Nov. 13, 1945. E. H. SOUTER 2,388,877

SQUEEZE RIVETER

Filed Dec. 1, 1941 3 Sheets-Sheet 1

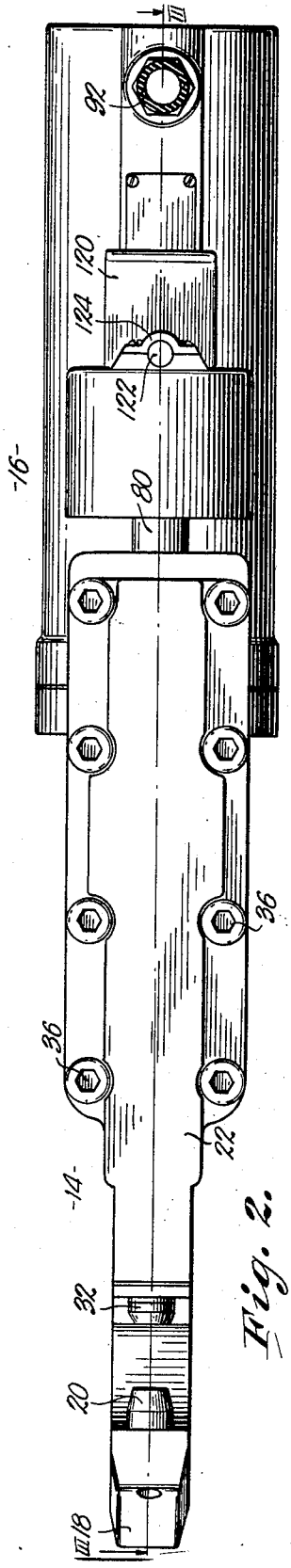


Fig. 2.

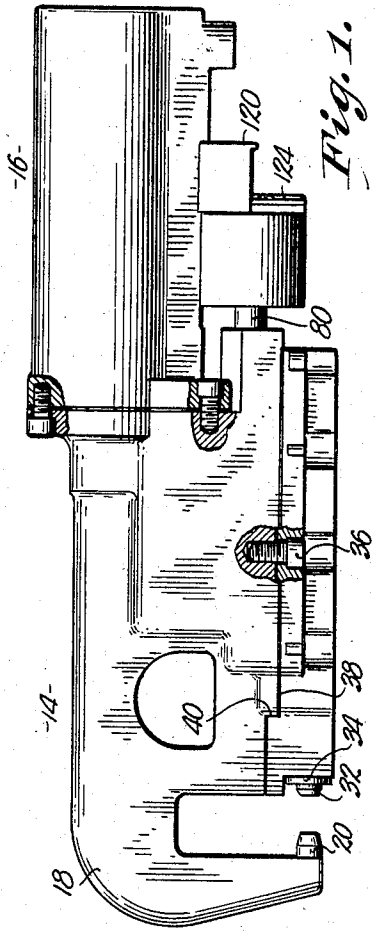


Fig. 1.

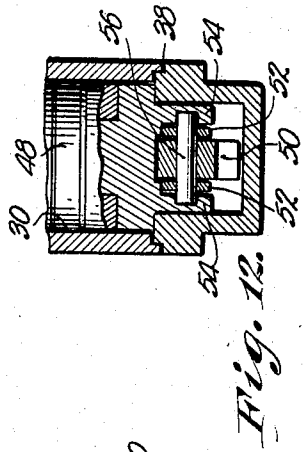


Fig. 12.

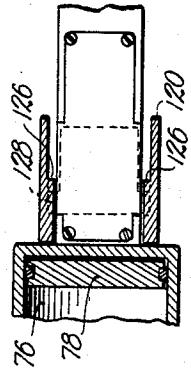


Fig. 11.

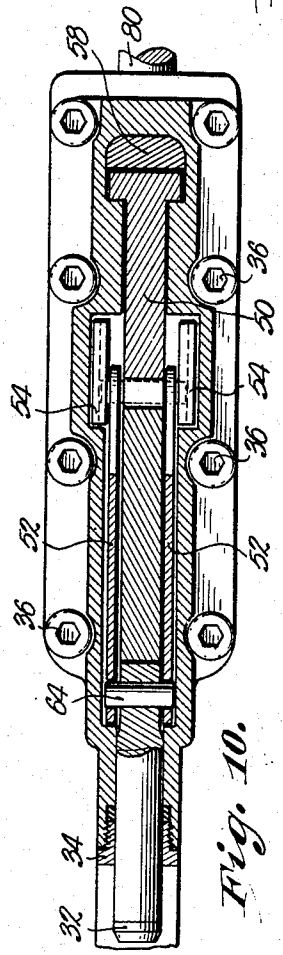


Fig. 10.

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SQUEEZE RIVETER

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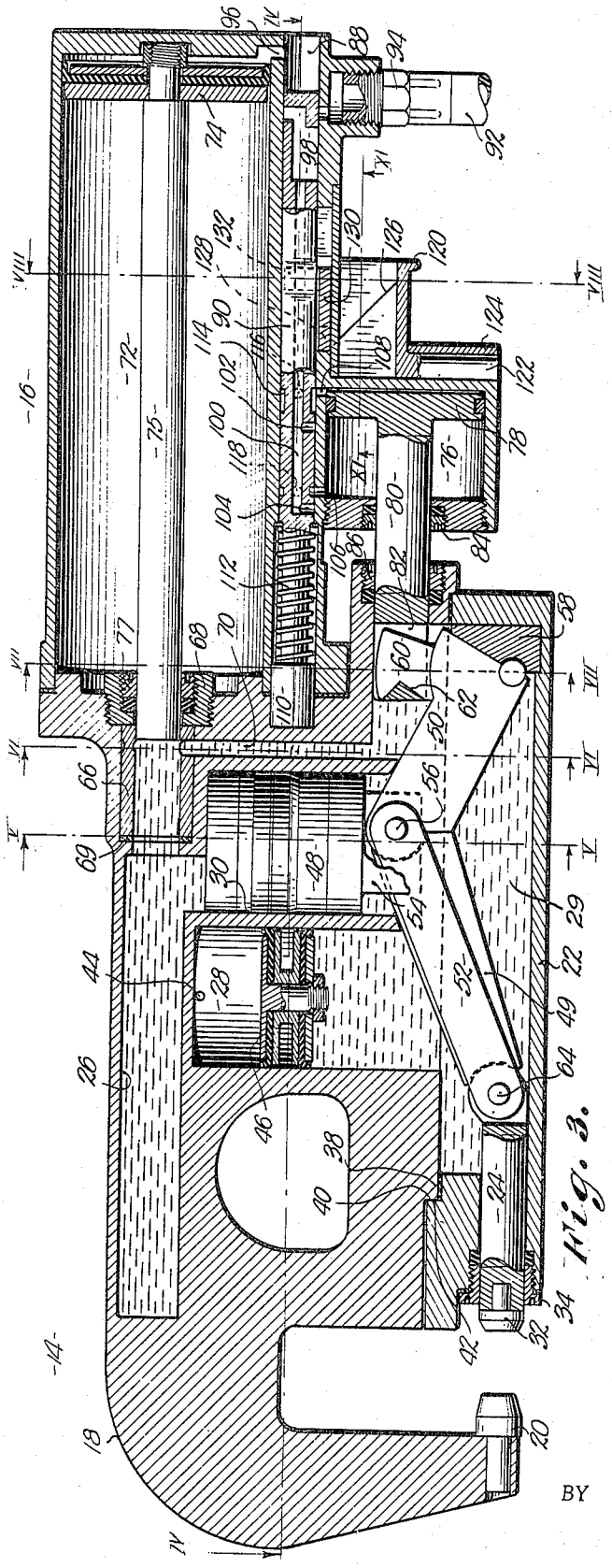


Fig. 3.

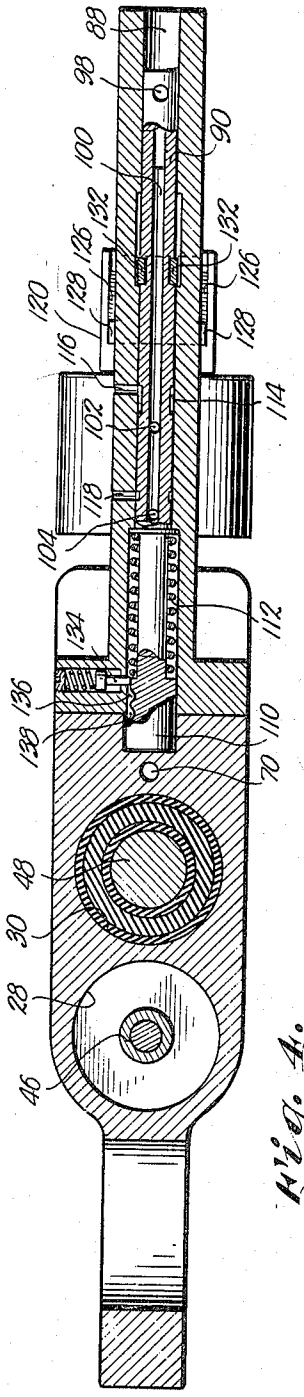


Fig. 4.



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SQUEEZE RIVETER

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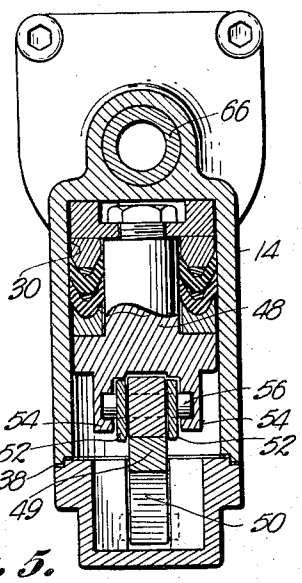


Fig. 5.

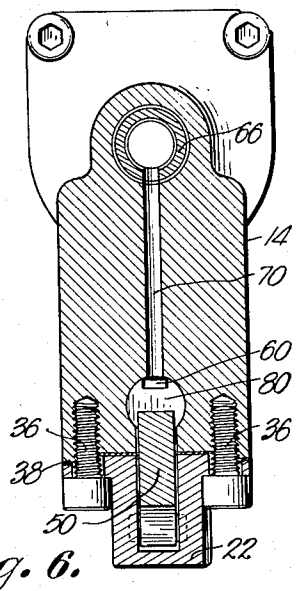


Fig. 6.

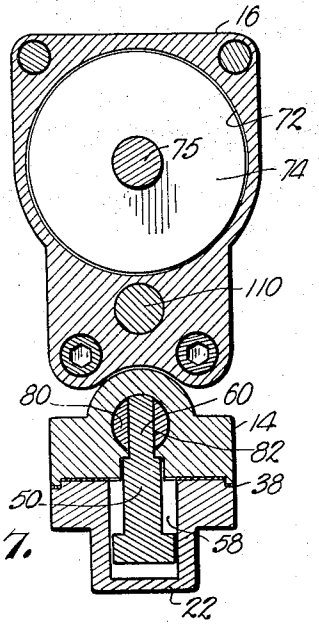


Fig. 7.

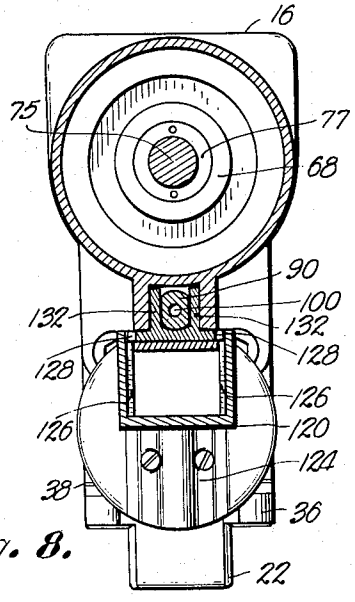


Fig. 8.

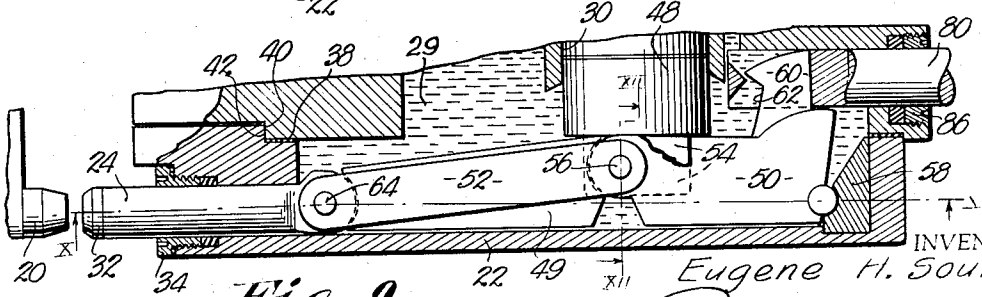


Fig. 9.

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2,388,877

SQUEEZE RIVETER

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Application December 1, 1941, Serial No. 421,184

26 Claims. (Cl. 78—41)

This invention relates to hand tools of the character employed in riveting or other compressing operations, and has for its primary object to provide a combined hydraulic and pneumatic squeeze riveter having a number of specially arranged chambers with pistons therein, some of which are operable by compressed air, while others are moved by displacing a volume of the liquid contained in the hydraulic portion of the tool.

One of the most important objects of this invention is the provision of a squeeze riveter having in combination at least one hydraulically operated piston, and a number of pneumatically operated pistons, at least one of which serves to move parts of the riveter through a power stroke, while another is designed to retract said parts to a "set" position.

This invention has for a further object to provide a combined hydraulic and pneumatic squeeze riveter that is capable of exerting necessary force to perform the job of upsetting the rivet through the employment of a relatively small number of parts, all of which are combined in a tool that is simple in construction, rugged, easy to assemble, and not likely to get out of order.

Another object of the invention is to provide a portable squeeze riveting machine with manually manipulatable parts formed to cause movement of the several pistons thereof in sequence, to accomplish the steps in the cycle of first moving the ram against the rivet with a comparatively light force, thereafter subjecting the ram to a thrust capable of upsetting the rivet upon which the machine is working, and thereafter retracting the upsetting ram and associated parts,—all of such steps taking place while the trigger is moved through its complete path of travel from and to a normal position.

Other objects and advantages of the invention are to provide a squeeze riveter with pistons movable by both hydraulic and pneumatical power; to provide compensating space for the liquid employed to impart hydraulic power, by appropriate means within the housing of the riveter; and to provide pneumatically operated means for insuring that the parts of the squeeze riveter are in the "set" position immediately prior to beginning the working cycle.

A further object is to provide a portable riveting tool operating on the pneumatic-hydraulic principle and including an operating piston connecting with force multiplying means for performing a riveting operation and which piston and means are located within a hermetically sealed hydraulic compartment provided by the tool.

Another object is to provide a riveter of the type described wherein the hermetically sealed hydraulic compartment has compensating means to compensate for the hydraulic fluid displaced by the operating piston as a result of a power stroke of said piston.

Another object of the invention is to provide a squeeze riveter of the portable type particularly adapted for use in aircraft manufacture and which will be compact, light in weight, and of relatively small size considering the power and efficiency of the device.

A vast number of minor objects are contemplated by this invention, all of which will become apparent to one skilled in the art during the following description of the preferred embodiment illustrated in the accompanying drawings wherein:

Fig. 1 is a side elevational view of a squeeze riveter made in accordance with the present invention.

Fig. 2 is an inverted edge elevational view of the same.

Fig. 3 is an enlarged longitudinal central sectional view taken on line III—III of Fig. 2.

Fig. 4 is a longitudinal cross sectional view taken on line IV—IV of Fig. 3.

Fig. 5 is a transverse cross sectional view taken on line V—V of Fig. 3.

Fig. 6 is a similar cross sectional view taken on line VI—VI of Fig. 3.

Fig. 7 is a cross sectional view taken on line VII—VII of Fig. 3.

Fig. 8 is a cross sectional view taken on line VIII—VIII of Fig. 3, looking in the direction of the arrows.

Fig. 9 is a fragmentary detailed sectional view through a portion of the riveter showing the links and associated parts thereof in a position at the end of their path of travel opposite to that illustrated in Fig. 3.

Fig. 10 is a fragmentary sectional view taken on line X—X of Fig. 9.

Fig. 11 is a fragmentary sectional view taken on line XI—XI of Fig. 3; and

Fig. 12 is a fragmentary sectional view taken on line XII—XII of Fig. 9 looking in the direction of the arrow.

The squeeze riveter contemplated by this invention is designed to occupy a minimum amount of space and therefore, to accomplish construction which presents working clearances of re-

duced dimensions. The manner of combining the parts of the riveter therefore becomes an important factor.

The housing of the tool is divided into two main groups of parts—the forward part or section, broadly designated by the numeral 14, carries the hydraulically operated elements, while the rearward section 16 of the tool contains elements operable by compressed air or similar fluid.

Section 14 of the housing may be cast, forged or otherwise created from metal having strength enough to overcome the pressures established within the machine. This section 14 comprises a yoke 18 whereon is mounted a stationary anvil 20; a cap 22 that journals longitudinally movable ram 24; and chambers 26, 28, 29 and 30.

Ram 24 has a hardened facing member 32 and is mounted to prevent loss of liquid through the medium of a packing nut 34 screwthreaded into an internally threaded opening of cap 22.

Cap 22 is mounted upon yoke 18 through the use of cap screws 36 and a gasket 38 is interposed between cap 22 and the remaining part of forward section 14.

A shoulder 40 on yoke 18 bears against shoulder 42 of cap 22 to insure rigidity and assist in overcoming shearing effects upon cap screws 36 during the operation of the riveter.

Chamber 28 has a breather opening 44 extending to the atmosphere therefrom and carries a floating, sealing piston 46, the construction of which is clearly illustrated in Fig. 3. Chamber 30 has an operating piston 48 slidably mounted therein and joined to a series of interconnected links 49, 50 and 52 located within chamber 29.

Grooved, depending ears 54 on piston 48 receive the ends respectively, of coupling pintle 56. This pintle passes through links 52 and link 50. While one end of link 50 receives pintle 56, the other end thereof bears against pillow block 58 positioned in cap 22 below lug 60, on link 50, that is notched to form a cam face as at 62. The inner end of ram 24 has pin 64 projecting transversely therefrom for engagement by links 52 on each side respectively of ram 24.

A hardened bushing 66 of an inside cross sectional area less than the transverse cross sectional area of chamber 26 is mounted in section 14 by a seating nut 68 and a gasket 69. A passage 70 joins chamber 26 with chamber 29 and therefore said passage also joins the top chamber with the lower parts of chambers 28 and 30. The cross sectional area of rod 75 is less than the cross sectional area of chamber 26.

Section 16 of the tool has a chamber 72 therein; a piston 74, mounted for reciprocation in said chamber 72; and a displacement rod 75 movable to and from a place within chamber 26 of section 14. Packing nut 77 insures tight seal around rod 75.

Another chamber 76 carries retractor piston 78 from which forwardly projects piston rod 80 having an opening 82 therethrough for the reception of lug 60. Piston rod 80 extends outwardly from section 16 through packing nut 84 and into section 14 through packing nut 86.

Chamber 88 slidably receives valve rod 90 specially formed to control the flow of compressed air fed to the riveter through hose 92 joined to section 16 by fitting 94. A port 96 joins chamber 88 and chamber 72 at a point immediately adjacent to one end of the latter.

A way 98 provided in valve 90 communicates with a longitudinal central bore 100 from which branches ports 102 and 104.

Chamber 76 has ports 106 and 108 extending therefrom to place the same in communication with chamber 88 wherein valve 90 is disposed.

The forward length of chamber 88 is larger in cross sectional area than the remaining portion thereof to accommodate head 110 and spring 112, as illustrated in Fig. 3. An annular groove 114 in valve rod 90 communicates with exhaust port 116 that extends outwardly to the atmosphere from chamber 88 as does exhaust port 118.

Any appropriate means may be employed to manually move valve 90 rearwardly and therefore, the structure about to be described, is merely an example of trigger mechanism capable of performing the desired function.

Trigger 120 has a stem 122 journalled in bearing 124 rigid with section 16. The upper portion of trigger 120 is U-shaped and the inner faces of each leg of the U-shaped trigger is provided with inclined shoulders 126. These shoulders 126 bear against laterally projecting ears 128 integral with holder 130.

A pair of upstanding fingers 132 ride in notches milled in valve rod 90 to establish operable connection between holder 130 and said valve 90.

Operation

During the following explanation of the operation, it must be understood that upward movement on the part of trigger 120 will cause longitudinal rearward movement of valve rod 90 because inclined shoulders 126 bearing against laterally extending ears 128 will impart a rearward force to valve rod 90 through holder 130, of which said ears are a part.

There are distinct locations of valve rod 90 and to overcome the possibility of arresting the movement of valve rod 90, at stages where full register of ports does not occur, a detent 134 is provided to be forced into notches 136 and 138 formed in head 110 of valve rod 90.

Assuming that the riveter is in a set or normal position when the parts are as illustrated in Fig. 3 and it is the desire of the operator to cause the machine to pass through a complete cycle.

Trigger 120 will be raised, whereupon valve rod 90 will move rearwardly to a position where detent 134 will drop into notch 136 and port 104 will come into register with port 106. Only an instantaneous dwell need then occur to assure the operator that ram 24 is spaced from anvil 20 a sufficient distance to receive the work.

This first movement of trigger 120 positions valve rod 90 in a place where way 98 is in communication with coupling 94 and compressed air is passing from hose 92 through way 98, bore 100, port 104 and port 106. Continued pressure upon trigger 126 will further move valve rod 90 to a place where way 98 is still in communication with coupling 94 and compressed air is passing from hose 92 through way 98, bore 100, port 102 and port 108. In this position, ports 104 and 106 are out of register and the reduced portion of valve 90 about which spring 112 is coiled, has passed port 106 and port 116 to place the same into communication. In such condition, piston 78 will receive the force of compressed air and move along chamber 76 to cause the series of links to move from the position shown in Fig. 3, toward that position shown in Fig. 9. Lug 60 will be engaged by the end of piston rod 80 to accomplish this movement of parts, and piston 48 will be drawn downwardly as seen in Fig. 3, as

ram 24 moves toward anvil 20 a distance sufficient to engage the work.

In this condition, the tool may be manipulated between positions where detent 134 is in notch 136 and where detent 134 is in notch 138 by the operator to insure proper alignment and adjustment with respect to the member against which ram 24 has been moved. The force is not great enough to perform the work of the tool when in these positions, and therefore, so long as the trigger is not further depressed, no damage can be done.

Such oil or liquid as is displaced by the downward movement of piston 48 will be drawn upwardly through passage 70 into the upper portion of chamber 30 through chamber 26.

When it has been determined that the relative position of riveter and work is proper, trigger 120 is further depressed and valve rod 90 is moved to close port 108 and place into communication port 96 and way 98. The length of way 98 is great enough to permit this movement without cutting off the supply of air from hose 92. When way 98 has interconnected port 96 and hose 92, compressed air from the source of supply, not here shown, flows into chamber 72 behind piston 74 to drive the same forward where displacement rod 75 enters chamber 26.

The area of piston 74 is much greater than the area of the end of displacement rod 75, and therefore, the force is multiplied within chamber 26 and exerted against piston 48. As displacement rod 75 moves into chamber 26, it closes the end of passage 70 to prevent flow of liquid therethrough. The tight sliding fit between bushing 66 and rod 75 precludes the escape of liquid from chamber 26 and a sufficient force is exerted through piston 48, links 49, 50 and 52 to ram 24 to perform the work. When piston 74 has been moved through its path of travel in one direction, the position of links 49, 50 and 52 are as illustrated in Fig. 9. Link 49 has its ends contoured to slidably engage the ends of ram 24 and link 50 between links 52. This link (49) will relieve pintle 56 and pin 64 of a force that might otherwise prove destructive but which is necessary to transmit sufficient power to ram 24.

At this juncture, trigger 120 is released, spring 112 returns valve rod 90 to the position shown in Fig. 3. During the return movement of valve 90, ports 104 and 106 come into register before way 98 leaves a position in communication with hose 92. Compressed air passing into chamber 76 in front of piston 78 retracts said piston, its rod 80, links 49, 50 and 52 and piston 48 to a set condition. Obviously, a pause is desirable when ports 104 and 106 are in register to permit a sufficient amount of air to enter chamber 76 for the purpose just described.

The upward movement of piston 48 exerts force against the end of displacement rod 75 to return that rod and piston 74 to their set position. While piston 78 is being so retracted, air in chamber 76 is exhausted through annular groove 114 and exhaust port 116. Air from within chamber 72 is exhausted therefrom through port 96 and chamber 88 that is open at its rear end to the atmosphere.

The inclined faces of lug 60, formed by notch 62, cooperate with the inclined or cam face of piston rod 80 as piston 78 is retracted to insure a sufficient force upon the links and piston 48 to lift the same and retract ram 24. The relative positions of the cooperating inclined faces is shown in Fig. 9.

The employment of parts as described above, insures a complete operating cycle without the necessity of manually resetting any parts of the machine.

The forward section 14 of the tool essentially provides a hermetically sealed compartment containing an hydraulic medium and within which compartment is located a piston 48 and the toggle means including the links 49, 50 and 51. Whereas, the hydraulic medium in the top chamber 26 is subjected to high operating pressures, the pressures developed on the hydraulic medium in the lower chamber 29 are relatively low and said pressures are maintained substantially uniform by reason of the expansible means in the form of the floating piston 46. Mechanical equivalents may be substituted for said floating piston since it is only necessary to provide a variable space to compensate for the hydraulic medium displaced by the operating piston as a result of a power stroke of said piston. The bypass 70 provides the sole connecting passage between the high pressure chamber 26 and the low pressure chamber 29. Said passage has particular utility when the operating piston 48 is moved downwardly by actuation of the toggle means through piston rod 80 to initially move the ram. The displaced liquid as a result of this downward movement of the operating piston flows upwardly through passage 70 to supplement the liquid in the top chamber.

Compressed air in conjunction with a liquid, perform the duty of imparting force to the elements during the power stroke of the riveter at such increasingly greater degrees as may be necessary to accomplish the work. As rod 75 moves into chamber 26 it closes passage 70 and displaces liquid against the top of piston 48 to cause downward movement thereof. Floating piston rises in its chamber to provide space for the liquid displaced at the bottom of piston 48.

Compressed air from a source of supply now commercially available, is all that need be utilized in successfully operating the squeeze riveter embodying the broad concepts of this invention and since the combination of two factors, i. e. pneumatic and hydraulic units contribute to the efficient performance, these factors may be combined in many ways other than those herein mentioned and shown in the accompanying drawings without departing from the scope of the appended claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a squeeze riveter of the character described, a housing having a plurality of chambers formed therein and arranged in two groups; a work-engaging ram mounted for longitudinal movement in the housing; a series of interconnected links operably joined to the housing and said ram; liquid contained in one group of said chambers; means for supplying air under pressure to the second group of chambers of the housing; an operating piston in a chamber of the one group of chambers; a floating seal in another chamber of said one group of chambers and setting off a liquid-free compartment therein, a driving piston in one of the chambers of the second group, having a portion thereof movable into a chamber of the said one group for displacing a portion of the liquid to drive the operating piston through a path of travel for moving the links to force the ram in one direction; a retractor piston in a chamber of the sec-

ond group of chambers in connection with the links; and a valve movable to successively direct said air under pressure first against the retractor piston and then to the driving piston, said floating seal being movable within its chamber to compensate for liquid displaced by the operating piston during its movement.

2. In a squeeze riveter of the character described; a unitary housing having a plurality of chambers formed therein; a work-engaging ram mounted for longitudinal movement in the housing; at least two of the chambers being interconnected and both having liquid therein; an operating piston in one of said two chambers; a series of interconnected links operably joined to the housing, the ram and the piston; a power piston in another of said chambers; a displacement rod on the power piston movable to a position within the other of said two chambers to drive the operating piston in one direction to move the ram; a retractor piston in still another of said chambers; a rod joining the retractor piston and the series of links; and means for selectively controlling the flow of compressed air into the chambers having the power piston and said retractor piston therein.

3. In a squeeze riveter of the character described; a housing having a plurality of chambers formed therein; a work-engaging ram mounted for longitudinal movement in the housing; at least two of the chambers being interconnected and both having liquid therein; an operating piston in one of said two chambers; a series of interconnected links operably joined to the housing, the ram and the piston; a power piston in another of said chambers; a displacement rod on the power piston movable to a position within the other of said two chambers to drive the operating piston in one direction to move the ram; a retractor piston in still another of said chambers; a rod joining the retractor piston and the series of links; and means for selectively controlling the flow of compressed air into the chambers having the power piston and said retractor piston therein, said operating piston having its axis perpendicular to the axis of the power piston and the retractor piston.

4. In a squeeze riveter of the character described; a housing having a plurality of chambers formed therein; a work-engaging ram mounted for longitudinal movement in the housing; at least two of the chambers being interconnected and both having liquid therein; an operating piston in one of said two chambers; a series of interconnected links operably joined to the housing, the ram and the piston; a power piston in another of said chambers; a displacement rod on the lower piston movable to a position within the other of said two chambers to drive the operating piston in one direction to move the ram; a retractor piston in still another of said chambers; a rod joining the retractor piston and the series of links; and means for selectively controlling the flow of compressed air into the chambers having the power piston and said retractor piston therein, said operating piston having its axis perpendicular to the axis of the power piston and the retractor piston, the axis of said power piston and the axis of the retractor piston being in parallel relation to one side of the operating piston.

5. In a squeeze riveter of the character described; a housing having a plurality of chambers formed therein; a work-engaging ram mounted for longitudinal movement in the housing; liquid in at least two of the chambers being interconnected and both having liquid therein; an operating piston in one of said two chambers; a series of interconnected links operably joined to the housing, the ram and the piston; a power piston in another of said chambers; a displacement rod on the power piston movable to a position within the other of said two chambers to drive the operating piston in one direction to move the ram; a retractor piston in still another of said chambers; a rod joining the retractor piston and the series of links; and means for selectively controlling the flow of compressed air into the chambers having the power piston and said retractor piston therein, said operating piston having its axis perpendicular to the axis of the power piston and the retractor piston, the axis of said power piston and the axis of the retractor piston being in parallel relation to one side of the operating piston, said means for selectively controlling the flow of compressed air comprising a longitudinally movable valve rod disposed between the power piston and said retractor piston.

6. In a squeeze riveter of the character described; a housing having a plurality of chambers formed therein; a work-engaging ram mounted for longitudinal movement in the housing; at least two of the chambers being interconnected and both having liquid therein; an operating piston in one of said two chambers; a series of interconnected links operably joined to the housing, the ram and the piston; a power piston in another of said chambers; a displacement rod on the power piston movable to a position within the other of said two chambers to drive the operating piston in one direction to move the ram; a retractor piston in still another of said chambers; a rod joining the retractor piston and the series of links; and means for selectively controlling the flow of compressed air into the chambers having the power piston and said retractor piston therein, said operating piston having its axis perpendicular to the axis of the power piston and the retractor piston, the axis of said power piston and the axis of the retractor piston being in parallel relation to one side of the operating piston, said means for selectively controlling the flow of compressed air comprising a longitudinally movable valve rod disposed between the power piston and said retractor piston, said valve rod being provided with ways for the passage of compressed air into the chambers containing the power piston and said retractor piston from a source of supply.

7. In a squeeze riveter of the character described, a housing having a plurality of interconnected chambers formed therein; a work-engaging ram mounted for longitudinal movement in the housing; liquid in said interconnected chambers; an operating piston in one of the chambers and submerged in the liquid; a pneumatically operated member for displacing a volume of the liquid to one side of the piston to move the piston in one direction; structure joining the ram and said operating piston whereby movement of the piston is transmitted to the ram; and an equalizing chamber for receiving displaced liquid at the opposite side of the operating piston due to movement of said piston.

8. In a squeeze riveter of the character described, a housing having a plurality of chambers formed therein and interconnected to establish an endless passage; a work-engaging ram mounted for longitudinal movement in the hous-

ing; liquid in the chambers; an operating piston in one of the chambers; structure operably joining the ram and said operating piston means projectable into one of the chambers for displacing a volume of liquid to one side of the piston to move the same in one direction through the endless passage; and an equalizing chamber in communication with the endless passage for receiving displaced liquid due to movement of the means, said means for displacing a volume of liquid serving to stop the flow of liquid through the endless passage from the other side of the operating piston during the displacing operation.

9. In a squeeze riveter of the character described, a support, a work engaging ram movable longitudinally on said support, a toggle having a pivot fixed with respect to said support, said toggle including a forwardly projecting member engaging said ram and an intermediate knuckle adapted to receive actuating force, a fluid actuated piston to provide said actuating force, and pressure operated means to initially extend said toggle.

10. In a squeeze riveter of the character described, a support, a work engaging ram movable longitudinally on said support, a toggle having a pivot fixed with respect to said support, said toggle including a forwardly projecting member engaging said ram and an intermediate knuckle adapted to receive actuating force, a fluid actuated piston to provide said actuating force, and additional means to initially extend said toggle.

11. In a squeeze riveter of the character described, a support, a work engaging ram movable longitudinally on said support, a toggle having a pivot fixed with respect to said support, said toggle including a forwardly projecting member engaging said ram and an intermediate knuckle adapted to receive actuating force, a fluid actuated piston to provide such actuating force, an expansible fluid actuated pump to provide fluid for actuating said piston and separate pressure operated means to initially extend said toggle.

12. In a squeeze riveter of the character described, a support, a work engaging ram movable longitudinally on said support, a toggle having a pivot fixed with respect to said support, said toggle including a forwardly projecting member engaging said ram and an intermediate knuckle adapted to receive actuating force, a fluid actuated piston to provide such actuating force, an expansible fluid actuated pump to provide fluid for actuating said piston and separate pressure operated means to initially extend said toggle, comprising an arm on said toggle and a fluid actuated piston engaging said arm.

13. In a squeeze riveter of the character described, a housing having a plurality of interconnected chambers formed therein; a work engaging ram movable longitudinally in the housing; lever mechanism engaging said ram and adapted to move the same; a fluid actuated piston in one of the chambers to provide force to move the lever mechanism and thereby shift the ram in its path of travel; and a sealing piston in a second chamber, said second chamber having a breather opening in communication with the atmosphere to maintain atmospheric pressure against one side of the sealing piston.

14. In a squeeze riveter of the character described, a housing having a plurality of interconnected chambers formed therein; a filling of fluid in the chambers; a work-engaging ram movable longitudinally in the housing; lever mechanism engaging said ram and adapted to move the same; a fluid actuated piston in one of the chambers to provide force to move the lever mechanism and thereby shift the ram in the path of travel; a displacement rod movable into a second chamber to force fluid against the said piston; and a sealing piston in a third chamber movable toward and from the bottom of the chamber to compensate for the fluid displaced by the piston, said third chamber having a breather opening in communication with the atmosphere to maintain atmospheric pressure against one side of the sealing piston as the fluid bears against the opposite side thereof.

15. In a squeeze riveter of the character described, a housing having a plurality of chambers formed therein; certain of the chambers being interconnected and having liquid therein; a work-engaging ram mounted for longitudinal movement in the housing; a series of interconnected links operably joined to the housing and said ram; means for displacing a portion of the liquid in one of the certain chambers; an operating piston having liquid against each end thereof in another of the certain chambers for moving the links to force the ram in one direction when the liquid is displaced; a retracting piston in another of said chambers other than the certain chambers for moving the links to draw the ram in the opposite direction; means for supplying motivating fluid to the chamber having the retracting piston therein; a valve for controlling the supply of motivating fluid; and a by-pass formed to permit flow of liquid from one end of the operating piston to the other end thereof when the retracting piston draws the ram in the said opposite direction.

16. In a squeeze riveter of the character described, a housing having a plurality of chambers formed therein; certain of the chambers being interconnected and having liquid therein; a work-engaging ram mounted for longitudinal movement in the housing; a series of interconnected links operably joined to the housing and said ram; means for displacing a portion of the liquid in one of the certain chambers; an operating piston having liquid against each end thereof in another of the certain chambers for moving the links to force the ram in one direction when the liquid is displaced; a retracting piston is another of said chambers other than the certain chambers for moving the links to draw the ram in the opposite direction; means for supplying motivating fluid to the chamber having the retracting piston therein; a valve for controlling the supply of motivating fluid; and a by-pass formed to permit flow of liquid from one end of the operating piston to the other end thereof when the retracting piston draws the ram in the said opposite direction, said above mentioned means for displacing the liquid in one of the certain chambers automatically closing the by-pass upon initial movement thereof in a liquid displacing direction and said means opening the by-pass as a result of return movement to original position.

17. In a riveting tool of the portable type, a forward section providing a sealed compartment containing an hydraulic medium, a work-engaging ram mounted for movement in a wall of said compartment, an operating piston within said compartment arranged to divide the compartment into two chambers communicating with

opposite ends of the piston respectively, means for intensifying the hydraulic pressure in one chamber to effect a working stroke of the piston, force multiplying means within the other chamber having connection with the ram and also having association with one end of said piston in a manner whereby the working stroke of the piston will cause movement of said ram, and compensating means for the last mentioned chamber to compensate for the hydraulic medium displaced by the working stroke of said piston.

18. In a riveting tool of the portable type, a forward section providing a sealed compartment containing an hydraulic medium, a work-engaging ram mounted for movement in a wall of said compartment, an operating piston within said compartment arranged to divide the compartment into two chambers communicating with opposite ends of the piston respectively, a passage normally connecting the chambers so that hydraulic medium from one chamber may flow into the other chamber, means for intensifying the hydraulic pressure in one chamber to effect a working stroke of the piston, said means upon initial actuation thereof closing said passage, force multiplying means within the other chamber having connection with the ram and also having association with one end of said piston in a manner whereby a working stroke of the piston will cause movement of said ram, and compensating means for the last mentioned chamber to compensate for the hydraulic medium displaced by the working stroke of said piston.

19. A riveting tool of the portable type, a forward section providing a sealed compartment containing an hydraulic medium, a work-engaging ram mounted for longitudinal movement in a wall of said compartment, an operating piston within said compartment arranged to move normal to the direction of movement of the ram, said operating piston dividing the compartment into two chambers communicating with opposite ends of the piston respectively, a passage normally connecting the chambers so that hydraulic medium from one chamber may flow into the other chamber, pneumatically actuated means for intensifying the hydraulic pressure in one chamber to effect a working stroke of the piston, said means upon initial actuation thereof automatically closing said passage, toggle means within the other chamber having connection with the ram and also having association with an end of said piston in a manner whereby a working stroke of the piston will move said toggle toward a straight line position to cause movement of said ram, and expansible means for the last mentioned chamber to compensate for the hydraulic medium displaced by the working stroke of said piston.

20. In a riveting tool of the portable type, a forward section providing a compartment including a plurality of interconnecting chambers, an operating piston mounted for movement within one of said chambers, said piston being located centrally whereby the other chambers are above and below the piston respectively, a work-engaging ram mounted for movement in a wall of the lower chamber, force multiplying means within the lower chamber adjacent the lower end of the piston and having connection with the piston and ram respectively, the upper chamber containing an hydraulic medium, and means for intensifying the hydraulic pressure in the upper chamber to effect a working stroke of the piston whereby said force multiplying means is actuated to cause movement of the ram.

21. In a riveting tool of the portable type, a forward section providing a compartment including a plurality of interconnecting chambers, an operating piston mounted for movement within one of said chambers, said piston being located centrally whereby the other chambers are above and below the piston respectively, a work-engaging ram mounted for movement in a wall of said lower chamber, toggle means within the lower chamber adjacent the lower end of the piston, said toggle means including a plurality of connected links operatively joining the piston and the ram whereby a working stroke of the piston will move the toggle means toward a straight line position to cause movement of the ram, the upper chamber containing an hydraulic medium, and means for intensifying the hydraulic pressure in the upper chamber to effect a working stroke of the piston.

22. In a riveting tool of the portable type, a forward section providing a compartment including a plurality of interconnecting chambers, an operating piston mounted for movement within one of said chambers, said piston being located centrally whereby the other chambers are above and below the piston respectively, a work-engaging ram mounted for movement in a wall of said lower chamber, a piston rod also mounted for movement in a wall of said lower chamber but spaced from said ram, toggle means within the lower chamber adjacent the lower end of the operating piston, said toggle means including a plurality of connected links operatively joining the ram and the piston rod with the operating piston, pneumatically actuated means for moving the piston rod to effect initial movement of the ram for engaging a rivet, and other means having associated relation with the upper chamber for effecting a working stroke of the piston to additionally move the ram for completing the riveting operation.

23. In a riveting tool of the portable type, a forward section providing a compartment including a plurality of interconnecting chambers, an operating piston mounted for movement within one of said chambers, said piston being located centrally whereby the other chambers are above and below the piston respectively, liquid in said compartment in contact with respective ends of the piston, a passage normally connecting the upper and lower chambers so that the liquid may flow from one chamber into the other, a work-engaging ram mounted for movement in a wall of the lower chamber, force multiplying means within said lower chamber adjacent the lower end of the piston and having connection with the piston and ram respectively, and reciprocating displacement means constructed and arranged to have movement through the passage and into the upper chamber for intensifying the hydraulic pressure in the upper chamber to effect a working stroke of the piston whereby said force multiplying means is actuated to cause movement of the ram, said means automatically sealing off said passage from the upper chamber upon initial actuation thereof as a result of movement through said passage.

24. In a squeeze riveter of the character described, a housing having a plurality of interconnected chambers formed therein; a work-engaging ram longitudinally movable in the housing; liquid filling all but one of said chambers; an operating piston having connection with the ram,

in one of the chambers; a pneumatically operated member for displacing a volume of liquid in the interconnected chambers to move the piston in one direction; and means in said one chamber to compensate for the displacement of the liquid due to movement of the operating piston.

25. In a squeeze riveter of the character described, a housing having a plurality of interconnected chambers formed therein; a work-engaging ram longitudinally movable in the housing; liquid filling all but one of said chambers; an operating piston having connection with the ram, in one of the chambers; a pneumatically operated member for displacing a volume of liquid in the interconnected chambers to move the piston in one direction; and a seal in said one chamber dividing a portion thereof from that portion containing the liquid, said seal being shiftable upon movement of the piston to permit the one chamber to receive liquid displaced by the piston as it travels in said one direction.

26. In a squeeze riveter of the character described, a housing having a plurality of interconnected chambers formed therein; a work-engaging ram longitudinally movable in the housing; liquid filling all but one of said chambers; an operating piston, having connection with the ram, in one of the chambers, a pneumatically operated member for displacing a volume of liquid in the interconnected chambers to move the piston in one direction; and a seal in said one chamber dividing a portion thereof from that portion containing the liquid, said seal being shiftable upon movement of the piston to permit the one chamber to receive liquid displaced by the piston as it travels in said one direction, said interconnected chambers being sealed, the portion of one chamber divided from the liquid by said seal being open to the atmosphere.

EUGENE H. SOUTER.