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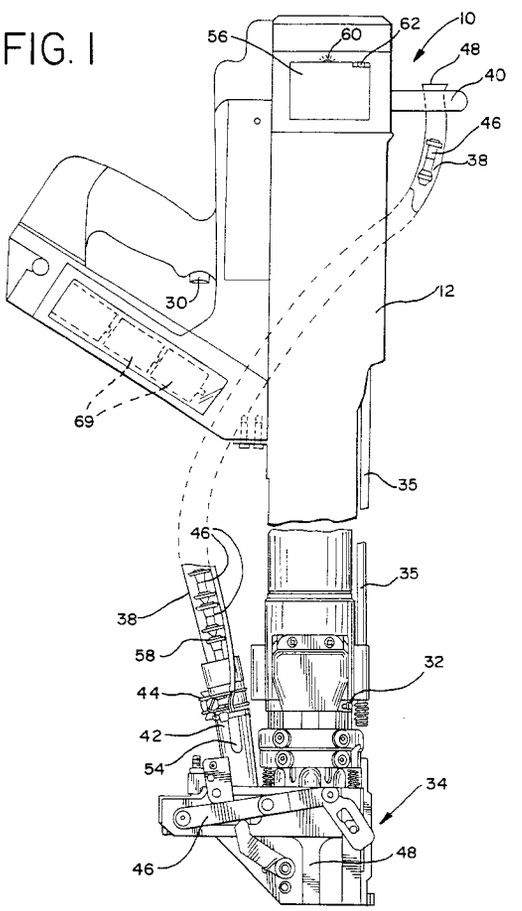
(54) Powered fastener driving tool

(57) A fastener detection system (70) is provided for both internal combustion and powder actuated fastener driving tools (10). A sensor (54) disposed at a portion of a fastener supply path (38) detects the presence or absence of a fastener (46). An indicator (60) notifies an operator when the sensor (54,55) detects the absence of a fastener. In the combustion tool (10), either or both of fuel delivery and combustion ignition may alternatively or also be disabled when no fastener (46) is detected.

FIG. 1



EP 0 818 280 A2

Description

The present invention relates generally to improvements in portable fastener driving tools, such as powder actuated and combustion powered tools, and specifically to improvements relating to the detection of fasteners, the disabling of firing systems when absence of a fastener is detected, and operator notification when absence of a fastener is detected.

Portable combustion powered tools for use in driving fasteners into workpieces are described in, U.S.-C-32,452, and U.S.-A-4,552,162, U.S.-A-4,483,473, U.S.-A-4,483,474, U.S.-A-4,403,722, and U.S.-A-5,263,439. Similar combustion powered nail and staple driving tools are available commercially from ITW-Paslode of Lincolnshire, Illinois under the IMPULSE ® brand.

Such tools incorporate a generally gun-shaped 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 the spark for ignition, and a fan located in the combustion chamber provides for both an efficient combustion within the chamber, and facilitates scavenging, including the exhaust of combustion by-products. The engine includes a reciprocating piston having an elongate, rigid driver blade disposed within a piston chamber of a 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 a nosepiece connected to the linkage is pressed against a workpiece. This pressing action also triggers a fuel metering valve to introduce a specified volume of fuel gas into the closed combustion chamber from the fuel cell. The metering valve may take the form of a solenoid valve, which is powered by the battery, or may be a purely mechanical valve.

Upon the pulling of a trigger switch, which causes the ignition of a charge of gas in the combustion chamber of the engine, the piston and driver blade are shot downward to impact a positioned fastener and drive it into the workpiece. As the piston is driven downward, a displacement volume enclosed in the piston chamber below the piston is forced to exit through one or more exit ports provided at a lower end of the cylinder. After impact, the piston then returns to its original, or "ready" position through differential gas pressures within the cylinder. Fasteners are fed into the nosepiece from a supply assembly, such as a supply tube or magazine, where they are held in a properly positioned orientation for receiving the impact of the driver blade.

A high velocity combustion powered tool of the same type having an extended piston chamber or cylinder is the subject of EP-A-0,765,715. The extended cylinder increases the stroke of the piston, thereby allowing for increased piston velocity and transfer of power from the driver blade to the fastener.

In one embodiment, the extended length also allows an operator to stand generally upright while driving fasteners which are at foot level. Fasteners are loaded into a supply tube at operator level, and positioned for firing into a nosepiece. Details of an operator level loading supply tube and associated nosepiece are disclosed in U.S.-A-5,199,624.

One inconvenience associated with combustion tools is the need for fuel cell replacement. Fuel cells used in the combustion tools may be used for a fixed number of combustions before becoming empty, at which time replacement is required. Convenience is enhanced when a cell lasts for a longer number of firings before replacement is necessary.

On occasion, the supply assembly delivering fasteners into the nosepiece may jam or empty. While such condition is easily remedied, an operator may attempt to fire the tool before realizing that a fastener is not appropriately positioned in the nosepiece. Such blank firing reduces the number of fasteners driven per fuel cell, requiring more frequent fuel cell replacement.

In addition, the total number of fasteners driven before the tool itself needs to be serviced is reduced by blank firings. Among the parts which become worn or broken over time is the piston. At each firing, the piston violently impacts a bumper disposed at the bottom of the cylinder. Over time, this contact can cause premature failure of the piston if blank firings are permitted to occur. Useful tool life is therefore also reduced by blank firings since fewer fasteners are driven before service is necessary.

Similar problems are encountered in powder actuated (PAT) fastener driving tools. Various features of PAT fastener driving tools are described, for instance, in U.S.-A-5,199,625 and U.S.-A-4,824,003. PAT tools are commercially available from Societe de Prospection et d' Inventions Techniques of Valence,. France, a subsidiary of Illinois Tool Works, Inc. of Glenview, Illinois.

In contrast to the internal combustion tools, PAT tools rely upon a powder cartridge loaded magazine style into the combustion chamber. Similarly to combustion tools, efficiency of PAT tools is decreased by blank firings. Indeed, since a single powder cartridge is used for a combustion in the PAT tools, blank firings are even more inconvenient and wasteful than in an internal combustion tool, in which the fuel cell is useful for many firings.

According to a first aspect of this invention a powered tool constructed to drive a driver blade in response to power from a power delivery source to impact a fastener and drive it into a workpiece, comprises a housing having a main chamber enclosing said power delivery source;

a nosepiece associated with said housing having an aperture defined therein to accept a fastener and guide an end of said driver blade toward impact with said fastener;

a fastener supply assembly associated with said

housing for supplying fasteners into said nosepiece;
a fastener detector for detecting presence or absence of a fastener within a portion of a fastener supply path defined by said supply assembly and said nosepiece; and
an indicator responsive to said fastener detector for notifying an operator when said fastener detector detects the absence of a fastener.

According to a second aspect of this invention a combustion powered tool having a self-contained internal combustion power source constructed and arranged for creating a combustion for driving a driver blade to impact a fastener and drive it into a workpiece, comprises:

a housing having a main chamber enclosing the power source;
a cylinder within said main chamber enclosing a piston for driving the driver blade the length of said cylinder;
a combustion chamber in communication with said piston;
a nosepiece having an aperture defined therein to accept a fastener and guide an end of said driver blade toward impact with said fastener;
a fuel cell disposed within said housing for delivering a predetermined amount of fuel into said combustion chamber;
an ignitor for igniting fuel within said combustion chamber to drive said piston;
a fastener supply assembly for supplying fasteners into said nosepiece;
a fastener detector for detecting presence or absence of a fastener within a portion of a fastener supply path defined by said supply assembly and said nosepiece; and,
combustion disabling means for preventing combustion in said combustion chamber when said fastener detector detects the absence of a fastener within said portion of said supply path.

An advantage of the present invention is that firing is prevented when a number of fasteners in, for example a magazine supply tube is reduced to a predetermined number.

If a fastener is not detected, switches may disable either or both fuel delivery and fuel ignition.

In a preferred embodiment, an extended length tool includes an optical sensor or a Hall effect device as the fastener detector. Positioning of a fastener into a predetermined part of the fastener supply path causes the optical sensor or Hall effect device to enable fuel delivery and ignition circuits. The tool may also include an indicator to notify the operator when a fastener is not detected. The indicator may be visible, such as a light emitting diode (LED), and/or audible.

Various features of the present invention may also be applied to PAT tools. Use of a fastener detector and indicator on a PAT tool in accordance with the present invention provides notice to an operator that fasteners should be loaded prior to firing.

A specific embodiment of the present invention provides a powered tool arranged for driving a driver blade to impact a fastener. A housing includes a main chamber enclosing a power source. An end of the driver blade is accepted into an aperture formed within a nosepiece associated with the housing. The aperture accepts a fastener and guides the end of the driver blade toward impact with the fastener. Fasteners are supplied into the nosepiece by a fastener supply tube associated with the housing. A fastener detector detects the presence or absence of a fastener within a portion of a fastener supply path defined by the supply tube. In response to a signal supplied by the detector, an indicator notifies an operator when the fastener detector detects the absence of a fastener.

A particular example in accordance with this invention will now be described with reference to the accompanying drawings; in which:

Figure 1 is fragmented side view of an extended stroke combustion fastener tool;
Figure 2 is an enlarged cross-sectional view of the power source of the fastener tool of Figure 1;
Figure 3 is a diagram of a fastener detection and combustion disabling circuit, and,
Figure 4 is a fastener detection and combustion disabling circuit contracted in accordance with the present invention for use with an optical fastener sensor.

Referring now to Figures 1 and 2, the preferred embodiment of an extended length high velocity combustion fastener tool suitable for practising the present invention is generally designated 10. A main housing 12 of the tool 10 encloses a self contained internal power source 16, which is detailed in FIG. 2. The power source includes a combustion chamber 20 that communicates with a cylinder 22. A piston 24 is disposed within the cylinder 22 and is connected to a driver blade 28. In the preferred embodiment, the cylinder 22 is of the extended length type and as such is considerably longer than the driver blade 28.

Through depression of a trigger 30, an operator induces combustion of a measured amount of propellant F, such as MAPP gas, within the combustion chamber 20. Propellant F is agitated by a fan 31 to help speed the combustion. In response to the combustion, the piston 24 is driven toward a terminal end 32 of the cylinder 22. As the piston 24 approaches the terminal end 32, the driver blade 28 will be guided into a nosepiece 34 and impact a fastener (not shown) held above a workpiece by the nosepiece. Although it is contemplated that the present tool will be used with a variety of fasteners,

it is preferred that the fastener be of the so-called pin type, described in more detail in U.S. Patent No. 5,199,625. Impact of the driver blade 28 drives the fastener into a workpiece or substrate. As a safety feature, and to regulate the use of fuel, the firing of the tool will not occur unless the nosepiece 34 is pressed against a workpiece. Such placement causes a linkage rod 35 to be pushed upward, which moves a valve sleeve 36 to seal the combustion chamber 20. Details concerning sealing of the combustion chamber 20, and related mechanisms may be found in the previously mentioned patents.

Upon ignition of propellant F in the combustion chamber 20, the piston 24 is driven toward the terminal end 32 of the cylinder 22. A bumper (not shown) is disposed within the cylinder 22 at its terminal end 32 and defines the end of travel of the piston 24 toward the terminal end 32, and differential gas pressures return the piston back toward combustion chamber 20 after the piston 24 completes its downward travel.

The tool 10 illustrated in FIG. 1 is a so-called extended length cylinder embodiment. The particular illustrated embodiment of the extended length cylinder 22 allows an operator standing generally upright to operate the tool 10 to drive fasteners at foot level. An important additional feature of the extended length tool 10 is the increase in the stroke of the piston 24. Through the increased stroke, velocity of the piston at impact and efficiency of power transfer is enhanced, when compared to an otherwise identical combustion powered tool having a smaller stroke.

As is known in the art, a PAT tool has a similar outer configuration to the tool 10 of Figure 1, but relies upon explosion of a powder cartridge to drive the piston 24. Similarly to a firearm, a powder cartridge is disposed into a combustion chamber, which is equivalent to the chamber 20 of the combustion tool 10, is located above the piston, and is ignited through the striking of a hammer to drive a driver blade into a nosepiece for impact with a fastener.

A fastener supply tube 38 is a preferred supply assembly applicable to both the combustion tool 10 and PAT tools. An upper end of the flexible supply tube 38 is typically attached to an upper portion of the housing 12, such as a handle 40, while a lower end of the supply tube 38 is attached to a nosepiece tube 42. The supply tube 38 may be attached at both ends by a suitable clamp 44. Fasteners 46 fed into an open end 48 of the supply tube 38 descend under the influence of gravity toward the nosepiece 34 and into the nosepiece tube 42. When an operator presses the nosepiece 34 against a workpiece, a lowermost fastener within nosepiece 34 is pushed by a shuttle block (not shown) attached to the linkage 46 until it is positioned within a channel 48 of the nosepiece 34. In this position, a fastener may be struck by the driver blade 28.

Both the PAT and combustion tools are utilized in environments which demand rapid cycling operation. An operator frequently repositions and fires the tool in rapid fashion to facilitate production. Operating under these or other conditions, an operator may fail to notice when the supply tube 38 becomes empty. Positioning of the nosepiece near an operator's foot and the opaque nature of the nosepiece 34 is an additional impediment to recognition that the supply tube 38 has become empty. Opaqueness of the supply tube 38, either by original design or accumulation of work environment dust and dirt thereon, similarly serves to reduce visibility of an empty condition of the supply tube 38.

Whatever the reason for an operator's failure to notice that the supply tube has become empty, such failure to notice may lead to a blank firing of the tool 10, e.g. a firing when no fastener is positioned over the channel 48. Blank firing of the tool reduces useful tool life since the wear associated with firing of the tool is produced even though no fastener is driven.

Additionally, blank firing wastes propellant. In a PAT tool, a blank firing wastes a powder cartridge, requiring a magazine of powder cartridges to be emptied more quickly. In the combustion tool 10, a fuel cell 50 shown in Figure 2 includes sufficient propellant F to drive a fixed number of cartridges, and propellant is wasted during a blank firing thereby requiring more frequent replacement of the fuel cell 50 by operator removal of a cap 52.

These and other inefficiencies associated with blank firing are alleviated in accordance with the present invention. Referring again to Figure 1, the tool in accordance with the present invention includes a fastener detector sensor 54 disposed along the fastener supply path defined by the supply tube 38 and the nosepiece 34, including the nosepiece tube 42. Preferably, the sensor 54 takes the form of an optical sensor tube that is responsive to a light source. The optical detector and source, such as a photodetector and LED pair, are mounted at a predetermined location in the fastener supply path defined by the supply tube 38 and the nosepiece 34 so that the presence of a fastener will optically separate the detector and source. The LED and photodetector may be mounted internally or externally to the supply path. External mounting requires that the predetermined location in the fastener supply path be transparent to allow light from the LED to reach the photodetector, while internal mounting must avoid mechanical interference between fasteners and the sensor components. External mounting is more convenient for existing tools, while either mounting may be easily incorporated into the design of modified tools.

An alternative to the LED and optical sensor arrangement is a Hall effect sensor 55, which has a proximity detection capability that obviates the need to place the switch within the actual fastener supply path. Use of the Hall effect sensor 55 requires fine calibration, however, and the sensor has a tendency to drift during operation. In addition, the Hall effect sensor 55 is only responsive to fasteners made of soft magnetic material, whereas the optical sensor will operate irrespective of

the type of material used for the fastener. With either type of sensor arrangement, the presence or absence of a fastener adjacent the sensor 54 is communicated to a fastener detection circuit within a circuit portion 56 of the housing 12 via leads 58.

Other sensors, such as a contact sensor may also be used in place of the preferred optical sensor. However, the contact sensor requires undesirable modification of the fastener supply tube 38 to permit fastener-to-sensor contact, thus introducing the potential for mechanical interference.

In the mechanically actuated PAT tools and in combustion tools having a mechanical fuel metering valve, warning is provided to an operator when the sensor 54 detects absence of a fastener in the portion of the supply path adjacent thereto. The warning is also preferably provided in the combustion tool 10 including an electrically controlled solenoid fuel metering valve, and may take the form of a light 60 disposed within an operator's line of sight, and or a grille 62 for an audible alarm, or other suitable alarm system sufficient to notify an operator when the sensor 54 detects the absence of a fastener. Upon notice provided through the grille 62 or the light 60, an operator loads additional fasteners into the open end 48 of the supply tube 38 to avoid a blank firing.

In tools including electrical components in the firing system, blank firing may also be prevented firing when no fastener is detected. In addition, waste of propellant may be avoided if the propellant is normally supply through use of electrical fuel metering components.

Taking advantage of the electrical components incorporated into the combustion powered tool 10, the present invention contemplates disabling combustion ignition of the combustion powered tool when the sensor 54 detects the absence of a fastener in the portion of the fastener supply path adjacent the sensor 54. Referring now to Figure 2, propellant F is introduced into the combustion chamber 20 through fuel passageway 64 under control of a solenoid fuel metering valve assembly 66. Electrical power for the valve assembly 66, fan 31, and spark coil 68 is provided by at least one battery 69 (best seen in Figure 1).

In conventional combustion powered tools, introduction of propellant F under control of the valve assembly 66 occurs in response to pressing of the nosepiece 34 against a workpiece. Movement of the fan 31 to agitate the propellant F also occurs in response to the pressing of the nosepiece. Firing then occurs when the spark coil 68 ignites the propellant F in response to depression of the trigger 30 by an operator. In a conventional combustion powered tool, this complete combustion process may be conducted even when the fastener supply tube 38 has emptied. According to the present invention, the combustion process is disabled when the sensor 54 detects absence of a fastener in the portion of the fastener supply path adjacent thereto. Either or both of the spark coil 68 and the fuel metering valve assembly 66 may be disabled to prevent firing when no fastener is detected.

The latter mentioned disablement of fuel delivery is not possible if the fuel metering valve assembly 66 is completely mechanical, but is preferred where a solenoid valve or other electro-mechanical valve is used in the valve assembly 66 because the additional benefit of fuel conservation is realized. Referring to Figure 2, if blank firing is prevented solely by disablement of the spark coil 68, propellant is still introduced into the combustion chamber 20 after the valve sleeve 36 is closed by action of the linkage rod 35. An operator prevented from firing the tool 10 by disablement of the spark coil 68 must lift the tool to restart the firing process thereby re-opening the combustion chamber 20 when the valve sleeve 36 moves down, and releasing the propellant which was introduced into the chamber. This waste of propellant is avoided by disabling the preferred electro-mechanical solenoid fuel metering valve assembly 66 when the sensor 54 detects that no fastener is present.

Referring now to Figure 3, shown is a combustion disabling and alarm circuit 70 for use where the sensor 54 comprises a Hall effect sensor 55. The circuit generally includes an oscillator section 72, an alarm section 76, and a disabling section 78.

The oscillator section 72, including resistors R1-R2, capacitor C1, diode D1 and NAND gate A1 produces power pulses preferably at a low rate to reduce power consumption from the battery 69 by driving light emitting diode 60 (D2) for short pulsating periods. Of course, the same technique is preferably used to drive an audio alarm (not shown in Figure 3) used in addition to or in place of the light emitting diode 60. While circuit values may be chosen to suit a particular application, the illustrated values produce an oscillation pulse of approximately 1ms/s.

The sensor section includes a stable voltage source 80 for powering the Hall effect sensor 55, and for providing a selectable voltage to the voltage-following comparator C1 through a voltage divider consisting of resistors R8 and R9, and variable resistor VR1. The voltage from the Hall effect sensor 55 is followed by the output of comparator C2. When the Hall effect sensor 55 detects a fastener, the voltage output from the comparator C2 exceeds the voltage from the comparator C1 to drive the output of comparator C3 high. This drives the output of NAND gate A2 low, thereby disabling diodes D2 and D3, which otherwise respectively provide signals to disable the spark coil 68 and the fuel metering valve assembly 66. In addition, the low potential output from the NAND gate A2 disables NAND gate A3 through gate A4 to prevent pulses from the oscillating circuit section from driving the light emitting diode 60.

Modification of the disabling and alarm circuit 70 for the PAT tools (and for mechanically actuated combustion tools) simply requires omission of the disabling circuit section 78, since there is no electrical system to disable combustion in typically PAT tools. Exact placement of the Hall effect sensor 55 along the fastener supply

path determines when combustion disabling or alarming occurs. In the position illustrated in Figure 1, disabling occurs when two fasteners 46 are remaining within the nosepiece 34 including the nosepiece tube 42. This is a convenient location for mounting the Hall effect sensor 55, but other locations may also be used. Movement of the sensor 54 or 55 to a lower portion of the fastener supply path could reduce the predetermined number of fasteners which trigger disabling and alarm to one or zero. The number of fasteners may be similarly raised by moving the sensor 54 or 55 upward toward or upon the fastener supply tube 38. The exact placement of the sensor 54 will depend upon the shape of the fastener used, and should be aligned to produce the strongest response. As an example, the preferred pin type fasteners produced the strongest response when the Hall effect sensor 55 was placed along the supply path to align with a washer portion of the pin.

For reliability and ease of manufacture, the Hall effect sensor 55 preferably has an output which is proportional to a magnetic field generated by a magnet attached to the back of the sensor when it is mounted to the fastener supply tube 38. Outside the presence of a magnet, the output of the Hall effect sensor 55 would generally be a fixed multiple of the voltage supplied from the voltage source section 80, for instance ½. This will increase once the magnet is attached, and also increases when a fastener is proximate to the Hall effect sensor 55. However, there may be a variance in the amount of increase produced by the magnet depending upon the properties and exact sizing of the magnet which is used.

Rather than providing more exacting tolerances for the magnet, variances in the produced magnetic field are accounted for during tool manufacture by setting the voltage at terminal 82 depending upon fastener and no-fastener voltages measured at terminal 84. Using the logic applied in the embodiment of Figure 3, the output of C2 (terminal 84) should be smaller than that presented by C1 (terminal 82) when no fastener is proximate to the Hall effect sensor 55. In the presence of a fastener the voltage presented by C2 should exceed that presented by C1. Preferably, the voltage at terminal 82 is set during manufacture through adjustment of the variable resistor VR1 to be the midpoint between the no-fastener and fastener voltages measured at pin 84. This setting may be accomplished at any time subsequent to mating of the Hall effect sensor 55 and its magnet.

This process also confirms that the polarity of the magnet is properly aligned with respect to the Hall effect sensor 55. When the magnet polarity is in the appropriate direction, a fastener causes an increase in the voltage at terminal 84. A decrease is observed if the polarity is reversed.

These calibration difficulties are overcome by employing a sensor 54 including a optical sensor detector and source, such as a photodetector 86 and LED 88, as shown in Figure 4. The photodetector 86 and LED 88 are arranged so that a pulse of light is allowed across the portion of the supply path where the sensor 54 is mounted in the absence of a fastener, and is blocked when a fastener is present .

An oscillator 90 generates a 2ms pulse every second which causes the driver transistor Q11 to produce a similarly short pulse of light in the LED 88. If no fastener is present, the light pulse is received by the photodetector 86. A signal from the photodetector 86 is amplified by an amplifier 92, formed from a buffer stage and two capacitor coupled gain stages. The capacitor coupling eliminates DC voltages. Peaks in the amplified LED signal are detected by a peak detector circuit 94 and used to determine the presence or absence of a fastener by a comparator C4, which has a reference voltage applied to its inverting output. When no fastener is present an output is produced by the comparator C4 to enable the NAND gate A5, thereby allowing the oscillator circuit to pulse the LED 60 (also shown in Figure 1). When applied to a combustion tool, diodes D4 and D5 are preferably used to provide signals to disable the spark coil 68 and the fuel metering valve assembly 66. Of course, when a fastener is present, the NAND gate is disabled so that the LED 60 is not pulsed and disable signals are nor provided by diodes D4 and D5. Modification of the circuit of Figure 4 for PAT tools is realized by leaving outputs of the diodes D4 and D5 unconnected, or by omitting the diodes and outputs entirely.

Claims

1. A powered tool (10) constructed to drive a driver blade (28) in response to power from a power delivery source (24) to impact a fastener (46) and drive it into a workpiece, comprising:

   a housing (12) having a main chamber enclosing said power delivery source (24) ;
   a nosepiece (34) associated with said housing (12) having an aperture (48) defined therein to accept a fastener (46) and guide an end of said driver blade (28) toward impact with said fastener (46);
   a fastener supply assembly (38) associated with said housing (12) for supplying fasteners (46) into said nosepiece (34);
   a fastener detector (54,55) for detecting presence or absence of a fastener (46) within a portion of a fastener supply path defined by said supply assembly (38) and said nosepiece (34); and
   an indicator (60) responsive to said fastener detector (54,55) for notifying an operator when said fastener detector detects the absence of a fastener.

2. A tool according to claim 1, wherein said tool is a combustion powered tool further comprising:

a combustion chamber (20) arranged to communicate combustion force to said driver blade (28);
a fuel cell (50) disposed within said housing (12) for delivering a predetermined amount of fuel (F) into said combustion chamber (20);
an ignitor (68) for igniting fuel within said combustion chamber (20) to drive said driver blade (28); and,
combustion disabling means (70) for preventing combustion in said combustion chamber (20) when said fastener detector (54,55) detects the absence of a fastener with said portion of said supply path (38).

3. A combustion powered tool having a self-contained internal combustion power source constructed and arranged for creating a combustion for driving a driver blade (28) to impact a fastener (46) and drive it into a workpiece, comprising:

a housing (12) having a main chamber enclosing the power source;
a cylinder (22) within said main chamber enclosing a piston (24) for driving the driver blade (28) the length of said cylinder (22);
a combustion chamber (20) in communication with said piston (24);
a nosepiece (34) having an aperture (48) defined therein to accept a fastener (46) and guide an end of said driver blade (28) toward impact with said fastener (46);
a fuel cell (50) disposed within said housing (12) for delivering a predetermined amount of fuel (F) into said combustion chamber (20);
an ignitor (68) for igniting fuel within said combustion chamber (20) to drive said piston (24);
a fastener supply assembly (38) for supplying fasteners (46) into said nosepiece (34);
a fastener detector (54,55) for detecting presence or absence of a fastener (46) within a portion of a fastener supply path defined by said supply assembly (38) and said nosepiece (34) ; and,
combustion disabling means (70) for preventing combustion in said combustion chamber (20) when said fastener detector (54,55) detects the absence of a fastener (46) within said portion of said supply path.

4. A tool as according to claim 2 or 3, wherein said combustion disabling means comprises a circuit (78) responsive to said detector (54,55), and said circuit (78) enables said ignitor (68) when said detector (54,55) detects a fastener (46).

5. A tool according to any one of claims 2,3 or 4, further comprising:

fuel delivery means (66) for regulating delivery of fuel from said fuel cell (50) to said combustion chamber (20); and
a fuel delivery switch within said circuit for enabling said fuel delivery means (66) when said detector (54,55) detects a fastener (46).

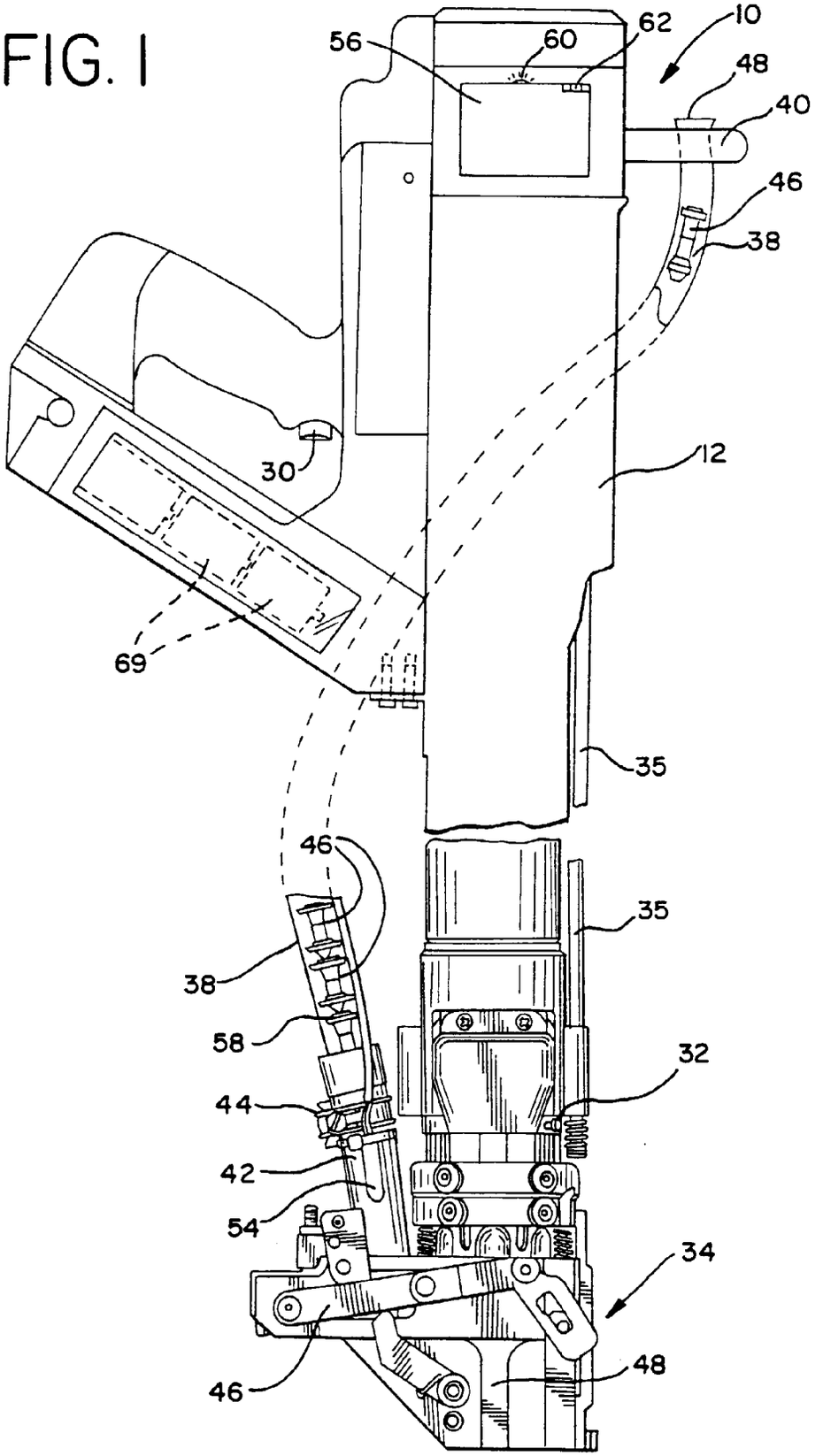
6. A tool according to any one of the preceding claims, wherein said fastener detector comprises a Hall effect sensor (55) located at a lower portion of said fastener supply tube (38)

7. A tool according to any one of claims 1 to 5, wherein said fastener detector (54) comprises an optical source (88) and an optical detector (86) located at a lower portion of said fastener supply tube (38) so that a fastener at said lower portion of said fastener supply assembly prevents a signal from said light source (88) from reaching said light detector (86).

8. A tool according to any one of the preceding claims, wherein said indicator comprises a light (60).

9. A tool according to any one of the preceding claims, wherein said indicator comprises an audio alarm (62).

FIG. 1



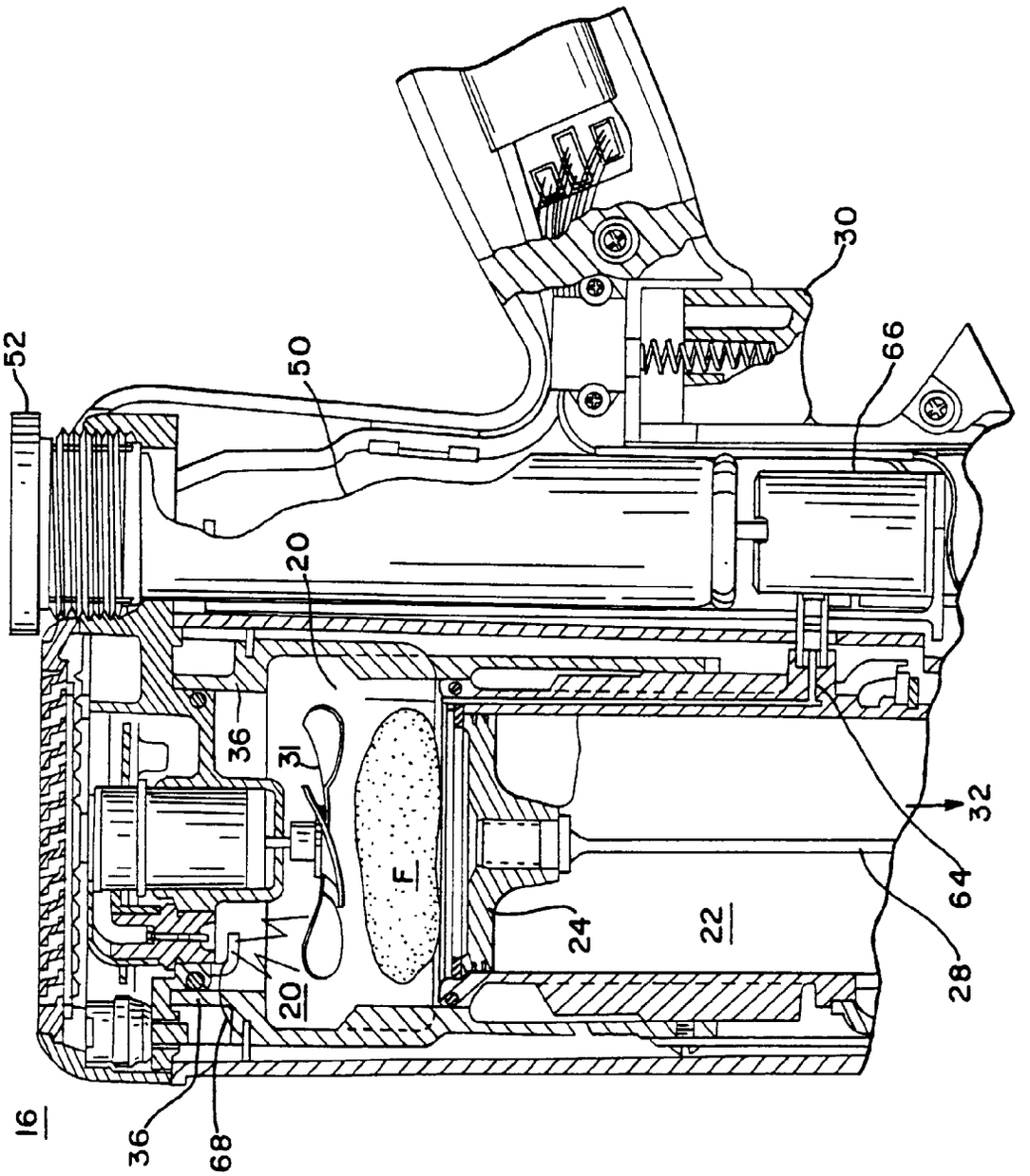
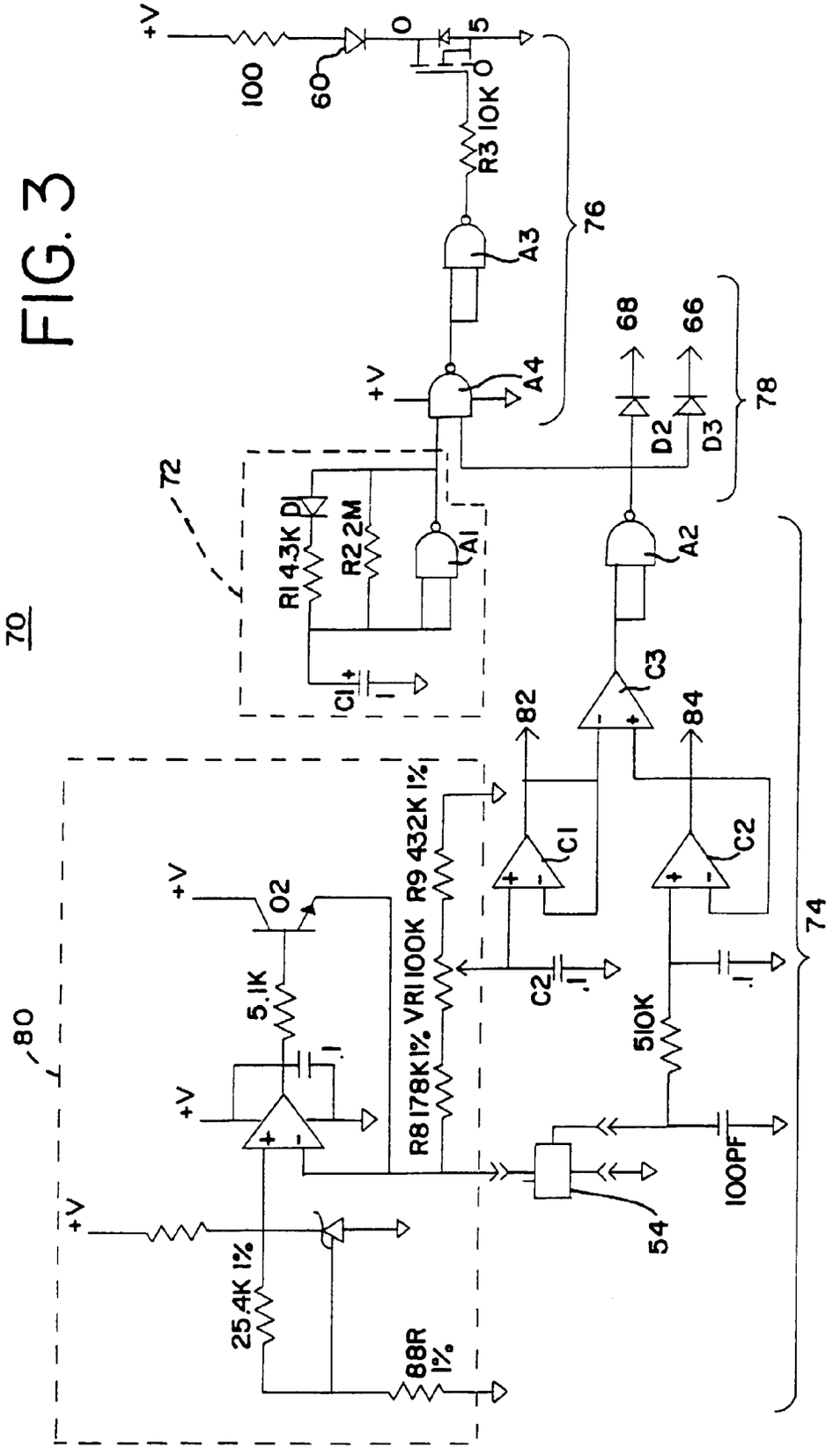


FIG.2

FIG. 3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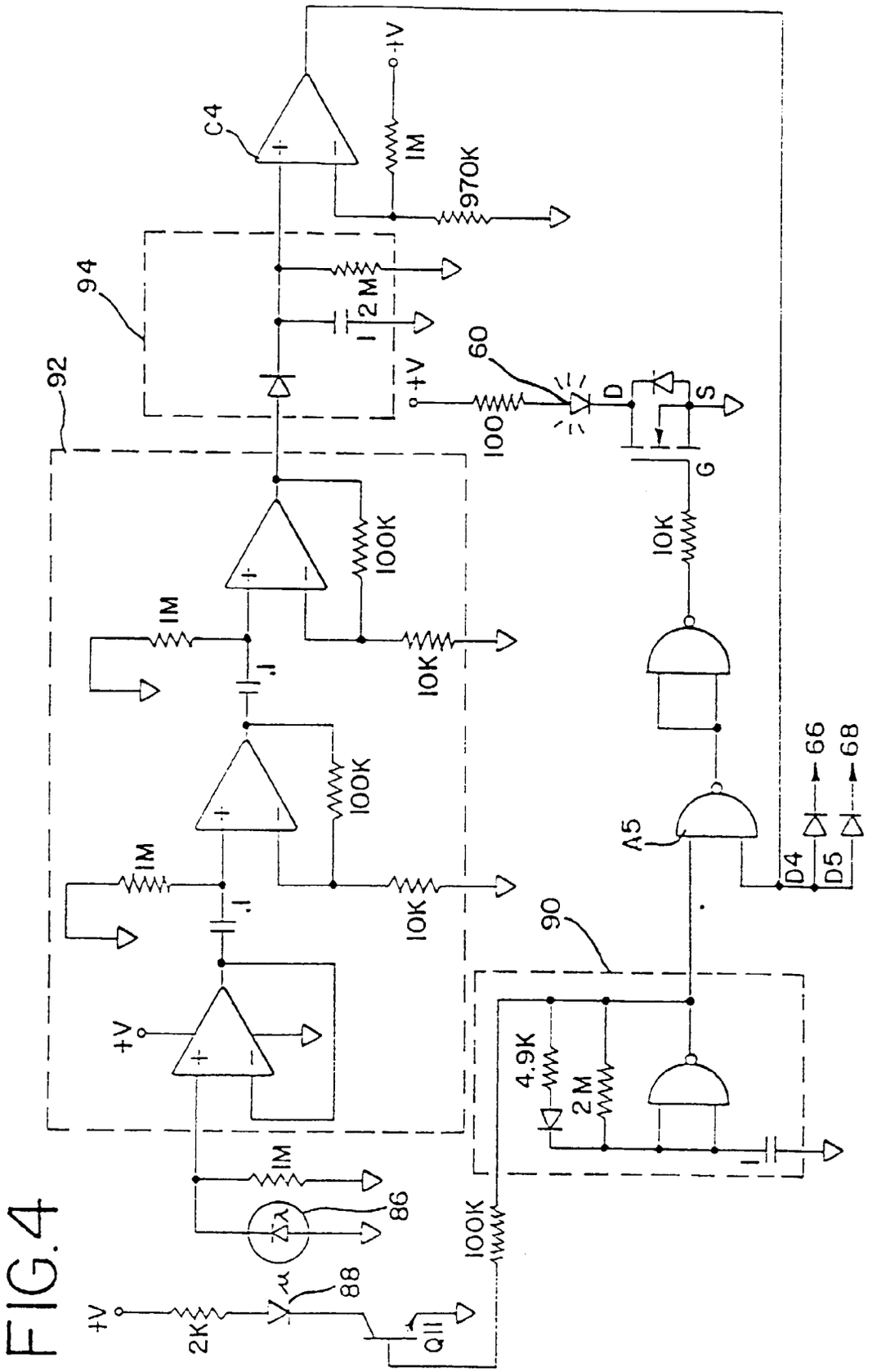
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100K
10K
1M
.1
100K
10K
A5
66
68
D4
D5
90
+V
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2M
1M
86
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Q11

FIG.4