The present invention relates to a cartridge powered cable swager, particularly of the type for coupling lengths of electric cables or the like by means of a compression fitting in the form of a tubular connector in which the conductor cable ends are secured, both mechanically and electrically, by indentations formed in the wall of the connector.

The tool of the invention employs an indentor piston arranged to be driven in a barrel having a breech end in which a cartridge is inserted, and a nuzzle end to which a work holding head is attached, the exploded powder charge of the cartridge driving the indentor piston to indent a compression fitting or other work piece held in the work holding head.

A principal object of the invention involves the kinetics of the indentor piston. It is proposed to provide spring means acting on the indentor piston to spring urge it toward the muzzle end of the barrel, so that with no compression fitting in place in the work holding head, the indentor piston repose against a stop at its maximum travel position. In this position the breech end of the piston has moved away from the cartridge providing considerable "boiler" space. If a cartridge is fired for the "no-work" shot, the powder burns in an oversize expansion chamber at a maximum pressure of only several hundred pounds per square inch, and there is no movement of any part. The gas cools so rapidly that the shell case will not be blown out, no matter how rapidly the breech is opened, and since there is no movement of any part it follows that there are no impulsive or damaging inertia forces on the "no-work" shot.

To accommodate a compression fitting in the work holding head it is proposed that the indentor piston be retracted against its spring to permit the fitting to be slid into the supporting anvil or die provided in the head. Releasing of the indentor piston then permits its spring to urge it against the compression fitting so that it incidentally, but importantly, serves as a work holding means to hold the fitting in the tool while the operator loads and fires. The presence of the compression fitting in the head causes the breech end of the indentor piston to repose nearer to the cartridge and "boiler" space is reduced. Firing of the cartridge then supplies powder gas to push the indentor piston forward indenting the compression fitting to the point where the piston reaches its movement limiting stop, the latter being so positioned that the total piston movement represents a fractional part of the diameter of the compression fitting, i. e., in the case of a one inch diameter compression fitting, the total movement would be of the order of slightly less than one-half inch.

During such movement the piston never achieves high velocity and is against the work piece target even as the cartridge fires.

A further object is to provide a swaging tool in which common fittings of varying sizes may be swaged in the same tool by providing work holding anvils or dies of varying sizes to accommodate various size fittings, and further to compensate for the difference in power required, as between large and small fittings, by varying the position of the indentor piston in accordance with the varying diameters of the fittings. This is in the case of a large fitting the breech end of the piston will be disposed within the firing chamber in close proximity to the cartridge, so that there will be small initial chamber volume before firing and a relatively high pressure will be developed upon firing. In the case of a small fitting the piston will be positioned at a greater distance from the cartridge, thus providing a medium initial chamber volume before firing with moderate pressure developed upon firing. In the case of a "no-work" shot, as above pointed out, the spring urged indentor piston is at its maximum travel before firing so that it is at its greatest distance from the cartridge, thus providing a large initial chamber volume before firing and relatively low pressure upon firing.

Other objects are to provide a swaging tool of relatively light weight which will be convenient to handle, and which embodies safety features to prevent accidental injury to the operator of the tool.

Other objects and advantages of the invention will become apparent from a consideration of the following detailed description taken in connection with the accompanying drawings wherein satisfactory embodiments of the invention are shown. However, it will be understood that the invention is not limited to the details disclosed but includes all such variations and modifications as fall within the spirit of the invention and the scope of the appended claims.

In the drawings:

Fig. 1 is a side elevational of a swaging tool according to the invention, the indentor piston being in its projected position;

Fig. 2 is a longitudinal vertical sectional view of the tool with the indentor piston in the projected position as shown in Fig. 1;

Fig. 3 is a longitudinal vertical sectional view with the indentor piston in retracted position and with the bolt of the receiver also in retracted position;

Fig. 4 is a view partially in rear elevation and partially in longitudinal vertical section, the indentor piston being shown in the projected position as illustrated in Figs. 1 and 2, and the bolt of the receiver being shown in its projected position ready for firing;

Fig. 5 is a view partially in rear elevation and partially in longitudinal vertical section, showing the indentor piston and the bolt of the receiver in the retracted position as illustrated in Fig. 3;

Fig. 6 is a vertical transverse sectional view on an enlarged scale, taken along the line 6—6 of Fig. 4;

Fig. 7 is a transverse vertical sectional view, also on an enlarged scale, taken along the line 7—7 of Fig. 4;

Fig. 8 is a transverse vertical sectional view, also on an enlarged scale, taken along the line 8—8 of Fig. 5;

Fig. 9 is a perspective view of the end portion of the indentor piston retracting bar for cooperation with the bolt;

Fig. 10 is a view partially in front elevation and partially in longitudinal vertical section, on an enlarged scale, showing the fire control mechanism employed, the bolt being in its retracted position;

Fig. 11 is a similar view, showing the bolt in its projected position with the fire control mechanism in its pre-firing relation, the safety means for preventing firing being shown in operative position in full lines and in inoperative position in dot-and-dash lines;

Fig. 12 is a longitudinal vertical sectional view showing the fire control mechanism and the indentor piston in the firing position;
3. Fig. 13 is a view partially in bottom plan and partially in horizontal longitudinal section, showing the fire control mechanism and safety means in the position as shown in Fig. 11;

Fig. 14 is a vertical longitudinal sectional view showing a modified form of indentor piston having a break-away feature for permitting a portion of the piston to shear when the tool is inadvertently fired when a solid or incompressible rod or the like is interposed against the indentor piston, preventing its movement;

Fig. 15 is a view showing the manner in which a part of the indentor piston is moved after shearing along the piston rod following the firing of the cartridge;

4. Fig. 16 is a longitudinal vertical sectional view of a modified form of the invention, the indentor piston being shown in its projected or "no-work" position and the fire control mechanism being shown in operative position preparatory to firing;

Fig. 17 is a front elevational of the tool as seen in Fig. 16;

Fig. 18 is a longitudinal vertical sectional view, partially in side elevation, and showing the breech of the fire control mechanism in open position and the indentor piston in retracted position;

Fig. 19 is a vertical transverse sectional view taken along the line 19—19 of Fig. 18;

Fig. 20 is a top plan view, partially broken away, of the tool shown in Fig. 16;

Fig. 21 is a rear elevation of the tool as seen in Fig. 16;

Fig. 22 is a rear elevational of the tool as seen in Fig. 18;

Figs. 23–28 are schematic views showing the relationship between the indentor piston, the connector fitting to be indented and the firing chamber;

Fig. 23 shows the tool with a large diameter connector fitting engaged therein before firing;

Fig. 24 shows the tool as illustrated in Fig. 23 after firing;

Fig. 25 shows the tool with a relatively small diameter connector fitting before firing;

Fig. 26 is a similar view showing the tool as seen in Fig. 25 after firing;

Fig. 27 shows the tool before firing with no connector fitting in place;

Fig. 28 is a view showing the tool as seen in Fig. 27 after firing a "no-work" shot.

Referring to the drawings, and more particularly to Figs. 1–13, the swaging tool, according to the embodiment of the invention shown therein, comprises a chamber or barrel 11, a barrel 12, and a chamber 13. The barrel 11 has an inner end for engagement by the threaded end of the barrel 17, the base of this socket portion being formed by a transverse stop wall 26 having a central cylindrical passage 27 therethrough for the indentor piston, as will presently more fully appear.

The work holding head member is of generally yoke-shape and has a recessed anvil or die member 28 removably engaged therein through lateral sliding movement between the yoke arms 29–29, the anvil member having at each of its upper and lower sides a dove-tail recess 30 engaged by a dove-tail lug 31 upon each of the respective arms 29, and being removably retained in place by spring pressed ball detents 32 carried in the lug portions 31 of the arms 29 and engaged in grooves 32a in the upper and lower sides of the anvil member. At its inner side the anvil member is provided with a recess 33 of substantially semi-cylindrical shape, in which the tubular connector fitting 34 for the barrel 35 is adapted to be seated, as seen in Fig. 23, preparatory to being indented by the indentor piston. The anvil or die members may be furnished in suitable sizes to receive standard sized connector fittings.

As best seen in Fig. 12, the indentor piston comprises a head 36 slidable engageable in the chamber 13 and provided with a flange 37 slidable engageable within the barrel 17, the piston head preferably being provided with compression rings 38 for sealing engagement with the wall of the chamber 13 and 39, and being provided with a friction ring 39 for engagement with the wall of the barrel 17, for the purpose of frictionally retaining the indentor piston in a retracted position while placing a connector fitting in the head. A piston rod 40, threaded at its respective ends, is screwed at its rearward end in a threaded socket 41 in the piston head 36, and at its forward end is screwed into a flanged tool holder 42 having a stem portion slidable in the passage 27 of the stop wall 26 of the head and having its flanged portion slidable engaged between the arms 29 of the head. Adjacent the inner end of the stem portion, and within the barrel 17, there is engaged upon the threaded end of the rod a lock nut member 43, which in the forward projected position of the indentor piston engages a facing washer 44 upon the inner side of the stop wall 26 to limit the projecting movement. Forward projecting movement is imparted to the indentor piston by a helical spring 45, interposed between the rearward end of the lock nut and a cup-shaped spring holder 46, disposed within the barrel 17 and restrained against rearward movement by a key 47. In the barrel by a key 47 on the side wall of the member 46 and having its end engaged with the inner end of a slot 48 in the forward end of the barrel 17. The lock nut is provided with an annular groove 49 engaged by a pin 50 extending through the slot 48 and secured in a cylindrical sleeve 51 slidably engaged upon the forward end of the barrel.

A knob 52 screwed to the sleeve projects through a slot 53 in a cylindrical housing 54 which is secured in surrounding relation to the receiver and barrel, as will presently more fully appear, the knob permitting manual retraction of the sleeve 50 through the pin 50 and the indentor piston against the force of the spring 45. The sleeve is also adapted to be retracted through the retraction of the bolt following a firing operation of the tool, so that the indentor piston is thus disengaged from the indented connector fitting simultaneously with the retraction of the bolt to extract the cartridge and permit the feeding of another cartridge into place. In the disclosed embodiment, the receiver is of the repeater type so that the opening and closing of the bolt prepares the tool for the firing of a repeat shot, as will presently more fully appear.

For convenience in providing suitably shaped indentor tools for different types of work, the indentor die element 55 is provided with a flange base 56, removably seated in a pocket 57 of the tool holder 42 and removably
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5 retained therein by a spring pressed ball detent 58 engaged in a recess 59 in the wall of the pocket 57. It is pointed out that the indenter die element 55 and the anvil member 28 are substantially like those employed in the patent to Matthysse, for Hydraulic Press, No. 2,254,615 dated September 2, 1941. However, it will be understood that other suitable types of dies and anvils may be employed, as, for instance, the circumferential groove indented type die and anvil as shown in the patent to Temple, for Pipe Pipe, No. 2,202,125 dated May 28, 1940.

The sleeve 51, Fig. 4, has an aperture ear 60 struck and bent outwardly therefrom, in which is slidably engaged a pull rod 61 also slidably engaged at a rearwardly spaced point along the barrel 17 with an apertured ear 62, provided upon the forward end of a pull bar 63, slidably mounted upon the receiver 18 by means of a pair of guide brackets 64 and 65 secured to the receiver by screws 66. The pull rod 61 is limited in its rearward movement through the ear 60 by a cotter pin or the like 67 engaged in its forward end, and is limited in its forward movement through the ear 62 by a cotter pin 68 on its rearward end. A helical spring 69 engaged about the pull rod 61, between ears 60 and 62 normally presses the sleeve 51 forwardly.

The pull bar 63 is adapted to be reciprocated forwardly and rearwardly with the forward and rearward reciprocation of the bolt, as will presently more fully appear, and the rearward movement serves to retract the sleeve 51 during the latter portion of such rearward movement. For this purpose the pull rod 61, in the normal projected position of the sleeve 51 and the pull bar 63, extends rearwardly from the ear 62 a distance less than the full retracting movement of the pull bar 63, so that during the initial retracting movement of the pull bar 63 the ear 62 moves along the pull rod 61 to the point where it engages the cotter pin 68, whereupon the pull rod and the sleeve 51 are moved rearwardly with the pull bar 63 during the latter part of its rearward movement to the position as seen in Figs. 3 and 5, the piston head 36 being in its fully engaged position in the firing chamber 13 in the retracted position.

The receiver 18 is of generally conventional form as employed in a repeater type firearm, except for certain modifications adapting it for use in the present tool. The body of the receiver is provided with a bolt receiving bore 70, Fig. 12, the forward portion of which opens to a cartridge case ejection opening 71, and the rearward portion of which is provided with diametrically opposed laterally opposite slots 72 through which the locking lugs of the bolt move during projecting and retracting movement of the bolt, as will presently more fully appear.

The bolt comprises a tubular locking member 73 provided at its forward end with an internal recess 74 and having also at its forward end a pair of diametrically opposed projecting locking lugs 75—75, which in the projected locked position of the bolt engage the rearward shoulder 76 of the opening 71, this shoulder being of circular form and extending into a lug receiving recess 77 in the lower portion of the receiver so that in the locked position, in which the lugs are vertically disposed, the upper lug engages the upper portion of the shoulder 76 and the lower lug engages the lower portion within the recess 77. The locking member 73 is adapted to be manually turned through ninety degrees to unlock it, as will presently more fully appear, this unlocking action bringing the lugs 75 into line with the grooves 78 so that the bolt can thereupon be retracted from the position as seen in Figs. 2, 4 and 12 to the position as seen in Figs. 3, 5 and 10.

The forward member 78 of the bolt is provided with a cylindrical firing pin receiving passage 79 in register with the bore of the rearward bolt member 73, the forward end of the passage being defined by the rearward stop wall of a forward closed end portion 80 which is provided with a recess 81 in its forward wall for receiving the rimmed head of the cartridge. The firing pin member 78 is provided in its under side with a longitudinal groove 82, engaged by a lug member 83 secured in the lower side of the opening 71 of the receiver by a bolt 133, to thus prevent rotation of the bolt member 78 as the rearward bolt member 73 is rotated.

The rearward end of the forward bolt member 78 is provided with a reduced diameter portion 84 engaged in the recess 74 of the bolt member 73, and is connected thereto by a pair of transverse pins 85—85 extending across the wall of the recess 74 and engaged in an annular groove 86 in the reduced diameter end 84 of the forward bolt member 78 to thus permit the rearward locking bolt member 73 to be rotated relatively to the bolt member 78.

The firing pin 87 comprises a cylindrical body portion 88, slidably engaged in the cylindrical passage 79 of the bolt member 78, and a firing pin portion 89, slidably engaged in a passage 90 extending to the recess 81, and which is offset from the axis of the bolt so as to engage the rim of the cartridge head 82 in its projected firing position. This arrangement is for rim fire cartridges, and in the case of center fire cartridges the firing pin portion would be axially disposed. An elongated stem portion 91 extends rearwardly from the body portion 88 through the center bore 92 of a nut member 93, and its rearward end is screwed into a head member 94 slidably engaged in a pocket 95 in the rearward end of the nut member 93.

The nut member is provided with external screw threads 96 engaged with internal screw threads 97 in the rearward end of the bolt member 73, which screw thread connection permits turning movement of the locking member 73 of the bolt relative to the nut member 93. A helical spring 98 is engaged about the stem 91 between the inner end of the nut member 93 and the body portion 88 of the firing pin, and exerts forward projecting spring pressure upon the firing pin.

The head member 94 is provided at its lower side with a downwardly projecting rib formation having a tooth projection 99 adapted to be engaged by the ear of the fire control mechanism to retract the firing pin, as will presently more fully appear, the firing pin being released upon releasing action of the sear. The head member 94 is also provided with a forwardly extending cam lug 100 which, in the fired position of the firing pin as seen in Fig. 12, is forwardly projected into a cam recess 101 in the rearward end of the locking bolt member 73, the bolt in this relationship being locked. Upon turning of the bolt member 73 through ninety degrees, by manual means hereinafter more fully described, to bring the lugs 75 into line with the grooves 78 to permit retraction of the bolt, the cam recess 101 through its engagement with the cam lug 100 forces the firing pin to its retracted position, as seen in Fig. 10, the rearward surface of the bolt member 73 being provided at the point where it has been turned ninety degrees with a dent on recess 102, Figs. 7 and 8, into which the end of the cam lug 100 drops to thus retain the firing pin in retracted position.

In the retracted position, as seen in Fig. 10, the locking tooth 99 is in line with the seat 103 which is pivotally mounted within a recess 104 in the under side of the receiver upon a cross pin 105, the seat being provided in its rearward end with a retaining tooth portion 106 and being normally pressed upwardly toward the under side of the bolt and locked by means presently more fully described, so that it is in longitudinal line with the tooth 99. Thus when the bolt is projected forwardly from its retracted position, as seen in Fig. 10, to the firing position, as seen in Fig. 11, the tooth 99 engages the tooth portion 106 of the sear, as seen in Fig. 11, so that, while the sear remains locked, projecting movement of the firing pin is prevented. While the pin is so held the bolt member 73 is rotated through ninety degrees to lock it, as seen in Fig. 11, thus disengaging the dent re-
cess 102 from the end of the cam lug 100 and at the same time bringing the cam recess 101 into longitudinal alignment with the cam lug, as seen in Fig. 11, so that a clear space is provided in the cam recess for forward movement of the cam lug upon release of the firing pin by releasing the spring mechanism of the sear. This allows the firing pin to be projected under the force of the spring 98 to the fired position, as seen in Fig. 12, the cam lug 100 being disposed within the recess 101 in this fired position so that it will be retracted upon the turning of the bolt member 73 through ninety degrees to release and retract the bolt.

The sear is adapted to be actuated by a slide member 107 consisting of a pair of side plates rigidly connected together by a trunnion bridge member 108, the side plates being disposed at each side of the sear and the bridge member 108 being disposed beneath the sear. The slide member is provided at its respective forward and rearward ends with guide slots 109 and 110, which are respectively engaged upon the cross pin 111 and pivotally mounts the sear and a second cross pin 112. A cross pin 112 is provided through the side plates of the slide member at an intermediate point and retains a leaf spring 113, the rearward end of which extends beneath the bridge member 108 into engagement with the under side of the sear to normally press it upwardly to engage a tongue portion 114 upon the rearward end of the sear with the cross pin 111. In this position the slide member is moved rearwardly, as seen in Figs. 10 and 11, to engage the bridge member 108 with the under side of the sear rearwardly of a notch 115 in the sear to thus lock the sear in its raised position.

Upon forward sliding movement of the slide member, by means presently to be described, the bridge member 108 is moved forwardly beyond the notch 115 to the position as seen in Fig. 12, thus releasing the sear for downward movement, which is imparted thereto through the force of the firing pin spring 98, the interengaging surfaces of the tooth 99 of the firing pin and the tooth portion 106 of the sear being at a suitable angle so that the sear is cammed downwardly against the force of its retaining leaf spring 113 by the greater force of the firing pin spring 98.

The leaf spring 113 is extended forwardly from the slide member where it is provided with a hole 116 engaged by a locking pin 117 screwed into the under side of the slide member to lock the member of the firing mechanism in its rearwardly moved position, as seen in Figs. 10 and 11, thus providing a disabling or safety lock to prevent firing until the spring 113 is disengaged from the pin 117. For this purpose a safety release bar 118 extending laterally along the inner side of the housing 54 from the fire control mechanism to a point in proximity to the forward knurled grip portion 119 of the housing, which is adapted to be gripped by one of the hands holding the tool during its operation. This bar has secured to its forward end an operating button 120 extending through a slot 121 in the housing, so that the button can only be operated by having a hand of the operator engaged about the hand grip portion 119 of the housing.

Upon the rearward portion of the bar 118 there is provided a laterally extending tooth member 122 which, in a forwardly projected position of the bar, is in line with the forwardly extending curved end of the leaf spring 113, as seen in Figs. 10 and 11. Upon moving the bar rearwardly the tooth 122 engages the end of the spring 113, as seen by the dot-and-dash lines in Fig. 11 and by the full lines in Fig. 12, to swing the end of the spring downwardly to disengage it from the locking pin 117, whereupon the slide member is free to be pressed forwardly by a trigger mechanism, presently to be more fully described, to release the sear and effect firing movement of the firing pin.

The safety bar 118 is normally spring pressed forwardly and the slide member of the firing mechanism is normally spring pressed rearwardly, and for this purpose the bar is provided with an apertured lug 123 to which one end of a helical compression spring 124 is connected, the other end being connected to a rod 125 about which the spring is engaged. This rod is extended rearwardly from one end of the slide member 107 and is formed into a trigger engaging loop 126, its end portion being laterally bent as at 127 into engagement with holes 128 in the side plates of the slide member, so that the compression of the spring draws the rod 125 and the slide member rearwardly and draws the fire control mechanism bar 118 forwardly. For convenience in guiding the movement of the bar along the receiver, it is provided at its rearward end with an extended stem portion 129 engaged beneath a projected portion of the pin 105 and above a projected portion of the pin 112, as seen in Fig. 13.

The receiver is provided in its lower side adjacent the chamber member 10 with a slot opening 130 through which a cartridge clip 131 is adapted to be engaged, this clip being removable retained in place by a spring 132 secured to the receiver by the bolt 133 securing the lug 83, laterally extending from the side member 107 and provided at the ends of the spring engaging notches 135 in the clip. A slot opening 136 is provided in the housing 54 through which the clip extends, and upon the under side of the housing there is secured a guard wall member 137. A cartridge clip 131, with a slot opening 134, is provided in the upper side of the housing.

The housing is rigidly secured to the receiver by one of each of the pairs of bolts 66 securing the guide brackets 64 and 65 to the side of the receiver, these bolts being of sufficient length to extend between the wall of the housing and the receiver and being engaged by sleeves 138 to space the housing from the receiver. The housing is additionally secured at its lower side by a pair of bolts 139 having spacing sleeves 140, one of these bolts being provided at the forward end of the receiver where its head is accessible through the guard wall member 137 and the other being provided adjacent the rear end of the receiver where it is disposed within the loop portion 126 of the fire control mechanism rod 125.

Rotation of the locking bolt member 73 through ninety degrees, to lock and unlash the bolt for retracting and projecting reciprocatory movement of the bolt assembly, is imparted by a handle 141 rigidly secured to the locking bolt member 73 by screws 142-143 engaged in a segment-like projecting lug 143 formed upon the rearward end of the bolt member 73. This handle, for convenience in manipulation for cocking the firearm, is also integrally formed upon the bolt member 73 and extending circumferentially from the segment lug 143 partially about the rearward end of the bolt member 73, is a flange 144 which serves as a retraction means for the actuating slide bar 63, as will presently more fully appear.

In the projected locked position of the bolt the segment lug 143 swings into a retaining notch 145 provided in the receiver adjacent the rearward end of the tubular guide portion 92, thus limiting the rotation of the locking bolt member 73 in a clockwise direction to that shown in Fig. 7, to bring the locking lugs 75 into vertical locking position. Upon rotation of the locking bolt member 73 through ninety degrees in a counterclockwise direction to unlock the bolt, the end of the flange 144 is brought into engagement with a ledge 146 formed upon the receiver at its opposite end from the notch 145, the lugs 75 being in register with the grooves 72 of the receiver in this position, as seen in Fig. 8, to allow the bolt to be retracted and projected.

The handle is provided with a suitable trigger mechanism which is adapted to be brought into operative alignment with the loop end 126 of the rod 125 connected to the sear operating slide member 107. This trigger mechanism comprises a slide bar 147 longitudinally slidable through a slot 148 in the upper arm of the handle 141 and provided at its rearward end with...
a finger engaging portion 149 having an upwardly projecting lug 150 in a slot 151 in the upper side of the handle, a cross pin 152 engaged through the lug and bearing upon the upper side of the handle retaining the slide bar in longitudinally slidable relation to the handle. The forward end of the slide bar is pivotally connected by a pin 153 to a lever 154 extending downwardly through a slot 155 in the upper arm of the handle and provided at its lower end with a contact portion 156 adapted upon swinging of the lever in a counter-clockwise direction to engage the loop end 126 of the rod 125 to move the slide member 107 forwardly from the position shown in Fig. 11 to the arm bearing position as shown in Fig. 12. This reaction is prevented while the leaf spring 113 is in the disabling or safety position engaged with the pin 116, as shown by the full lines in Fig. 11, and is made possible by movement of the leaf spring to its released position, as shown by the dot-and-dash lines, through rearward sliding movement of the safety release bar 117.

The trigger slide bar 147 is normally retained in its projected position by a V-shaped leaf spring 157 having notches 158 and 159 in its respective ends, this spring being located in the space 147 and the lever 154 with its notches 158 and 159 respectively engaged by the bar and the lever, so that it exerts forward spring pressure upon the bar and at the same time positions the parts of the trigger mechanism against looseness.

The bolt member 93 is provided with a forwardly facing shoulder 160 in spaced opposed relation to the flange 144 of the locking bolt member 73, and forms with this flange a circumferential groove in which is engaged an arcuate flange projection 161, Fig. 9, of a block member 162 secured upon an upward extension 163 provided upon the rearward end of the slide bar 63 for actuating the indentor piston retracting sleeve 46. An arcuate spacer block 164 is secured upon the outer side of the extension 163 by the screws 165 which secure the block 162, this spacer block being slidable engaged at its outer surface with the inner surface of the housing 54 to thus prevent any tendency for the end of the bar 63 to flex outwardly during retracting and projecting movement of the bolt.

It will be seen that the flange 161 engaged in the groove between the flange 144 and the shoulder 160 is thus connected to the bolt assembly for projecting and retracting movement therewith. Upon retracting movement of the bolt assembly from the position as seen in Fig. 4 to the position as seen in Fig. 5, the slide bar 63 on the bottom of the pull rod 61 to the point where the lug 62 engages the cotter pin 68 at the rearward end of the rod, whereupon during the final retracting movement of the bolt the rod 61 is retracted with the bar 63 and retracts the sleeve 46 and the indentor piston, bringing the indentor die element 55 to its retracted position and the piston head 36 to its fully engaged position within the chamber 13, as seen in Fig. 3. In this position the cable connector 34 with the cable ends inserted therein may be placed in the anvil 28 of the work-holding head 24, the indentor die element 55 being so dimensioned that it will be clear of the connector when the bolt retracting handle is pulled to its extreme retracted position, so that the cable connector can be inserted in the tool with facility. Upon release of the handle from its extreme retracted position, the indentor piston will be projected by the spring 45 so that the indentor die element 55 is spring pressed against the connector, thus firmly holding it in place in the anvil preparatory to the indenting operation.

By reference to Figs. 23–28, it will be observed that the dimensional relationship of the particular cable connector to the indentor piston and the anvil determines the projecting movement of the piston head in the chamber preparatory to firing. Thus in the case of a large diameter connector, as seen in Figs. 23 and 24, the projecting movement will be of a very small order so that the initial chamber volume is relatively small and the high pressure is therefore developed upon firing of the cartridge to indent the large diameter connector, as seen in Fig. 24. By virtue of the fact that the indentor die element is initially pressed against the connector, there is no movement of the tool through free space upon firing of the cartridge. On the other hand, the indentor piston never achieves high velocity and is against the mass of the connector and the cable, so that the indenting action is a relatively slow one during which there is a gradually increasing resistance as the tube is indented and the cable rings are compressed. This action continues until the forward end of the lock nut member 43 engages the compression washer 44 at the inner side of the stop wall 26, which thus determines the distance dimension of the indentation.

In the case of a smaller diameter connector, as seen in Figs. 25 and 26, the dimensional relationship is such that the indentor die element and the piston head are projected to a greater extent than is the case with the larger diameter connector shown in Figs. 23 and 24, to bring the indentor die element into contact with the connector, which results in a greater projecting movement of the piston head before firing, so that the initial chamber volume is of a smaller or medium volume, with the result that a lesser or medium pressure is produced upon firing a cartridge, thus providing compensation for the fact that the smaller connector and cable provide less resistance to indenting.

In the case of a "no-work" shot, the indentor die element and piston head will be moved to their fully projected position when the bolt is closed, so that prior to firing a "no-work" shot there is a large initial chamber volume producing a poor powder burning condition and relatively low pressure. Under these conditions the tool is then taken out of the indentor piston and without any appreciable damage pressure upon any parts of the tool.

Upon occasion the cartridge employed may be of too great power for the particular work being done, so that the resistance of the work during the indenting operation is of such a low order as to prevent the lock nut to engage the stop wall with excessive impact. It is proposed to provide a tool of relatively light weight construction and under normal conditions, of a material intended that it be operated without excessive impact. Should this occur, however, the provision of the impact washer 44 prevents continued operation under these conditions.

To render such an impact washer 44 in the form of an expendable ring formed of a suitable material such as aluminum or soft steel, so that excessive impact thereon will cause it to distort radially into binding relation between the work-holding head and the indentor piston to bind or lock it against movement. This signals the user that the tool is being operated under excessive impact conditions so that proper correction can be made, the distorted impact ring being removed and a new replacement ring installed.

In Figs. 14 and 15 there is illustrated a modified form of piston. This consists of a cup-like piston head 166 secured to the piston rod 40 by a screw 167 engaged in a transverse end of the head. Concentric to the screw and in substantially circumferential line with the periphery of the piston rod the head is provided with a groove 168 which provides a weakened shear area across the head in line with the periphery of the piston rod. Under normal indenting operating conditions, where the resistance of the work to be pierced is normal, the indentor piston will be driven upon firing the cartridge in the normal manner. However, should a piece of material such as a hard steel bar be placed in the tool, instead of a suitable indentable work piece, such bar will resist any appreciable movement of the indentor piston.
Firing of the cartridge under these conditions will cause the main body of the piston head to shear away from the immovably held piston rod, as seen in Fig. 15, so that the body of the piston head will move harmlessly down along the piston rod and the excessive pressure that would otherwise be produced in the firing chamber will have no damaging effect upon the tool.

In Figs. 16–22 there is illustrated a modification employing a breeching and fire control mechanism in which a single cartridge is loaded for each operation, as distinguished from the repeater type fire control mechanism of the foregoing embodiment, the particular mechanism being of the general type as disclosed in the patent to Walker for Stud Driving Tool, No. 2,645,772, dated July 21, 1935, and of the specific type as shown in the prior co-pending application of Walker, Reed and Catlin for Powder Actuated Tool, Serial Number 517,192, filed June 22, 1955.

The tools as disclosed in said prior patent and application comprise a front or barrel assembly and a rear breeching and fire control assembly, and intermediate therebetween is provided a chamber plate adapted to hold a chamber piece or bushing which contains the cartridge, the three elements being integrated into a unitary structure which is susceptible to opening to provide access to both the breech end of the barrel and to the chamber bushing, for cartridge case ejection and reloading, all within the limits of the unitary structure. The front or barrel assembly embodies a powder actuated tool means adapted for the driving of various sizes and shapes of studs or other fastening devices to be driven into a particular host material or article. It is proposed in the present modification to provide a barrel and piston indenter assembly adapted to be connected to the breeching and fire control assembly, as disclosed in said patent and application, as an accessory or replacement part for the stud driving barrel assembly disclosed in said patent and application.

The barrel assembly comprises a barrel 170 having at its rear or breech end a threaded connection with a tubular chamber member 171, which in turn has a threaded connection with a frame plate 172. A cylindrical housing 173, open at its rearward end and provided with a forward wall 174, is fitted at its rearward end about the periphery of the frame plate 172 and is provided in its forward wall 174 with a circular opening 175 in which the forward end portion of the barrel 170 is engaged, the housing being connected to the frame plate 172 by the bolts 176. The chamber member 171 is engaged with the frame plate 172 in upwardly offset eccentric relation, and the opening 175 of the wall 174 is similarly upwardly offset, so that the barrel is eccentrically disposed within the housing and a substantial space is provided beneath the barrel to accommodate certain mechanism presently to be described.

A work holding head 177 is provided in its rear end portion with a cylindrical indenter piston guide pocket 178, internally screw threaded at its rearward portion as at 179 and screwed upon a connecting ring 180, which in turn would otherwise be produced in the firing chamber, the threaded portion 181 of the barrel 170. The work holding head 177 is of generally yoke form and is substantially like the work holding head of the first embodiment, being provided with a removable die or anvill member 182 for receiving the connector fitting to be indented.

The indenter piston is also substantially similar to the indenter piston of the first embodiment, and comprises a piston rod 183 upon the rear end of which is secured a piston head 184 which is substantially similar to the shear type piston head shown in Figs. 14 and 15, being of cup shape and secured to the piston rod by a screw 185, the transverse end of the head being provided with a circumferential groove 186 concentric to the screw 185 and in line with the periphery of the piston rod, so as to provide a shear area in line with the periphery of the piston rod whereby under excessive pressure conditions, such as might occur when a substantially incompressible piece of material, such as a hard steel bar, is inadvertently placed in the work holding head, as described in connection with the indenter piston modification shown in Figs. 14 and 15, the cylindrical wall of the head will shear away from the transverse end and move down the piston rod, with no other damaging effect upon the tool.

The piston head is adapted to move in a chamber extension sleeve 187 fitted within the rearward end of the barrel against the chamber member 171, the forward end of the sleeve being flared as at 188 and provided with gas escape notches 189. A helical spring 190 is interposed between the forward end of the bushing 187 and a tool holder member 191 screwed upon the forward end of the piston rod.

The tool holder member 191 is provided in its forward end with an indenting die element 192 removably engaged therewith in substantially similar manner to the die 58 of the first embodiment. The tool assembly is pivotally guided within a passage 193 in the work holding head extending forwardly from the cylindrical pocket 178, the passage being of reduced diameter to provide a stop shoulder 194 at the forward end of the pocket 178. At its rearward end the tool holder and indenter piston is provided with a flange 195 slidably engaged within the pocket 178 and provided at its forward side with a facing impact ring 196, which in the forward spring pressed position of the indenter piston engages against the shoulder 194. The impact ring 196 performs the same function as the expendable impact ring 44 of the first embodiment, being formed of aluminum or soft steel and adapted under excessive charge conditions, where the impact against the shoulder 194 is excessive, to expand into bind relation with the tool holding head to thus prevent continued improper operation of the tool, the expendable ring 196 being removed following such improper operation and replaced by a new ring.

In the lower portion of the housing 173 there is provided a longitudinally movable pull rod 197, guided in its movement through a bushing 198 engaged in the frame plate 172 and through a passage 199 in the forward wall 174 of the housing, a helical expansion spring 200 being interposed between then bushing 198 and a collar 201 secured to the shaft to normally exert forward projecting pressure upon the rod. This rod is adapted, through expansive pressure upon the indenter piston, to move the barrel assembly into operative relation with the breeching and fire control assembly, as will presently more fully appear. Upon opening the breeching and fire control assembly to the position as shown in Fig. 18, the rod is retracted in the barrel assembly and through such retraction is adapted to retract the indenter piston. To this end the pull rod is provided upon its forward end with an upwardly extending lug 202, engaged in a longitudinal slot 203 in the work holding head and disposed in forwardly opposed relation to the flange 195 of the tool holder and indenter piston, as shown in Fig. 16, with the breeching and fire control assembly in the closed position with the pull rod 197 projected, the lug 202 is spaced forwardly of the stop shoulder 194 against which the flange 195 is engaged. During the first part of the retracting movement of the pull rod, the indenter piston remains stationary, and during the latter part of the retracting movement the lug 202 engages the flange 195 and retracts the indenter piston to the position as seen in Fig. 18, the open position of the breeching and fire control assembly being retained by detent means, as will presently more fully appear, for the purpose of cartridge ejecting and reloading.

Following the reloading, the breeching and fire control assembly is moved to closed position, as seen in Fig. 16,
and during the initial closing movement the indentor piston moves forwardly under the pressure of the spring 190 to engage the indenting die element 192, with the connector fitting engaged in the anvil member 182, the lug 202 then moving forward free of the indentor piston, as the breaching and fire control assembly is moved to the closed position. In the fully retracted condition established between the connector fitting, the indentor piston and the firing chamber the same is described in connection with the first embodiment of the invention.

By comparing the closed position of the tool as shown in Fig. 16 with 20 and 21 to the open position as shown in Figs. 18 and 17a, it will be seen that the plate 204 is retracted from the open position the rear breeching and fire control assembly is rearwardly separated from the front or barrel assembly, and at the same time the operating handle of the rear assembly is rotated through approximately one hundred and sixty degrees, the intermediate one chamber plate 204 channel being rotated to a lesser extent, i.e., approximately forty degrees, so that in the open position as seen in Fig. 22 it exposes the breech end of the front barrel assembly, and has its cartridge receiving bushing exposed for the purpose of ejecting a fired cartridge and reloading.

The pull rod 197 is rigidly connected intermediate its ends to the chamber plate 204, and its portion extended rearwardly from the plate 204 is guided through a bushing 216 provided in a breech plate 206 secured within the housing 207 by the bolts 208, the housing having attached thereto or integral with a handle 209. Upon the rearward end of the rod 197 there is engaged a washer 210 secured by a nut 211, and a helical spring 212 is engaged about the rod between the washer and the breech plate, the expansive force of this spring normally pressing the housing forwardly upon the rod toward the chamber plate 204, and the expansive force of the spring 200 within the forward barrel assembly pressing the latter rearwardly toward the chamber plate 204, so that in the closed position, as seen in Fig. 16, the parts are drawn into contiguous contacted relation, and the forward end of the pull rod 197 is projected forwardly free of the indentor piston, the latter reposing against the stop shoulder 194 under the force of its spring 190.

In the open position, as seen in Fig. 18, the springs 212 and 200 are compressed and the pull rod 197 is retracted, first moving free of the indentor piston and during the latter part of the retracting movement retrace the indentor piston to the position as seen in Fig. 18. In the fully retracted open position the handle is rotated to a lug 219 disposed in a slot 220 in the breeching sleeve 228, this slot including a narrow locking portion of the long wide releasing portion. The sleeve is normally pressed by spring means (not shown) in a clockwise direction to disengage the lug 239 in the narrow portion of the slot 240, in which relation the sleeve is not in its fully locked breeching relation with the front barrel assembly. Thus if one hand is engaged with the handle portion 209 of the tool it is necessary, in order to actuate the trigger to fire the cartridge, for the other hand to be engaged with the sleeve 228 and to rotate it against the force of its spring into a fully locked position. The wide part of the slot 240 is brought into relation with the lug 239, as seen in Fig. 20. While the sleeve is so held the trigger bar may be actuated.

What is claimed is:

1. A powder actuated tool comprising a barrel having a breech end and a muzzle end, a cartridge receiving chamber in said breech end, a work holding head secured to said muzzle end, a work supporting anvil die carried by said head in longitudinal alignment with said barrel, an indentor piston movably in said barrel for projecting and retracting movement and including a piston head at its rearward end and an indentor tool element at its forward end opposed to said anvil die, stop means engageable by said indentor piston to limit its projecting movement, and yieldable means normally pressing said indentor
piston to its projected position against said stop means, said indenter tool element adapted to be engaged with a work piece disposed in said anvil die under the pressure of said yieldable means to determine the preforming retracted position of said piston head relatively to said chamber.
2. A tool according to claim 1, in which said yieldable means comprises a helical spring interposed between said barrel and said indenter piston.
3. A tool according to claim 1, in which said stop means comprises an annular shoulder surrounding a guide passage through which said indenter piston is movable, and said indenter piston includes an outwardly projecting annular flange in longitudinal alignment with said shoulder.
4. A tool according to claim 3, in which an impact washer is interposed between said shoulder and said flange, said washer being formed of a material deformable upon excessive impact.
5. A tool according to claim 1, in which said piston heads includes a friction ring engaged with the inner surface of said barrel.
6. A tool according to claim 1, in which said indenter piston includes a piston rod, and said piston head includes a transverse end portion removably secured to the rearward end of said rod and a cylindrical portion surrounding said rearward end of said rod, there being a circumferential weakened area between said transverse and cylindrical portions substantially in line with the periphery of said rod whereby an explosive force within said chamber will cause said cylindrical portion to shear away from said transverse portion.
7. A tool according to claim 1, in which said chamber is internally flared at its forward end.
8. A tool according to claim 1, in which said chamber is provided with circumferentially spaced gas-escape notches in its forward end.
9. A tool according to claim 1, comprising a fire control means connected to the breech end of said barrel and including an actuating handle adapted to be moved between breech opening and closing positions, and connection means between said handle and said indenter piston for imparting retracting movement to said indenter piston through breech opening movement of said handle.
10. A tool according to claim 9, in which said indenter piston is retractable in the breech closing position of said handle.
11. A tool according to claim 9, in which said breech opening and closing movement is accomplished by a combination of transverse rotational and longitudinal translational movements of said handle.
12. A tool according to claim 9, in which the opening and closing movement of said handle is substantially greater than the retracting and projecting movement of said indenter piston, and in which said connection means is adapted to move free of said indenter piston during the initial part of its opening movement and during the final part of its closing movement.
13. A tool according to claim 9, in which said connection means comprises a sleeve engaged for projecting and retracting movement on said barrel, means carried by said sleeve engageable with said indenter piston to retract the latter through retracting movement of said sleeve, a pull rod connected to said sleeve, a pull bar connected to said handle for retracting and projecting movement with the opening and closing movement of said handle and connected to said pull rod to move free of said pull rod during its initial retracting movement and to retract said pull rod during its final retracting movement.
14. A tool according to claim 13, in which spring means is interposed between said sleeve and said pull bar to exert a force in the projecting direction on said sleeve and in the retracting direction on said pull bar.
15. A tool according to claim 9, in which said connection means comprises a pull rod connected to said handle for retracting and projecting movement with the opening and closing movement of said handle, and a lug carried by said rod moveable free of said indenter piston during its initial retracting movement and engageable with said indenter piston during its final retracting movement to retract said indenter piston.
16. A tool according to claim 9, in which said fire control means includes a repeater type receiver and a bolt to which said handle is connected to impart opening and closing movement thereto.
17. A tool according to claim 9, in which said fire control means includes a chamber plate having a cartridge receiving chamber, and a breech plate, and means permanently joining said barrel, chamber plate and breech plate while enabling relative movement thereof from a breech closed position to a breech open position.
18. A tool according to claim 9, comprising fire control disabling means, and manually operable means positioned rearwardly of said work-holding head for operation by the hand of the user of the tool not engaged with said handle for rendering said disabling means inoperative.

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