Oct. 26, 1965 A. NEUMEIER 3,213,607

IMPACT TOOL

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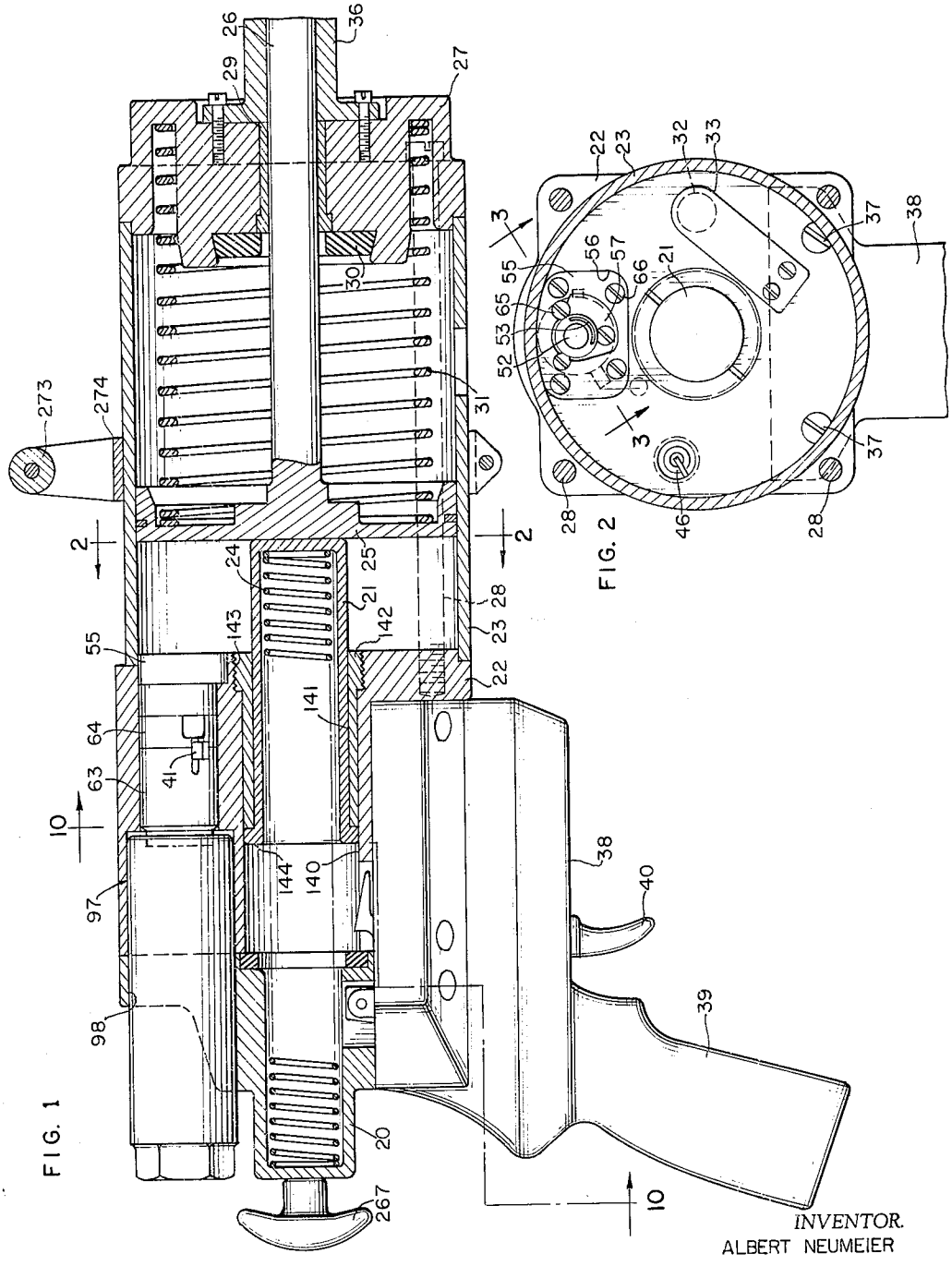

FIG. 1

FIG. 2

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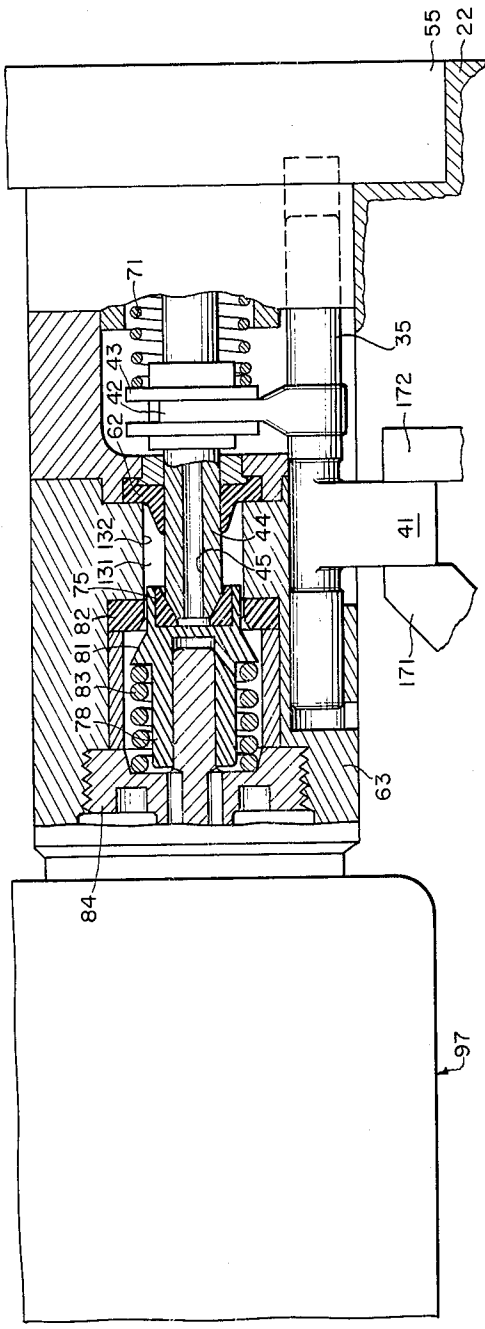

FIG. 3

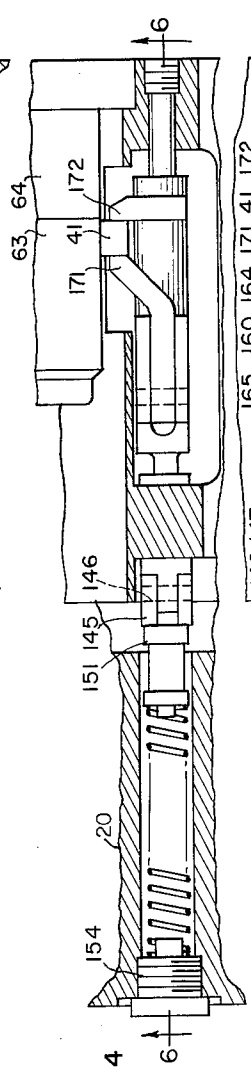

FIG. 4

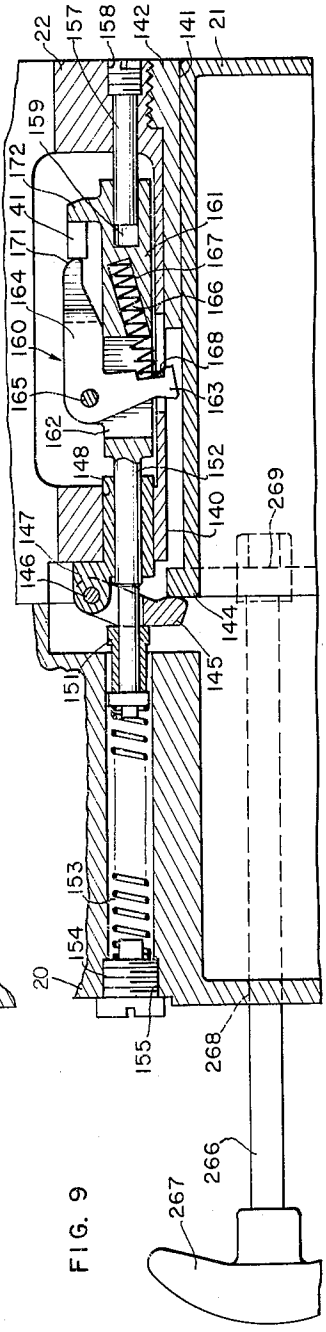

FIG. 9

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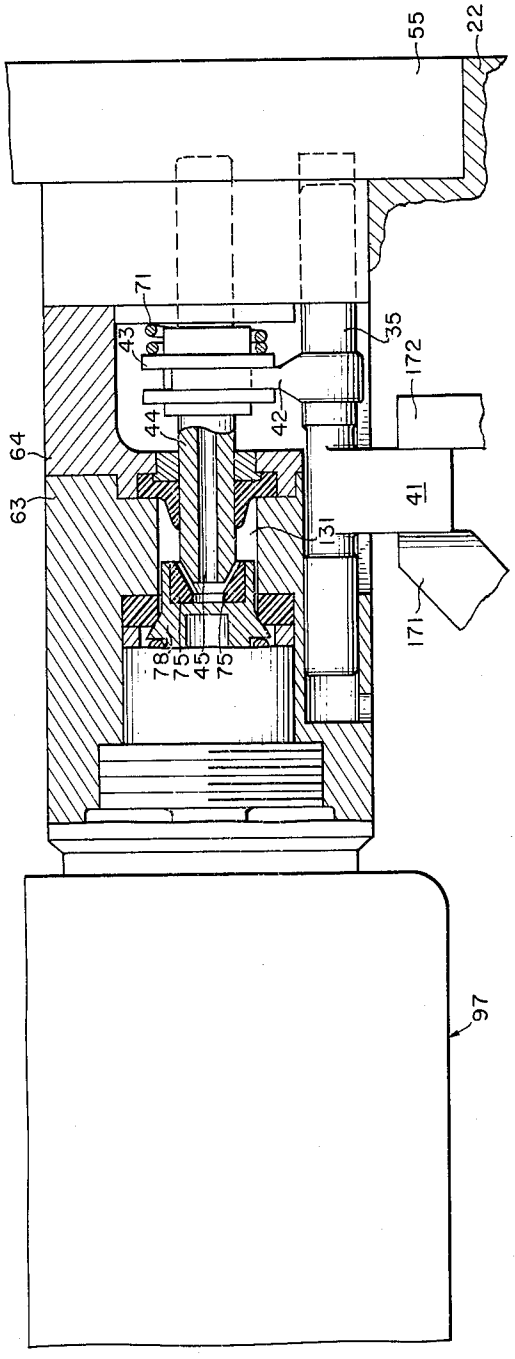

FIG. 5

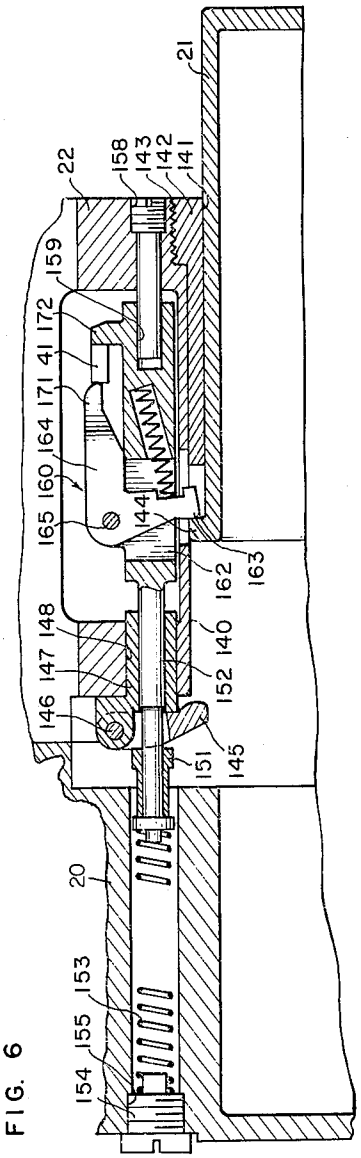

FIG. 6

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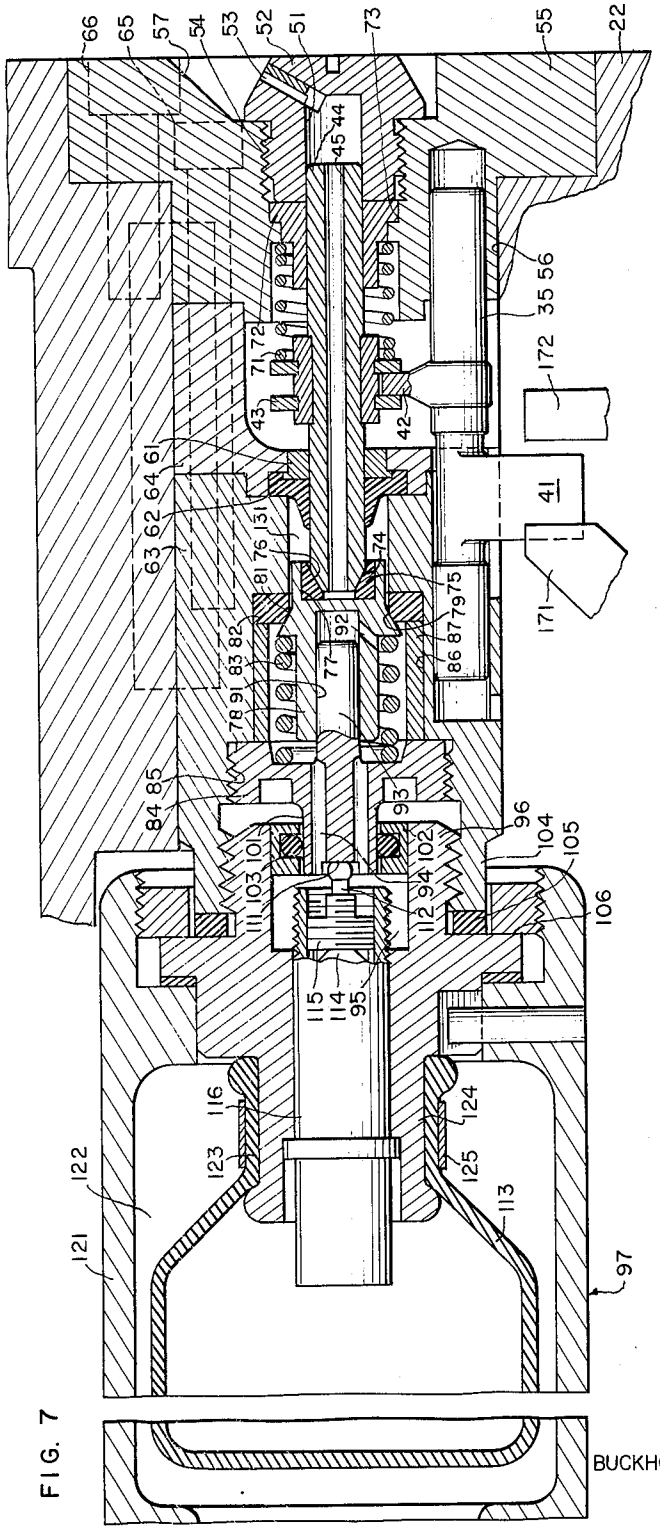

FIG. 7

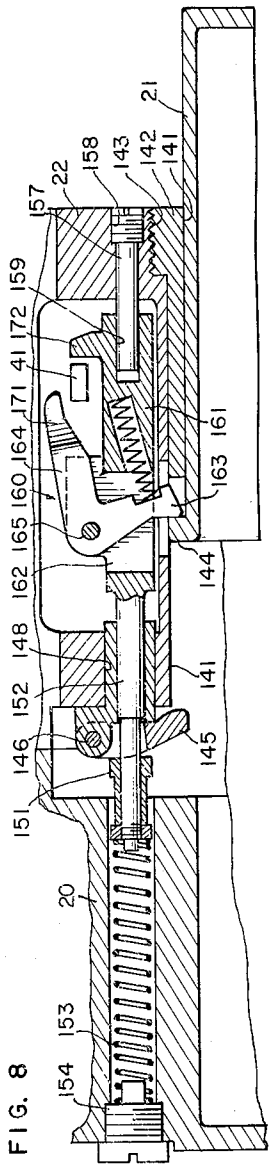

FIG. 8

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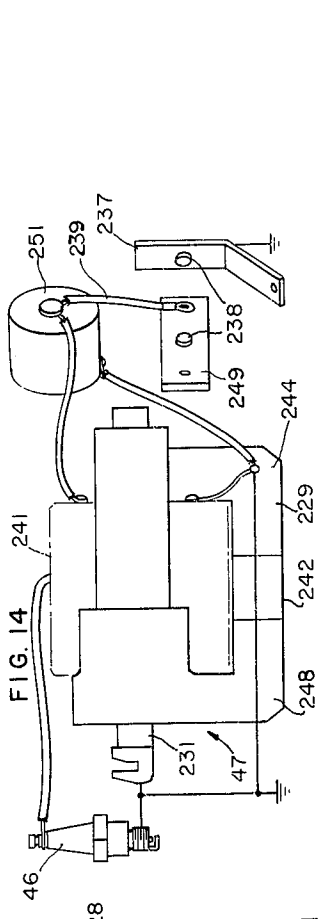

FIG. 14

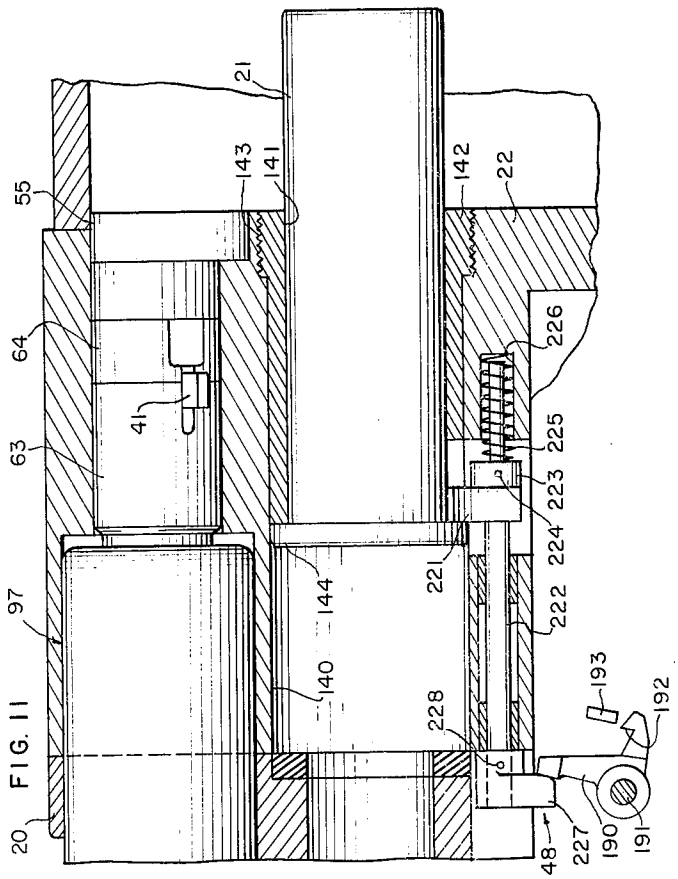

FIG. 11

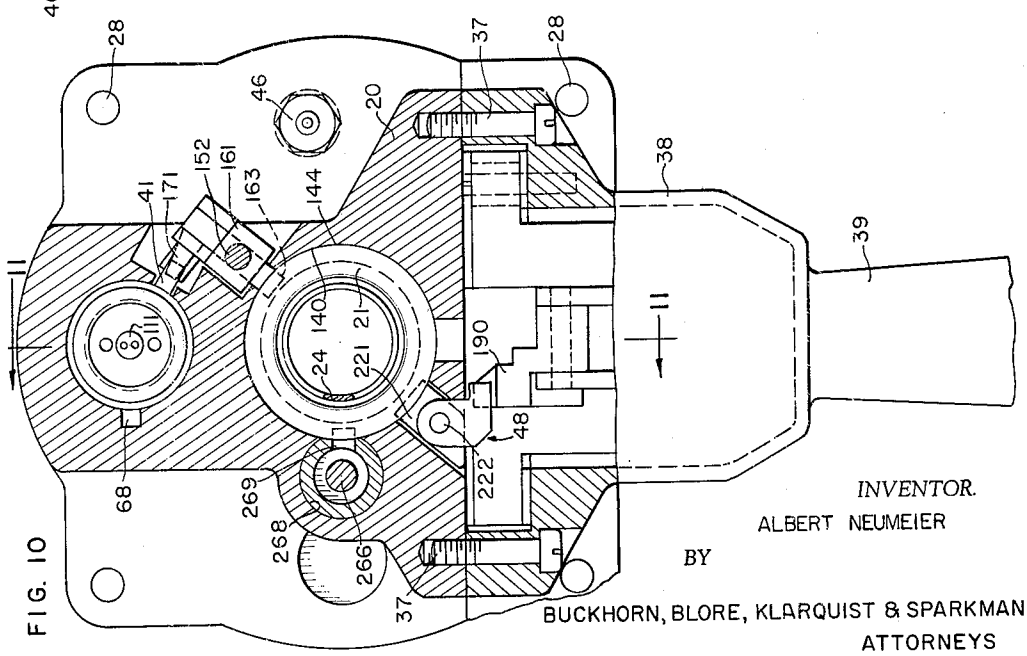

FIG. 10

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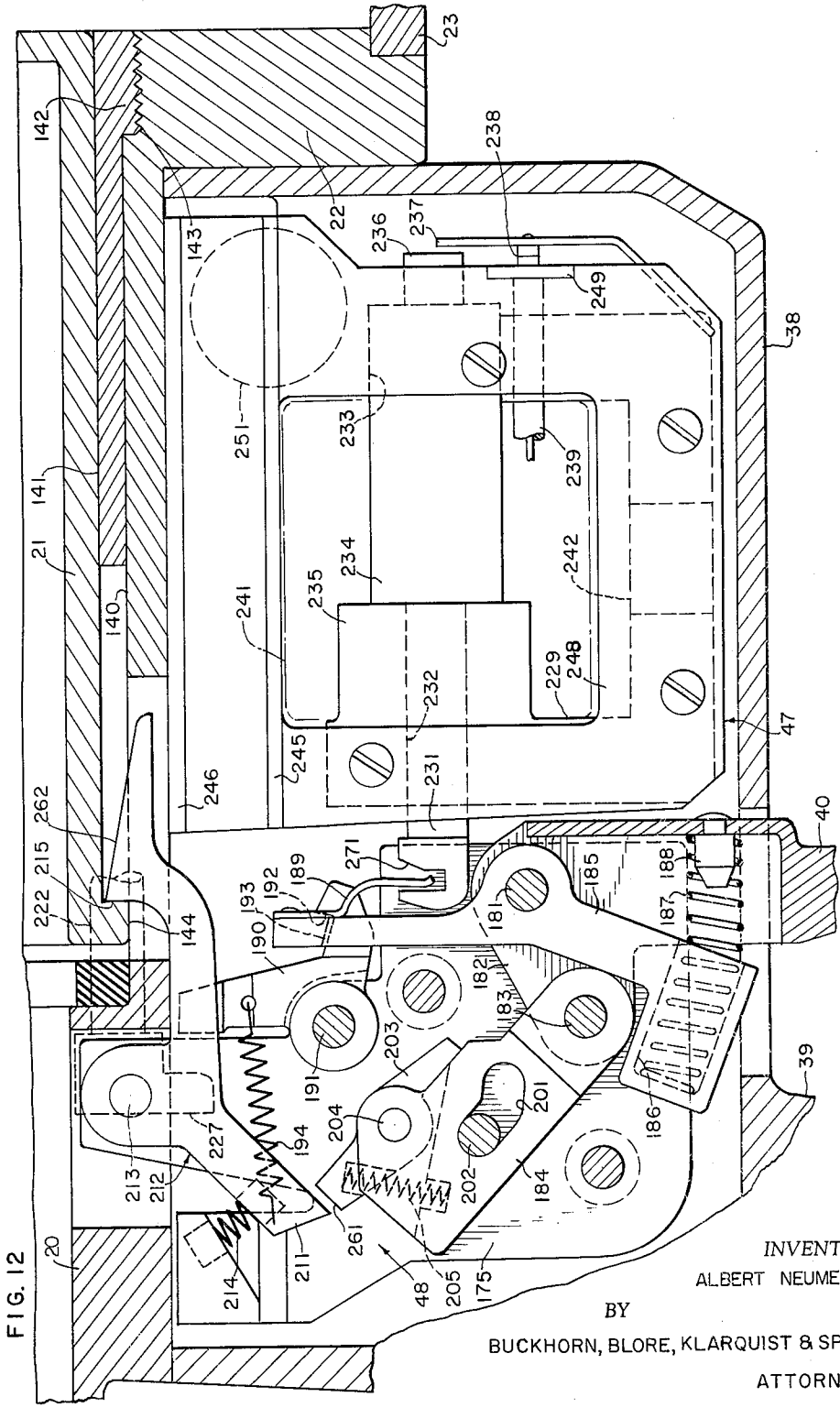

FIG. 12

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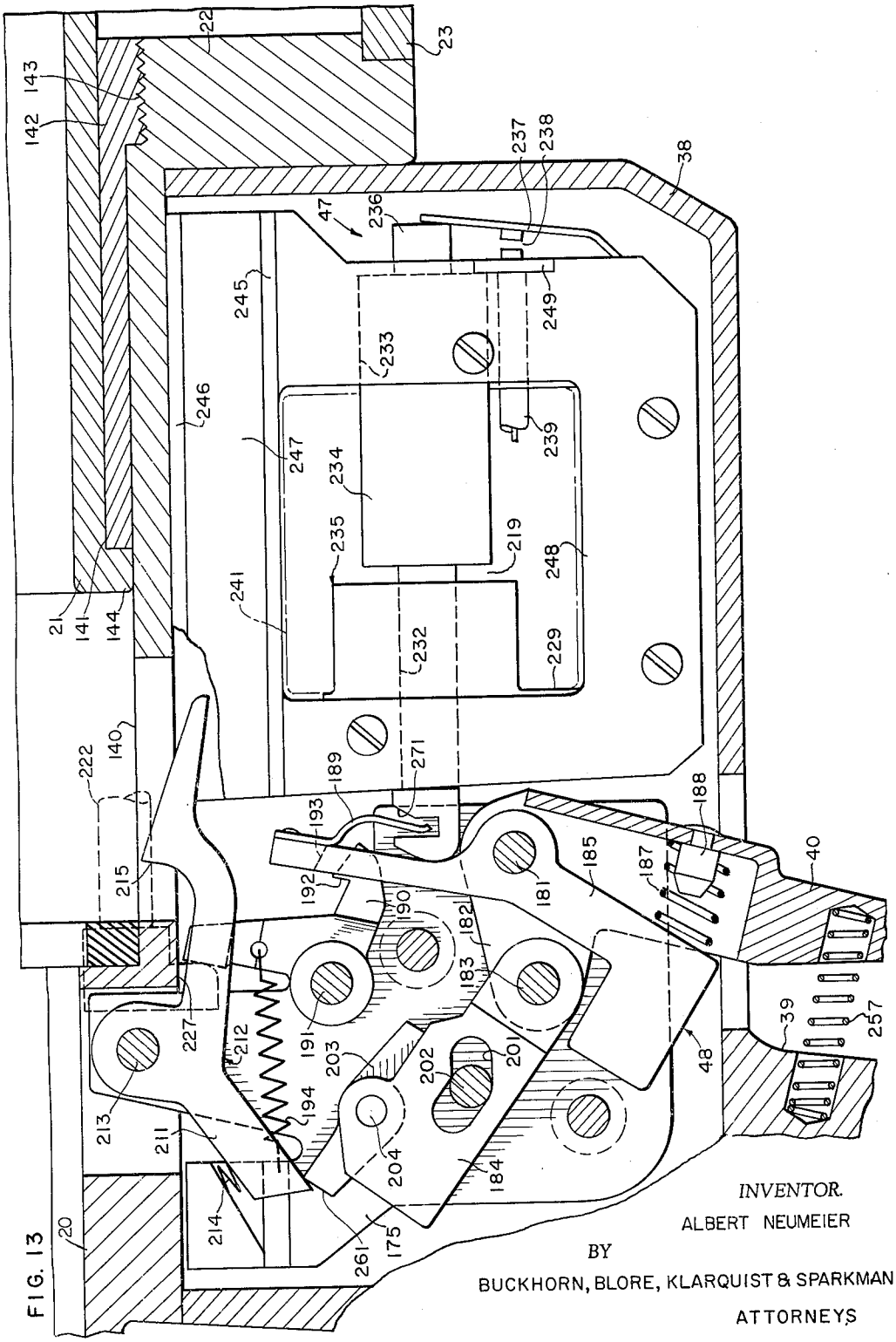

FIG. 13

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United States Patent Office 3,213,607 Patented Oct. 26, 1965

3,213,607

IMPACT TOOL

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Filed July 3, 1963, Ser. No. 292,701
14 Claims. (Cl. 60—26.1)

This invention relates to an impact tool and more particularly to a tool actuated by explosion of a fuel-air mixture driving a piston.

It has been found, in the use of impact tools of the type disclosed in United States Patent 2,898,893 in which a piston is moved from one end of a cylinder to an intermediate position to draw a supply of fuel and air into the cylinder, and the mixture thusly drawn into the cylinder is ignited to drive the piston on further, that improved operation of the tool occurs if the amount of fuel supplied to the cylinder is always a uniform amount, and the firing takes place at an exact time. The tool disclosed in the above-mentioned patent works well, but the operation thereof would be improved by supplying a measured quantity of fuel thereto for each explosion operating the tool.

An object of the invention is to provide an impact tool in which a precisely measured amount of fuel is introduced into the tool for each operation thereof.

A further object of the invention is to provide a new and improved fuel supply for an impact tool.

Still another object of the invention is to provide an impact tool in which a metering chamber filled with a high vapor pressure fuel is opened to a cylinder at a predetermined point in the movement of a piston in the cylinder.

The present invention provides an impact tool in which a main piston is movable between one end of the cylinder and the other end of the cylinder, together with an auxiliary piston movable after a manual triggering operation from a retracted or cocked position to an extended position moving the main piston to an intermediate position between the ends to draw air into the interior of the cylinder. During such movement of the auxiliary piston from its retracted position to its fully extended position, a first valve between a metering chamber and a supply of liquid fuel under pressure is closed and a second valve between the metering chamber and the cylinder is opened so that fuel in the metering chamber will flow through the second valve into the interior of the cylinder. As the auxiliary piston reaches the intermediate position thereof, the fuel-air mixture in the cylinder is ignited to drive the main piston on in a power stroke. Before the explosion occurs the second valve is closed and the first valve remains closed until the auxiliary piston is cocked at the end of the explosion. When the auxiliary piston is cocked the first valve is opened to refill the metering chamber with fuel. Preferably the first valve is a check valve at one end of the metering chamber, and the second valve is a tubular valve member urged toward the first valve member with a force sufficient to seal the end of the tubular valve member but not sufficient to move the first valve member away from a position closing the metering chamber from the fuel container. The explosion of the fuel-air mixture drives the auxiliary piston back to its retracted position, in which position the auxiliary piston is latched.

A complete understanding of the invention may be obtained from the following detailed description of an impact tool forming a specific embodiment thereof, when read in conjunction with the appended drawings, in which:

FIG. 1 is a fragmentary, partially sectional view of an impact tool forming one embodiment of the invention;

FIG. 2 is a vertical sectional view taken generally along line 2—2 of FIG. 1;

FIG. 3 is an enlarged, partially sectional view taken generally along line 3—3 of FIG. 2;

FIG. 4 is a fragmentary, partially sectional view generally similar to FIG. 3;

FIG. 5 is an enlarged, fragmentary, partially sectional view similar to FIG. 3 with parts thereof shown in different positions from those in which they are shown in FIG. 3;

FIG. 6 is a fragmentary, partially sectional view taken generally along line 6—6 of FIG. 4;

FIG. 7 is a view generally similar to FIG. 5 but with the parts thereof in different positions from those in which the parts are shown in FIG. 5;

FIG. 8 is a view similar to FIG. 6 with the parts thereof shown in positions corresponding to those of FIG. 7;

FIG. 9 is a vertical sectional view similar to FIG. 8 and illustrating a manual cocking mechanism of the impact tool of FIG. 1;

FIG. 10 is an enlarged vertical sectional view taken along line 10—10 of FIG. 1;

FIG. 11 is an enlarged vertical sectional view taken along line 11—11 of FIG. 10;

FIG. 12 is an enlarged vertical sectional view showing a trigger mechanism and a magneto mechanism of the impact tool of FIG. 1;

FIG. 13 is a view similar to FIG. 12 but with the parts thereof in different positions; and

FIG. 14 is a schematic view of an ignition system of the impact tool of FIG. 1.

Referring now in detail to the drawings, an impact tool forming one embodiment of the invention includes a rear casting 20 (FIG. 1), a cast cylinder head 22 and a trigger housing 38 all secured together. An auxiliary piston or plunger 21 is movable from a retracted position in the cylinder head 22 for a cylinder 23 toward the right, as viewed in FIG. 1, by a compression spring 24 to move a main piston 25 from a normal position thereof adjacent the head 22 to an intermediate or firing position thereof spaced substantially from both ends of the cylinder 23. As the auxiliary piston 21 so moves, it moves against a compression spring 31 which is weaker than the compression spring 24 and draws air into the portion of the cylinder 23 therebehind through a port 32 (FIG. 2) covered by a resilient valve closing member 33 mounted on the cylinder head 22. Also, during this movement of the auxiliary piston 21, the piston 21, through means described below, moves a driving rod 35 (FIG. 3) to the right, as viewed in FIG. 3, first to the position thereof shown in FIG. 5 and then releases the driving rod 35, which is moved back to the position thereof shown in FIG. 7. The position of the driving rod shown in FIG. 7 is intermediate the positions thereof shown in FIGS. 3 and 5. The rod 35 controls the supply of a fuel under pressure to the interior of the cylinder 23. The rod 35 has a lateral driven arm or dog 41 rigid thereon and a second rigid driving arm or dog 42 projecting into a grooved collar 43 rigidly fixed to a tubular valve member 44.

The impact tool includes a piston rod 26 slidable in cylinder head 27 and in barrel 36 for driving a fastener or stud (not shown) positioned in the barrel 36 as is well known in the art. Cap screws 28 secure the heads 27 and 22 together. A cushion 30 at the end of a guide sleeve 29 in the cylinder head 27 acts as a bumper for the main piston 25. Cap screws 37 secure trigger housing 38 to the cylinder head 22. The trigger housing has a handle 39, and carries a trigger 40. A spark plug 46 (FIGS. 2 and 14) provides ignition from a magneto ignition mechanism 47, and a trigger mechanism 48 (FIGS. 12 and 13) is provided.

The tubular valve member 44, as best shown in FIG. 7,

has an axial passage 45 extending therethrough and the righthand end of the valve member 44 is guided by bushing 72 and is slidable in a bore 51 of a nozzle member 52 having a nozzle orifice 53. The nozzle member 52 is threaded into a tapped bore 54 in a headed, tubular insert 55 fixed in a complementary recess or passage 56 in the cylinder head 22. The tubular valve member 44 is also slidable in a bronze, flanged bushing 61 and a seal 62 of poly-tetrafluoroethylene. The bushing 61 and the seal 62 are secured between generally tubular members 63 and 64 secured to the headed insert 55 in alignment therewith by capscrews 65. Capscrews 66 threaded into the cylinder head 22 secure the assembly of the threaded insert 55 and the members 63 and 64 rigidly in position in the counterbored recess or passage 56.

A compression spring 71 seats against a bronze flanged bushing 72 held by the nozzle member 52 in a counterbored recess 73 in the insert 55 and at its other end engages the collar 43 to urge the tubular valve member 44 to the left, as viewed in FIG. 7. This urges a tapered or frusto-conical end portion 74 of the valve member 44 into sealing engagement with a nylon valve seat insert 75 having a complementary tapered valve seat 76. The insert 75 is seated in a socket 77 in a valve member 78. The valve member 78 is urged toward the right by a compression spring 83, as viewed in FIG. 7, toward seating engagement of a frusto-conical end portion 81 thereof with a poly-tetrafluoroethylene valve insert 82. The spring 83 is substantially stronger than the compression spring 71, and normally holds the valve member 78 seated against the valve seat 79 of insert 82 against the action of the spring 71. During storage of the tool while uncocked, both of these valves are closed. A plug 84 threaded in a counterbore 85 in the tubular member 63 holds the valve seat 82 seated against the end of a counterbore 86 in the member 63 by means of a sleeve 87 fitting into the counterbore 86. The valve member 78 has a bore 91 therein which is opened at the lefthand end thereof, as viewed in FIG. 7, and is closed at the righthand end, with a transverse passage 92 connecting the righthand end portion of the bore 91 to the outer periphery of the valve member 78. Fitting closely and slidably in the bore 91 is a cylindrical guide rod or post 93 integral with the plug 84, and this mounts the valve member 78 slidably along the longitudinal axis of the insert 55. When the tool is stored in an uncocked condition, both the valve members 44 and 78 are closed.

The plug 84 is provided with passages 94 therethrough, which connect a counterbore 95 in a connector bushing 96 of a cartridge or container 97 to the interior of the sleeve 87. The plug 84 has a cylindrical portion 101 projecting through a grooved bushing 102 fixed in the open end of the counterbore 95 of the connector bushing 96. The bushing 102 carries an O-ring 103 which sealingly engages the cylindrical portion 101. Interiorly tapped nose portion 104 of the member 63 is adapted to receive the threaded bushing 96 and to engage a gasket 104 and press the gasket 105 against a flange 106 of the bushing 96 to seal the end of the bushing 96 in the member 63. The cylindrical portion 101 of the plug 84 has a socket 111 for receiving a spring-pressed valve member 112 of the cartridge 97, and moving the valve member 112 to a position opening a resilient, rubber bag or bladder 113 to the counterbore 95 and passages 94 in the plug 84. The valve member 112 has a head 114 and normally is urged to the right to close a valve passage in member 115 by a spring (not shown) in tube 116, but when the connector bushing 96 is threaded into the nose portion 104 of the member 63, the valve member 112 is held stationary while the member 115 is moved to the right to open the passage in the member 115. The tube 116 connects the member 115 to the interior of the bag 113. The bag 113 is filled with a liquid fuel having a high vapor pressure and under a pressure substantially greater than that of the atmosphere, and the container 97 also includes a cylindrical outer container 121 having a space 122 therein between the bag 113 and the interior walls of the container 121 filled with a fluid having an even higher vapor pressure than that contained in the bag 113, which maintains the liquid in the bag 113 under a substantial pressure. Neck portion 123 of the bag 113 is sealed to a stem portion 124 of bushing 96 by a band 125. The liquid fuel in the bladder may be dimethyl ether, and the higher vapor pressure fluid in the space 122 may be Freon 12 or Kerene 500, for example. During storage of the tools in an uncocked condition, the fuel is doubly sealed by the O-ring 103 and gasket 105.

The greater vapor pressure of the fluid in the space 122 surrounding the bladder 113 than that of the liquid fuel in the bladder keeps the fuel in liquid form, and the vapor pressure of the fuel tends to move the liquid in the bladder through the passages 94 in the plug 84 into the space in the sleeve 87. Then, when the auxiliary piston 21 is in its retracted or cocked position, the valve member 78 is in the position shown in FIG. 3 in which the frusto-conical portion 81 thereof is positioned out of engagement with the valve insert 82. The fuel flows into a metering chamber 131 and fills the chamber 131. The metering chamber 131 is defined as the space between the seal 62 on the righthand side and the valve member 78 on the lefthand side and between the interior of a bore 132 in the member 63 and the exterior of the tubular valve member 44. Then, as the auxiliary piston 21 (FIG. 1) is triggered and released from its retracted position, the rod 35 is moved toward the right, as viewed in FIG. 3, to permit the spring 83 to move the valve member 78 into sealing engagement with the valve seat 82, at which time a predetermined volume of the liquid fuel under a predetermined pressure is enclosed within the chamber 131.

On further movement of the auxiliary piston 21 (FIG. 1), the rod 35 is moved farther to the right and moves the valve member 44 against the action of spring 71 to the right, as viewed in FIG. 3, to the position of the valve member 44 shown in FIG. 5, in which the lefthand end of the valve member 44 has moved away from the valve insert 74, and the fuel under the high vapor pressure in the chamber 131 flows out of the chamber 131 through the axial passage 45 in the valve member 44 and through the orifice 53 in the nozzle member 52 into the interior of the cylinder 23 (FIG. 1). Then before the air and the fuel in the cylinder 23 is ignited, the drive of the rod 35 from the auxiliary piston 21 is released and the spring 71 (FIG. 7) moves the valve member 44 back to its closed position shown in FIG. 7, in which the lefthand end of the valve member 44 sealingly engages the valve insert 75, after which the ignition of the air-fuel mixture takes place. Thus, the metering chamber 131 is closed off from the combustion chamber. Also, the orifice 53 is so small and the interior of the bore 51 and the passage 45 are filled with the fuel, probably in the vapor form, and have no air therein so that combustion stops at the exit end of the orifice 53. The orifice 53 also is so small that the increased pressure occurring during the explosion of the fuel-air mixture and the duration of the explosion is so short that the pressure in the passage 45 is not increased sufficiently to move the valve member 78 against the action of the spring 83.

The auxiliary piston 21 (FIG. 1) is slidable in a bore 141 in a bushing 142 positioned in a bore 140 and threaded into a tapped bore 143 formed in the cylinder head 22, and is movable between a cocked or retracted position thereof, as illustrated in FIG. 9, through an intermediate position thereof, as shown in FIG. 6, to an extended position thereof shown in FIG. 8. When the auxiliary piston 21 is in the position thereof shown in FIG. 9, a flange 144 thereof engages a slotted lever 145 pivoted on pin 146 carried by a bushing 147 fixed in a laterally opening slot 148 in the cylinder head 22 and holds the lever 145 in a position engaging the collar 151 to hold the collar 151

and rod 152 against the action of compression spring 153 in extreme lefthand positions of the collar 151 and rod 152. A plug 154 threaded into a tapped counterbore 155 in the head 22 seats the lefthand end of the spring 153. The rod 152 carries a slide portion 161 having a slot 162 through which projects an arm 163 of a lever 160 having a second arm 164 and mounted pivotally on a pin 165 carried by the slide 161. A compression spring 166 seated in a socket 167 in the slide 161 and a notch 168 in the arm 163 urges the lever 160 in a clockwise direction, as viewed in FIG. 9, to a position in which a rounded nose portion 171 of the arm 164 engages the arm 41, along with a fixed arm 172 integral with the slide 161, the nose portion 171 and the arm 172 bracketing the arm 41. The slide 161 has a bore 159 therein fitting slidably on guide rod 157 threaded into tapped counterbore 158.

The trigger mechanism 48 (FIGS. 10 to 13) includes the trigger 40 mounted pivotally on pin 181 and having a clevis 182 connected by a pin 183 to a link 184. The pin 181 is mounted in a fixed position on trigger side plate 175 fixed in the trigger housing 38. A magneto driving lever 185 also is mounted pivotally on the pin 181 and has a socket 186 in one arm thereof in which is seated a compression spring 187 which also fits over spring seating pin 188 fixed to the trigger 40. The lever 185 carries a hook member 189 on the other end thereof and is adapted to be held in latched position by a latching lever 190 pivoted on a pin 191 fixed to the trigger side plate 174 and having a latching hook 192 adapted to hook over a laterally projecting lug 193. A tension spring 194 urges the lever 190 in a counterclockwise direction, as viewed in FIGS. 12 and 13. When the trigger 40 is pivoted in a clockwise direction, as viewed in FIGS. 12 and 13, to fire the tool, it moves the link 184 upwardly to the left, as guided by a cam slot 201 and a pin 202 fixed to the trigger side plate 175. The link 184 carries thereon a lever dog 203 pivoted on pin 204 and urged clockwise by a spring 205 (FIG. 12) toward a position in which the lower arm thereof abuts against the link 184. The dog 203 engages an arm 211 of a sear 212 pivoted on pin 213 fixed to the plate 175, and pivots the sear 212 against the action of a compression spring 214 to move a catch 215 out of latching engagement with the flange 144 of the auxiliary piston 21 to permit the auxiliary piston 21 to be driven by the spring 24 (FIG. 1) to the right in its work stroke from its retracted or cocked position.

The auxiliary piston in its work stroke moves the main piston 25 away from the cylinder head 22 to draw air into the cylinder 23, actuates the tubular valve member 44, as described above, to supply a measured quantity of fuel to the interior of the cylinder through the orifice 53 (FIGS. 2 and 7, and then releases the valve member 44 to permit it to return to the position thereof shown in FIG. 7 prior to the end of this pre-ignition movement of the pistons 21 and 25 (FIG. 1). As the auxiliary piston 21 is released to make its work stroke by pivoting of the sear 212 (FIGS. 12 and 13), the flange 144 of the piston 21 moves into engagement with an arm 221 (FIG. 11) fixed to a plunger 222 by a collar 223 and pin 224 and moves the plunger 222 to the right, as viewed in FIG. 11, against the action of compression spring 225 mounted in bore 226 in the cylinder head 22. This moves a dog 227 to the position thereof shown in FIG. 11, the dog 227 being fixed to the rod 22 by pin 228. The dog 227 engages the latching lever 190 and moves it to a position releasing the magneto driving lever 185. The spring 187 having been compressed by movement of the trigger 40 swings the lever 185 clockwise, as viewed in FIGS. 12 and 13, and the lever 185 engages the end of high reluctance rod 231 mounted slidably in slot 232 of a core 229 of the magneto 47, and moves a low reluctance member 234 away from a core portion 235 of the magneto, the low reluctance member 234 being slidable in slot 233 in the core 229. A plate 249 is fixed to the core 229, and acts to stop the member 234 in its travel to the right. The movement of the low reluctance member 234 creates a gap 219 (FIG. 13) in the magnetic path and also has an end portion 236 which passes a grounded spring arm 237 to the right to break points 238 on the arm 237 and on plate 249 connected by the conductor 239 in series with a primary magneto winding forming part of coil 241. This produces a rapid collapse of the flux in the core of the magneto to induce a high voltage in a secondary magneto winding also forming a part of the coil 241. The electrodes of the sparkplug 46 (FIG. 14) are connected in series with such secondary winding so that a spark is produced between such electrodes to fire the fuel-air mixture in the cylinder. The magneto includes and is supported by high reluctance mounting plates 248. The magneto has a permanent magnet 242 and core portions 243 and 244 of low reluctance, the core 229 being mounted on members 245 and 246 of rubber or other insulation and fixed to the trigger housing 38 by screws (not shown), a high reluctance member 247 being positioned between the sheets 245 and 246. Capacitor 251 is connected across the breaker points to prevent burning of such points.

The explosion of the gas in the cylinder 23 (FIG. 1) drives the main piston 25 on to the right to drive the fastener in the barrel 36 into the object to which it is to be secured, and also re-cocks the auxiliary piston 21 by driving it to the left against the action of the spring 24. During the triggering action, end portion 261 of the dog 203 is moved away from the arm 211 to permit the sear 212 to return to the latching position thereof shown in FIG. 12, and as the piston 21 moves back to the cocked position, as shown in FIG. 12, it rides along an inclined face 262, snaps over the catch 215 and is secured in its cocked or retracted position, the spring 214 urging the sear 212 back into latching engagement with the flange 144 of the piston 21. Then release by the operator of the trigger 40 permits the trigger to be returned to its normal position, as illustrated in FIG. 12, by spring 257. The trigger pulls link 184 back to the right, and the end of the link 184 engages the driving lever 185 and swings it counter-clockwise to pull the rod 231 through the hook member 189 which projects into a notch 271 in the rod 231, back to the left to the position thereof shown in FIG. 12. This pulls the rod 231 back to the left. In this position, the low reluctance member 234 engages the core member 235 to again increase the flux in the core 229, and the latching lever 190 again swings back under the lug 193 of the lever 185 to latch the lever 185 into position. Also, the dog 203 again swings under the arm 311 of the sear 212 as illustrated in FIG. 12.

The above described apparatus gives a sure, uniform charge of fuel to the cylinder 23 for each firing thereof and directs the fuel in a wide spray through the arcuate orifice 53 away from the spark plug 46, as illustrated in FIG. 2, and toward the port 32 through which the air is being drawn into the cylinder by the piston. This causes the fuel and the air to mix thoroughly as the air is introduced into the cylinder 23, and forms an ideal, uniform combustion mixture for each actuation of the impact tool. The ignition mechanism (FIGS. 12, 13 and 14) provides a hot spark precisely timed in the cycle to surely ignite the fuel-air mixture on each operation.

It is to be understood that the above-described arrangements are simply illustrative of the application of the principles of the invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. In an impact tool,
a cylinder,
a piston reciprocable in the cylinder,
a metering chamber,
a fuel supply chamber,

a firing mechanism for igniting a fuel-air mixture in the cylinder,
cocking means for cocking the firing mechanism,
first valve means responsive to actuation of the cocking means for connecting the metering chamber to the fuel supply chamber,
a trigger,
trigger actuated means for actuating the firing mechanism,
and second valve means actuated by the rigger actuated means for connecting the metering chamber to the cylinder.

2. In a fuel supplying device of an explosively actuated tool having a combustion chamber,
first tubular means,
a fuel container having fuel under pressure therein mounted at one end of the tubular means in communication therewith,
a first valve member in the first tubular means slidable along the tubular member between a closed position closing the supply container from the interior of the first tubular means and an open position permitting flow of fuel from the container into the first tubular means,
spring means maintaining the first valve member normally in the closed position thereof and permitting movement of the first valve member along the first tubular means toward the container against the action of the spring means to open position thereof,
a tubular metering chamber beyond the first tubular means,
a tubular valve member slidable in the metering chamber,
spring means urging one end of the tubular valve member into engagement with the first valve member to close said one end of the tubular valve member,
the other end of the tubular valve member being open to the combustion chamber,
and an actuator connected to the tubular valve member for moving the tubular valve member along the tubular metering means to move the first valve member to the open position thereof while maintaining said one end of the tubular valve member closed and also movable in a second direction to move the tubular valve member away from the first valve member to open said one end of the second valve member and permit fuel in the metering chamber to flow through the first valve member into the combustion chamber.

3. In an impact tool,
a cylinder having a forward end and a rear end,
a main piston slidable along the cylinder and urged toward a normal position near the rear end of the cylinder,
ignition means positioned at the rear end of the cylinder,
a guideway extending from the rear end of the cylinder,
an auxiliary piston mounted slidably in the guideway,
means urging the auxiliary piston forwardly into the cylinder to push the main piston to an intermediate position,
means for latching the auxiliary piston in a retracted position permitting the main piston to be positioned near the rear end of the cylinder,
trigger means for releasing the auxiliary piston,
air inlet valve means positioned near the rear end of the cylinder adapted to supply air into the cylinder behind the main piston as the main piston moves from its position near the rear end of the cylinder to its intermediate position,
a metering chamber,
fuel supply means,

first valve means for connecting the fuel supply means to the metering chamber,
second valve means for connecting the metering chamber to the rear end of the cylinder,
and actuator means operable by the auxiliary piston for sequentially closing the first valve means, opening the second valve means, and closing the second valve means as the main piston is moved from the normal position thereof to the intermediate position thereof.

4. In an impact tool,
a cylinder having a forward end and a rear end,
a main piston slidable along the cylinder and urged toward a normal position near the rear end of the cylinder,
ignition means positioned at the rear end of the cylinder,
a guideway extending rearwardly from the rear end of the cylinder,
an auxiliary piston mounted slidably in the guideway,
means urging the auxiliary piston forwardly from a retracted position to an extended position in the cylinder to push the main piston to an intermediate position,
means for latching the auxiliary piston in the retracted position thereof to permit the main piston to be positioned near the rear end of the cylinder,
trigger means for releasing the auxiliary piston,
air inlet valve means positioned near the rear end of the cylinder adapted to supply air into the portion of the cylinder behind the main piston as the main piston moves from the normal position of the cylinder near the rear end of the cylinder to the intermediate position thereof,
a tubular guide member mounted on the rear end of the cylinder and having an opening communicating with the interior of the cylinder,
a bushing member positioned in the guide member,
a guide bushing mounted in the guide member in alignment with the bushing member,
a tubular valve member having a passage extending longitudinally therethrough and slidably mounted in the bushing member,
a pair of spaced, parallel collars mounted on the tubular valve member and held thereon against longitudinal movement relative to the valve member,
a tubular metering chamber aligned with the guide member and having openings at the ends thereof,
guide means mounted in one of the metering chamber and fitting around the tubular valve member and permitting longitudinal movement of the valve member while sealing the valve member,
a valve seat member positioned at the other end of the metering chamber,
a second valve member mounted slidably in alignment with the tubular valve member,
spring means urging the second valve member toward the tubular valve member and toward the valve seat to normally hold the second valve member against the valve seat to close off the metering chamber,
the second valve member also being provided with a valve seat portion adapted to be engaged by and seal off the end of the tubular valve member when the tubular valve member is pressed thereagainst,
spring means urging the tubular valve member toward a normal position engaging the second valve member and closing off the passageway therethrough,
and fuel supply means for supplying fuel to the second valve member.

5. In an impact tool,
a fuel supply chamber,
a metering chamber,
first valve means connecting the fuel supply and metering chambers,

a combustion chamber,
second valve means connecting the metering and the combustion chambers,
piston means movable in the combustion chamber between a cocked position and an actuated position,
means operable by the piston means as it is moved toward the cocked position thereof to open the first valve means,
means operable by the piston means as it is moved toward the actuated position thereof for sequentially closing the first valve means and opening the second valve means,
and means for sequentially reclosing the second valve means and firing the fuel in the combustion chamber.

6. In an impact tool,
a fuel supply chamber,
a metering chamber,
first valve means connecting the fuel supply and the metering chambers,
first spring means normally holding the first valve means closed,
a combustion chamber,
means for supplying air to the combustion chamber,
tubular valve means connecting the metering and combustion chambers and extending slidably into the metering chamber,
second spring means normally holding the tubular valve means against the first valve means to close the tubular valve means without opening the first valve means,
piston means movable in the combustion chamber between a cocked position and an actuated position,
means operable by the piston means as it is moved toward the cocked position thereof to move the tubular valve means against the first valve means in a direction against the first spring means to open the first valve means while keeping the tubular valve means closed,
means operable by the piston means as it is moved toward the actuated position thereof for sequentially closing the first valve means and moving the tubular valve means away from the first valve means to open the tubular valve means,
and means for sequentially reclosing the tubular valve means and firing the fuel in the combustion chamber.

7. In an impact tool,
a cylinder,
a piston reciprocable in the cylinder,
first means urging the piston toward one end of the cylinder,
second means for moving the piston against the action of the first means to an intermediate position in the cylinder to provide an explosion chamber,
locking means for locking the second means in inactive position to enable the first means to move the piston to said end,
manually controlled means for releasing the locking means to enable the second means to cause movement of the piston to the intermediate position,
means for introducing a charge of air into the chamber during the movement of the piston to the intermediate position thereof,
means for introducing a measured quantity of fuel into the chamber during movement of the piston toward the intermediate position thereof,
and means for igniting the fuel when the piston reaches the intermediate position thereof.

8. In an impact tool,
a cylinder,
a piston reciprocable in the cylinder,
first means urging the piston toward one end of the cylinder,
second means for moving the piston against the action of the first means to an intermediate position in the cylinder to provide an explosion chamber,
locking means for locking the second means in inactive position to enable the first means to move the piston to said end,
manually controlled means for releasing the locking means to enable the second means to cause movement of the piston to the intermediate position,
means for introducing a charge of air into the explosion chamber during the movement of the piston to the intermediate position thereof,
a metering chamber having an inlet and an outlet aligned with the inlet,
tubular nozzle means open at one end to the explosion chamber,
the other end of the tubular nozzle means being slidable in the metering chamber through the outlet thereof and closing the outlet,
a fuel source connected to the inlet,
a valve member urged against the inlet to close the inlet,
spring means urging said other end of the tubular nozzle means against the valve member to close said other end of the tubular nozzle means,
means operable by the second means as the second means moves the piston to said intermediate position to first move the valve member to a closed position, then move the nozzle means away from the valve member to admit a measured quantity of fuel from the metering chamber and then move the nozzle means to a position against the valve member without moving the valve member away from the inlet,
means for igniting the fuel when the piston reaches the intermediate position thereof,
and means operable by the second means when moved to said inactive position for moving the valve member to a position away from the inlet and for holding the nozzzle member against the valve member.

9. In an impact tool,
a cylinder,
a piston reciprocable in the cylinder,
first means for urging the piston toward a retracted position at one end of the cylinder,
triggerable means for moving the piston from the retracted position thereof to an intermediate position in which the piston is spaced substantial distances from both ends of the cylinder,
check valve means for supplying air to the cylinder as the piston is moved from the retracted position thereof to the intermediate position thereof,
a metering chamber of predetermined volume having an inlet and an outlet aligned with the inlet,
a source of liquid fuel under pressure connected to the inlet,
a first valve member urged toward the outlet and a closed position closing the inlet with a predetermined force,
a tubular valve member slidable in the outlet and urged to a normal position engaging the first valve member with a second force less than said predetermined force,
means operable by the trigger means when the piston is in its retracted position for holding the tubular valve member against the first valve member with sufficient force to open the inlet,
means operable by the trigger means when actuated for first moving the tubular valve member away from the first valve member to close the inlet and open the tubular valve member to the metering chamber and then permit the tubular valve member to move to the normal position thereof,
and means for igniting the fuel-air mixture as the piston reaches the intermediate position thereof.

10. In an impact tool,
a cylinder having a head provided with an air inlet port,

the cylinder head having a first bore extending therethrough parallel to the longitudinal axis of the cylinder,
the cylinder head also having a second bore therein parallel to the first bore,
a piston reciprocable in the cylinder,
first means urging the piston toward a retracted position at the cylinder head end of the cylinder,
triggerable plunger means movable in the second bore from a cocked position for moving the piston against the action of the first means from the retracted position thereof to an intermediate position in the cylinder to provide an explosion chamber,
manually controlled trigger means for triggering the triggerable plunger means to move the piston to the intermediate position thereof,
means for introducing a charge of air into the chamber during the movement of the piston to the intermediate position thereof,
a valve body mounted in the first bore having an axial passage extending therethrough,
a fuel cartridge containing a volatile liquid therein secured to the valve body at an outer end of the axial passage and having a valve in communication with the axial passage,
a valve plunger in a fixed position in the axial passage such as to hold the valve open to the passage,
a first valve member having a valve head at one end thereof and an axial bore opening at the other end thereof and slidable on the plunger,
the first valve member also having an opening extending from the axial bore in the valve member to the exterior of the valve member,
the relative sizes of the exterior of the valve member and the axial passage in the valve body being such as to provide a passage therebetween,
an annular valve seat positioned in the axial passage in the valve body,
a first compression spring of a predetermined strength urging the valve member toward a closed position away from the fuel cartridge in which the valve head engages the valve seat,
the valve head having a socket opening away from the cartridge,
a valve seat member seated in the socket,
a nozzle member fixed in the axial bore in the valve member at the end thereof adjacent the interior of the cylinder having a bore therethrough axially aligned wtih the bore in the valve member and also provided with an orifice extending from the bore in the nozzle member to the interior of the cylinder,
a tubular valve member having one end portion fitting closely and slidably in the bore in the nozzle member and a second end portion adapted to sealingly engage the valve seat member in the socket when pressed thereagainst,
a second compression spring substantially weaker than the first compression spring and normally urging the tubular valve member into engagement with the valve seat member,
an annular guide positioned in the axial passage in the valve body between the socket and the nozzle member and serving to guide the tubular valve member and sealingly engage the tubular valve member and the bore in the valve body to define a metering chamber with the valve head, the exterior of the tubular valve member and the interior of the axial passage in the valve body,
a first rod mounted for slidable movement parallel to the axial passage in the valve body and connected to the tubular valve member and having a laterally projecting dog,
a second rod having a fixed lateral abutment member for engaging the dog on one side thereof and moving the rod in a direction away from the interior of the cylinder,
a lever pivotal on the second rod and urged toward a first position engaging the other side of the dog for moving the dog toward the interior of the cylinder and movable to a second position releasing the dog,
a flange on the plunger means for engaging the lever to move it to the second position thereof at the extreme end of the movement of the plunger into the cylinder,
spring means urging the second rod toward the interior of the cylinder,
and lost motion means operable by the plunger means for moving the second rod in a direction away from the interior of the cylinder during the latter portion of the movement of the plunger means toward the cocked position thereof and for holding the second rod against the action of the spring means in a position holding the first rod in position holding the tubular valve member against the valve seat member and the head of the valve member away from the valve seat.

11. In an impact tool,
a cylinder,
a piston reciprocable in the cylinder,
first means urging the piston toward one end of the cylinder,
second means for moving the piston against the action of the first means to an intermediate position in the cylinder to provide an explosion chamber,
locking means for locking the second means in inactive position to enable the first means to move the piston to said end,
manually controlled means for releasing the locking means to enable the second means to cause movement of the piston to the intermediate position,
means for introducing a charge of air into the chamber during the movement of the piston to the intermediate position thereof,
a container holding a supply of volatile liquid fuel under a predetermined pressure,
a tubular metering chamber having a predetermined inner diameter and valve seat means at one end thereof communicating with the container,
an annular guide member having an inner diameter substantially less than that of the metering chamber closing the other end of the metering chamber,
a valve member having a head urged toward the valve seat to close the metering chamber from the container,
a tubular nozzle member slidable in the guide member and adapted to sealingly engage the head and movable away from the head to permit liquid in the metering chamber to flow into and through the nozzle member,
means urging the tubular nozzle member against the head,
means operable by the second means for holding the tubular nozzle member in a position holding the head away from the valve seat while the second means is in its inactive position and for moving the tubular nozzle member away from the head to permit the head to seat against the valve seat and to open the interior of the tubular nozzle member to the interior of the chamber as the second means moves the piston to the intermediate position thereof and for releasing the tubular nozzle member to move back against the head before the piston reaches the intermediate position thereof,
and means for igniting the fuel when the piston reaches the intermediate position thereof.

12. In an impact tool,
a cylinder,
a main piston reciprocable in the cylinder,
first means urging the piston toward one end of the cylinder,

an auxiliary piston for moving the main piston against the action of the first means to an intermediate position in the cylinder to provide an explosion chamber,
locking means for locking the auxiliary piston in inactive position to enable the first means to move the main piston to said end,
manually controlled means for releasing the locking means to enable the auxiliary piston to cause movement of the main piston to the intermediate position,
means for introducing a charge of air into the chamber during the movement of the main piston to the intermediate position thereof,
a container holding a supply of volatile liquid fuel under a predetermined pressure,
a tubular metering chamber having a predetermined inner diameter and a valve seat at one end thereof communicating with the container,
an annular guide member having an inner diameter substantially less than that of the metering chamber closing the other end of the metering chamber,
a valve member having a head urged toward the valve seat to close the metering chamber from the container,
a tubular nozzle member slidable in the guide member and adapted to sealingly engage the head and movable away from the head of the valve member to permit liquid in the metering chamber to flow into and through the nozzle member,
means urging the tubular nozzle member against the head of the valve member,
means operable by the auxiliary piston for holding the tubular nozzle member in a position holding the head of the valve member away from the valve seat while the second means is in its inactive position and for moving the tubular nozzle member away from the head to permit the head to seat against the valve seat and to open the interior of the tubular nozzle member to the interior of the chamber as the auxiliary piston moves the main piston to the intermediate position thereof and for releasing the tubular nozzle member to move back against the head before the main piston reaches the intermediate position thereof,
and means for igniting the fuel when the main piston reaches the intermediate position thereof.

13. In an impact tool,
a cylinder head having an axial bore therein and also being provided with a passage therethrough parallel to the bore and a socket at the rear end of the passage,
a fuel container having a discharge end,
means securing the discharge end of the container in the socket,
valve means in the passage for opening the passage for flow of fuel from the container to the cylinder,

a cylinder extending from the cylinder head,
a main piston slidable in the cylinder,
stud-driving means driven by the main piston,
an auxiliary piston slidable in the axial bore in the cylinder head for moving the main piston from a position adjacent the cylinder head to a position intermediate the ends of the cylinder,
and mechanical drive means operable by the auxiliary piston for controlling the valve means to supply fuel from the passage to the cylinder as the main piston is moved to the position thereof intermediate the ends of the cylinder.

14. In a fuel-supplying device,
a fuel container having an outlet and containing fuel under pressure,
elongated tubular housing means having an inlet end in communication with the outlet of the container and also having an outlet end,
a first valve seat member mounted in the housing means near the inlet thereof,
a first valve closure member mounted in the tubular housing means between the outlet of the container and the first valve seat and urged by the fuel toward closing engagement with the first valve seat member,
a second valve seat member in the tubular housing means at the discharge side of the first valve seat member,
a second valve closure member for engaging the second valve seat member,
metering chamber means including a portion of the interior of the tubular housing means defining a metering chamber between the first valve seat member and the second valve seat member,
means for urging the second valve member toward engagement with the second valve seat member,
means for alternately moving the first valve closure member away from the first valve seat member and the second valve closure member away from the second valve seat member,
a cylinder connected at one end thereof to the second valve seat member,
and a piston movable along the cylinder away from said one end of the cylinder to an intermediate position to draw fuel from the metering chamber means after the second valve closure member has been moved away from the second valve seat member.

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