Nov. 9, 1965 G. M. KELSEY 3,216,158

IMPACT TOOL

Original Filed March 31, 1960 2 Sheets-Sheet 1

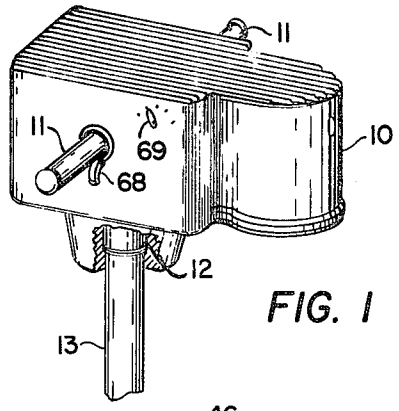


FIG. 1

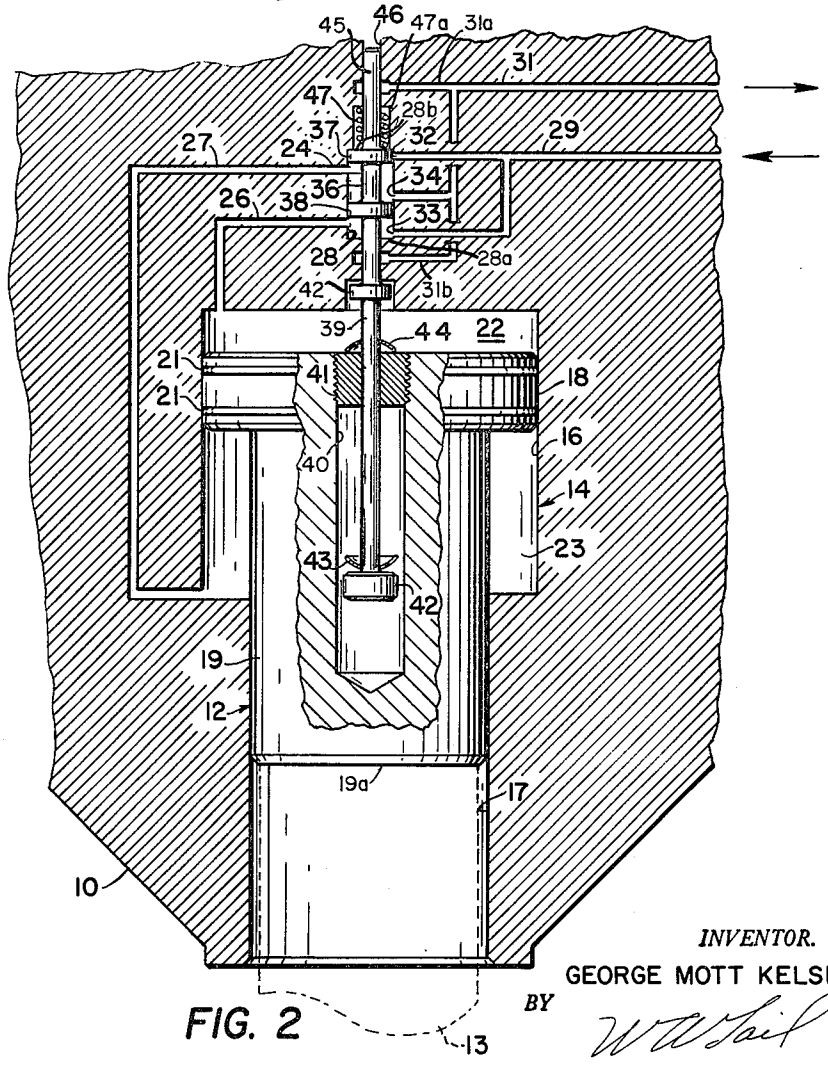


FIG. 2

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IMPACT TOOL

Original Filed March 31, 1960 2 Sheets-Sheet 2

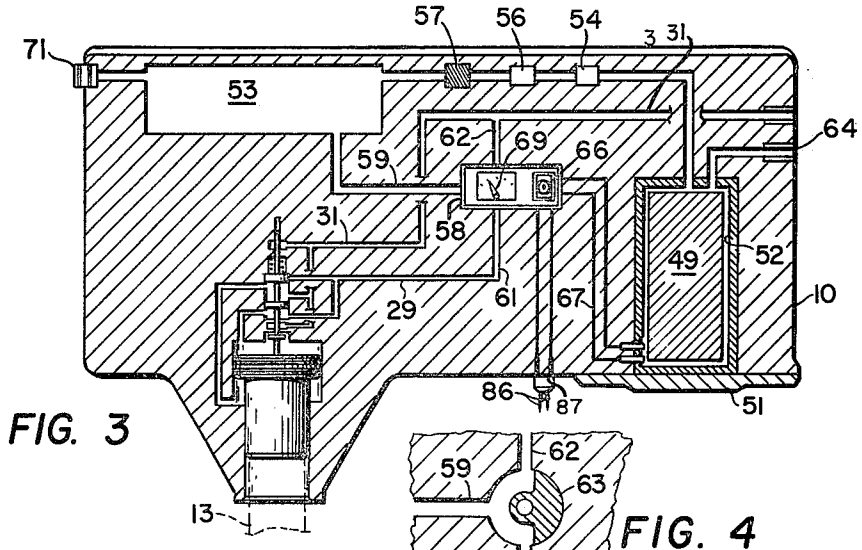


FIG. 3

FIG. 4

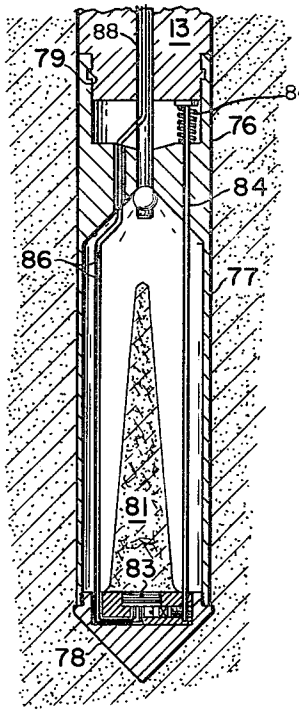


FIG. 5

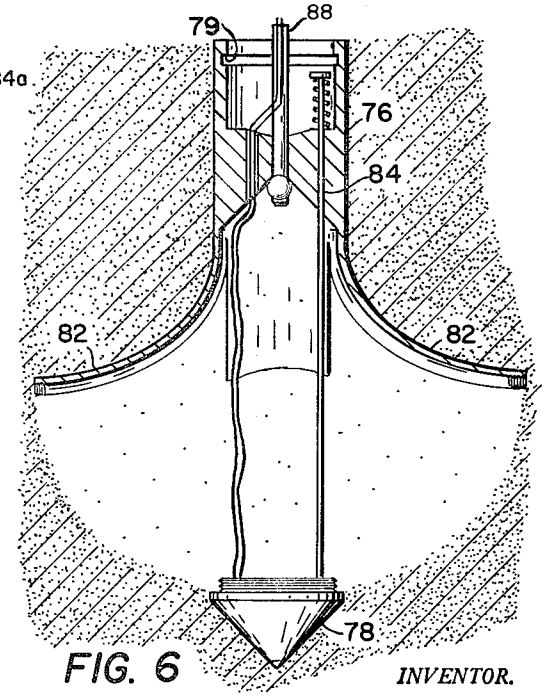


FIG. 6

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United States Patent Office 3,216,158 Patented Nov. 9, 1965

3,216,158

IMPACT TOOL

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Continuation of application Ser. No. 18,992, Mar. 31, 1960. This application July 22, 1963, Ser. No. 300,951
8 Claims. (Cl. 52—155)

This application is a continuation application of my now abandoned application, Serial No. 18,992, filed March 31, 1960, entitled "Impact Tool."

This invention relates generally to power-driven impact tools or driving hammers and, more particularly, to a portable impact tool or driving hammer particularly adapted to be driven by a propellant cartridge which is ignited to generate gas under pressure.

It is an important object of the present invention to provide an impact tool or driving hammer particularly adapted to utilize a combustible propellant as a gas generator to drive an impact mechanism.

Another important object of this invention is to provide a propellant driven portable impact tool or driving hammer suitable for use in driving land anchors and the like.

Still further, an important object of the present invention is to provide a new and improved land anchor and impact tool or driving hammer particularly adapted to be powered by a gas generator of the combustible propellant type.

It is still another object of this invention to provide an impact tool or driving hammer particularly adapted to utilize an ignitable propellant for a source of power in combination with a land anchor which comprises explosive means to increase the holding power of the anchor after it is driven into the ground.

It is a still further object of the present invention to provide a land anchor which can be driven into the earth comprising an explosive which is operable to spread tangs or the like, positioned upon the anchor, to improve its holding or anchoring power.

Other objects and important features of the invention will be apparent from a study of the specification following taken with the drawing, which together show, illustrate, describe and disclose a preferred embodiment or modification of the invention and what is now considered to be the best mode of practicing the principles thereof. Other embodiments or modifications may be suggested to those having the benefit of the teachings herein, and such other embodiments or modifications are intended to be reserved especially as they fall within the scope and spirit of the subjoined claims.

In the drawing:

FIGURE 1 is a perspective view illustrating a preferred impact tool or driving hammer constructed in accordance with the present invention;

FIGURE 2 is an enlarged schematic view illustrating certain details of one form of a reciprocating motor suitable for use in connection with the present invention;

FIGURE 3 is a schematic view illustrating an impact tool or driving hammer and system comprising control valving and pneumatic connections, all in accordance with the present invention;

FIGURE 4 is an enlarged fragmentary view of a control valve used to regulate the operation and speed of the reciprocating motor;

FIGURE 5 is an enlarged fragmentary view of a land anchor prior to detonation of the charge contained therein, and

FIGURE 6 is a view similar to FIGURE 5 showing the anchor after the charge has been ignited to deflect the tangs and improve the anchoring characteristics thereof.

On construction sites and also in military operations, it is often necessary to provide means for anchoring equipment such as winches, landing mats and any other pieces of equipment to firmly secure them in place. In such locations, normal power sources are often unavailable. Thus, a completely portable, simple driving means and land anchor mechanism is desirable. An impact tool or driving hammer, constructed in accordance with the present invention, utilizes a reciprocating hammer element particularly adapted to drive a land anchor into the earth. The power for operating the hammer is provided by an ignitable propellant cartridge which, when ignited, develops gas under pressure. Since the combustion process, once initiated, continues until the propellant is exhausted, the various elements and component parts of the impact tool or driving hammer are sized so that, in normal operations, a single cartridge can be used to drive a single land anchor. A preferred land anchor, constructed in accordance with the present invention, also comprises an explosive charge which can be ignited from the surface, after the anchor is driven into the earth. This deflects tangs outwardly, increasing the projected area of the anchor and vastly improving the anchoring power of the instant device.

One form of the impact tool or driving hammer, constructed in accordance with the present invention, is illustrated in FIGURE 1. As shown therein, a body **10** is provided upon which opposed handles **11** are positioned, which handles are particularly adapted to be gripped and used by an operator to handle and control the device. A force applicator, generally designated by the reference character **12**, is disposed and reciprocal within the body **10**, said applicator comprising a hammer portion engageable with the upper end of a driving rod **13** to drive the land anchor into the earth. The applicator **12**, in cooperation with the body **10**, comprises a reciprocating pneumatic motor, generally designated by the reference character **14**, as best shown in FIGURE 2.

The penumatic motor **14** comprises a first bore **16** and a coaxial second bore **17**, of smaller diameter, formed within the body **10**. The force applicator **12** comprises a first piston **18**, of substantially the same diameter as the bore **16**, whereby to dispose the piston in a close fitting sliding relationship with respect to the wall thereof. A second piston **19** is connected to the first piston **18**, in coaxial relationship with respect thereto, and is of reduced diameter. The second piston is of substantially the same diameter as the second bore **17**, whereby to dispose the piston in a close-fitting sliding relationship with respect to the wall thereof. At least one, and, as shown in FIGURE 2, a plurality of piston rings **21**, of conventional construction, are positioned upon the first piston **18**, and completely annularly thereabout, to provide slidable sealing engagement between the piston **18** and the wall of the first bore **16**. In accordance with the above construction, the body **10** and the first piston **18** define an upper or first chamber **22** therebetween. Additionally, a second or lower chamber **23** is defined by the first piston **18** and the body **10** completely annularly about the second piston **19**. As will be described more fully hereinafter, gas, under pressure, is particularly adapted to be supplied to the first chamber **22**, wherein it produces a force over the entire area of the first piston **18**, urging the force aplicator **12** downwardly in a driving stroke. Conversely, and as will be described more fully hereinafter, gas under pressure is particularly adapted to be supplied to the second chamber **23**, wherein a force is developed upon the first piston **18**, over an annular area defined by the difference between the diameter of the first piston **18** and the second piston **19**, urging the force applicator **12**

upwardly in a return stroke. It is considered readily apparent that the force in a downward direction, within the first chamber 22, is substantially equal to the pressure of the gas times the cross-sectional area of the first piston 18, while the force in an upward direction, within the second chamber 23, is substantially equal to the pressure of the gas times the difference in area between the first piston 18 and the second piston 19. The differential area between the first piston 18 and the second piston 19 is less than the area of the first piston per se. Thus, a much larger force is produced during the downward or driving stroke of the force applicator 12 than on the upward or return stroke thereof.

Reciprocation of the force applicator 12 is produced by valve means, preferably in the form of a spool valve generally designated by the reference character 24 in FIGURE 2. The spool valve 24 comprises at least two control passages or passageways 26 and 27, one of which is connected to the first or upper chamber 22 and the other of which is connected to the second or lower chamber 23. The body 10 is provided with a valve bore 28, disposed or located centrally of the force applicator 12, and, thus, in coaxial relationship therewith, which valve bore is particularly adapted to be selectively connected to an inlet 29 and an outlet or exhaust 31. The inlet 29 communicates with the valve bore 28 by means of two ports 32 and 33, spaced longitudinally thereof. The exhaust 31 communicates with the valve bore 28 by means of a single port 34, which port is positioned or disposed substantially centrally of the valve bore and between the ports 32 and 33. A spool valve 36 is positioned or disposed within the valve bore 28 in longitudinal sliding engagement with respect thereto between a first or upper position, as shown in FIGURE 2, and a second or lower position. The spool 36 is provided with two completely annular spaced lands 37 and 38. When the spool valve 36 is in the first or upper position, as shown in FIGURE 2, the control passage 26 is in communication with the inlet 29 by means of the inlet port 33. Simultaneously, the control passage 27 is in communication with the exhaust 31 by means of the exhaust port 34. Thus, gas under pressure is particularly adapted to be supplied to the first or upper chamber 22, whereby to cause the force applicator 12 to move in a driving stroke downwardly with respect to the body 10. When the spool valve 36 moves or shifts to its second or lower position, the just described communications or connections of the control passages 26 and 27 with respect to the inlet 29 and 31 are reversed. Thus, the control passage 26 is in communication with the exhaust 31 by means of the exhaust port 34, and the control passage 27 is in communication with the inlet 29 by means of the inlet port 32. In this latter position of the spool valve 36, therefore, gas under pressure is particularly adapted to be supplied to the second or lower chamber 23, thereby causing a return stroke of the force applicator 12 in a direction upwardly with respect to the body 10.

It is considered readily apparent that, in accordance with the above construction, the spool valve means 24 is particularly adapted to shift or oscillate longitudinally of and with respect to the force applicator 12, in order to produce both the driving and return strokes thereof. To this end, the spool valve means 24 is provided with a means for causing a shifting or oscillating thereof comprising an integral extension or stem 39 extending in a direction generally downwardly therefrom, and projecting into and within a bore 40 disposed generally centrally of the force applicator 12. The bore 40 terminates short of the lower end 19*a* of the second piston 19, whereby the bore is closed at one end, as indicated by the reference character 40*a*. The other end of the bore 40 is open and is threaded, and is, therefore, particularly adapted to be mutually cooperatively engageable with a valve operating sleeve or threaded plug 41. The sleeve 41 is dimensionally so constituted and arranged as to be mutually cooperatively engageable, in turn, with first and second or upper and lower shifting lands or heads 42—42, respectively, the lands or heads being fixedly positioned upon the stem or extension 49. In accordance with this construction, when the force applicator 12 approaches the end of its driving stroke, the valve operating sleeve 41 engages a spring 43, which is preferably of semi-spherical configuration, positioned about the extension or stem 39 and in abutting engagement with the second or lower head 42, thereby shifting the spool valve means 24 downwardly, to its second position, and reversing the position of the inlet port 29 and the exhaust port 31 with respect to the control passages 26 and 27 from the position therebetween when the spool valve is in its first or upper position. When the force applicator 12 approaches the end of its return stroke, in a direction upwardly with respect to the body 10, a spring 44, similar to the spring 43, and adapted to be positioned substantially adjacent the valve operating sleeve 41, mutually cooperatively engages the first or upper head 42 and shifts the spool valve means 24 back to its first or upper position, as shown in FIGURE 2.

When the spool valve means 24 is in either one of its first or second positions, as described above, it is desirable that the valve means be held in that position until shifted to its other position by means of the valve operating sleeve 41. To this end, and with reference first to the upper position of the valve spool means, as shown in FIGURE 2, exhaust pressure is communicated to the undersurface of the upper land 37 and to the upper surface of the lower land 38 by means of the exhaust port 34. Inlet pressure is communicated to the under surface of the lower land 38 by means of the inlet port 33. In this manner, a pressure differential acting upwardly retains the valve means in the position shown in FIGURE 2. To assure that the pressure differential maintains the valve in this position, any inlet pressure communicating with the upper surface of the upper land 37 is immediately exhausted by means of an extension bore 46 and an auxiliary exhaust passage 31*a*.

When the spool valve 36 is in its second or lower position (not shown), exhaust pressure is communicated to the under surface of the upper land 37 and the upper surface of the lower land 38 by means of the exhaust port 34. Additionally, inlet pressure is communicated to the upper surface of the upper land 37 by means of the inlet port 32. Exhaust pressure acting on the lower surface of the upper land 37 and the upper surface of the lower land 38 presents no pressure differential since the area of each of the lands 37 and 38 is the same. The inlet pressure acting on the upper surface of the upper land 37, however, produces a downwardly directed force to maintain the spool valve in its second or lower position. To assure retention or maintenance of the spool valve 36 in its lower position, any inlet pressure communicated to the under surface of the lower land 38 by means of the inlet port 33 is immediately exhausted by means of any other auxiliary exhaust port 31*b*. It is considered readily apparent, therefore, that the spool valve 36 is retained or maintained in one or the other of its first or second positions while the force applicator 12 is driving or returning and does not shift or oscillate until one or the other of the shifting lands 42 mutually cooperatively engages one or the other of the springs 43 or 44. A spring chamber 47 is provided, of smaller diameter than the valve bore 28 and of greater diameter than the extension bore 46, as by counter-boring the body 10 accordingly, within which a light spring 47*a* is particularly adapted to be positioned. The spring 47*a* normally biases the spool valve 36 to its second or lower position, whereby the first stroke of the force applicator 12 will always be a return stroke in an upwardly disposed direction with respect to the body 10. This spring, however, is so constituted and arranged as to produce a very light force which does not overcome or override the pressure differential across the spool valve 36, described above,

for maintaining or retaining the valve in one or the other of its positions.

The valve bore 28 is so constituted and arranged as to present a means for determining or defining the limit of movement of the spool valve 36 in either one of its directions. Thus, a first or lower end 28*a* defines the limit of movement of the spool valve in a direction towards its second or lower position. And, a second or upper end 28*b*, comprising a shoulder defined by the difference in diameter between the valve bore 28 and the spring chamber 47, determining the limit of movement of the spool valve toward its first or upper position.

Additionally, movement of the spool valve 36 is maintained exactly longitudinally of the force applicator 12 and the body 10. Thus, it is considered readily apparent, that the integral extension or stem 38 is guided in its movement longitudinally of and with respect to the valve operating sleeve 41. Additionally, an integral guide stem 45, integrally connected to the spool valve 36, and extending coaxially opposite with respect to stem 38, cooperates with the extension bore 46 in guiding the movement of the spool valve longitudinally of the force applicator 12 and the body 10.

It is to be understood that the springs 43 and 44 exert a greater force on the spool valve 36, when one or the other mutually cooperatively engages one of the shifting lands 42, than the pressure exerted on the lands 37 or 38. It is therefore assured that the spool valve 36 will shift when the force applicator 12 reaches the end of either a driving or return stroke. Additionally, the force of the springs 43 and 44 is such as to assure a shifting or oscillation of the spool valve 36 and, specifically, the lands 37 and 38 thereof, past the corresponding one of the inlet ports 32 and 33 and the exhaust port 34 to preclude stalling. Once the lands 37 and 38 have passed a corresponding one of the inlet ports 32 and 33 and the exhaust port 34, the pressure communicated to that one of the lands moving the valve to its next position becomes predominant and, subsequent to completion of the movement of the valve to such position, retains the valve therein, as pointed out above.

The reciprocating pneumatic motor 14, constructed in accordance with the present invention, is particularly adapted to be operated or powered by a gas generator of the combustible propellant type. To this end, a propellant material 49, in the form of a replaceable cartridge, is particularly adapted to be mounted or positioned in a cavity or chamber 52 provided in the body 10, as shown in FIGURE 3. An end cover 51 is removably threaded into the body 10, whereby the replacement of the propellant cartridge is facilitated. The propellant cartridge may be comprised of any relatively slow burning propellant, thereby generating the gas to operate the reciprocating pneumatic motor 14. Preferably, the propellant is selected and sized so as to burn for approximately one minute. The cavity or chamber 52, within which the propellant cartridge 49 is disposed, is connected to an accumulator chamber 53 by means of and through a filter 54, a dump valve 56 and a check valve 57. Each of the filter 54, the dump valve 56 and the check valve 57 may be of any suitable and well-known construction. The accumulator 53, which may also be of any suitable and well-known construction, is connected to a control valve 58 through a passage 59. The control valve 58 is, in turn, connected to the inlet 29 through a passage 61 and to the exhaust 31 through a passage 62. With particular reference now to FIGURE 4, a preferred form of control valve 58 is illustrated therein. The control valve comprises a rotor 63 rotatable between a plurality of positions. In one position, illustrated in FIGURE 4, passage 61, connected to the inlet 29, and the passage 62, connected to the exhaust 31, are each of them connected to the passage 59 leading to and communicating with the accumulator 53. In a second and third position, each of the passages 61 or 62 are selectively adapted to be isolated from the passage 59. In accordance with this construction, therefore, rotatable movement of the valve rotor 63 provides control of the operation of the force applicator or hammer 12. Thus, closing the passage 61 stops the pneumatic motor 14, since gas under pressure, developed by the propellant cartridge 49, is communicated directly to the exhaust by means of the passage 62 and the exhaust 31, the latter being communicated to the atmosphere. Conversely, if the valve rotor 63 is rotatably moved to a position blocking or closing only the passage 62, all of the gas under pressure is directed or communicated directly to the pneumatic motor. It is within the scope of the present invention to position the valve rotor 63 medially of the two positions just described, wherein the speed of the pneumatic motor 14 is controlled, the same being accomplished by modulating the bleed of gas under pressure through the passage 62 and to exhaust by means of the exhaust passage 31. The body 10 is provided with a pressure relief valve 64, of any suitable and well-known construction, providing an exhaust for gas under pressure when the pneumatic motor 14 is shut off. In this manner, explosion of the pneumatic motor is precluded.

An ignition mechanism 66, of any suitable and well-known construction, is positioned upon the body 10. Preferably, the ignition mechanism 66 is electrically operable and is connected to the propellant cartridge 49 by means of suitable electrical wiring 67. In the preferred embodiment of the present invention, the ignition mechanism is controlled by a suitable trigger 68 positioned adjacent the handles 11, upon the body 10, as illustrated in FIGURE 1. The position of the control valve 58 is remotely determined by a pointer 69 positioned exteriorly of the body. It is within the scope of this invention to make use of existing compressors, as a source of gas under pressure, for the operation of the force applicator or hammer 12. To this end, a quick disconnect coupling 71, of any suitable and well-known construction is provided upon the body 10 to provide communication directly with and to the accumulator 53. The check valve 57, as is considered readily apparent, operates to prevent flow of the compressed gas into the zone of the propellant cartridge 49.

With reference now to FIGURES 5 and 6, there is illustrated therein a preferred form of land anchor constructed in accordance with the present invention. The land anchor comprises a body 76 comprising, in turn, or having frangible side walls 77. The lower end of the body 76, comprising the frangible side walls 77, is interiorly threaded for mutual cooperative engagement with an exteriorly threaded igniter head 78. The igniter head may be of any suitable configuration, depending upon the particular type of material into which the land anchor is to be driven. As illustrated, the igniter head is of generally conical configuration, which configuration would be generally suitable for a large variety of earth materials. It is to be remembered, however, that other shapes are contemplated for special uses. The upper end of the body 76 of the land anchor is formed with an interiorly disposed coarse thread 79 particularly adapted to be mutually cooperatively engageable with the driving rod 13. It is considered readily apparent, therefore, that the land anchor is mounted upon an end of the driving rod 13 and is particularly adapted to be driven into the earth by means of the force applicator 12 until it is at the desired depth. As pointed out above, the side walls 77 are frangible and, therefore, are particularly adapted to be exploded outwardly of the body 76 to form tangs 82, as illustrated in FIGURE 6. To explode the side walls 77 outwardly, an explosive charge 81, preferably of conical configuration, as illustrated in FIGURE 5, is positioned within the body 76 and upon the igniter head 78. After the anchor is buried, this charge is ignited to break and dispose the side walls 77 outwardly of the body 76.

An ignition mechanism 83, of any suitable and known construction, and, preferably, electrically operable, is positioned within the head 78 to ignite and explode the charge 81. A safety pin 84 is provided to preclude accidental ignition of the charge 81 during the driving stroke of the force applicator 12. Thus, as illustrated in FIGURE 5, the safety pin 84 is held or maintained in the position shown therein by the end of the driving rod 13, in which position the pin is so constituted and arranged as to prevent a complete electrical circuit at the ignition mechanism 83, whereby to prevent ignition of the charge 81. However, once the anchor is embedded within the ground, the driving rod 13 is removed from the body 76 by threading the same outwardly thereof at the threads 79. This automatically releases the safety pin 84, inasmuch as the same is preferably resiliently biased, by such as a spring 84*a*, to an inoperative position in which an electrical circuit is completed at the ignition mechanism 83 for explosion of the charge 81. Suitable electrical wiring 86 connects the ignition mechanism 83 to a location outside the land anchor and, preferably, is so constituted and arranged as to connect the ignition mechanism 83 to the same ignition mechanism used to control the operation of the impact tool, that is, to the ignition mechanism 66. In this manner, unnecessary expense and duplication are avoided. To this end, a plug-in connector 87, of any suitable and known construction, is provided. Additionally, an anchor cable 88 is positioned within one end of the body 76 of the land anchor to provide a connection between the land anchor and the surface after the anchor is properly positioned. This cable is suitable for connection to any desired device to be secured in position by the land anchor.

In accordance with the above construction, it will be understood by those skilled in the art to which the present invention pertains that a driving hammer or impact tool, constructed in accordance with the present invention, is particularly adapted for use in connection with field services because of its extreme simplicity, its compactness and light weight. Additionally, the requirement of elaborate or bulky power means is eliminated, inasmuch as the power source for driving the impact tool is provided by an ignitable propellant. Though the propellant power products short operational periods, the same is more than satisfactory since an impact tool or driving hammer constructed in accordance with the present invention is particularly adapted to the driving or embedding of land anchors. It is considered readily apparent, therefore, that the instant impact tool in combination with a land anchor that can be exploded after it is embedded in the earth to vastly improve its holding power results in a highly portable, easily operable, reliable system. It is to be noted that suitable filtering is provided since the gas developed in accordance with the above construction, is capable of producing clogging during operation. In addition to suitable filtering, and to preclude clogging during operation, all of the component parts described above are fabricated under relaxed tolerance requirements and used with simple sealing structures.

While the invention has been shown, illustrated, described and disclosed in terms of an embodiment or modification which it has assumed in practice, the scope of the invention should not be deemed to be limited by the precise embodiment or modification herein shown, illustrated, described or disclosed, such other embodiments or modifications intended to be reserved especially as they fall within the scope of the claims here appended.

What I claim as my invention is:

1. An impact tool comprising, in combination;
a body, said body having
a cavity;
a replaceable combustible cartridge positioned within said cavity for igniting therein to produce a quantity of gas under pressure;

a reciprocating pneumatic motor positioned within said body for engaging a land anchor, said pneumatic motor having
a first bore,
a second bore of reduced diameter with respect to said first bore, and
a force applicator disposed within said first and second bores for reciprocating longitudinal movement therein, said force applicator comprising;
a first piston disposed within said first bore, and
a second piston disposed within said second bore;
said second piston being of reduced diameter with respect to said first piston,
said first piston and said body defining a first and second chamber therebetween, said second chamber being disposed completely annularly about said second piston,
said force applicator being movable reciprocally with respect to said body in each of a plurality of directions;
valve means positioned within said body for causing the reciprocal movements of said force applicator, said valve means comprising;
said body having a valve bore disposed therewithin,
a valve disposed within said valve bore and having a plurality of positions therewithin, said valve comprising;
a plurality of spaced lands; and
means for causing oscillation of said valve means, said oscillation means comprising;
a stem extending from said valve in a direction towards said force applicator,
said force applicator having an open-ended bore disposed therewithin,
a valve operating sleeve positioned within said bore at the open end thereof,
a plurality of shifting lands positioned upon said stem, one of said shifting lands being disposed within said bore for reciprocal movement with respect thereto, and
a plurality of springs, one of said springs being positioned adjacent said valve operating sleeve for engaging one of said shifting lands, another of said springs being positioned adjacent the other of said lands to engage said valve operating sleeve, whereby the valve operating sleeve is engageable with one of said plurality of springs to oscillate said valve to one of its plurality of positions by another of said plurality of shifting lands; and
a land anchor, said anchor comprising;
a body, said body having;
a plurality of frangible side walls particularly adapted to be exploded outwardly thereof, and
one end particularly adapted to be connected to said force applicator;
a head connected to another end of said body, said head comprising;
an ignition mechanism; and
a cartridge of combustible material positioned within said body particularly adapted to be ignited by said ignition mechanism for exploding said frangible side walls outwardly of said body and providing tangs increasing the force with which the land anchor is capable of being embedded in the ground.

2. In the assembly as defined in claim 1, wherein
a safety pin is provided in mutual cooperative engagement with said force applicator and said ignition mechanism when said force applicator is connected to the body of said land anchor, whereby completion of an electrical circuit within said ignition mechanism is precluded, thus preventing explosion of the cartridge positioned within the body of said land anchor until the same is embedded within the ground and the force applicator is disconnected from the body thereof.

3. An impact tool comprising, in combination;
a body, said body having
a cavity,
a replaceable combustible cartridge positioned within said cavity for ignition therein to produce a quantity of gas under pressure;
a reciprocating pneumatic motor positioned within said body for engagement with a land anchor, said pneumatic motor having
a first bore positioned within said body,
a second bore, coaxially disposed with respect to, and of reduced diameter than, said first bore, and
a force applicator disposed within said first and second bores for reciprocating longitudinal movement therein, said force applicator comprising;
a first piston disposed within said first bore in a close fitting sliding relationship with respect thereto, and
a second piston disposed within said second bore in a close fitting sliding relationship with respect thereto;
said second piston being connected to said first piston and being of reduced diameter,
said first piston and said body defining a first chamber and a second chamber therebetween, said second chamber being disposed completely annularly about said second piston, whereby the area of said first piston facing said second chamber is less than the area of said first piston facing said first chamber,
said force applicator being movable reciprocally with respect to said body in one direction, in which the movement of said applicator defines a driving stroke, and being movable with respect to said body in another direction, in which the movement of said applicator defines a return stroke;
valve means positioned within said body for causing the reciprocal movements of said force applicator, said valve means comprising;
said body having a valve bore therein disposed generally centrally of said force applicator,
said body further having a plurality of control passages with one of said control passages providing communication between said valve bore and said first chamber and the other of said control passages providing communication between said valve bore and said second chamber,
a plurality of inlet ports providing ingress to said valve bore and being particularly adapted to provide communication therefrom, through said valve bore and to each of said control passages, and
an exhaust port providing egress from said valve bore to provide communication thereto from each of said control passages and through said valve bore,
a spool valve disposed within said valve bore having a first and a second position therewithin, said spool valve comprising;
a plurality of spaced lands, one of said lands providing communication between one of said inlet ports and one of said control passages while another of said lands provides communication between the exhaust port and the other of said control passages in one of the positions of said spool valve and vice-versa, whereby, in one of the positions of said spool valve, gas pressure is communicated therethrough to one of said first and second chambers while the other of said chambers is communicated to exhaust, and, in another position of said spool valve, gas under pressure is communicated to the other of said first and second chambers while said one chamber thereof is communicated to exhaust;
means for causing oscillation of said valve means, said oscillation means comprising;
a stem integral with said spool valve and extending therefrom in a direction towards said force applicator,
said force applicator having a bore disposed therewithin, said bore having a closed end adjacent an end of said second piston and an open end,
a valve operating sleeve positioned within said bore at the open end thereof,
a plurality of shifting lands positioned upon said integral stem, one of said shifting lands being disposed within said bore for longitudinal reciprocal movement thereof, and
a plurality of springs of semi-spherical configuration positioned upon said integral stem, one of said springs being positioned adjacent said valve operating sleeve for engagement with one of said shifting lands, another of said springs being positioned adjacent the other of said lands for engagement with said valve operating sleeve, whereby the valve operating sleeve is mutually cooperatively engageable with one of said plurality of springs to oscillate said spool valve to one of its first and second positions by one of said shifting lands when the force applicator reaches the end of a driving stroke, and the valve operating sleeve is mutually cooperatively engageable with another of said plurality of springs to oscillate said spool valve to the other of its first and second positions by the other of said shifting lands when the force applicator reaches the end of a return stroke;
the valve bore of said valve means having a first and second end, each of said ends cooperating with a corresponding one of said plurality of spaced lands, thereby defining the limit of movement of the spool valve of said valve means in a direction towards each of the first and second positions thereof,
said body also having a chamber disposed adjacent said valve bore,
resilient means comprising a spring positioned within said chamber, said spring cooperating with one of said plurality of spaced lands to normally bias said spool valve towards that one of its first and second positions in which the inlet port is in communication with that one of said control passages providing communication between said valve bore and said second chamber, whereby, when said pneumatic motor is started, the force applicator thereof moves in a direction defining a return stroke,
a plurality of auxiliary exhaust ports, each of said ports being in communication with the ends of said valve bore, whereby, when said spool valve is in either of its first and second positions, any pressure communicated to that one of the ends of said bore tending to move the spool valve to the other of its first and second positions prior to an oscillation thereof by said oscillation means is immediately exhausted, and
a guide stem integrally connected to said spool valve in coaxial relationship and oppositely disposed with respect to said integral stem for guiding the movement of said spool valve exactly longitudinally of said force applicator in conjunction with said integral stem;
an accumulator positioned within said body,
said body having a passage providing communication between the cavity in which said combustible cartridge is disposed and said accumulator,
a control valve positioned within said body, said control valve comprising;
a rotor having a plurality of positions and being adjustable from without said body;
said body also having a passage providing communication between the accumulator and the control valve, an inlet passage providing communication between said control valve and said inlet ports and an exhaust passage extending to without said body and providing communication between the exhaust and auxiliary exhaust ports and the atmosphere,
said body further having a passage providing communication between said control valve and said exhaust passage,

one of the positions of said control valve providing communication between the inlet passage, the passage between the accumulator and the control valve, and the passage between the control valve and the exhaust passage,

and more than one of the other positions of said control valve closing at least one of the inlet passage and the passage from the control valve to the exhaust passage,

said control valve having positions medially of said plurality of positions for controlling the speed of said force applicator, and

means comprising an ignition mechanism electrically connected to said combustible cartridge for igniting the same and providing the gas pressure to operate the force applicator.

4. An impact tool comprising, in combination;

a body;

a reciprocating pneumatic motor positioned within said body, said pneumatic motor having

a first bore,

a second bore of reduced diameter with respect to said first bore, and

a force applicator disposed within said first and second bores for reciprocating longitudinal movement therein, said force applicator comprising;

a first piston disposed within said first bore, and

a second piston disposed within said second bore;

said second piston being of reduced diameter with respect to said first piston,

said first piston and said body defining a first and second chamber therebetween, said second chamber being disposed completely annularly about said second piston,

said force applicator being movable reciprocally with respect to said body in each of a plurality of directions; and

valve means positioned within said body for causing the reciprocal movements of said force applicator, said valve means comprising;

said body having a valve bore disposed therewithin,

a valve disposed within said valve bore and having a plurality of positions therewithin, said valve comprising;

a plurality of spaced lands; and

means for causing oscillation of said valve means, said oscillation means comprising;

a stem extending from said valve in a direction towards said force applicator,

said valve bore comprising first and second end portions each of which cooperate with corresponding ones of said plurality of spaced lands to limit movement of the valve of the valve means in each of the plurality of directions,

said body further having a chamber disposed adjacent the valve bore,

resilient means disposed within said chamber for cooperating with one of the plurality of spaced lands to normally bias said valve toward one of the plurality of positions,

a guide stem connected to the valve in opposed relationship relative to the stem for guiding the movement of the valve generally longitudinally of the force applicator in conjunction with the stem,

a plurality of auxiliary exhaust ports disposed in communication with the ends of said valve bore, whereby, when said valve is in any one of the plurality of positions, any pressure communicated to that one of the ends of said bore tending to move the valve to another of the plurality of positions prior to an oscillating movement thereof by said oscillation means is immediately exhausted,

said force applicator having an open-ended bore disposed therewithin,

a valve operating sleeve positioned within said bore at the open end thereof,

a plurality of shifting lands positioned upon said stem, one of said shifting lands being disposed within said bore for reciprocal movement with respect thereto, and

a plurality of springs, one of said springs being positioned adjacent said valve operating sleeve for engaging one of said shifting lands, another of said springs being positioned adjacent the other of said lands for engaging said valve operating sleeve, whereby the valve operating sleeve is engageable with one of said plurality of springs to oscillate said valve to one of its plurality of positions by one of said shifting lands, and the valve operating sleeve is engageable with another of said plurality of springs to oscillate said valve to another of its plurality of positions by another of said plurality of shifting lands.

5. An impact tool comprising, in combination;

a body;

a reciprocating pneumatic motor positioned within said body, said pneumatic motor having

a first bore,

a second bore of reduced diameter with respect to said first bore,

a force applicator disposed within said first and second bore for reciprocating longitudinal movement therein, said force applicator comprising;

a first piston disposed within said first bore, and

a second piston disposed within said second bore,

said second piston being of reduced diameter with respect to said first piston,

said first piston and said body defining a first and second chamber therebetween, said second chamber being disposed completely annularly about said second piston,

said force applicator being movable reciprocally with respect to said body in each of a plurality of directions; and

valve means positioned within said body for causing the reciprocal movements of said force applicator, said valve means comprising;

said body having a valve bore disposed therewithin,

a valve disposed within said valve bore and having a plurality of positions therewithin, said valve comprising;

a plurality of spaced lands;

means for causing oscillation of said valve means, said oscillation means comprising;

a stem extending from said valve in a direction toward said force applicator,

said force applicator having an open-ended bore disposed therewithin,

a valve operating sleeve positioned within said bore at the open end thereof,

a plurality of shifting lands positioned upon said stem, one of said shifting lands being disposed within said bore for reciprocal movement with respect thereto, and

a plurality of springs, one of said springs being positioned adjacent said valve operating sleeve for engaging one of said shifting lands, another of said springs being positioned adjacent the other of said lands to engage said valve operating sleeve, whereby the valve operating sleeve is mutually cooperatively engageable with one of said plurality of springs to oscillate said valve to one of its plurality of positions by one of said shifting lands, and the valve operating sleeve is engageable with another of said plurality of springs to oscillate said valve to another of its plurality of positions by another of said plurality of shifting lands;

the valve bore of said valve means having a first and second end, each of said ends cooperating with a corresponding one of said plurality of spaced lands, thereby defining the limit of movement of the valve of said valve means in each of the plurality of directions thereof,

said body further having a chamber disposed adjacent the valve bore,

resilient means disposed within said chamber, said resilient means cooperating with one of said plurality of spaced lands to normally bias said valve toward one of its plurality of positions, a guide stem connected to said valve in oppositely disposed relationship with respect to said stem for guiding the movement of said valve generally longitudinally of said force applicator in conjunction with said stem, and a plurality of exhaust ports, at least one of which communicates with each of the ends of said valve bore, whereby, when said valve is in any one of its plurality of positions, any pressure communicated to that one of the ends of said bore tending to move the valve to another of its plurality of positions prior to an oscillating movement thereof by said oscillation means is immediately exhausted.

6. A control system for a pneumatic reciprocating motor, said control system comprising;

a body, said body having

a cavity;

a replaceable combustible cartridge positioned within said cavity for ignition therein to produce a quantity of gas under pressure;

an accumulator positioned within said body,

said body having a passage providing communication between said cavity and said accumulator,

a control valve positioned within said body, said control valve comprising;

a rotor having a plurality of positions;

said body further having a passage providing communication between said accumulator and said control valve,

said body also having an inlet passage providing communication from said control valve, an exhaust passage providing communication to atmosphere and a passage providing communication between the control valve and the exhaust passage;

one of the positions of said control valve providing communication between the inlet passage, the passage between the accumulator and the control valve, and the passage between the control valve and the exhaust passage,

and more than one of the other positions of said control valve closing at least one of the inlet passage and the passage from the control valve to the exhaust passage,

said control valve having positions medially of said plurality of positions to modulate the proportion of gas under pressure to said inlet passage.

7. A control system for a pneumatic reciprocating motor, said control system comprising;

a body, said body having

a cavity;

a replaceable combustible cartridge positioned within said cavity for ignition therein to produce a quantity of gas under pressure;

an accumulator positioned within said body, a passage providing communication between said cavity and said accumlator,

a control valve positioned within said body, said control valve comprising;

a rotor having a plurality of positions;

said body having a passage providing communication between the accumulator and said control valve, an inlet passage providing communication from said control valve and an exhaust passage providing communication with the atmosphere without said body,

said body having a passage providing communication between said control valve and said exhaust passage,

valve means positioned within said body for responding to the gas under pressure produced by said combustible cartridge to cause reciprocating movements of a pneumatic motor, said valve means comprising;

said body having a valve bore disposed therewithin,

a valve disposed within said valve bore and having a plurality of positions therewithin, said valve comprising;

a plurality of spaced lands;

means for causing oscillation of said valve means, said oscillating means comprising;

a stem extending from said valve

a plurality of shifting lands positioned upon said stem, and

a plurality of springs, each of said plurality of springs being engageable with a corresponding one of said plurality of shifting lands for causing oscillation of said valve means;

a plurality of inlet ports providing ingress to said valve bore, each of said inlet ports being connected to said inlet passage to provide communication between said control valve and said valve bore, and

an exhaust port providing egress from said valve bore and being connected to said exhaust passage within said body to provide communication between said valve bore, said exhaust passage and the atmosphere without said body;

one of the positions of said control valve providing communication between the inlet passage, the passage between the accumulator and the control valve, and the passage between the control valve and the exhaust passage,

and more than one of the other positions of said control valve closing at least one of the inlet passage and the passage from the control valve to the exhaust passage,

said control valve having positions medially of said plurality of positions to modulate the proportion of gas under pressure to said inlet passage.

8. In the assembly as defined in claim **7**, wherein a plurality of auxiliary exhaust ports is provided, each of said exhaust ports being in communication with each of a corresponding one of a plurality of ends of said valve bore, whereby, when said valve is in any one of its plurality of positions within said valve bore, any pressure communicated to that one of the ends of said bore tending to move said valve to another of its plurality of positions prior to an oscillating movement thereof by said oscillating means is immediately exhausted.

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