United States Patent [19]

Gress et al.

[11] 3,837,211

[45] Sept. 24, 1974

[54] **MULTI-STROKE HAND TOOL**

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[73] Assignee: **AMP Incorporated**, Harrisburg, Pa.

[22] Filed: **July 6, 1973**

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[52] **U.S. Cl.** ..... **72/410**, 29/203 DT, 81/363, 72/451

[51] **Int. Cl.** **B21d 7/06**

[58] **Field of Search** ..... 72/410, 412, 415, 451; 29/203 DT; 81/363, 357, 300

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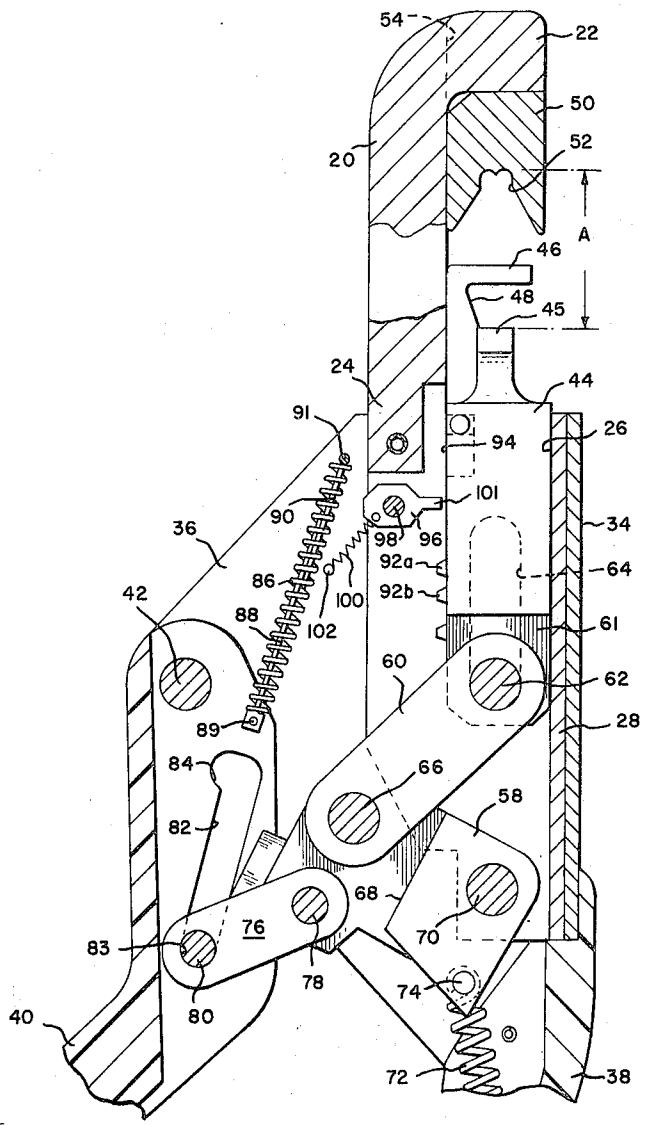
Primary Examiner—Charles W. Lanham
Assistant Examiner—Gene P. Crosby

[57] **ABSTRACT**

Two stroke hand tool has a reciprocable ram, a toggle mechanism for moving the ram, and a movable handle for straightening the toggle mechanism. A connecting link extends from the handle to one of the links of the toggle mechanism. This connecting link is connected to the handle at one location during the first stroke of the handle to bring about substantial ram travel. During second stroke of the handle, the connecting link is pivoted to the handle at a second location to develop high thrust in the ram during the final portion of the ram stroke.

5 Claims, 10 Drawing Figures



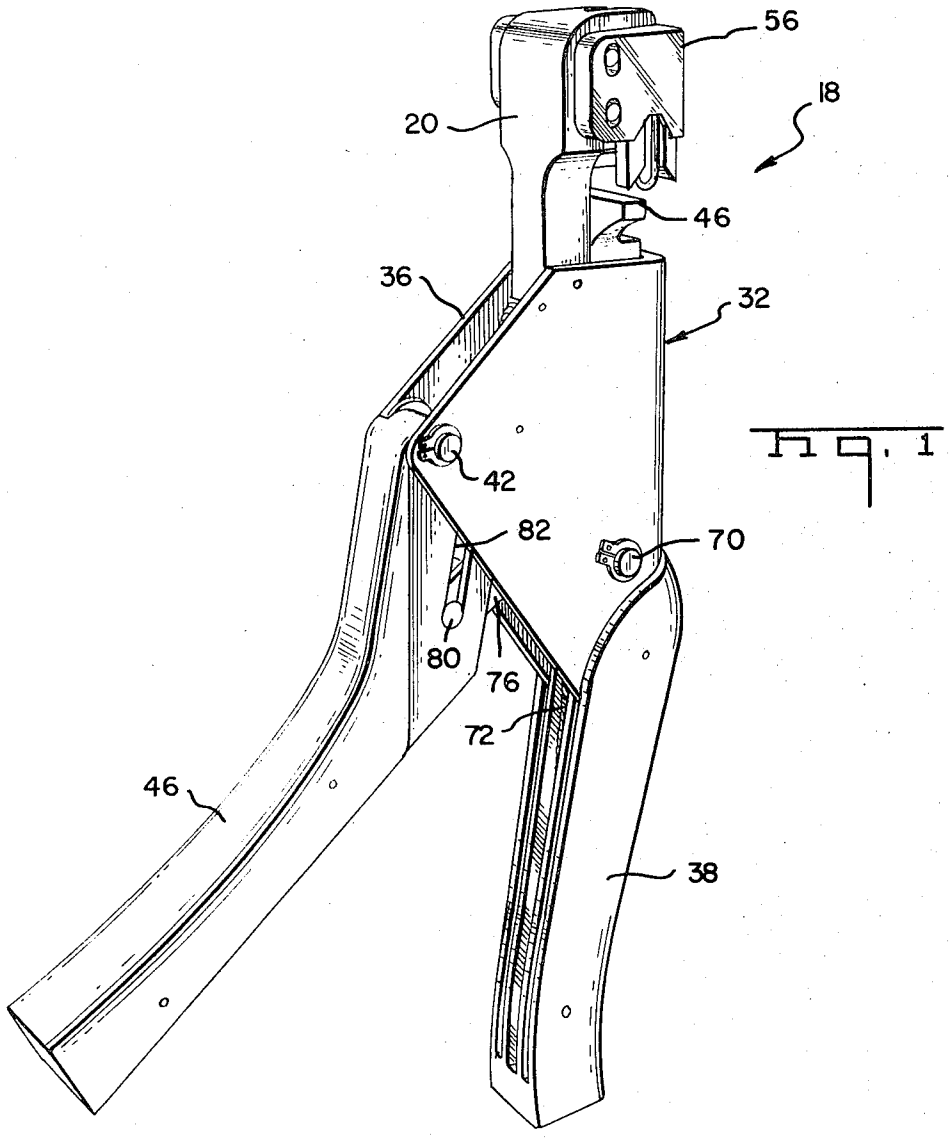


Fig. 1

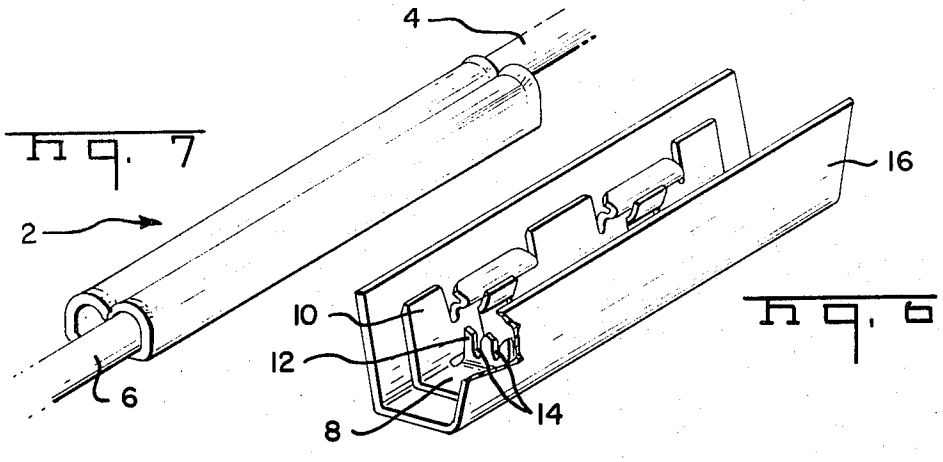


Fig. 7

Fig. 6

Fig. 2

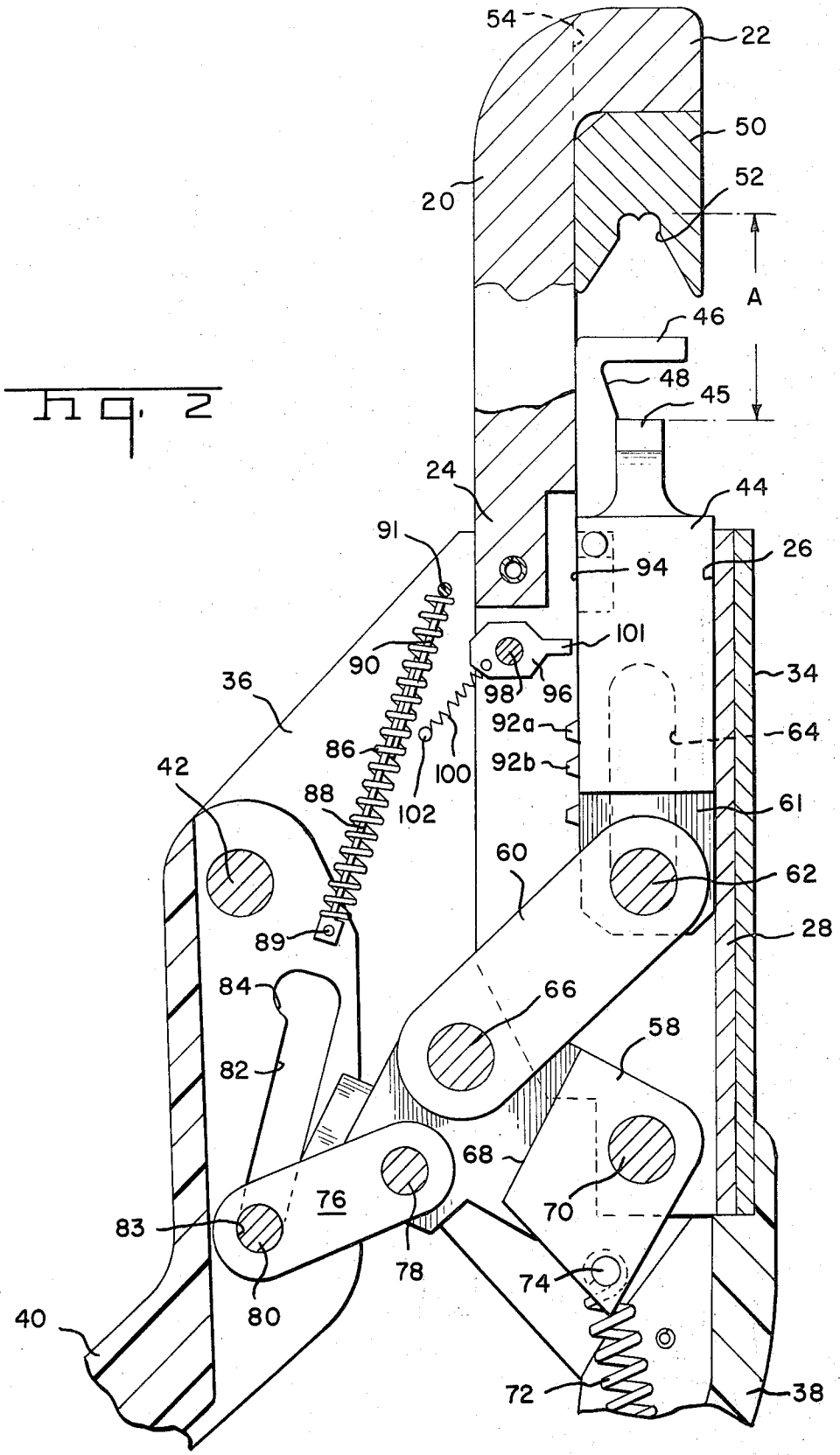

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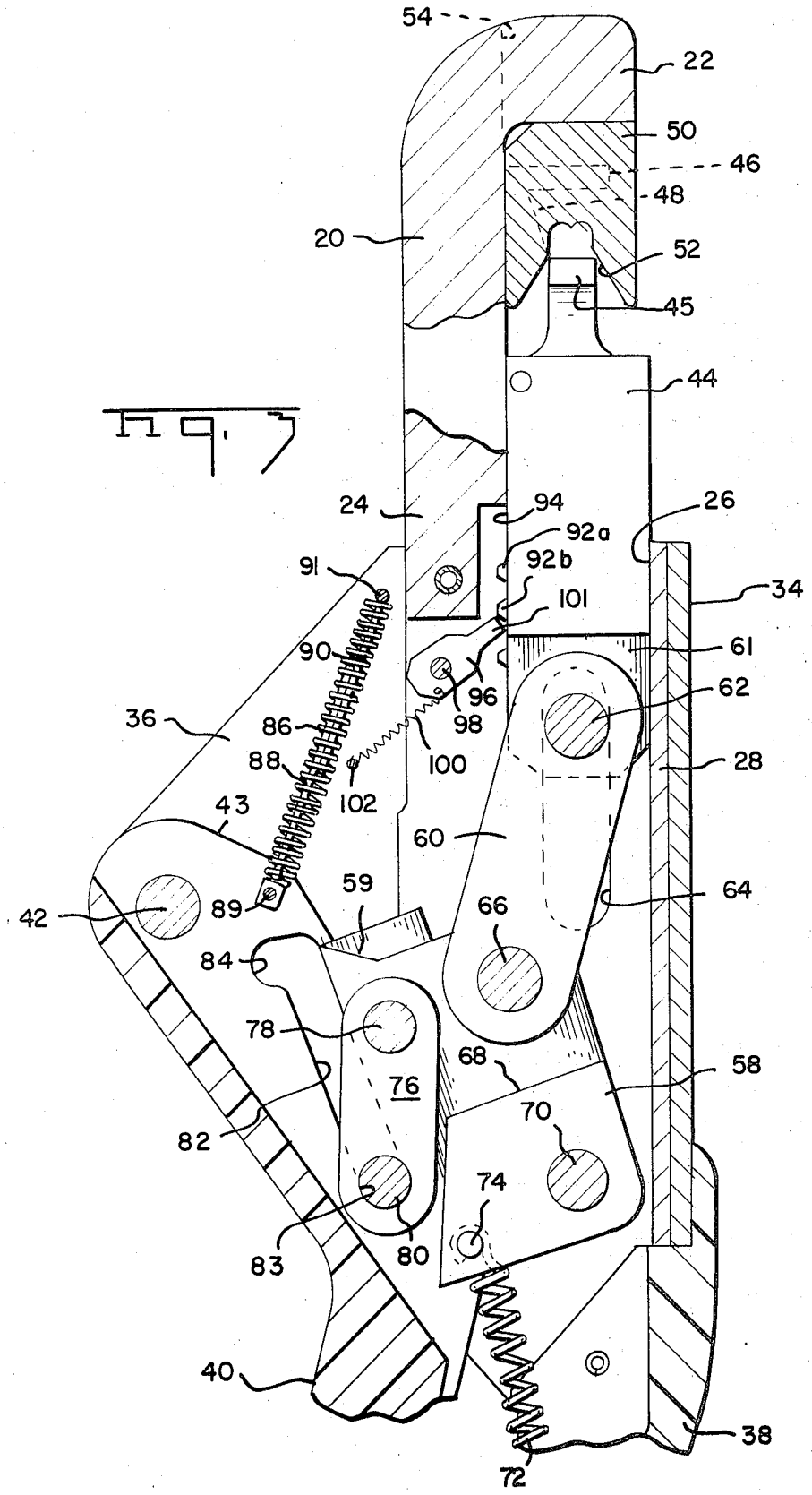
Fig. 7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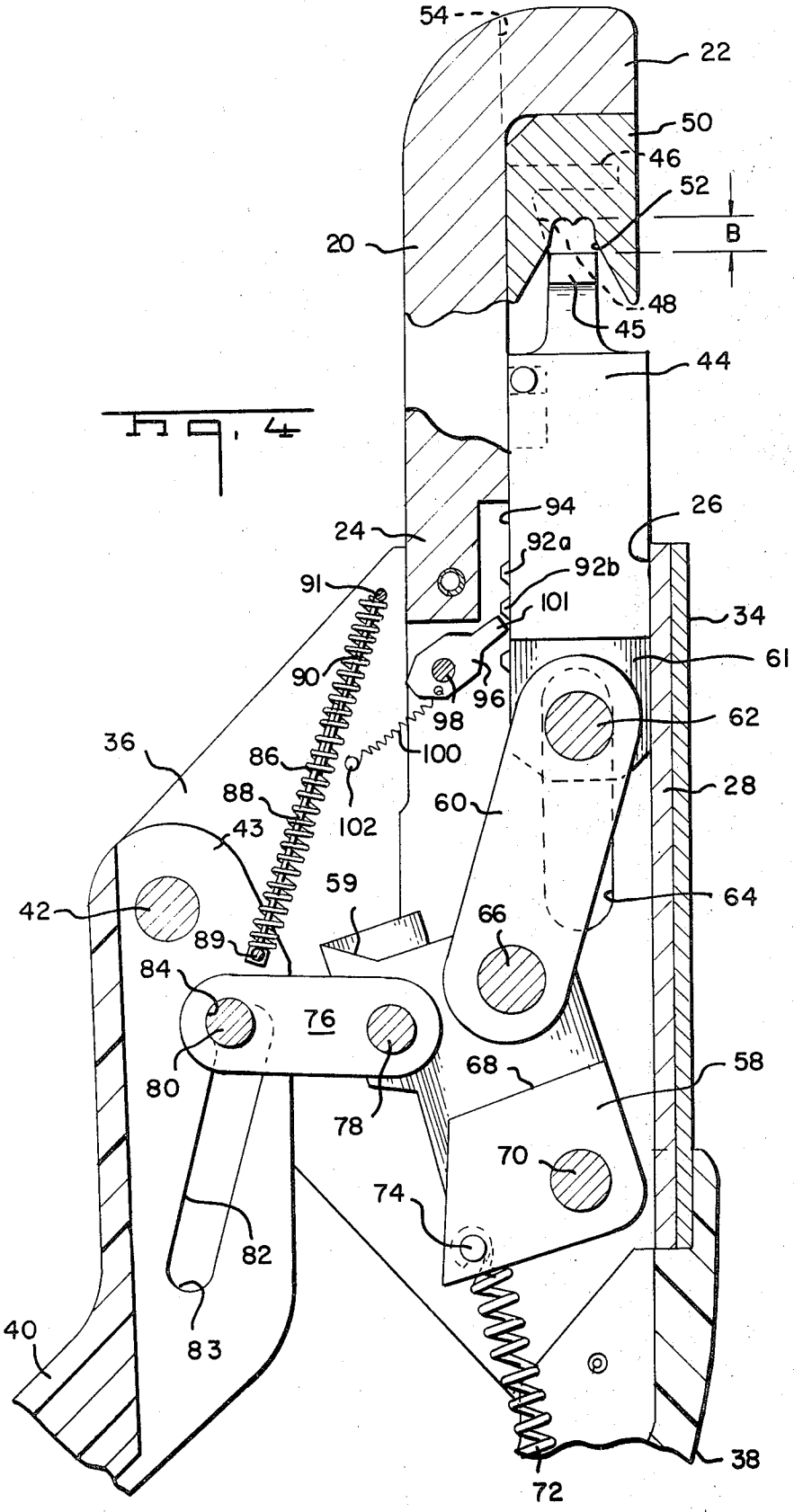
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Fig. 4

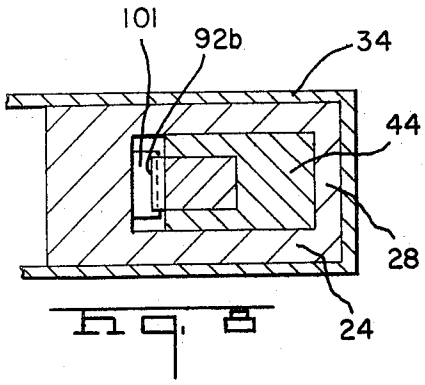
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Fig. 6

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Fig. 5

Fig. 9

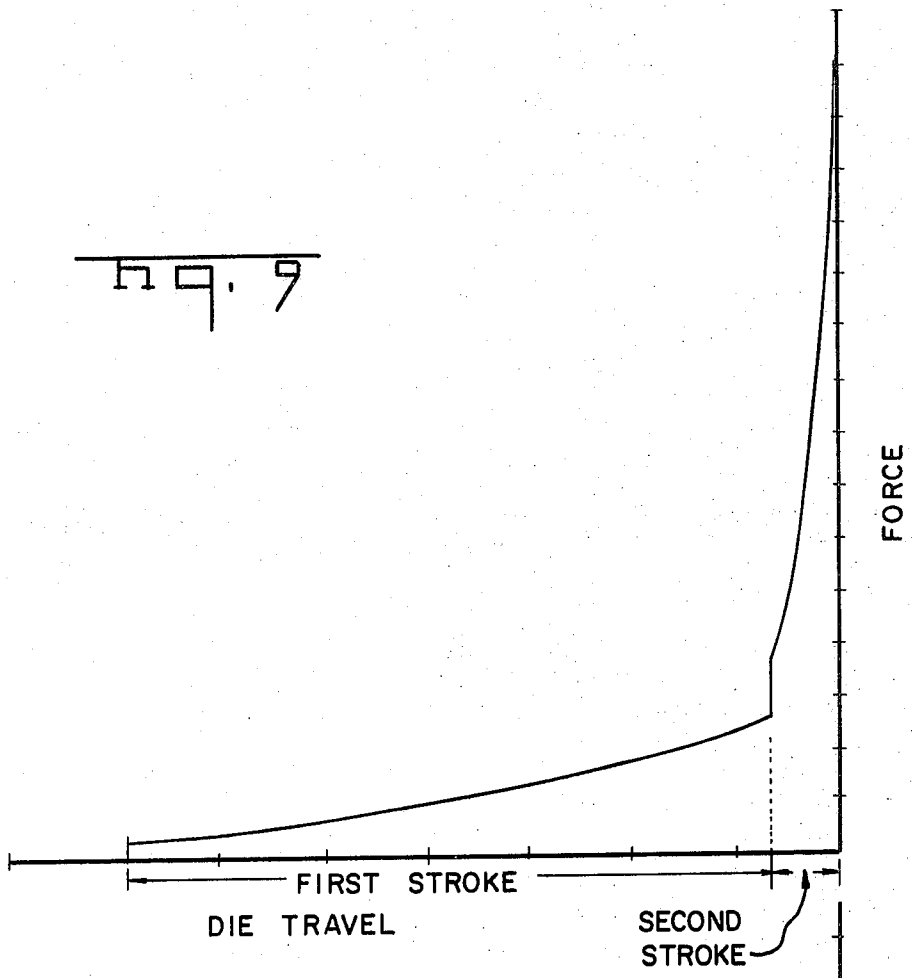
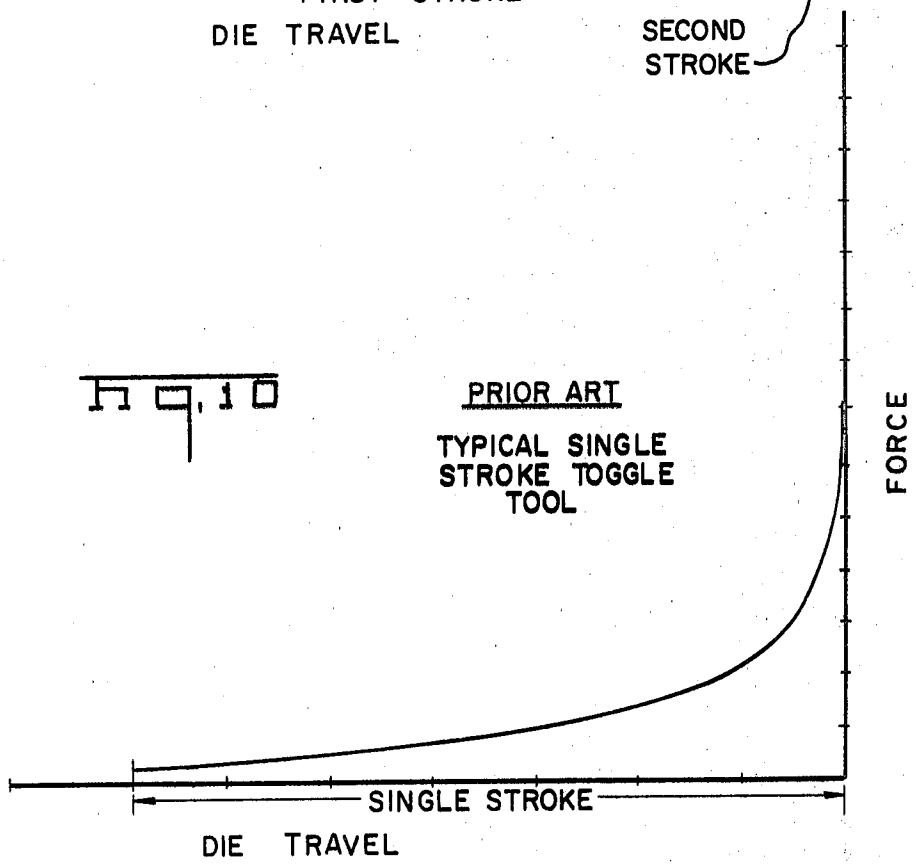


Fig. 10

PRIOR ART

TYPICAL SINGLE STROKE TOGGLE TOOL



MULTI-STROKE HAND TOOL

BACKGROUND OF THE INVENTION

This invention relates to multi-stroke apparatus having a reciprocable ram such as a multi-stroke hand tool. The embodiment of the invention disclosed herein comprises a crimping tool for crimping electrical connecting devices onto wires and the advantages of the invention are discussed with reference to this type of operation. It will be apparent, however, that the principles of the invention can be used in hand tools adapted for other purposes and/or for simple bench presses or the like.

It is quite often a requirement of crimping tools for crimping connecting devices onto wires that the ram of the tool have a relatively long stroke in order that the die and anvil will be separated when they are remote from each other in their open positions by a distance which is sufficient to permit the operator to place the connecting device between the crimping dies of the tool. Usually, the crimping operation, during which the connecting device is crimped onto the conductor, takes place during only the end portion of the stroke and the forces required to perform a crimping operation are often quite high. Very little force is developed in the ram during the initial portion of the stroke of the tool since the ram is merely being moved towards the fixed die to take up the long stroke of the tool.

These requirements give rise to a design problem in that the person using the hand tool must develop the highest forces during the final portion of the stroke. In other words, virtually all of the work accomplished when a terminal is crimped must be accomplished during a very short portion of the stroke. Many commonly used crimping tools thus require handle pressures at the end of the stroke which are almost beyond the capabilities of a person of average strength.

The present invention is directed to the achievement of an improved multi-stroke hand tool which utilizes the characteristics of a toggle linkage for driving a ram in combination with a variable ratio linkage between the toggle and the movable handle, the arrangement being such that during the first closure of the tool handles, the ram is caused to travel through a substantial portion of its stroke although the linkage provides only a low mechanical advantage during this closure of the handles. During the second closure of the handles, a substantially increased mechanical advantage is obtained and this improved mechanical advantage, coupled with the fact that the toggle at this time delivers a high mechanical advantage, results in the achievement of extremely high forces in the ram for crimping purposes. Retrograde movement of the ram during the interval between the two closings of the handles is prevented by a full stroke compelling mechanism.

It is accordingly an object of the invention to provide an improved multi-stroke hand tool. A further object is to provide an apparatus having a reciprocable ram and a multi-stroke mechanism for reciprocating the ram in which each successive stroke has a greater mechanical advantage than the previous stroke. A further object is to provide a hand tool having a toggle mechanism for reciprocating a ram and a multi-stroke means for straightening the toggle.

These and other objects of the invention are achieved in a preferred embodiment thereof, which are briefly described in the foregoing abstract, which is described in detail below, and which is shown in the accompanying drawing in which:

FIG. 1 is a perspective view of a preferred form of hand tool in accordance with the invention.

FIG. 2 is a sectional side view of the upper portion of the tool of FIG. 1 showing the positions of the parts at the beginning of the operating cycle.

FIGS. 3–5 are views similar to FIG. 2 but showing the positions of the parts at different stages of the operating cycle.

FIG. 6 is a perspective view of an electrical connecting device of a type adapted to be crimped by the tool of FIGS. 1–5.

FIG. 7 is a perspective view of the connecting device crimped onto two wires.

FIG. 8 is a view taken along the lines 8—8 of FIG. 2.

FIGS. 9 and 10 are graphical representations of the handle travel ram force characteristics of the tool of the instant invention and of a conventional toggle type tool.

Referring first to FIGS. 6 and 7, the herein disclosed embodiment of the invention is adapted to crimp a channel-shaped connecting device 2 onto the ends of the wires 4, 6 which extend towards each other. Prior to crimping, the connecting device has a web 8 and sidewalls 10 and lances 12 are struck up from the web as shown. These lances have wire-receiving slots 14, the edges of which penetrate the insulating of the wires to establish electrical contact therewith. The connecting device 2 has a film of insulation 16 bonded to its external surface so that after crimping, the sidewalls 10 are bent inwardly towards each other and the insulation covers the entire external surface of the crimped connection. Connecting devices of this type are disclosed and claimed in U.S. Pat. No. 3,320,354 and a previously known type of tool for crimping such devices is shown in U.S. Pat. No. 3,328,871.

The crimping operation requires that the end portions of the wires be trimmed in the tool, as will be described below, and that the sidewalls 10 be bent inwardly and downwardly as noted above, and relatively high forces must be composed on the connecting device in order to accomplish this bending operation.

A preferred form of tool 18 in accordance with the invention has a frame means comprising a head 20, from which a horizontal arm 22 extends, and a body section 24 (FIG. 2). The body section has a rectangular opening 26 through which the upper portion of a tool ram 44 extends and the lower portion of the frame which extends downwardly from the body is generally U-shaped having a web 28 and parallel sidewalls 30. A generally U-shaped cover plate 32 is fitted over the body portion of the frame and has a wall 34 which is disposed against the web 28 of the frame and sidewalls 36 which extend beside and beyond the sidewalls 30 of the frame. A fixed handle 38 extends downwardly from the lower portion of the U-shaped section of the frame and has a suitable plastic cover fitted thereon.

A movable handle 40 has an upper end which is pivoted at 42 between the leftwardly projecting portions of the sidewalls 36 of the cover plate. The upper portion of handle 40 comprises a pair of spaced apart plate sections 43 which are disposed against the internal surfaces of these sidewalls 36 as shown in FIG. 2.

A movable die or anvil 45 extends centrally from the upper end of the ram 44 and has an upper surface

which is adapted to support the web of a connecting device 2. A cutter bar 46 projects laterally across this upper surface and is integral with the ram by means of a connecting leg 48 which extends downwardly on the lefthand side of the anvil as viewed in FIG. 2. The upper, or fixed, die means 50 is mounted against the arm 22 of the frame and has forming surfaces 52 which are opposed to the anvil for bending the sidewalls 10 of the connecting device inwardly and downwardly while the ram is moved to its closed position. A slot 54 extends into the upper die means 50 and into the arm 22 from the rightwardly facing side thereof as viewed in FIG. 2. When a connecting device is to be crimped onto wires, the ends of the wires are located proximate to the forming surfaces 52 and led through the slot as shown in FIGS. 1 and 2 and as explained more fully in the above-identified U.S. Pat. No. 3,328,871. Advantageously, wire holders 56 are mounted against the sides of the upper dies and the arm portion 22 of the tool to retain the wires in the tool while the operator carries out the manipulative steps of the crimping operation.

The ram 44 is reciprocated towards and away from the tool head by a toggle means comprising links 58, 60, the toggle link 60 extending into a slot 61 in the lower end of the ram and being connected thereto by means of a pin 62. The ends of this pin extend into slots 64 in the sidewalls 30 of the frame so that the pin 62 moves along a straight line path during straightening of the toggle as will be apparent from an inspection of FIGS. 2–5. The toggle link 58 is pivoted at 70 to the lower end of the channel-shaped section of the frame and a spring 72 has its upper end connected to a pin 74 in this link and has its lower end connected to a fixed pin in the lower end of the handle. It will be apparent that this spring 72 tends to bias the toggle to its broken condition but that the toggle can be straightened with concomitant elongation of this spring.

The toggle links 58, 60 are pivoted to each other in a knee joint by means of a pivot pin 66. As shown in FIG. 2, the link 58 is slotted as shown at 68 and the link 60 extends into this slot.

The ram is driven upwardly from the position of FIG. 2 upon straightening of the toggle links and such strengthening of the toggle links is carried out by a connecting length 76 which pivoted at 78 to the toggle link 58. The toggle link 58 thus functions as a bell crank as well as an element of the toggle mechanism. Link 76 extends leftwardly and between the side blades 43 of the movable handle 40 and is connected by means of a pin 80 and a slot 82 to this movable handle. The slots 82 have a lower ends 83 in which the pin 80 is located at the beginning of the operating cycle and upper ends 84 in which the pin 80 is located during the second portion of the operating cycle. The slots 82 have leftwardly extending recesses 84 at their upper ends in which the pin is seated during the second handle stroke as will also be explained below.

The movable handle is resiliently biased to its open position, FIGS. 1, 2 and 4 by means of a compression spring 86 which extends between a plate 91 and a pin 89. A pin 89 extends between the plate sections 43 of the movable handle and the plate 91 extends between the sidewalls 36 of the cover plate. Overlapping rods 88, 90 extend from the plate member 91 and pin 89 to retain the spring 86 in position. When the handle is closed, the spring is thus compressed and stores energy which returns the handle to its normal position after completion of the handle stroke.

A full stroke compelling mechanism for ensuring full closure of the ram 44 is provided and compresses a pawl 96 pivoted on a pin 98 in a recess in the body portion of a frame. This pawl is normally biased by a spring 100 to the position in FIG. 2 so that the arm 101 of the pawl extends horizontally as viewed in the drawing. The spring has one end fixed to the pawl and is fixed at its other end to a pin 102 which extends between the sidewalls 36 of the cover plate. The arm 101 is adapted to cooperate with three teeth 92 on the leftwardly facing side 94 of the ram as will be described below.

OPERATION

At the beginning of the operating cycle, the tool parts will be in the positions of FIG. 2 with the movable handle in its open position and the ram at its remote position relative to the die means 50. The operator first positions a connecting device 2 on the upper surface of the movable die or anvil 45 and then locates the wires within the forming surfaces 52 of the dies with the ends of the wires extending through the slot 54. He then squeezes the handles and moves the handle 40 towards the fixed handle until the parts are in the positions of FIG. 3. During this portion of the cycle, the link 76 transmits forces to the toggle link and bell crank 58 to partially straighten the toggle mechanism and drive the ram through a substantial portion of its stroke. The wires will be cut during this portion of the cycle as the cutter bar 46 moves into the slot 54, and the teeth 92A 92B will move past the arm 101 of the pawl so that this arm will be lodged against the lower side of the tooth 92B. The operator then releases the handles and the movable handle will be returned to its open position (FIG. 4) under the influence of the stored energy in the spring 86. Since the ram is prevented from moving downwardly during return of the movable handle to its open position, the toggle links remain in the same position and the pin 80 is required to move relatively along the slots 82 until the pin is lodged in the recess 84 in the upper end of these slots as shown in FIG. 4. The operator again squeezes the handles and the toggle mechanism is substantially fully strengthened to drive the ram the additional short portion of its stroke which remains. It should be added that at the beginning of the second handle stroke, the pin 80 may have a tendency to travel relatively down (as viewed in the drawing) the slot 82. This tendency can be overcome by providing a fairly stiff pivotal mounting of the link 76 on the pin 78 so that the pin 80 will remain in the recess 84 as the handle is closed. Alternatively, a spring loaded ball-type detent can be provided in the link 58 to hold the link 76 in the position of FIG. 4 while the handle is being closed during this second stroke. The lower tooth 92C of the full stroke compelling mechanism moves past the arm 101 of the pawl so that when the handles are subsequently released the ram can return under the influence of the spring 72 to its initial condition (FIG. 2). At the same time, the pin 80 moves to the lower ends of the slots 82 under the influence of the spring 72.

In order to ensure this downward movement of the pin 80 in the slot 82, a stop is provided on the link 58 which has a surface 59 which engages the link 76 as the handle is opened from the position of FIG. 5. As shown in FIG. 1, the surface 59 remains in engagement with

link 79 while the link 58 is swung in a counterclockwise direction during opening of the handle.

It will be apparent from the foregoing that the first stroke of the movable handle brings about ram travel through a substantial portion of its stroke although the mechanical advantage achieved is relatively low because of the position of the link 76 and its orientation relative to the toggle mechanism. When the pin 80 moves to the upper ends of the slots 82, this link is in an orientation such that an extremely high mechanical advantage is obtained for the full stroke of the handle.

FIGS. 9 and 10 illustrate the advantages achieved by a toggle type tool in accordance with the invention as compared with a conventional toggle type tool. These graphs are presented primarily for purposes of clarifying the principles of the invention and do not represent precise data.

FIG. 9 shows the handle travel of a conventional toggle tool plotted against the force developed by the ram of the tool. A conventional tool has the movable handle which is in direct engagement with the knee joint of the toggle. During the single stroke of the movable handle, the toggle is straightened and the ram is driven through its entire stroke. The characteristic handle-travel force curve thus shows that during most of the stroke of the handle, the ram travels through a substantial portion of its stroke but only a low force is developed because of the fact that the toggle is bent during this portion of the stroke of the handle. As the toggle approaches its straightened condition, the mechanical advantage increases so that the curve rises abruptly. The amount of work which can be obtained from the tool is represented by the area under the curve.

FIG. 10 illustrates the handle travel force curve of a tool in accordance with the invention during both of the handle strokes. It can be seen from FIG. 10 that during the first stroke of the movable handle, the ram travels through a major portion of its stroke and at the end of the first stroke, the curve is abruptly displaced upwardly. During the second stroke of the handle, the ram travels only a short distance to the end of its stroke and the curve again rises abruptly. Again, the amount of work which can be accomplished is represented by the area under the curve. The area under the curve of FIG. 10 is substantially greater than the area under the curve of FIG. 9 for the reason that the mechanical advantage is increased between the first and second strokes (as represented by the upward displacement of the curve of FIG. 10) and a full stroke of the handle is available to permit full utilization of this increased mechanical advantage.

While the disclosed embodiment of the invention is adapted to move the ram through its working stroke in two strokes of the movable handle 40, it will be apparent that it is within the scope of the invention to design the tool such that three or more strokes of the movable handle drive the ram through its working stroke. A three stroke tool would thus require a recess in the slots 82 intermediate the ends of the slots and a full stroke compelling mechanism adapted to prevent retrograde movement of the ram between the first and second strokes and between the second and third strokes. This could be done by dimensioning and locating the teeth 92 at suitable intervals.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only.

What is claimed is:

1. An apparatus of the type comprising a frame, a movable handle pivoted to said frame on a first pivotal axis, said handle being movable towards and away from said frame, a ram reciprocably supported on said frame, toggle means comprising first and second toggle links, said first toggle link being pivoted to said frame and to said second toggle link, said second toggle link being pivoted to said ram whereby, upon straightening said toggle means, said ram is driven through its working stroke, the improvement to said apparatus comprising:

a connecting link, said connecting link being pivoted at one of its ends to said first toggle link and having another end which is pivoted to said handle,

a plurality of connecting link pivot positions on said movable handle, said positions being at different distances from said first pivotal axis, and

means for shifting said other end of said connecting link from a relatively remote one of said positions to a relatively proximate one of said positions during movement of said handle away from said frame whereby during each stroke of said movable handle towards said frame, said toggle means is partially straightened and said ram is driven through a portion of its stroke, and during successive strokes as said toggle means is straightened, the mechanical advantage of said apparatus increases.

2. In a toggle type hand tool of the type comprising a frame, having a fixed handle extending therefrom, a movable handle pivoted to said frame on a first pivotal axis, said movable handle being movable towards and away from said fixed handle, a ram reciprocably supported on said frame, toggle means comprising first and second toggle links, said first toggle link being pivoted to said frame and to said second toggle link, said second toggle link being pivoted to said ram whereby, upon straightening said toggle means, said ram is driven through its working stroke, the improvement to said apparatus comprising:

a connecting link, said connecting link being pivoted at one of its ends to said first toggle link and having another end which is pivoted to said movable handle

a plurality of connecting link pivot positions on said movable handle, said positions being at different distances from said first pivotal axis, and

means for shifting said other end of said connecting link from a relatively remote one of said positions to a relatively proximate one of said positions during movement of said handle away from said frame means whereby during each stroke of said movable handle towards said fixed handle, said toggle means is partially straightened and said ram is driven through a portion of its stroke, and during successive strokes as said toggle means is straightened, the mechanical advantage of said tool increases.

3. A tool as set forth in claim 2, said movable handle having slot means therein, said slot means having a first end which is proximate to said first pivotal axis and having a second end which is remote from said first pivotal axis, said ends of said slot means constituting said pivot positions.

4. A tool as set forth in claim 3 wherein said means for shifting said other end of said connecting link comprises ratchet means effective between said ram and said frame, said ratchet means being effective to prevent retrograde movement of said ram when said ram is at an intermediate position in its stroke whereby said other end of said connecting link is moved in said slot during movement of said movable handle away from said fixed handle.

5. In a toggle type hand tool of the type comprising a frame and having a fixed handle extending therefrom, a movable handle pivoted to said frame on a first pivotal axis, said handle being movable toward and away from said fixed handle, a ram reciprocably supported on said frame, toggle means comprising first and second toggle links, said first toggle link being pivoted to said frame and to said second toggle link, said second toggle link being pivoted to said ram whereby, upon straightening said toggle means, said ram is driven through its working stroke, the improvement to said apparatus comprising:

a connecting link, said connecting link being pivoted at one of its ends to said first toggle link and having another end which is proximate to said movable handle,

slot means in said movable handle, said slot means having a first end which is proximate to said first pivotal axis and a second end which is remote from said first pivotal axis, said other end of said connecting link being pivoted in said slot means, and

ratchet means effective between said ram and said frame, said ratchet means being effective to prevent retrograde movement of said ram when said ram is at an intermediate position in its working stroke whereby, at the beginning of the stroke of said ram, said toggle is broken, said movable handle is in its open position, and said connecting link is pivoted to said movable handle at said other end of said slot means, and upon a first stroke of said movable handle towards said fixed handle, said handle is partially straightened and said ram is driven through a major portion of its working stroke, and upon opening said handle, said ram remains stationary and said other end of said connecting link moves to said first end of said slot means, and upon closing said movable handle a second time, said toggle is fully straightened and said ram travels through the remainder of its working stroke.

* * * * *