July 29, 1958 R. R. WYLAND ET AL 2,844,978

RIVET SQUEEZER

Filed Oct. 8, 1956 3 Sheets-Sheet 1

FIG. 1

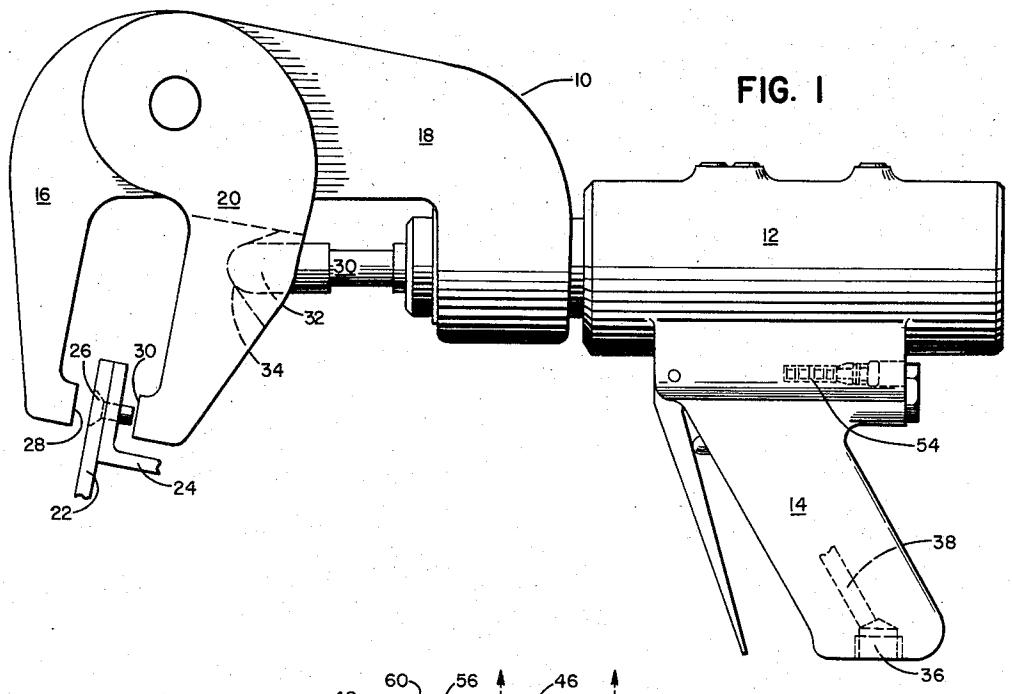

FIG. 2

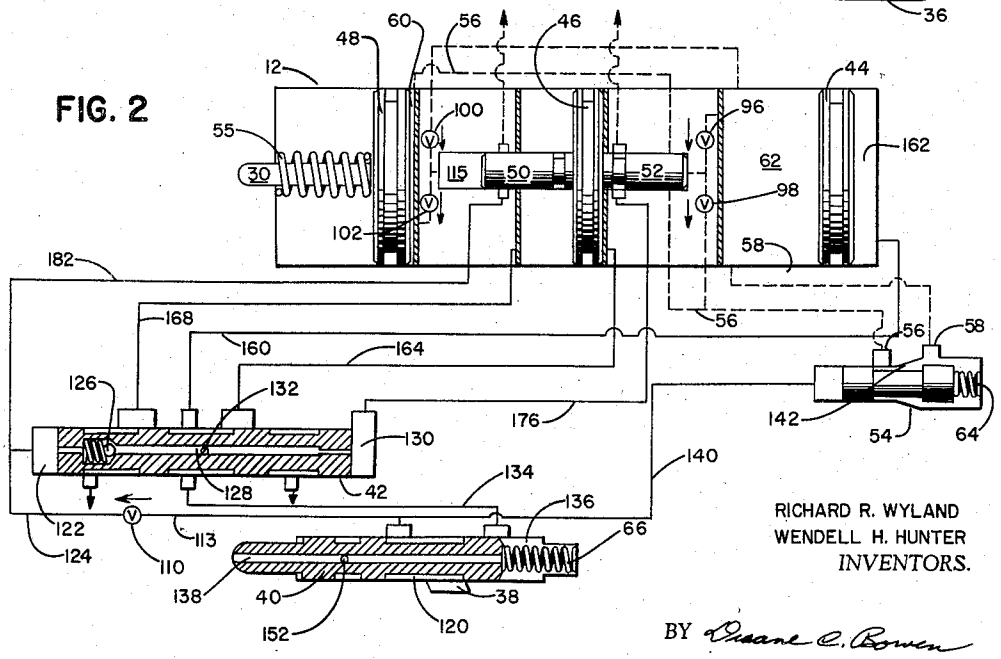

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FIG. 3

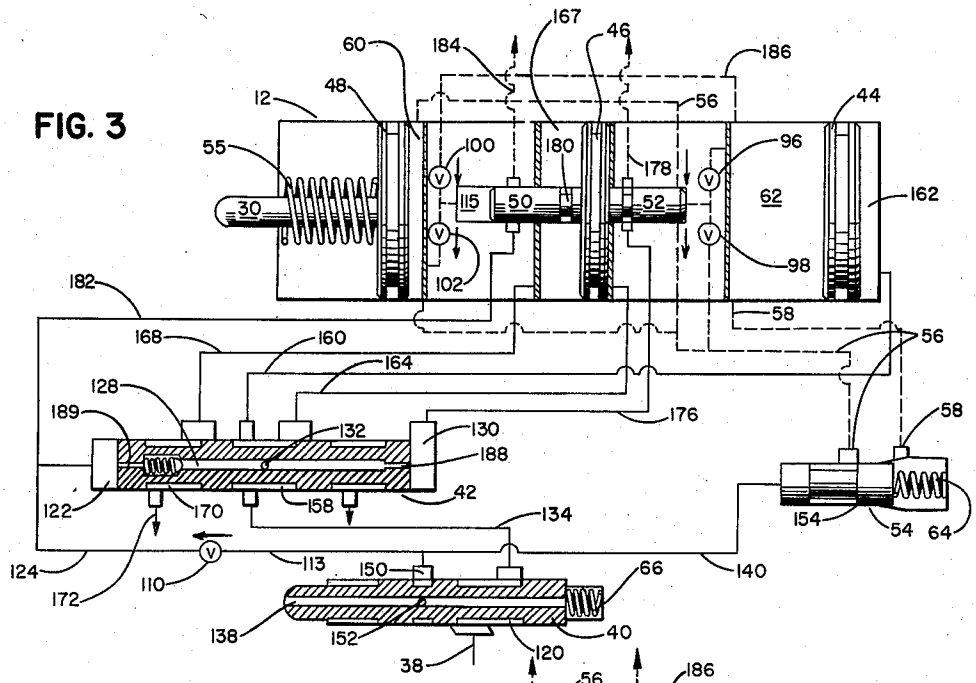
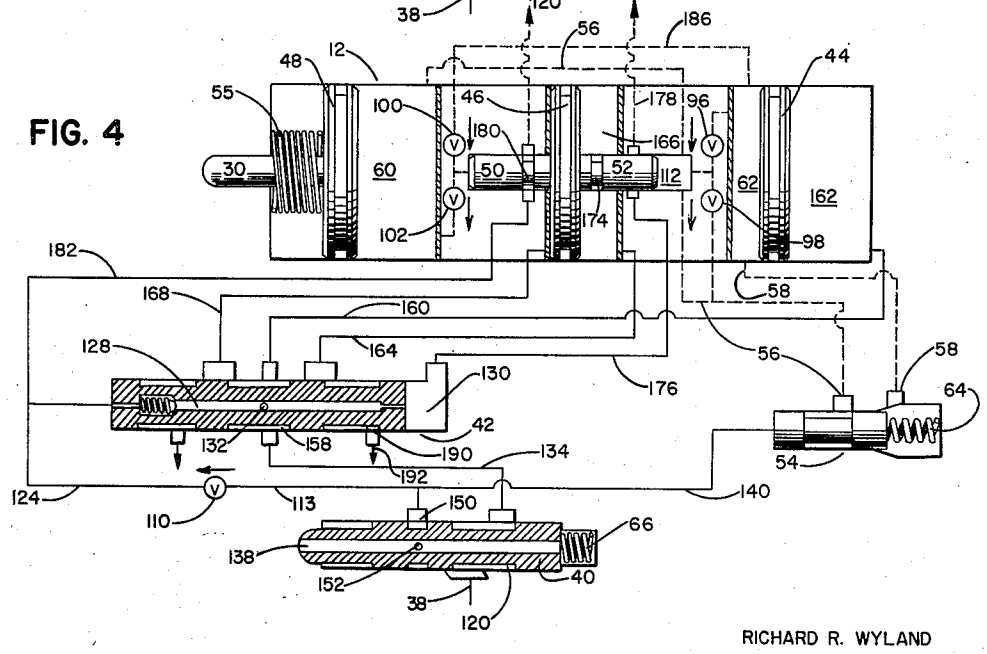


FIG. 4



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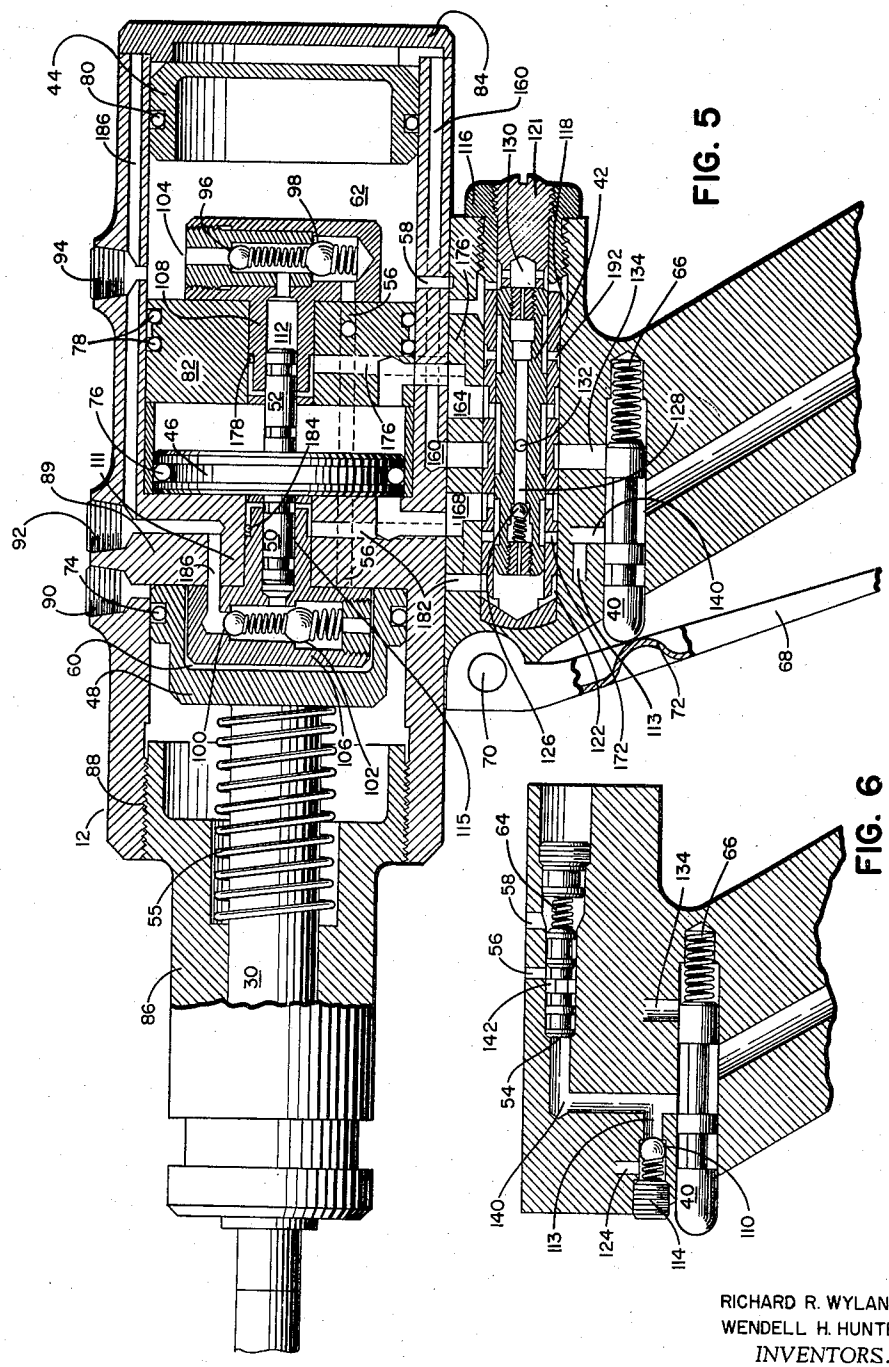

FIG. 5

FIG. 6

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RIVET SQUEEZER

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Application October 8, 1956, Serial No. 614,415

8 Claims. (Cl. 78—42)

Our invention relates to rivet squeezing and, more particularly, to a rivet squeezer powered by low pressure air. The structure includes a reciprocating air-hydraulic pump operated by the low pressure air and building high hydraulic pressure by a multiplicity of strokes.

Rivet squeezers are of increasing importance, particularly in the aircraft industry. They are efficient and reduce noise over hammer type riveting. For various purposes it has become desirable to provide a portable rivet squeezer adapted to be conveniently handled by one man. This could be provided in a relatively simple tool with high pressure air. Plants in certain industries such as airplane manufacturers are well supplied with outlets for low pressure air but have few sources of high pressure air. It is desirable to provide a portable rivet squeezer operable with the existing low pressure sources. The riveter must have minimum bulk and weight to be conveniently portable and adapted for one-man-operation.

The objectives of our invention include, therefor: to provide a portable rivet squeezer adapted to be operated by one man; to provide a structure adapted to be powered by low pressure air; and to provide such a tool with minimum weight and bulk, economy of manufacture, ease of maintenance, and efficient operation.

Our invention will be best understood, together with additional objectives and advantages thereof, from a reading of the following description, read with reference to the drawings in which:

Figure 1 is a side elevational view of a specific embodiment of our rivet squeezer;

Figures 2, 3 and 4 are schematical views of the main operating parts showing, respectively, the position before operating, a first position during operation and a second opposite position during operation;

Figure 5 is an enlarged fragmentary view taken as shown in Figure 1, only being principally in section in an irregular cutting plane; and

Figure 6 is an enlarged fragmentary side view, principally in section, showing a portion of the upper handle structure lying principally in an irregular cutting plane above the plane of Figure 5.

Figure 1 shows a side view of a rivet squeezer **10** constructed according to our invention. To give some idea of size, the length from right to left might be approximately 20 inches and the weight might be about 15 pounds. Principal parts are a barrel **12**, a handle **14**, a fixed jaw **16**, supported on barrel **12** by an arm **18**, and a movable jaw **20**. The jaws may be modified according to the type of riveting to which the tool is adapted. Essentially, they will operate in the manner shown in Figure 1 in which a pair of metal structural members **22**, **24** are to be joined by a rivet **26** which is to be secured by a squeezing action between the bearing surfaces **28**, **30** of jaws **16**, **20**. Movable jaw **20** is moved to closing by the action of a piston rod **30** having

a bearing end **32** acting in a seat **34** formed in movable jaw **20**.

A low pressure air line may be attached by suitable means to a socket **36** shown in dotted lines at the base of handle **14** and connecting with an air supply passageway **38**. Low pressure air supply in aircraft factories commonly use between 80 and 100 pounds per square inch and our rivet squeezer is operable by air pressure in that range. If the rivet squeezer were to be powered directly by high pressure air, this probably would have to be supplied at 5000 pounds per square inch. The present rivet squeezers can be designed to reach a hydraulic pressure comparable to this high air pressure.

The structure of Figures 5 and 6 will be first described with only brief indication of functions and operating sequences. The operation will be later explained in detail in the discussion of the simplified schematical views, Figures 2–4, which are easier to follow.

The principal operating parts are a trigger valve **40**, a shuttle valve **42**, a fast approach piston **44**, a reciprocating piston **46** and a ram piston **48**. Ram piston **48** connects to piston rod **30**. Reciprocating or pump piston **46** supports a pair of centrally-disposed, small slave hydraulic pistons **50**, **52**. A by-pass or hydraulic return valve **54** permits return of ram piston **48** by compression spring **55** between operations by connecting passageways **56** and **58** which extend respectively to the ram piston cylinder **60** behind ram piston **48** and the forward side of fast approach piston cylinder **62**. Valve **54** blocks this flow in the position shown in Figure 6 while the squeezer is in operation and would be moved toward opening when trigger valve **40** is positioned as shown in Figure 6. Valve **54** is normally biased to the blocking position by compression spring **64**. Trigger valve **40** is normally pressed to an inoperative position by a compression spring **66**. A manually operable trigger lever **68** is pivoted to handle **14** by pivot pin **70** and activates the squeezer upon inward pressing of its bearing surface **72** against trigger valve **40**.

A number of seals have been omitted from the drawings to reduce the complexity of the disclosure and it will be obvious to those skilled in the art when they will be used. Some principal seals are shown, including the O-rings **74**, **76**, **78** and **80** on the ram piston, pump piston, separator wall **82** and fast approach piston, respectively. Because of their small size these have not been sectioned for rubber although some such composition would be used.

Figure 5 shows a convenient construction for manufacture of the tool, including the use of an end cap **84** at one end of barrel **12** and a counterbored bearing **86** at the other end threadedly engaged with threads **88** in barrel **12**. The central portion of barrel **12** is left solid at **111** and Thomas head nuts **90**, **92**, **94** are used to close certain bores used to form passageways in the structure. Four check valves **96**, **98**, **100** and **102** are used in the assembly and they are mounted in duo-cylindrical fittings **104** and **106**, which are T-shaped in cross-section and have bored cylindrical leg portions **108**, **110** forming cylinders **112**, **115** for the slave pistons **50**, **52**. The check valves **96—102** are formed by balls acting under compression springs in stepped counterbored passageways within fittings **104**, **106**. Another check valve **110** in line **113** leading from trigger valve **40** is shown in Figure 6 to consist of a spring-pressed ball backed by a nut **114**. Shuttle valve **42** is enclosed by a ported cylinder **116** threadedly engaged in a bore **118** in handle **14** and the rear end of cylinder **116** is closed by a plug **121**.

Figures 5 and 6 show portions of passageways **56**, **58**, **134**, **113**, **124**, **178**, **184**, **172**, **192** and certain portions do not appear in either figure because some of these

passageways pass between and out of the planes of Figures 5 and 6 and these cutting planes are irregular to illustrate certain relationships. These passageways are indicated in their entireties in Figures 2–4.

SEQUENCE OF OPERATION

The circuit diagrams Figures 2–4 will now be described, together with the sequence of operation. Parts appearing in Figures 5 and 6 will be identically numbered in the schematic views. The dotted lines in these views indicate circuits which carry hydraulic fluid and the full lines indicate circuits which carry air.

Figure 2.—Before operation

Low pressure air is supplied to the tool through the trigger valve **40** from supply line **38**. Trigger valve **40** is normally held in return position by return spring **66**. Air pressure is directed from line **38** by the spool passage **120** through line **113**, past check valve **110**, through line **124** to shuttle valve port **122**. A ball check **126** in spool **42** prevents air passage into the spool open center **128**. The open center and the opposite end port **130** are open to the atmosphere through mid opening **132** and through line **134** to trigger valve **40**, port **136** and then out through the open center **138** of trigger valve **40**. By these means, a pressure differential is developed maintaining shuttle valve spool **42** at the right hand side. Air pressure is also directed through line **140** to the end of hydraulic return valve **54** forcing the spool to the right end of the valve, compressing the return spring **64** and opening a hydraulic fluid return line from the high pressure hydraulic ram cylinder through line **56** by way of a spool passage **142** through line **58** into the low pressure hydraulic reservoir side **62** of fast approach piston **44**. This permits hydraulic fluid flow under pressure of ram piston return spring **55** from the high pressure hydraulic ram cylinder **60** into the low pressure hydraulic reservoir side of fast approach piston **44**. The pump piston **46** can be in either right or left side position before operation.

Figure 3.—Beginning operation

Trigger valve **40** is actuated by finger pressure, moving the valve to the right and compressing return spring **66**. The end of hydraulic return valve **54** is now open to the atmosphere through line **140** to trigger valve port **150** then through spool opening **152** and out through spool passageway **138**. The spool in hydraulic return valve **54** is moved to the left by return spring **64** and hydraulic return lines **56**, **58** are blocked by the land **154** of the spool in hydraulic return valve **54**.

Air pressure is also directed by trigger valve **40** through line **134** and by spool passageway **158**, thence by line **160** to the air side **162** of fast approach piston **44**. (In Figure 3, the movement of fast approach piston **44** has not started and Figure 4 shows the piston in its position at the end of the stroke.)

Air pressure is also directed from shuttle spool passageway **158** through line **164** to the right side **166** of pump piston **46**. Exhaust from the left side **167** of pump piston **46** is made through line **168** to shuttle valve spool passageway **170** out line **172** to the atmosphere. Pump piston **46** is moved to the left from the position shown in Figure 3. Pilot valve **174** on right hand hydraulic slave piston **52** closes as pump piston **46** moves to the left shutting off port **130** of shuttle valve **42** through lines **176**, **178** to the atmosphere. Hydraulic intake for slave piston **52** is obtained through ball check valve **96** from the low pressure hydraulic reservoir side **62** of fast approach piston **44**. Intake from the high pressure hydraulic ram cylinder **48** through line **56** is prevented by ball check valve **98**. Pilot valve **180** on the pump left hand hydraulic slave piston **50** opens when the limit of travel to the left is completed and shuttle valve port **122** is opened through lines **182**, **184** to the atmosphere.

The hydraulic fluid in the pump left hand slave piston cylinder **115** is forced through ball check valve **192** into the hydraulic ram cylinder **60**. High pressure fluid is prevented from entering the low pressure hydraulic reservoir side **62** of fast approach piston **44** through line **186** by ball check valve **100**,

Low pressure air against fast approach piston **44** forces hydraulic fluid from the low pressure reservoir **62** through lines **56** and **186** through the respective check valves to the high pressure side **60** of ram piston **48**. Ram piston **48** will move to the left until contact is made with the rivet being squeezed, as **26**. The low pressure is insufficient to deform the rivet. At this time hydraulic pump **46** and slave pistons **50**, **52** will begin actuation to build up sufficient pressure to deform the rivet.

The shuttle valve port **122** having been opened and port **130** having been closed in the previous sequence, a pressure differential is created between port **122** and the end adjacent port **130** by air passing from the open center **128** of the spool through restricted opening **188** to port **130**. The pressure differential causes spool **42** to move to the left to the position of Figure 4.

Figure 4.—Opposite position of operation

Trigger valve **40** is still compressed and the hydraulic return valve **54** is still in closed position in Figure 4. Shuttle valve **40** has reached the limit of its travel to the left. In this position air pressure is still applied to the fast approach piston **44**. Air pressure is now directed from spool passageway **158** out line **163** to the left side of pump air piston **46**. Exhaust from the other side of pump piston **46** as it moves to the right is made through line **164** through spool passageway **190** and out line **192** to the atmosphere.

Pump piston **46** is forced to the right and the right hand pump hydraulic piston **52** forces high pressure fluid out past ball check valve **98**, through line **56** to hydraulic ram cylinder **48**. The high pressure fluid is prevented from entering the low pressure hydraulic reservoir side **62** of fast approach piston **44** by ball check **96**. Pilot valve **174** on pump right hand slave piston **52** is opened when the limit of travel to the right is reached, opening shuttle valve port **130** through lines **176**, **178** to the atmosphere. Also, as pump piston **46** moves to the right, the left hand slave piston **50** draws an intake supply past check valve **100** through line **186** from hydraulic reservoir **62**. High pressure fluid from hydraulic ram cylinder **60** is prevented from entering cylinder **115** of left hand slave piston **50** by ball check **102**. Pilot valve **180** on the left slave piston **50** closes as the piston travels to the right, shutting off line **182** to port **122** of shuttle valve **42**.

There is now a pressure differential between the left hand end of shuttle spool **42** and the ambient pressure of port **130** causing spool **42** to move to the right limit of its travel, in which position the pump piston action as described in Figure 3 is repeated. Pressure is applied to port **122** from open spool center **128**, past ball check **126** and through restricted passageway **189**. This shuttling action continues until the high pressure capacity of the pump is obtained in the high pressure hydraulic ram or trigger valve **40** is released. The rivet will be deformed under the pressure of ram piston **48** in the process. Maximum pressure for this embodiment under the conditions given is calculated at 5,000 p. s. i.

Restrictions **188** and **189** at opposite ends of the open center **128** of shuttle valve **42** and the ball check **126** act during operation of rivet squeezer **10** to apply air pressure alternately to left and right hand ends of shuttle valve **42**. When pressure is applied to one end, the other end is open to the atmosphere which results in greater pressure on one end than the other although they are both supplied with air from open center **128**. Restrictions **188**, **189** prevent the end open to the atmosphere from drawing off enough of the supplied air pressure to prevent the shuttling operation. It will be understood that the air

ingress and egress passageways should have sufficient size relative restrictions **188**, **189** so as not to interfere with the creation of these pressurse differentials. Ball check **126** will only be lightly spring loaded.

When trigger valve **40** is released, return spring **66** moves the valve back to the position described in Figure 2, the hydraulic fluid in ram cylinder **60** is returned to the hydraulic reservoir side **62** of fast approach piston **44** through lines **56**, **58** as described in connection with Figure 2.

Having thus disclosed our invention, we do not wish to be limited to the precise details of construction shown but instead wish to cover those modifications thereof which will occur to those skilled in the art from our disclosure, and which fairly fall within the scope of our invention, as defined in the appended claims.

We claim:

1. A device having work operating means powered by external low pressure fluid supply means, comprising: a hydraulic ram piston and cylinder connected to said operating means to power the same by a stroke in one direction, a pump piston and cylinder in which the piston is mounted to reciprocate between ends of its cylinder, said external supply means being connected to the ends of said pump cylinder and control means interposed therebetween alternately directing fluid from the supply means to opposite ends of said pump cylinder to reciprocate said pump piston, a pair of slave pistons and cylinders connected to said pump piston and of smaller diameter and the slave pistons reciprocating on each reciprocation of said pump piston, a fast approach piston and cylinder having an in-put side connected to said low pressure fluid supply means and having an out-put side connected directly to said ram cylinder by means including a one-way valve and said out-put side containing a hydraulic fluid, said out-put side of said fast approach piston and cylinder forming a source of hydraulic fluid and cylinders for said slave pistons and cylinders connected to said hydraulic fluid source and to said ram cylinder by lines having interposed valve means directing hydraulic fluid alternately from each slave piston and cylinder to said ram cylinder during a power stroke and drawing a supply of hydraulic fluid from said source during an intake stroke, whereby said fast approach piston supplies hydraulic fluid to said ram cylinder at lower pressure comparable to the pressure of said low pressure supply means in a single stroke upon initiation of operation of the device to initially move said ram piston under low pressure and said slave pistons thereafter supply hydraulic fluid to said ram cylinder at a higher pressure increasing at each stroke of said pump piston to move said ram piston under increasingly high pressure when resistance is incurred to the operation of said work operating means.

2. Portable means to squeeze a rivet operated by external low pressure fluid supply means, comprising: jaw members and jaw operating means operative to move said jaw members toward closing, a housing on which said jaw members and operating means are mounted and including handle means, a hydraulic ram piston and cylinder contained within said housing and connected to said operating means to power the same, a pump piston and cylinder contained within said housing and the pump piston being mounted to reciprocate between ends of its cylinder, said housing having a port to which a line from said external supply means may be connected and said port being connected to the ends of said pump cylinder and control means in said housing interposed between port and said ends of said pump cylinder operative to alternately direct fluid from the supply means to opposite ends of said pump cylinder to reciprocate said pump piston, a pair of slave pistons and cylinders in said housing and of smaller diameter than said pump piston and connected to said pump piston to reciprocate therewith, a source of hydraulic fluid in said housing and slave piston cylinders connected to said hydraulic fluid source and to said ram cylinder by lines having interposed valve means in said housing directing hydraulic fluid alternately from each slave piston and cylinder to said ram cylinder during a power stroke and drawing a supply of hydraulic fluid from said source during an intake stroke, whereby a high hydraulic pressure is produced in said ram cylinder by successive reciprocations of said pump piston powered by said low pressure fluid, said housing being a portable, self-contained, hand-held tool accomplishing operation of said jaw operating means by application of fluid under pressure from said external fluid supply means.

3. The subject matter of claim 2 in which there is a fast approach piston and cylinder in said housing having an in-put side connected to said port and having an out-put side connected directly to said ram cylinder by means including a one-way valve and said out-put side containing a hydraulic fluid, whereby said fast approach piston supplies hydraulic fluid to said ram cylinder at lower pressure comparable to the pressure of said low pressure supply means in a single stroke upon initiation of operation of the device to move said ram piston so that said jaw members are moved to rivet engaging position and said slave pistons thereafter supply hydraulic fluid to said ram cylinder at higher pressure increasing at each stroke of said pump piston until said ram piston powers said operating means to move said jaw members to deform a rivet.

4. The subject matter of claim 3 in which said out-put side of said fast approach piston and cylinder forms said source of hydraulic fluid source for said slave pistons and cylinders.

5. Portable means to squeeze a rivet operated by external low pressure fluid supply means, comprising: jaw members and jaw operating means operative to move said jaw members toward closing, a housing on which said jaw members and operating means are mounted and including handle means, said housing having a barrel and a hydraulic ram piston and cylinder positioned in one end of said barrel and connected to said operating means to power the same, a pump piston and cylinder disposed in said barrel and generally coaxial with said ram piston and the pump piston being mounted to reciprocate between ends of its cylinder, said housing having a port to which a line to said external supply means may be connected and said port being connected to the ends of said pump cylinder and control means in said housing interposed between said port and said ends of said pump cylinder operative to alternately direct fluid from the supply means to opposite ends of said pump cylinder to reciprocate said pump piston, a pair of slave pistons and cylinders in said barrel and generally coaxial with said pump piston and connected thereto, said slave pistons being of smaller diameter than said pump pistons and reciprocating therewith, a source of hydraulic fluid in said housing and cylinders in said housing for said slave pistons and cylinders connected to said hydraulic fluid source and to said ram cylinder by lines having interposed valve means in said housing directing hydraulic fluid alternately from each slave piston and cylinder to said ram cylinder during a power stroke and drawing a supply of hydraulic fluid from said source during an intake stroke, whereby a high hydraulic pressure is produced in said ram cylinder by successive reciprocations of said pump piston produced by said low pressure fluid, said housing being a portable, self-contained, hand-held tool accomplishing operation of said jaw operating means by application of fluid under pressure from said external low pressure fluid supply means.

6. The subject matter of claim 5 in which there is a fast approach piston and cylinder in said barrel and generally coaxial with said ram and pump pistons and having an in-put side connected to said port and having an out-put side connected directly to said ram cylinder by means including a one-way valve and said out-put

side containing a hydraulic fluid, whereby said fast approach piston supplies hydraulic fluid to said ram cylinder at lower pressure comparable to the pressure of said low pressure supply means in a single stroke upon initiation of operation of the device to move said ram piston so that said jaw members are moved to rivet engaging position and said slave pistons thereafter supply hydraulic fluid to said ram cylinder at higher pressure increasing at each stroke of said pump piston until said ram piston powers said operating means to move said jaw members to deform a rivet, said out-put side of said fast approach piston and cylinder forming said source of said hydraulic fluid for said slave pistons and cylinders.

7. A device having work operating means powered by external low pressure fluid supply means, comprising: a hydraulic ram piston and cylinder connected to said operating means to power the same by a stroke in one direction, a pump piston and cylinder in which the piston is mounted to reciprocate between ends of its cylinder, two-position operating valve means manually operable between a non-operating position and an operating position and said valve means in said operating position connecting said supply means to opposite ends of said pump cylinder, there being a shuttle valve interposed between said operating valve means and said ends of said pump cylinder, said shuttle valve having positioning means responsive to the movement of said pump piston to alternately direct fluid to said opposite end of said pump cylinder to reciprocate the pump piston, said pump piston having smaller diameter slave pistons connected thereto to reciprocate with said pump piston, said slave pistons having cylinders, a hydraulic fluid source and said slave cylinders being connected to said ram cylinder and to said source by means including one-way valves whereby each slave piston has a power stroke supplying fluid to said ram cylinder at pressure greater than the pressure of said low pressure supply means and has an intake stroke drawing hydraulic fluid from said source, said operating valve means in said non-operating position connecting said supply means and one end of said shuttle valve biasing said shuttle valve toward the opposite end whereby a dead center position is avoided, a fast approach piston and cylinder having an in-put side and having an out-put side connected directly to said ram cylinder by means including a one-way valve and containing hydraulic fluid, said operating valve means in said operating position connecting said supply means directly to said in-put side of said fast approach piston.

8. A device having work operating means powered by external low pressure fluid supply means, comprising: a hydraulic ram piston and cylinder connected to said operating means to power the same by a stroke in one direction, a pump piston and cylinder in which the piston is mounted to reciprocate between ends of its cylinder, two-position operating valve means manually operable between a non-operating position and an operating position and said valve means in said operating position connecting said supply means to opposite ends of said pump cylinder, there being a shuttle valve interposed between said operating valve means and said ends of said pump cylinder, said shuttle valve having positioning means responsive to the movement of said pump piston to alternately direct fluid to said opposite ends of said pump cylinder to reciprocate the pump piston, said pump piston having smaller diameter slave pistons connected thereto to reciprocate with said pump piston, said slave pistons having cylinders, a hydraulic fluid source and said slave cylinders being connected to said ram cylinder and to said source by means including one-way valves whereby each slave piston has a power stroke supplying fluid to said ram cylinder at pressure greater than the pressure of said low pressure supply means and has an intake stroke drawing hydraulic fluid from said source, a fast approach piston and cylinder having an in-put side and having an out-put side connected directly to said ram cylinder by means including a one-way valve and containing hydraulic fluid, said operating valve means in said operating position connecting said supply means directly to said in-put side of said fast approach piston, a bypass line between said ram cylinder and said out-put side of said fast approach piston and cylinder, a relief valve interposed in said bypass line and having a first position in which flow through said bypass line is blocked and a second position in which flow through said bypass line is open, spring means biasing said relief valve to one of said positions and a line from said operating valve means connecting said supply means and said relief valve in one position of said operating valve means to move said relief valve to the other of said positions whereby operation of said operating valve means automatically opens said bypass line to permit return of said ram piston when the operating valve means is in said non-operating position, and spring means acting on said ram piston to return the same in an opposite direction to its power stroke.

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