April 22, 1958 N. A. HARVEY 2,831,377

PORTABLE CABLE TERMINAL SWAGING DEVICE

Filed Aug. 31, 1953

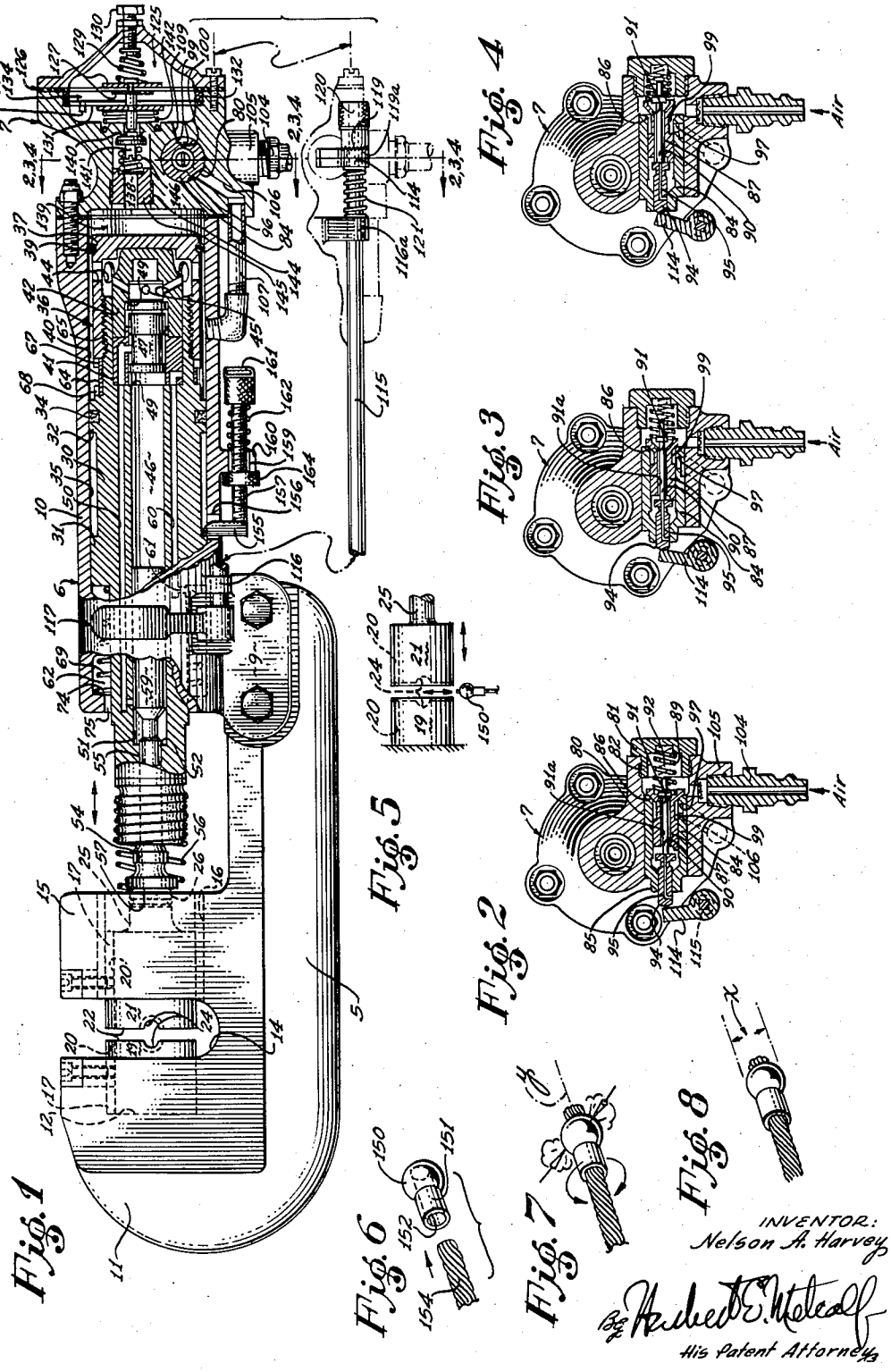


Fig. 1

Fig. 4

Fig. 3

Fig. 2

Fig. 5

Fig. 6

Fig. 7

Fig. 8

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United States Patent Office 2,831,377 Patented Apr. 22, 1958

2,831,377

PORTABLE CABLE TERMINAL SWAGING DEVICE

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Application August 31, 1953, Serial No. 377,445

1 Claim. (Cl. 78—42)

My invention relates broadly to metal forming tools, and more particularly to a novel power operated tool for performing swaging operations.

Swaging, in a broad sense, relates to a type of forging process for cold forming metal. In the manufacture of aircraft, for example, a number of swaging operations are performed generally having to do with fastening certain components together. One such operation consists of fastening steel ball terminals on the ends of steel cables for use in surface control systems, engine control systems, etc. The manner in which the ball terminals are fastened onto the cables can best be described as shrinking the ball terminal onto the cable by working the material of the ball terminal radially inwardly toward the axis of the cable. Other swaging operations generally performed in conjunction with aircraft are of a similar nature.

As far as is presently known, most ariframe manufacturers employ relatively large and expensive swaging machines of a stationary type for at least the majority of swaging operations. One criticism of such machines, many of which are of the single shot or impact type, has been that unless extraordinary care is exercised in the operation thereof, the impact delivered by the machine, of the single impact type, can and frequently does fracture the material of the components being swaged.

Moreover, in most of the swaging machines discussed above, it is difficult to swage ball terminals on to cables to an accurate final size with a satisfactory degree of uniformity, and extra operations, therefore, are usually required to remove flash and finish the ball terminals to final dimensions.

Ordinarily, the fabrication of airframes is more or less transient in nature; being conducted along assembly lines in which each airframe unit is actually moved from one construction stage, or station, to another. Obviously, then, power tools which are portable, i. e., tools which can be carried and handled by an operator, save time and reduce production costs.

With these and other considerations in view, it is an object of my invention to provide a novel power operated swaging tool which can be easily carried and handled by an operator.

It is another object of my invention to provide a swaging tool which can be properly operated with the use of ordinary mechanical skill.

It is still another object of my invention to provide a swaging tool which is capable of accurately performing swaging operations which require the maintenance of exacting tolerances and high quality in accordance with U. S. A. F. standards.

A still further object of my invention is to provide a swaging tool which is capable of accurately performing swaging operations to final dimensions, thereby eliminating subsequent finishing operations.

Another object of my invention is to provide a swaging tool incorporating a novel means for retaining the work piece in place while the swaging operation is being performed.

Other objects and advantages will be seen as the specification continues.

Briefly, the swaging tool of my invention, in one preferred embodiment thereof, takes the form of a pair of matched swaging dies supported in a yoke which is in turn mounted to a power driven actuating unit. One of the swaging dies remains stationary to assume the role of a bucking die, while the other die is associated with the actuator for reciprocation thereby under a relatively high head of pressure toward and away from the bucking die to deliver a rapid succession of sharp hammer-like blows against a work piece held in place between the reciprocated die and the bucking die to gradually reduce the exterior size thereof to swage the work piece onto another component. A pressure actuated means is also provided; being associated with the actuator to advance the movable die toward the bucking die under a separate and constant low head of pressure to retain the work piece therebetween so that the operator of the swaging tool can easily and accurately maneuver the work piece for uniform swaging thereof.

A clearer understanding of my invention will result with reference being made to the appended drawings wherein:

Figure 1 is a diagrammatic side elevation view in partial section showing the construction of one preferred embodiment of my swaging tool.

Figure 2 is an end elevation view taken on line 2—2 of Figure 1, showing the throttle valve assembly in partial section. In this figure, the valve is closed.

Figure 3 is an end elevation view taken on line 3—3 of Figure 1, showing the throttle valve assembly of Figure 2 with the valve being initially opened to advance the actuator barrel and movable swaging die toward the bucking die.

Figure 4 is an end elevation view taken on line 4—4 of Figure 1, showing the throttle valve of Figures 2 and 3 with the valve being fully opened for swaging.

Figure 5 is an auxiliary diagrammatic view showing the swaging dies removed; the directional arrows indicating the movement of the movable die, and insertion of a ball terminal to be swaged.

Figure 6 is an auxiliary diagrammatic view showing the assembling of the cable and ball terminal prior to swaging.

Figure 7 is an auxiliary diagrammatic view demonstrating the preferred rotational movement of the ball terminal, and the direction of impact delivered by the swaging tool.

Figure 8 is an auxiliary view of the swaged ball terminal and cable; the critical final dimension being indicated by the symbol X.

As shown in Figure 1, the swaging tool of my invention comprises a die supporting yoke 5, actuator 6, which in the embodiment herein described is designed for pneumatic power operation, and pressure housing 7. The yoke 5 is adapted for mounting to a mounting bracket 9 which forms a part of the outer cylinder casing 10 of the actuator 6. The anvil 11 of the yoke 5 has a die recess 12 opening in the inner face thereof. A work space 14 separates the anvil 11 from a bushed die support 15; this die support 15 being provided with a die passage 16 therethrough which is accurately line bored with the die recess 12 of the yoke anvil 11. The die recess 12 of the anvil 11, and the bushed die passage 16 of the die support 15, are preferably provided with keys 17, of suitable cross section, which extend longitudinally therethrough.

A swaging die 19 is housed and retained in the die recess 12 of the yoke anvil 11 in the usual manner, and will be referred to herein as the bucking die. The bucking die 19 has a key slot 20 for engaging the key 17 of the die recess 12. A movable swaging die 21 is slidably mounted in the die passage 16 of the die support 15; being coaxially aligned with the bucking die 19. The opposed faces 22 of the matched dies 19 and 21 are surfaced in the usual manner and provided with facial contour cavities 24 which are accurately sized to the final dimensions of the particular work piece to be swaged.

The movale die 21 terminates on the end thereof opposite its contour face 22 with a coaxial shank 25 and end button 26.

The outer cylindrical casing 10 of the pneumatic actuator 6 slidably encloses a barrel assembly 30 having an outer circumferential land 31 and an inner circumferential land 32, the latter land 32 carrying a central gland 34 in sealing engagement with the inner wall of the casing 10. The lands 31 and 32 are preferably lapped to a proper fit with the inner casing wall 35.

The inner end of the barrel 30 is threadably engaged with a head block 36 which is provided with an external circumferential groove 37 on the end thereof; the groove 37 retaining an O ring 39 in sealing engagement with the casing cylinder wall 35. The head block 36 has an outside diameter sufficiently smaller than the inside diameter of the casing cylinder 10 to define an annular space 40 therebetween. A counterbore 41 in the barrel 30 recesses a valve box 42 with the head block 36 completely enclosing the barrel 30 end and recessed valve box 42. A number of ports 44 are provided around the head block 36 on the forward side of the O ring 39. The valve box 42 likewise has a number of ports 45 leading to the hollow interior thereof which defines an operating space 46 for pressure fluid. Within operating space 46, a shuttle valve 47 is slidably mounted, and the travel thereof in the space 46 is restricted in either direction by means of shoulders 49 properly located therein.

A passage 50 extends longitudinally through the section of the barrel 30 leading to the forward end thereof and thence makes a right angle turn inwardly to open into the interior of the operating space 46 as shown. The diameter of the inner bore 51 at the forward end of the barrel 30 is diminished to define an inner shoulder 52, and a die set 54 of suitable configuration is slidably mounted in the decreased diameter bore 55 which extends through the outer opening of the barrel 30. The outer periphery of the forward end of the barrel 30 is threaded to engage a heavy duty tension spring 56 on one end thereof, the other end of the spring 56 having a reduced diameter and being engaged with the button 26 of the swaging die shank 25. In this manner the button 26 of die shank 25 is kept in abutting relationship with the end face 57 of die set 54.

A sliding hammer 59 is mounted in the usual manner in the barrel bore 51 intermediate die set 54 and shuttle valve 47.

An exhaust passage 60 and exhaust port 61 lead from the interior barrel bore 51 to an annular space 62 between the barrel 30 and outer cylinder casing 10.

A flat locking spring 64 is provided around the barrel 30, being positioned between the barrel end threads 65 and the head block 36. Lateral ears 67 on the spring 64 mesh with aligning notches 68 in the barrel 30 and head block 36 to lock the same in proper position and prevent relative rotation thereof.

The barrel assembly 30 is normally bottomed within cylinder casing 10 under the force of a heavy duty compression spring 69 positioned between outer land 31 and an internal shoulder 74 provided around the inner opening 75 of the cylinder casing 10.

For operation and control of the actuator 6 I provide a throttle valve assembly in novel combination with a pressure regulator, the two being combined in housing 7 which is mounted over the aft opening of cylinder casing 10.

The throttle valve assembly, as best shown in Figures 2–4, is mounted in a valve bore 80 which is enclosed at one end thereof by a cap 81 having a sleeve 82 extending thereinto. The throttle valve assembly comprises a throttle valve bushing 84 fitting and mounted in the valve bore 80. One end of valve bushing 84 extends out of the valve bore 80; being somewhat tapered at the protruding end to form a boss 85. The other end of valve bushing 84 terminates inwardly of the end of the cap sleeve 82, with a space therebetween, and is counterbored to form a tapered valve seat 86. A throttle valve 87 of suitable configuration is slidably mounted in valve bushing 84 and is sized to seat into valve seat 86 in the usual manner. The valve 87 is maintained in closed position by a compression spring 89 extending between valve 87 and cap 81, being recessed within cap sleeve 82.

A pilot valve 90 is mounted within the bore of the throttle valve 87, the outer end of pilot valve 90 being seated in and closing off a tapered valve seat 91 formed around the bore opening of the throttle valve 87. The pilot valve 90, in similar fashion to that of throttle valve 87, is maintained in closed position by means of a compression spring 92 concentrically enclosed within throttle valve compression spring 89.

The pilot valve 90 abuts a throttle valve plunger 94 at its outer end; being coaxially aligned therewith, and the plunger 94 extends out of and beyond the bushing boss 85. A coaxial passage 95 through the plunger 94 makes a right angled turn outwardly and opens adjacent the outer end of the plunger 94 to the exterior of housing 7, so that fluid may escape from the valve interior in the customary manner.

On the outer periphery of valve bushing 84 adjacent the outer end thereof a cylinder supply groove 96 is provided and forms a fluid space between the wall of bore 80 and the bushing 84. An opening 97 extends through the wall of bushing 84 leading to the interior thereof.

A cylinder supply passage 106 extends from the supply groove 96 which leads through the throttle valve seat 86, the passage 106 being connected, by means of a conduit 107, to the annular chamber 40 surrounding head block 36 in cylinder casing 10.

A regulator supply groove 99, as best shown in Figure 1, is provided on the outer periphery of valve bushing 84 adjacent the inner end thereof; an opening 100 leading from interior of the bushing 84 and opening into the supply groove 99.

Another passage 109 connects the regulator supply groove 99, which leads through the pilot valve seat 91, pilot valve bore 91*a*, and connects with the interior of pressure regulator housing 7.

The interior of the throttle valve bore 80 is connected to a source of air under pressure in the usual manner, such as by a hose fitting 104 threadably engaged in supply port 105 leading into the valve interior.

Operation of the throttle valve 87 is achieved by means of a throttle lever 114 mounted on throttle rod 115 which is journaled in rod supports 116 and 116*a* which form a part of the outer cylinder casing 10.

Throttle lever rod 115 is rotated in the usual manner by means of manual lever 117, to operate the throttle lever 114 which in turn actuates the throttle valve plunger 94. Throttle lever 114 has a number of radially extending teeth 119 on one side thereof which mesh with a like number of teeth 119*a* extending from a valve lever adjuster 120 which disengages in the usual manner to longitudinally shift the position of valve lever 114, against the force of compression spring 121 which encircles the throttle lever rod 115, and abuts rod support 116*a* at one end thereof, and the opposite side of throttle lever 114 on the other end thereof.

A standard type pressure regulator assembly, which

is enclosed in housing 7 along with the throttle valve assembly, comprises a pressure chamber 125 divided by a diaphragm 126 backed on either side by rigid washers 127, and a helical regulating spring 129 which responds, in the usual manner, to adjustment of an adjustment screw 130. A baffle 131 is mounted in pressure regulator chamber 125 forwardly of diaphragm 126, being separated therefrom by an annular ring 132 to provide a pressure balancing chamber 134 therebetween, and is connected with the opposite side of baffle 131 by a by-pass sleeve 135 extended through baffle 131 to equalize the pressure on either side thereof.

A bore passage 138 leads from the regulator chamber 125 to connect the same with operating space 139 in the cylinder casing 10 behind head block 36 which is separated from annular chamber 40 by O-ring 39. At the regulator chamber end of passage 138 the opening is formed to define a valve seat 140 having a valve poppet 141 mounted therein. The valve poppet 141 is connected through baffle 131 to the regulator diaphragm 126 as shown. A compression spring 142 is positioned between the baffle 131 and the end of the regulator chamber 125 around the valve opening of bore passage 139. Bore passage 139 is counterbored and provided with a threaded portion 144 at its forward end to receive a regulator valve bushing 145 having a valve passage extending coaxially therethrough leading to the operating space 46 behind head block 36. A compression spring 146 is mounted between the inner recessed end of valve bushing 145 and valve poppet 141 to maintain the valve poppet 141 in closed relation with valve seat 140.

The throttle valve being connected to a source of air under pressure; the manual lever 117 is pressed to rotate throttle rod 115, and bring throttle lever 114 into contact with throttle plunger 94. As throttle plunger 94 is moved inwardly, and pilot valve 90 therewith, valve seat 91 is uncovered to admit air into groove 99, passage 100 and into regulator chamber 125. By proper adjustment of adjustment screw 130 to advance diaphragm 126 forwardly, the regulator valve poppet 141 is unseated from valve seat 140 and a predetermined head of air under pressure is directed into operating space 139 behind head block 36. This pressure then moves head block 36 and barrel 30 forwardly in cylinder casing 10 to move swaging die 21 toward bucking die 19. Thus by proper adjustment of pressure regulator a separate constant relatively low head of pressure, on the order of 10 p. s. i. for example, can be maintained on the barrel 30 so that a work piece to be swaged can be retained between the swaging dies 19 and 21 while the swaging operation is performed thereon when pilot valve 90 is operated, using the full line pressure on the order of 150 p. s. i., which is achieved by operation of throttle valve 87 as will be described thereby eliminating the necessity of manually holding the work piece in proper position in the die cavities 24. The operator is therefore free to rotate the work piece so that the swaging is achieved uniformly.

It can be seen that the throttle valve plunger 94 moves in two distinct steps, i. e., initially the plunger 94 advances through the first step to open the pilot valve 90 to direct pressure, as was described above, into operating space 139; further advancement of the plunger 94 performing a second step of moving throttle valve 87 out of valve seat 86. Thus air is admitted to bushing groove 96 through opening 97, the air then being led through passage 106, conduit 107, into annular chamber 40, and thence through head block ports 44 and valve box ports 45 to operate the shuttle valve 47. The shuttle valve 47 then shuttles back and forth under air pressure alternately opening and closing the fore and aft pressure ports and exhaust port 61, as is well known in the art, and operates sliding hammer 59 back and forth to strike the die set 54 on each forward trip. In this manner, as is also well known in the art, the impact of sliding hammer 59 delivers the necessary force and movement, imparted through die set 54, to reciprocate the movable swaging die 21 so that a rapid series of hammer-like blows are delivered against a work piece held between the two dies 19 and 21.

As herein discussed, the ball terminal 150 as shown in Figure 6, has a sleeve 15, the sleeve bore 152 thereof extending through the ball as shown. As accurate final dimension must be maintained within relatively close tolerances which are established by the U. S. A. F. in the manufacture of military aircraft.

In practice, the ball terminal 150 is slipped, sleeve first, over a cable 154 of proper size. The ball terminal 150 is then inserted, as indicated diagrammatically in the auxiliary view of Figure 5, between the swaging dies 19 and 21 of Figure 1. As the actuator is operated in the manner described above, the ball terminal 150 is preferably manually rotated as diagrammatically shown in Figure 7, the impact of the dies 19 and 21 very gradually shrinking or forming the material of the ball terminal radially inwardly toward the axis Y of the cable 154. When the opposed faces of dies 19 and 21 subsequently come into contact, the actuator is shut off, it being quite certain that the final dimension X of the ball terminal has been reached, as shown in Figure 8. Thus the ball terminal 150, has, in effect, been shrunk onto the cable 154 by swaging and is securely fastened thereon.

Each time a swaging operation has been completed, the necessity of the barrel assembly 30 returning all of the way back into the cylinder casing 10 is eliminated by provision of a back stop lever 155 extending through an opening 156 in the outer casing 10, the lever being moved inwardly to engage the inner side of barrel land 31. The lever 155 is mounted on the end of a threaded rod 157 supported in an elongated bore 159 through a rod support 160 which forms a part of casing 10. An adjustment screw 161 and compression spring 162 is provided for longitudinal shifting of lever 155 in the usual manner. A knurled nut 164 is provided on the opposite side of support 160 for setting the back stop lever 155.

Thus I have disclosed the novel character of the swaging tool of my invention and it can well be seen that uniform gradual forming of the work piece material tends to prevent work hardening and damage of the material. It has been found that the accurately sized die cavities will form the ball terminal to a final dimension, thereby eliminating extra finishing operations.

The novel innovation of the pressure regulator saves time and assures a corrected and aligned position of the work piece relative to the swaging dies during the swaging operation.

Light weight and portability of the tool has not only appreciably reduced production costs, but has minimized the amount of prefabricated swaged items which must be carried in stock.

Speedy interchangeability of swaging dies from one size to another has been a further factor in reducing production expense.

While in order to comply with the statute, the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the method, means and construction herein disclosed comprises a preferred form of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claim.

What is claimed is:

A portable swaging tool comprising in combination; a pair of matching swaging dies, means stationarily mounting one of said dies, means mounting the other said die for movement in swaging alignment with said one die, pressure responsive means for moving said

movable die toward said stationary die to grip a workpiece, a supply of pressure, a control valve in between said supply and said pressure responsive means to control the movement of said movable die, a regulating valve in between said control valve and said pressure supply capable for adjustment for a predetermined low pressure, pressure actuated impact means for impacting said movable die, and means connecting said impact means directly to said pressure supply including a control valve for determining the actuation of said impact means.

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