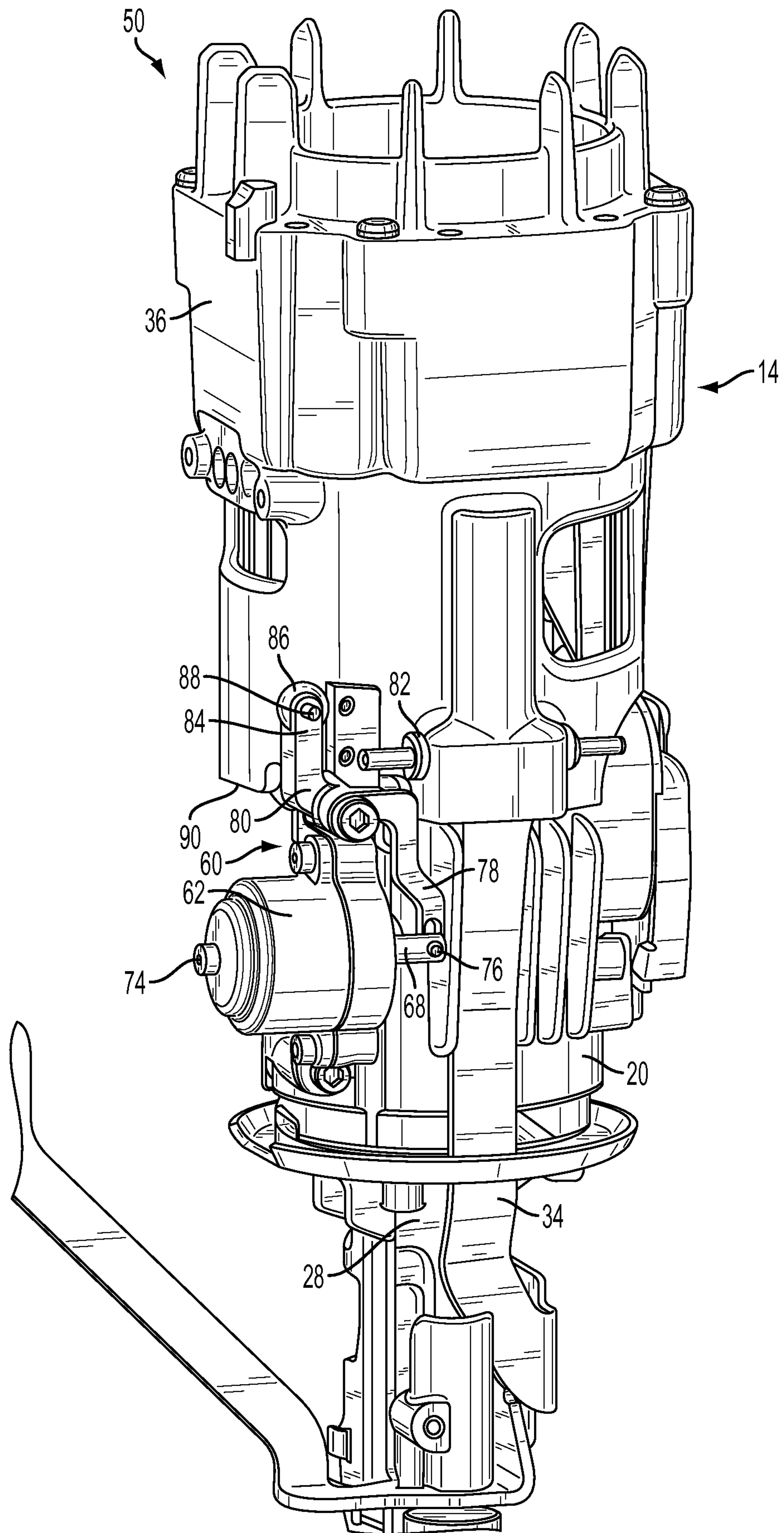


FIG. 4

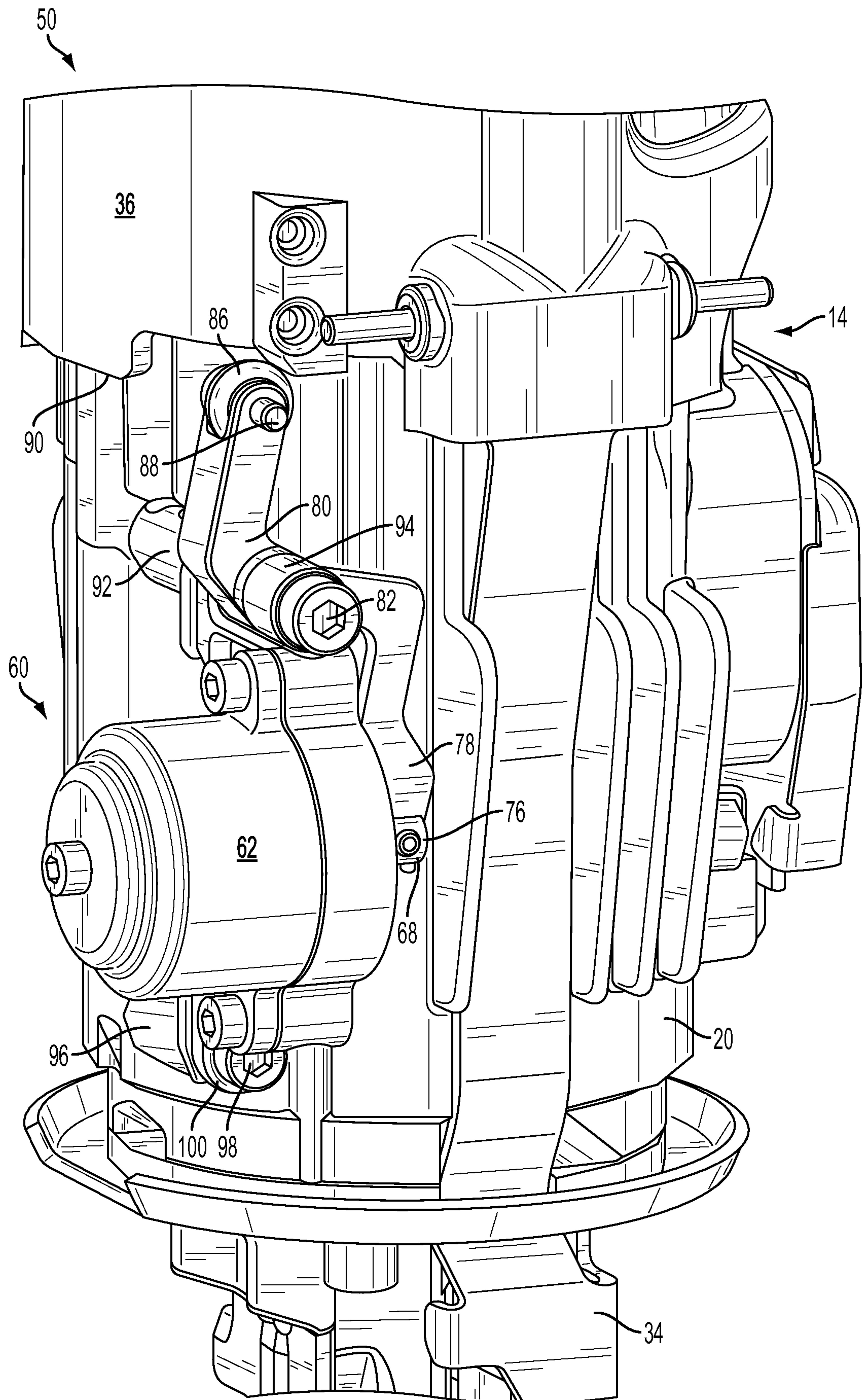


FIG. 5

6/6

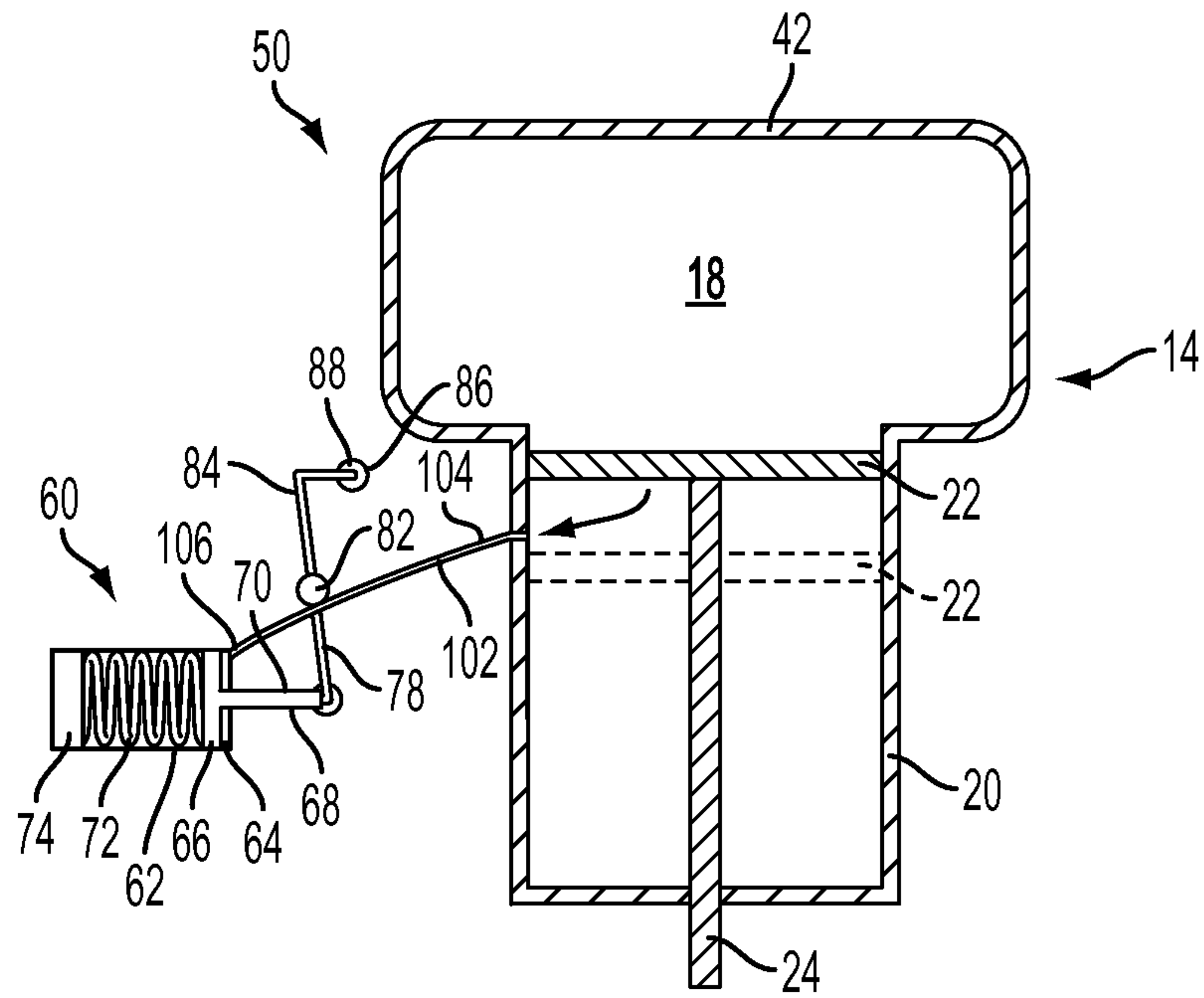


FIG. 6

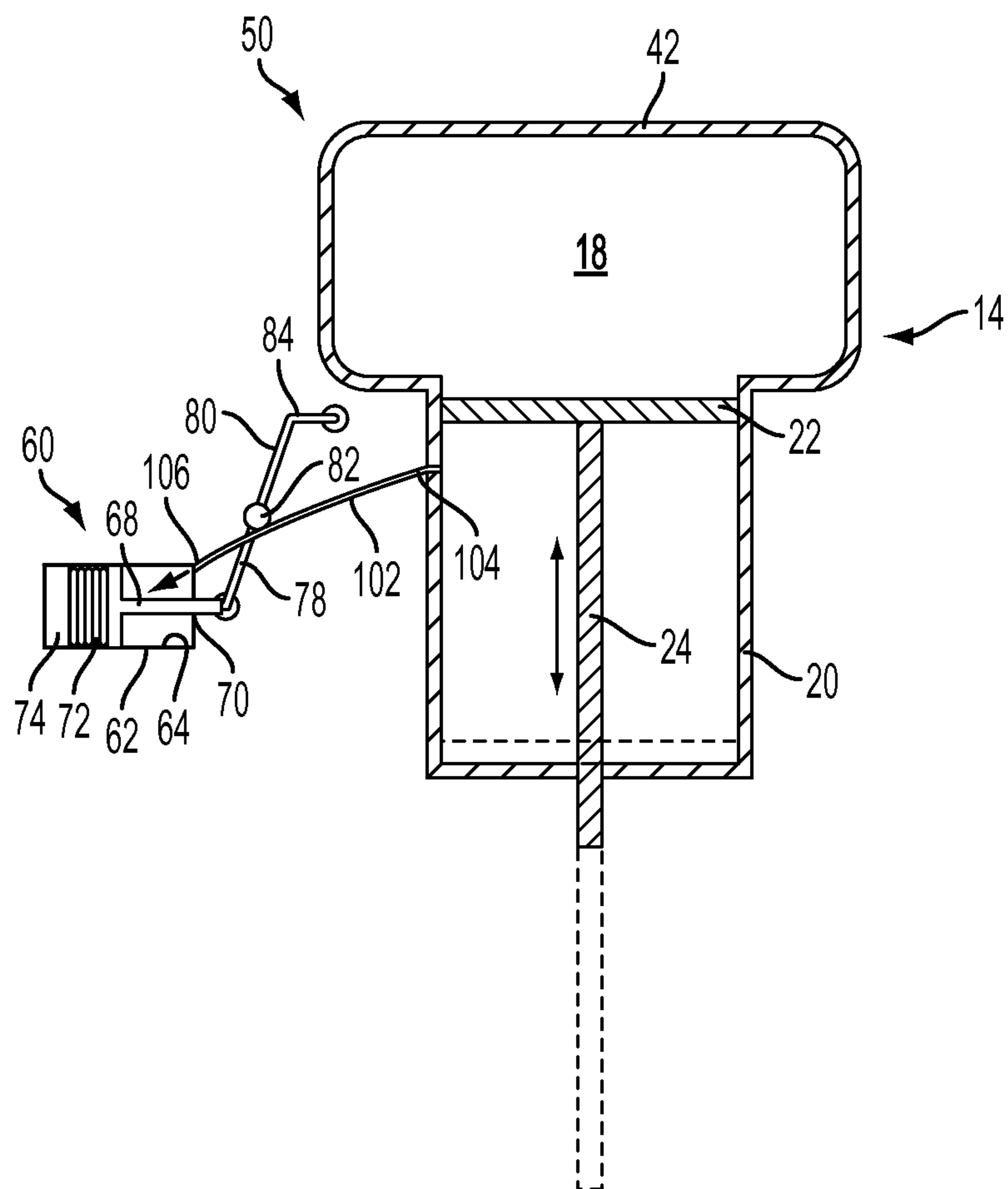


FIG. 7

