

[54] SINGLE SHOT RIVETING DEVICE

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[58] Field of Search 173/121, 120, 119, 115; 91/5, 4 R, 4 A

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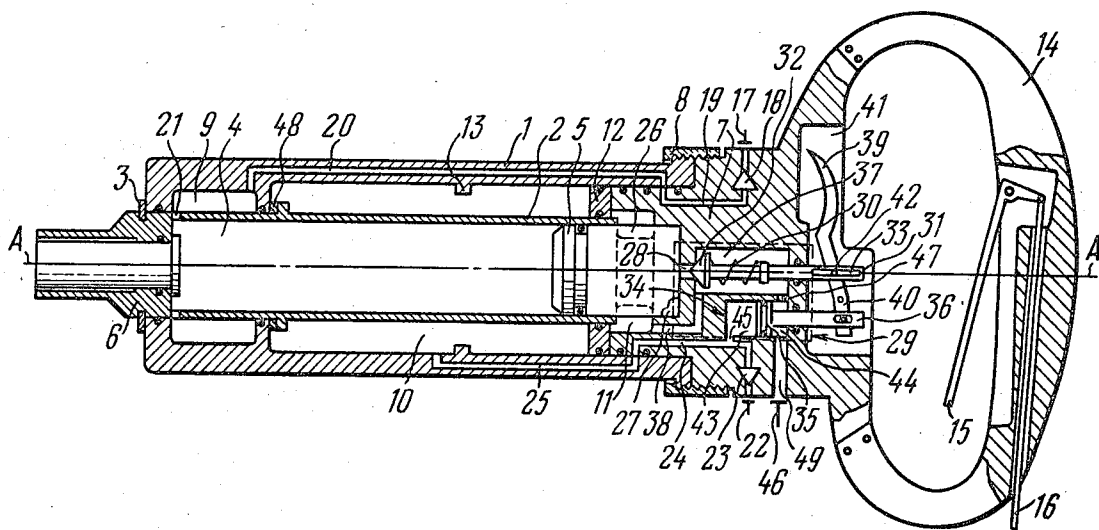
[57] ABSTRACT

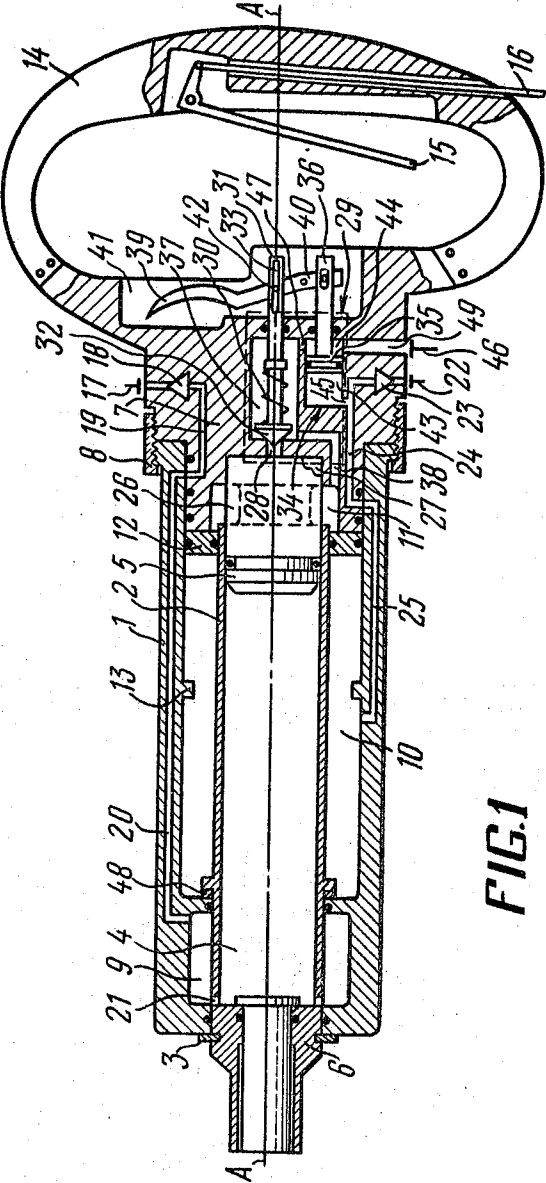
The device is intended for clinching steel and aluminum alloy rivets.

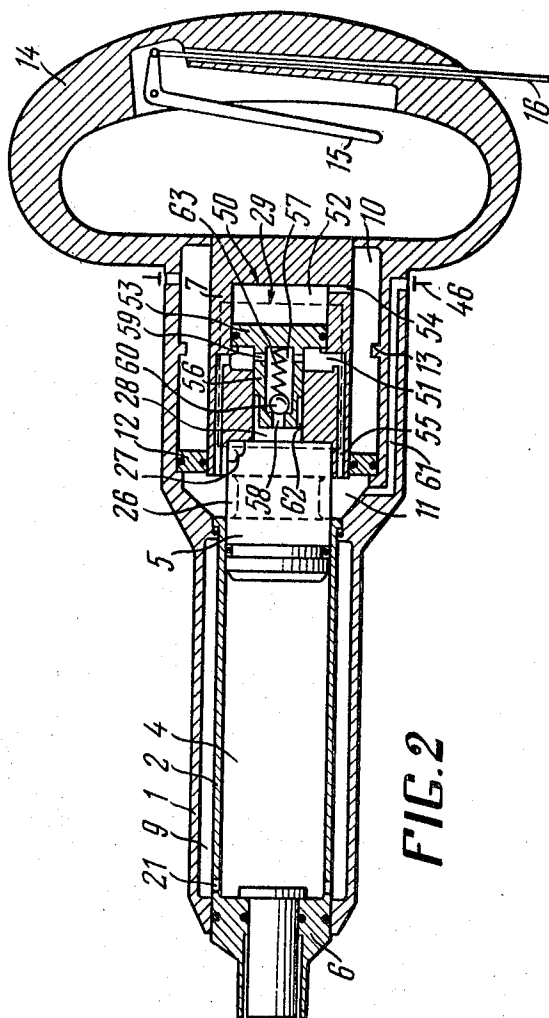
The striking means travels inside a cylinder and a rivet set means is arranged at one end face of the cylinder, and a cover having a socket receiving the striking means is at the other cylinder end.

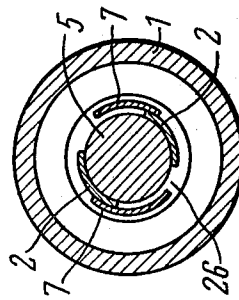
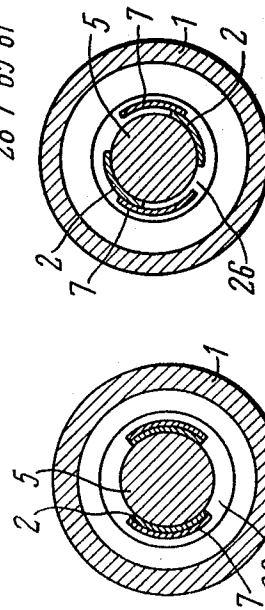
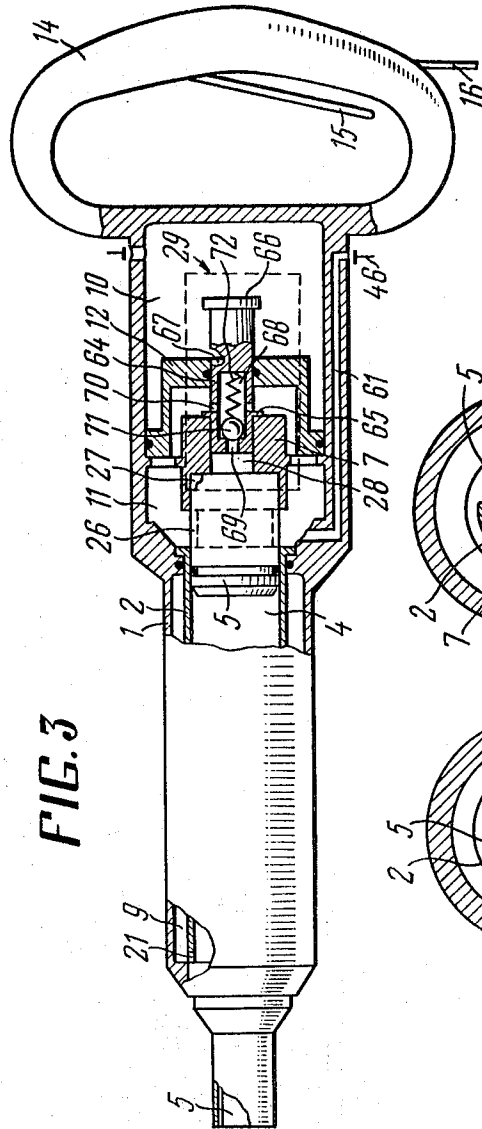
The striking means working stroke is effected under the action of a high-pressure compressed gas, and a low-pressure compressed gas is used to return the striking means to its initial position. The device incorporates a control valve opening a through hole made in the cover in the vicinity of the socket during the striking means working stroke.

7 Claims, 6 Drawing Figures









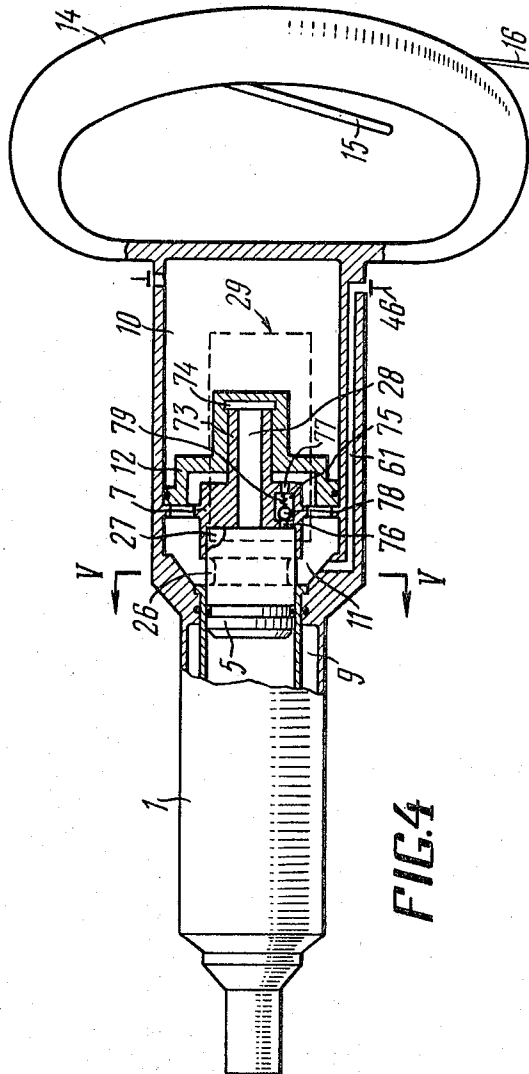


FIG. 4

SINGLE SHOT RIVETING DEVICE

The present invention relates to pressure shaping machines and tools, and more particularly to single-shot riveting devices employing compressed gas energy for driving a striking element.

Riveting devices employing compressed gas energy for driving a striking element are well known in the art. These may be single-shot or multiple-shot pneumatic devices.

When compared with multiple-shot riveting devices, the single-shot devices have important advantages such as the absence of vibration and noise harmfully affecting the operator's health. In addition, the quality of single-shot riveted joints is better than that of multiple-shot riveted joints, since the snap heads in single-shot riveted joints are free from cold work hardening.

The prior art single-shot riveting devices comprise a housing having a hollow cylinder wherein a striker is moving and at whose one end side a rivet set for upsetting rivet heads is arranged. The cylinder cavity, via the openings made therein, is connected with the compressed gas source to provide for the striker return to the initial position.

The striker working stroke is effected due to the compressed gas action, and the operator of such a riveting device has to press a lever or trigger in an abrupt manner in order to ensure an instantaneous opening of the line supplying the high-pressure compressed gas actuating the striker. As a result, the operator gets fatigued very rapidly and cannot maintain the proper shape of rivet snap heads. Besides, these devices exhibit an insufficient shock energy, since they are generally designed for operation on 5 kgf/cm² of gas mains. Therefore, they do not permit the clinching of aluminum alloy rivets having a diameter over 4 mm which are particularly difficult to clinch. The pressure variations in the compressed air main lead to lower shock energy stability, thus deteriorating the riveting quality.

It is an object of the present invention to provide a single-shot riveting device which will have a sufficient shock energy permitting the clinching of steel and aluminum alloy rivets having a diameter of 5 to 6 mm, and which will automatically store the energy, thus substantially improving conditions of work.

This and other objects and purposes of the invention are attained in a single-shot riveting device comprising a housing having a hollow cylinder in whose cavity a striking means travels and at whose one end face a rivet set means is arranged, said hollow cylinder cavity being connected with a compressed gas source via the openings made therein and in the vicinity of said rivet set means for returning said striking means to its initial position, wherein, according to the invention, said housing has a hydropneumatic cylinder arranged therein, said hydropneumatic cylinder having a floating piston, said floating piston separating a high-pressure compressed gas pneumatic portion and a hydraulic portion, which moves into said hydraulic portion when the fluid feed and the compressed gas pressure increases within said pneumatic portion whereby a working stroke of said striking means is effected within said hollow cylinder cavity, said last-named cavity communicating with said housing hydropneumatic cylinder hydraulic portion and being closed at the other hollow cylinder end face opposite said rivet set means by a cover fastened within said housing and having a clearance-free socket

receiving said striking means upon its return to the initial position and a through hole communicating said socket with said housing hydropneumatic cylinder hydraulic portion during the striking means working stroke and with the fluid feed being shut off from this hydropneumatic cylinder hydraulic portion by a control valve mounted in said cover.

In such an embodiment of the invention, higher shock energies are achieved by providing a hydropneumatic cylinder in the device's housing, said housing hydropneumatic cylinder including a high-pressure gas pneumatic portion and a hydraulic portion separated by a floating piston which compresses the gas in the pneumatic portion to a higher degree while moving therein.

The increase in the shock energy enables the clinching of steel and aluminum alloy rivets having a diameter of 5 to 6 mm to be effected with the use of the devices according to the invention.

The control valve employed in the device according to the invention permits the striking means working stroke to be automatically performed after the energy stroke storage is completed.

The invention is characterized in that the pneumatic portion of said hydropneumatic cylinder has overrunning stops arranged therein at its side walls, said stops restricting the floating piston travel, thus providing for a constant gas compression ratio and energy stroke stability.

The invention is further characterized in that the communication of the hollow cylinder cavity with the hydropneumatic cylinder hydraulic portion is effected via the openings closed by the striking means and made in the hollow cylinder near its cover, the fluid from hydropneumatic cylinder hydraulic portion flowing into the hollow cylinder during the striking means working stroke through these openings, and the hollow cylinder being mounted so that it is capable of turning around its axis relative to the cover in order to provide for varying the passage area of the openings for the purpose of controlling the striking means stroke energy.

Owing to the provision of openings in the hollow cylinder and the possibility of turning thereof, the striking means stroke energy can be controlled as it is desired in a particular case, since the fluid flow velocity through the openings decreases with the opening area reduction resulting in a reduced striking means velocity, and, consequently, a reduced stroke energy thereof. The stroke energy may be varied in the range from zero to maximum.

On the whole, the invention provides a single-shot riveting device exhibiting the required shock energy to be effectively controlled in a wide range.

In accordance with one embodiment of the invention, the floating piston may be made in the form of a washer, said hollow cylinder extending through said washer hole, and the control valve may be made of two assemblies, one of said assemblies being a spring-loaded spindle having a cone head at its one end for shutting off said cover through hole and a slot at its other end for coupling said spindle with a starting trigger employed in the device to manually open the valve, said spindle being arranged in a hydraulic cavity made in said cover and communicating with said cover through hole and with said housing hydropneumatic cylinder hydraulic portion, and its other assembly being a hydropneumatic cylinder arranged in said cover and hav-

ing a piston therein, said cover hydropneumatic cylinder piston being hinge-connected with said trigger via a rod to ensure a small uplift of said trigger after the displacement of said cover hydropneumatic cylinder piston prior to the manual opening of said valve but following the gas compression cycle completion and separating a pneumatic portion of said cover hydropneumatic cylinder from a hydraulic portion thereof, said cover hydropneumatic cylinder pneumatic portion being connected with said housing hydropneumatic cylinder pneumatic portion by means of passageways made in said housing and said cover, and said cover hydropneumatic cylinder hydraulic portion being connected with a pressure main line via a port made in said cover and with said housing hydropneumatic cylinder hydraulic portion via said cover hydraulic cavity.

When such construction of the control valve is utilized, the partial or small ascent of the starting trigger will indicate that the device has stored the required energy and that the striking means is ready for effecting a working stroke.

Although the starting trigger of the device should be cocked or pulled up manually by the operator, the operation does not require the application of great pulling forces and thus cannot cause weakness or slanting of rivet snap heads. Therefore, the invention provides for the proper clinching of rivets.

In accordance with another embodiment of the invention, the floating piston may be made in the form of a washer, with said cover extending through said washer hole, and the control valve being made in the form of a hydropneumatic cylinder arranged in said cover, said cover for the hydropneumatic cylinder pneumatic portion being connected with said housing for the hydropneumatic cylinder pneumatic portion via a port made in said cover and said cover for the hydropneumatic cylinder hydraulic portion being connected with said housing for the hydropneumatic cylinder hydraulic portion via a passageway made in said cover, said cover hydropneumatic cylinder having a piston separating said cover for the hydropneumatic cylinder pneumatic and hydraulic portions, said cover of hydropneumatic cylinder piston including a hollow rod arranged in said cover hydropneumatic cylinder hydraulic portion and having ports therein which connect said hollow rod cavity with said housing of the hydropneumatic cylinder hydraulic portion and with said cover through said hole, said hollow rod cavity having a spring-loaded check valve arranged therein which opens one of said rod ports running into said cover through a hole for draining the fluid therethrough from said cover socket when said striking means is being returned to its initial position, said hollow rod having a free end clearance-free entering said cover through hole and thereby preventing the fluid from flowing into said cover socket from said housing hydropneumatic cylinder hydraulic portion via said cover through hole when the fluid is fed into said housing hydropneumatic cylinder hydraulic portion, and leaving this cover through a hole for communicating said cover socket with said housing hydropneumatic cylinder hydraulic portion during the said striking means working stroke.

Thus, in the embodiment of the present invention briefly stated above, the control valve will enable the striking means to effect the working stroke right after the gas compression process when the housing hydro-

pneumatic cylinder pneumatic portion has been completed.

In accordance with yet another embodiment of the present invention, the control valve may be a movable hollow rod extending through a hole made in the floating piston, one end of said movable hollow rod entering clearance-free said cover through hole and thereby preventing the fluid from flowing into said cover socket via said cover through hole upon the fluid being fed into said housing hydropneumatic cylinder hydraulic portion and leaving said cover through hole for in order to communicate said cover socket with said housing hydropneumatic cylinder hydraulic portion during the striking means working stroke, said movable hollow rod having ports connecting its cavity with the housing hydropneumatic cylinder hydraulic portion and with the cover through hole, and shoulders at its outer surface spaced at some distance from each other, one of said shoulders being adapted for restricting the travel of said movable hollow rod inside said cover through hole and the other of said shoulders being adapted for interacting with the floating piston so that the latter draws out said movable hollow rod from said cover through hole while moving up during said striking means working stroke, said movable hollow rod cavity having a spring-loaded check valve arranged therein which opens one of said rod ports running into the cover through hole for draining the fluid therethrough from the cover socket when the striking means is being returned to its initial position.

In accordance with still another embodiment of the present invention, the control valve may be formed by an extension provided on said cover, the cover through hole passing through the extension, and by a socket made in the floating piston, said extension entering clearance-free said socket and thereby preventing the fluid from flowing into the cover socket via the through hole when the fluid is fed into the housing hydropneumatic cylinder hydraulic portion and leaving the floating piston socket for communicating the cover socket with the housing hydropneumatic cylinder hydraulic portion during the striking means working stroke and the floating piston travel, the cover having a cavity therein which is connected with the housing hydropneumatic cylinder hydraulic portion and the cover socket by means of ports made in the cover, said cover cavity having a spring-loaded check valve arranged therein which opens one of the cover ports running into the cover socket for communicating the cover socket with the housing hydropneumatic cylinder hydraulic portion when the striking means is being returned to its initial position.

The single shot riveting devices may be successfully employed for such production operations as metal branding, punching, perforating, caulking of turbine blade tenons, etc. In order to meet the standards of this case it is only necessary to change the rivet set means for a suitable attachment well known in the art.

Owing to the afore-mentioned features, the single-shot riveting device has smaller weight and overall dimensions, exhibits a higher specific shock energy and improved shock stability, thus enabling high-quality riveted joints to be obtained regardless of the operator's skill.

The above-mentioned and other features and objects of the present invention and the manner of attaining them will become more apparent and the invention it-

self will be best understood by reference to the following detailed description of several embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 shows diagrammatically a longitudinal sectional view of the single-shot riveting device according to the invention;

FIG. 2 shows a view similar to FIG. 1, but illustrating a second embodiment of the invention;

FIG. 3 shows a view similar to FIG. 1, but illustrating a third embodiment of the invention;

FIG. 4 is a view similar to FIG. 1, but illustrating a fourth embodiment of the invention;

FIG. 5 is a sectional view along the line V—V of FIG. 4;

FIG. 6 is a view similar to FIG. 5 with the hollow cylinder position changed with respect to the cover.

The single-shot riveting device comprises a housing 1 (FIGS. 1, 2, 3, 4) having a hollow cylinder 2 concentrically arranged therein and fixed with respect to the housing by a retaining ring 3. Cylinder 2 has a cavity 4 with a striking means 5 therein which travels reciprocatingly within the cavity performing a stroke. A rivet set means 6 for upsetting rivet heads is arranged at one end face of cylinder 2, and a cover 7 fixedly jointed with a housing 1 by a nut 8 is arranged at the other cylinder end face (FIG. 1).

In order to ensure the travel of striking means 5, the housing is provided with a cavity 9 for accommodating the low-pressure gas used to return a striking means 5 to its initial position, and a hydropneumatic cylinder having a pneumatic portion 10 used for accommodating the high-pressure compressed gas driving a striking means 5 during its working stroke and a hydraulic portion 11 separated from the pneumatic cavity 10 by a floating piston 12 compressing the gas in portion 10, while moving therein, and thereby increasing the gas pressure therein, i.e., for effecting the compressed gas energy storage for performing a working stroke by striking means 5 when the fluid is fed into a hydraulic portion 11. The travel of the floating piston 12 is restricted by overrunning stops 13 mounted in the pneumatic portion 10 at its sidewalls.

A handle 14 having a lever 15 and a flexible shaft or cable 16 is fastened to cover 7.

The cavity 9 is filled with a low-pressure gas from a compressed gas source (not shown in the drawing) via a pipe connection 17, a check valve 18, a passageway 19 in cover 7 and a passageway 20 in housing 1; ports 21 made in cylinder 2 in the vicinity of a rivet set means 6 serve to connect housing cavity 9 with cavity 4 of cylinder 2.

Pneumatic portion 10 is filled with low-pressure compressed gas via a pipe connection 22, a check valve 23, a passageway 24 in cover 7 and a passageway 25 in housing 1.

The hydraulic portion 11 of the housing hydropneumatic cylinder communicates with cavity 4 of cylinder 2 via openings 26 made in the hollow cylinder near cover 7. Openings 26 are shut off by striking means 5 on its way back to the initial position and opened during the working stroke of the striking means 5; openings 26 are adapted for to admit the fluid from the hydraulic portion 11 of the housing hydropneumatic cylinder into cavity 4 of cylinder 2. In order to control the passage section variation of openings 26 and thus controlling the striking energy, hollow cylinder 2 is turn-

ably mounted around its axis A—A relative to cover 7.

FIG. 5 illustrates the position of hollow cylinder 2, after it has been turned with respect to cover 7, corresponding to the maximum passage section of openings 26 when the device operates at a maximum shock energy.

When a lower striking energy is desired, it will be necessary to turn the hollow cylinder 2 and set it with respect to cover 7, for example, as shown in FIG. 6. At this cylinder position the passage section of openings 26 will be reduced, and, as a result, a smaller amount of the fluid will flow through these openings per unit time.

The cover 7 (FIGS. 1, 2, 3, 4) has a socket 27 made therein which is entered clearance-free by striking means 5 on its way back to the initial position, whereby the fluid is prevented from flowing into the space between striking means 5 and the cover 7 from hydraulic portion 11 when the fluid is fed into this portion, and the striking means 5 leaves after the required pressure has been built up in portion 11 when the gas compression cycle has been completed in the pneumatic portion 10.

In the vicinity of a socket 27, cover 7 has a through hole 28 connecting this socket with hydraulic portion 11 via a control valve 29 mounted in cover 7. This control valve shuts off hole 28 during the pressure build-up in the housing hydraulic portion 11 and opens it during the striking means working stroke and then returns it to the initial position.

Control valve 29 may be variously embodied, and the four particular embodiments of the control valve described below do not constitute a departure from the spirit of the invention but imply various alternatives or modifications affecting only the cover 7 (as can be clearly seen from FIGS. 1, 2, 3, 4) and the number of passageways through which the compressed gas is fed into a pneumatic portion 10. It will be mentioned that the passageways through which the low-pressure compressed gas flows into housing cavity 9 are not shown in FIGS. 2, 3, 4 in order to make the drawings more easily read.

EMBODIMENT I

Control valve 29 (FIG. 1) may have two assemblies, one of which is a spindle 31 spring-loaded by spring 30 and having a cone head 32 at one end and a slot 33 at its other end and the other assembly is a hydropneumatic cylinder 3 arranged in cover 7 and having a piston 35 with a rod 36, and adapted for controlling the gas compression in the pneumatic portion 10 of housing 1.

The spindle 31 is housed in the hydraulic portion 37 made in cover 7 and communicating with through hole 28 of the cover and, via a passageway 38 in cover 7, with hydraulic portion 11 of the hydropneumatic cylinder arranged in housing 1. Cone head 32 fits in hole 28 by its pointed or tapered portion and shuts off or closes this hole during the working stroke of a striking means 5, thus preventing the fluid from flowing into socket 27 during the gas compression in pneumatic portion 10 of the housing hydropneumatic cylinder.

A trigger 39 mounted on a pin 40 or stud 40 in a pit 41 of cover 7 is designed for a manual control of valve 29. Trigger 39 has its one end hinge-connected with rod 36 of piston 35. The travel of piston 35 causes a

partial uplift of trigger 39 so that it partially leaves pit 41 before spindle 31 is manually raised and the through hole 28 is opened when the gas compression in the pneumatic portion 10 of the housing hydropneumatic cylinder is completed.

The middle portion of trigger 39 is connected with spindle 31 by means of a hinge 42 fitted into slot 33. When moving, piston 35 with rod 36 displace trigger 39 with hinge 42 sliding in slot 33 and spindle 31 remaining at a checked position, i.e., with hole 28 remaining closed.

Hydropneumatic cylinder 34 of cover 7 has a pneumatic portion 32 and a hydraulic portion 44 separated by piston 35. Pneumatic portion 43 is connected with pneumatic portion 10 of the hydropneumatic cylinder of housing 1 via a port 45 and passageways 24 and 25 made in cover 7 and housing 1, respectively, and hydraulic portion 44 is connected with a pressure main line 46 as well as with hydraulic portion 11 of the housing hydropneumatic cylinder via a port 47 in cover 7, hydraulic portion 37 and passageway 38.

In order to absorb the shock energy, a shock absorber 48 is installed between hollow cylinder 2 and housing 1.

With such arrangement for control valve 29, piston 12 is made in the form of a washer with hollow cylinder 2 extending through the washer hole.

The operation of the single-shot riveting device comprising the above-described control valve is as follows:

The device is first aimed at a rivet (not shown in the drawing). Then lever 15 is pressed, and this lever, via a flexible shaft or cable 16, turns on the fluid feed into a passageway 49 from pressure main line 46, for example via a multiplying means (not shown in the drawing).

The fluid is fed into hydraulic portion 44 via passageway 49 and then into cover cavity 37 via port 47, and by passageway 38 the fluid is fed into hydraulic portion 11 of the hydropneumatic cylinder of housing 1. Floating piston 12 is displaced to the left (in the drawing plane) and compresses the gas in pneumatic portion 10 of the housing hydropneumatic cylinder to a greater extent by pressure, i.e., the compressed gas energy is stored for effecting a working stroke by striking means 5.

Piston 35 of hydropneumatic cylinder 34 arranged in cover 7 is at the extreme right-hand position, since the piston effective area is larger at the side of pneumatic portion 43 than at the side of hydraulic portion 44. Head 32 of spindle 31 enters through hole 28 under the action of spring 30 and shuts off this hole.

When floating piston 12 reaches stops 13, the fluid pressure in hydraulic portion 11 and correspondingly in cover hydraulic cavity 37 and hydraulic portion 44 grows, and piston 35 begins to move to the right (in the drawing plane).

Since rod 36 is hinge-connected with trigger 39, the latter will turn around stud 40 and, due to the travel of hinge 42 in slot 33 of spindle 31, partially leave pit 41.

Due to the presence of slot 33 in spindle 31, the spindle will remain in the original position shutting off hole 28. Later on, when trigger 39 is manually pressed, the spindle 31 goes up, its head 32 leaves through hole 28 and the fluid from cover hydraulic cavity 37 begins to

exert pressure on a striking means 5 via this hole 28 and forces the striking means from cover socket 27.

The fluid occupies the volume of socket 27 and drives striking means 5 into cavity 4 of cylinder 2, i.e., striking means 5 is speeded up by the fluid which is enclosed within hydraulic portion 11 at a compressed gas pressure built up in pneumatic portion 10.

Due to the action of the compressed gas present in pneumatic portion 10, the floating piston 12 is displaced to the right, and the fluid is expelled from the hydraulic portion 11 into cavity 4 of cylinder 2 via openings 26. From cavity 4 of cylinder 2 the gas is forced out and into housing cavity 9 via ports 21. Striking means 5 hits or snaps on rivet set means 6 which upsets a rivet shank.

In order to return striking means 5 to its initial position, it is necessary to release trigger 39 and lever 15. As a result, passageway 48 will be connected with a drain line (not shown in the drawings), and the gas held in the housing cavity 9 will drive the striking means 5 into its initial position, i.e., into socket 27 of cover 7. At the same time, from cavity 4 of cylinder 2, the fluid flows into a drain line via openings 26, passageway 38, cover hydraulic cavity 37, port 47, hydraulic portion 44 of cylinder 34 and passageway 49. The remainder of the fluid cut off by the end face of striking means 5 in socket 27, assisted by striking means 5, presses out head 32 of spindle 31, and then it is drained via hole 28, cavity 37, port 47, portion 44 and passageway 49. Under the action of the gas fed into pneumatic portion 43 from pneumatic portion 10 via passageways 25 and 24, piston 35 of hydropneumatic cylinder 34 is moved to its initial position; at the same time, trigger 39, while turning around stud 40, enters pit 41. Which being driven by spring 30, head 32 of spindle 31 shuts off hole 28.

Striking means 5 occupies its initial position in socket 27, and is now ready for the next working stroke.

EMBODIMENT II

Control valve 29 is made in the form of a hydropneumatic cylinder 50 (FIG. 2) arranged in cover 7. A hydraulic portion 51 of this hydropneumatic cylinder is separated from a pneumatic portion 52 by a piston 53.

Pneumatic portion 52 is connected with pneumatic portion 10 of the hydropneumatic cylinder of housing 1 via a port 54 made in cover 7, and hydraulic portion 51 is connected with hydraulic portion 11 of the housing hydropneumatic cylinder via a passageway 55 of cover 7.

Piston 53 has a hollow rod 56 which is housed in hydraulic portion 51 of cylinder 50. The free end of this hollow rod is received clearance-free by through hole 28 of cover 7 thereby preventing the fluid from flowing into socket 27 of cover 7 from hydraulic portion 11 of the housing hydropneumatic cylinder via this through hole 28, after the pressure has been built up in hydraulic portion 11, and leaves hole 28 for communicating socket 27 with hydraulic portion 11 during the working stroke of striking means 5.

A cavity 57 of rod 56 communicates with through hole 28 and hydraulic portion 11 of the housing hydropneumatic cylinder via ports 58 and 59, respectively, made in rod 56.

Cavity 57 of rod 56 has a spring-loaded check valve 60 arranged therein which shuts off a port 58 running into through hole 28 of cover 7 and opens this port for

draining the fluid therethrough from socket 27 of cover 7 when striking means 5 is being returned to its initial position.

In such arrangement for the control valve 29, floating piston 12 is made in the form of a washer and cover 7 extends through the washer hole. Valve 29 is opened automatically after the gas compression in the pneumatic portion 10 of the housing hydropneumatic cylinder is completed.

The fluid feed into hydraulic portion 11 is accomplished via a passageway 61, and in order to drive striking means 5, the fluid is fed into socket 27 when rod 56 is drawn out of through hole 28.

The operation of the single-shot riveting device incorporating a control valve according to the above-described embodiment is as follows:

After the device is aimed at a rivet, the operator presses lever 15 which turns on the fluid feed into hydraulic portion 11 of the housing hydropneumatic cylinder from pressure line 46 via passageway 61 by means of flexible shaft or cable 16. Floating piston 12 moves to the right (in the drawing plane) and compresses the gas in pneumatic portion 10 of the housing hydropneumatic cylinder to a greater extent by pressure. Since the effective area of piston 53 of hydro- pneumatic cylinder 50 is larger at the side of pneumatic portion 52 than that of the side of hydraulic portion 51, piston 53 with rod 56 remains at its initial or shut-off position, i.e. rod 56 is fitted clearance-free in through hole 28 and prevents the fluid from flowing into socket 27 of cover 7 from hydraulic portion 11 via port 59. When floating piston 12 reaches stops 13, the pressure in the hydraulic system grows causing a corresponding pressure rise within hydraulic portion 51 of cylinder 50. Due to the fluid action, piston 53 is displaced to the right and rod 56 leaves hole 28 opening the way for the fluid to flow into hole 28 from hydraulic portion 51 via recess 62 at the side surface of rod 56.

The continuously growing fluid pressure at hole 28 acts on striking means 5 and presses it out. As a result, striking means 5 leaves cover socket 27, and the fluid inflow appearing in this socket displaces striking means 5 to the left (in the drawing plane). As soon as the striking means 5 leaves socket 27 completely, the striking means end face will be affected by the fluid pressure available in a hydraulic portion 11, with the fluid pressure being equal to the compressed gas pressure within pneumatic portion 10. The fluid gets into cavity 4 of cylinder 2 via openings 26, and speeds up striking means 5 for a shot.

In order to return striking means 5 to its initial position, it is necessary to release lever 15. Simultaneously, passageway 61 will be communicated with the drain system, the pressure in hydraulic portion 11 of the housing hydropneumatic cylinder will drop and striking means 5 will return to its initial position under the action of the gas operating in housing cavity 9 while expelling the fluid from cavity 4 of cylinder 2 via openings 26, hydraulic portion 11 and passageway 61. Piston 53 driven by the gas operating in pneumatic portion 52 connected with pneumatic portion 10 by port 54, with rod 56 also returns to its initial position, i.e. rod 56 fits in through hole 28 disconnecting hydraulic portion 51 of hydropneumatic cylinder 50 and socket 27 in cover 7.

A portion of the fluid is forced out of socket 27 into the drain system via hole 28 and port 58, while check

valve 60 is retracted, and then drained via cavity 57 of rod 56, port 59, hydraulic portion 51, passageway 55, hydraulic portion 11 and passageway 61. As soon as striking means 5 fits in socket 27 completely, check valve 60 will return to its initial position and shut off port 58 due to the action of a spring 63.

Now, the device is now ready for the next working cycle.

EMBODIMENT III

Control valve 29 is a movable hollow rod 64 (FIG. 3) having shoulders 65 and 66 provided at its outer surface and spaced from each other. Floating piston 12 has a through hole 67 made therein, and movable rod 64 extends through this hole 67. One end of movable rod 64 is capable of entering clearance-free the through hole 28 for preventing the fluid from flowing into socket 27 of cover 7 via through hole 28 when the fluid is fed into hydraulic portion 11 of a hydropneumatic cylinder arranged in housing 1, and leaving this through hole 28 for communicating socket 27 with hydraulic portion 11 during the working stroke of striking means 5. Rod 64 also ports 69 and 70 made therein and said rod 64 is communicated by with through hole 28 and hydraulic portion 11 of the housing hydropneumatic cylinder, respectively.

Shoulder 65 of rod 64 is adapted for restricting the travel of rod 64 in through hole 28 of cover 7, and shoulder 66 is adapted for interacting with floating piston 12 which, while moving, draws out rod 64 from through hole 28 during the striking means working stroke.

Cavity 68 of rod 64 has a spring-loaded check valve 71 arranged therein which opens a port 69 in rod 64 for draining the fluid out from cover socket 27 via this port and hole 28 when the striking means is returned to its initial position.

The operation of the single-shot riveting device is as follows:

After the device is aimed at the rivet to be clinched, the operator presses lever 15 which turns on the fluid supply into hydraulic portion 11 of the housing hydropneumatic cylinder from pressure main line 46 via passageway 61 by means of flexible shaft or cable 16. Floating piston 12 will move to the right (in the drawing plane) and compress the gas in pneumatic portion 10 to a greater extent by pressure. It should be mentioned that rod 64 is arranged in through hole 28 and is subject to the action of the gas held in pneumatic portion 10, thus disconnecting hydraulic portion 11 from socket 27.

When moving to the right, floating piston 12 engages with a shoulder 66 of rod 64 and starts displacing the latter in order to draw it out of through hole 28. After the compression of the gas in pneumatic portion 10 reaches a pre-set or desired extent, rod 64 completely leaves hole 28 making hydraulic portion 11 communicable with cover socket 27 via through hole 28. The fluid flows into socket 27 from hydraulic portion 11 and actuates striking means 5. The latter performs a working stroke in a similar manner as has been described earlier in Embodiments I and II. During the working stroke of the striking means 5, the floating piston 12 and rod 64 move to the left under the action of gas operating in the portion 10. A rod 64 fits in a cover hole 28 disconnecting the portion 11 and socket 27 the shoulder 65 abutting against the cover 7 and restricting

the travel of the rod 64 through the hole 28. To return the striking means 5 to its initial position, it is necessary to release the lever 15. As a result, the passageway 61 is put in communication with the draining system, the pressure in the hydraulic portion 11 of the housing hydropneumatic cylinder drops and, under the action of gas operating in the cavity 9 striking 7 and made at cover 7 and a socket 74 made at cover 7 in floating piston 12. Extension 73 can be clearance-free fitted into socket 74 for preventing the fluid from flowing into socket 27 of cover 7 from hydraulic portion 11 via through hole 28 when the fluid is fed into hydraulic portion 11, and withdrawn from this socket 74 for communicating cover socket 27 with housing hydraulic portion 11 during the working stroke of striking means 5 and travel of floating piston 12. means 5 returns to its initial position expelling the fluid from cavity 4 of the cylinder 2 via openings 26, the hydraulic cavity 11 and the passageway 61. The fluid forced out from the socket 27 by the striking means 5 retracts a valve 71 via the hole 28 and a port 69 and flows into the cavity 68 of the piston 64. From the cavity 68 the fluid is drained via ports 70, the hydraulic cavity 11 and the passageway 61. Since the fluid pressure in the cavity 11 is continuously dropping, a valve 71 will shut off the port 69 under the action of a spring 72.

The device is now ready for the next working operating cycle.

Embodiment IV

Control valve 29 is formed by an extension 73 (FIG. 4)

Through hole 28 in cover 7 is made so that it passes through extension 73 as shown in the FIG. 4. Cover 7 has a cavity 75 therein which is communicable with socket 27 and hydraulic portion 11, respectively, via ports 76 and 77 made in the cover. Cavity 75 has a spring-loaded check valve 78 arranged therein which opens a port 76 for communicating socket 27 with hydraulic portion 11 when striking means 5 is returned to its initial position.

The operation of the single-shot riveting device incorporating the control valve 29 according to the above-described embodiment is as follows:

After the device is aimed at the rivet to be clinched, the operator presses lever 15 which turns on the fluid supply into hydraulic portion 11 of housing 1 from pressure main line 46 via passageway 61 by means of flexible shaft or cable 16. Driven by the fluid, floating piston 12 will move to the right (in the drawing plane) and compress the gas in pneumatic portion 10 to a greater extent by pressure. During the travel of piston 12 in the R.H. direction extension 73 of cover 7 leaves piston socket 74, and after the gas in pneumatic portion 10 is compressed to the desired extent, extension 73 completely leaves socket 74 making hydraulic portion 11 communicable with socket 27 via hole 28. The fluid flowing from hole 28 actuates striking means 5. The latter leaves cover socket 27 and performs a working stroke as described above with reference to Embodiments I and II. During the working stroke of striking means 5, floating piston 12 is moved to the left (in the drawing plane) driven by the gas operating in pneumatic portion 10. Extension 73 enters socket 74 of piston 12 disconnecting hydraulic portion 11 from socket 27 of cover 7.

In order to return striking means 5 to its initial position, it is necessary to release lever 15. As a result, passageway 61 will be communicated with the draining system, the pressure in hydraulic portion 11 will drop and, driven by the gas operating in housing cavity 9, striking means 5 will return to its initial position expelling the fluid from cavity 4 of cylinder 2 via openings 26, hydraulic portion 11 and passageway 61. The fluid forced out from cover socket 27 via a port 76 and a cavity 75 by striking means 5 will retract a valve 78. From cavity 75 the fluid gets into hydraulic portion 11 via a port 77 and then is drained via passageway 61. Since the fluid pressure in hydraulic portion 11 is continuously dropping, valve 78 will shut off port 76 under the action of a spring 79.

The device is now ready for the next working cycle.

We claim:

1. A single-shot riveting device comprising: a housing; a hollow cylinder arranged in said housing and having a cavity and two end faces; a striking means traveling in said cavity of said hollow cylinder for effecting clinching; a rivet set means adapted for upsetting rivet heads arranged at one end face of said hollow cylinder; ports made in said hollow cylinder in the vicinity of said rivet set means; a cavity made in said housing and connected with said cylinder cavity via said ports and with a compressed gas source for returning said striking means to its initial position; a hydropneumatic cylinder arranged in said housing and having a high-pressure compressed gas pneumatic portion adapted for storing the compressed gas energy and effecting a working stroke of said striking means, and a hydraulic portion communicating with said hollow cylinder cavity during the travel of said striking means; a floating piston separating said pneumatic and hydraulic portions of said housing hydropneumatic cylinder and moving in said housing hydropneumatic cylinder, whereby the compressed gas pressure in said housing hydropneumatic cylinder pneumatic portion is increased for said storage of the compressed gas energy upon the fluid feed into said housing hydropneumatic cylinder hydraulic portion; a cover arranged at the other end face of said hollow cylinder and fixedly connected with said housing; a socket made in said cover at the side of said hollow cylinder, said socket receiving clearance-free the said striking means when the latter is being returned to its initial position and thereby preventing the fluid from flowing into the space between said striking means and said cover from said hydraulic portion when said fluid is fed thereto; a through hole made in said cover and connecting said socket with said hydraulic cavity during the working stroke of said striking means; a control valve mounted in said cover and shutting off said cover through hole when said fluid is fed into said port housing hydropneumatic cylinder hydraulic portion and opening it during the working stroke and returning said striking means to its initial position; a pressure main line connected with said hydraulic housing hydraulic portion for supplying the fluid thereto.

2. A device as claimed in claim 1, wherein said pneumatic portion of said housing hydropneumatic cylinder has overrunning stops arranged therein at the side walls, said stops restricting the travel of said floating piston.

3. A device as claimed in claim 1, wherein the communication of said hollow cylinder cavity with said

housing hydropneumatic cylinder hydraulic portion is effected via openings shut off by said striking means and made in said hollow cylinder in the vicinity of said cover, the fluid from said housing hydropneumatic cylinder hydraulic portion flowing into said hollow cylinder cavity during the working stroke of said striking means via said openings, and said hollow cylinder being mounted so that it is capable of turning around its axis relative to said cover and varying the passage section of said openings whereby the shock energy of said striking means may be controlled.

4. A single-shot riveting device comprising: a housing; a hollow cylinder arranged in said housing and having a cavity and two end faces; a striking means traveling in said cavity of said hollow cylinder for effecting clinching; a rivet set means adapted for upsetting rivet heads arranged at one end face of said hollow cylinder; ports made in said hollow cylinder in the vicinity of said rivet set means; a cavity made in said housing and connected with said cylinder cavity via said ports and with a compressed gas source for returning said striking means to its initial position; a hydropneumatic cylinder arranged in said housing and having a pneumatic portion for high-pressure compressed gas adapted for storing the compressed gas energy and effecting a working stroke of said striking means and a hydraulic portion for communicating with said hollow cylinder cavity during the travel of said striking means; a floating piston made in the form of a washer, said hollow cylinder extending through the hole of said washer, said floating piston separating said pneumatic and hydraulic portions of said housing hydropneumatic cylinder and moving in said housing hydropneumatic cylinder, whereby the compressed gas pressure in said pneumatic portion of said housing hydropneumatic cylinder is increased for said compressed gas energy storage, upon the fluid feed into said hydraulic portion of said housing hydropneumatic cylinder; a cover arranged at the other end face of said hollow cylinder and being fixedly connected with said housing; a socket made in said cover at the side of said hollow cylinder, said socket receiving clearance-free said striking means when the latter is being returned to its initial position and preventing the fluid from flowing into the space between said striking means and said cover from said hydraulic portion when said fluid is fed thereto; a through hole made in said cover and connecting said socket with said housing hydropneumatic cylinder hydraulic portion during a working stroke of said striking means; a hydraulic cavity made in said cover and communicating with said cover through hole and said hydraulic portion of said housing hydropneumatic cylinder; a spring-loaded spindle arranged in said cover hydraulic cavity; a cone head arranged at one end of said spring-loaded spindle and adapted for shutting off said through hole cover through hole; a slot made at the other end of said spring-loaded spindle; a starting trigger employed in said device to manually raise said spindle and draw out its cone head from said cover through hole during a working stroke of said striking means; a hydropneumatic cylinder arranged in said cover and having a hydraulic portion and a pneumatic portion; a piston separating said hydraulic and pneumatic portions of said cover hydropneumatic cylinder; a rod arranged in said hydraulic portion of said cover hydropneumatic cylinder and having its one end rigidly connected with said piston thereof and its other end hinge-connected with

said starting trigger to ensure a small uplift of the latter before said spindle is manually moved up and said cover through hole is opened and after the gas compression cycle is completed in said pneumatic portion of said housing hydropneumatic cylinder; a passageway made in said housing and serving as a continuation of said housing passageway; said cover and housing passageways communicating said pneumatic portion of said cover hydropneumatic cylinder with said pneumatic portion of said housing hydropneumatic cylinder; a port made in said cover and communicating said hydraulic portion of said cover hydropneumatic cylinder with said cover hydraulic cavity; a pressure main line feeding said hydraulic portion of said housing hydropneumatic cylinder with the fluid via said hydraulic portion of said cover hydropneumatic cylinder, said cover hydraulic cavity and said passageways.

5. A single-shot riveting device comprising: a housing; a hollow cylinder arranged in said housing and having a cavity and two end faces; a striking means traveling within said cavity of said hollow cylinder for effecting clinching; a rivet set means adapted for upsetting rivet heads arranged at one end face of said hollow cylinder; ports made in said hollow cylinder in the vicinity of said rivet means; a cavity made in said housing and connected with said cylinder cavity via said ports and with a compressed gas source for returning said striking means to its initial position; a hydropneumatic cylinder arranged in said housing and having a pneumatic portion for high-pressure compressed gas adapted for storing the compressed gas energy and effecting a working stroke of said striking means, and a hydraulic portion communicating with said hollow cylinder cavity during the travel of said striking means; a cover arranged at the other end side of said hollow cylinder and fixedly connected with said housing; a floating piston made in the form of a washer, said hollow cylinder extending through the hole of said washer, said floating piston separating said pneumatic and hydraulic portions of said housing of hydropneumatic cylinder, whereby the compressed gas pressure in said pneumatic portion of said hydropneumatic cylinder housing is increased for said compressed gas energy storage when the fluid is fed into said hydraulic portion of said housing hydropneumatic cylinder; a socket made in said cover at the side of said hollow cylinder, said socket receiving clearance-free said striking means when the latter is being returned to its initial position and preventing the fluid from flowing into the space between said striking means and said cover from said hydraulic portion when said fluid is fed thereto; a through hole made in said cover and connecting said socket with said hydraulic portion of said housing hydropneumatic cylinder during a working stroke of said striking means; a hydropneumatic cylinder arranged in said cover and having a pneumatic portion and a hydraulic portion; a port made in said cover and connecting said pneumatic portion of said cover hydropneumatic cylinder with said pneumatic portion of said housing hydropneumatic cylinder; a passageway made in said cover and connecting said cover hydropneumatic cylinder hydraulic portion with said housing hydropneumatic cylinder hydraulic portion; a piston of said cover hydropneumatic cylinder separating said portions thereof; a hollow rod arranged in said hydraulic portion of said cover hydropneumatic cylinder and having its one end connected with said cover hydropneumatic cylinder piston, and the other end of

said hollow rod entering clearance-free said cover through hole for preventing the fluid from flowing into said cover socket from said hydraulic portion of said hydropneumatic cylinder housing via said cover through hole when said fluid is fed into said hydropneumatic cylinder hydraulic housing portion, and leaving said cover through hole for communicating said cover socket with said hydropneumatic cylinder hydraulic portion housing during a working stroke of said striking means; ports made in said hollow rod and connecting said hydropneumatic cylinder hydraulic portion housing with said cover through hole, one of said rod ports running into said cover through hole and the other of said rod ports leading into said cover hydropneumatic cylinder hydraulic portion; a spring-loaded check valve arranged in a cavity of said hollow rod and opening one of said rod ports running into said cover through hole for draining the fluid therethrough from said cover socket when said striking means is being returned to its initial position; a pressure main line connected with said housing of the hydropneumatic cylinder hydraulic portion for feeding the fluid thereinto.

6. A single-shot riveting device comprising: a housing; a hollow cylinder arranged in said housing and having a cavity and two end faces; a striking means travelling within said cavity of said hollow cylinder for effecting clinching; a rivet set means adapted for upsetting rivet heads arranged at one end side of said hollow cylinder; ports made in said hollow cylinder in the vicinity of said rivet means; a cavity made in said housing and connected with said cylinder cavity via said ports and with a compressed gas source for returning said striking means to its initial position; a hydropneumatic cylinder arranged in said housing and having a high-pressure compressed gas pneumatic portion adapted for storing the compressed gas energy and effecting a working stroke of said striking means, and a hydraulic portion communicating with said hollow cylinder cavity during the travel of said striking means; a floating piston separating said pneumatic and hydraulic portions of said housing hydropneumatic cylinder and moving in said housing hydropneumatic cylinder whereby the compressed gas pressure in said housing hydropneumatic cylinder pneumatic portion is increased to a greater extent for said compressed gas energy storage when the fluid is fed into said housing hydropneumatic cylinder hydraulic portion; a cover arranged at the other end face of said hollow cylinder and fixedly connected with said housing; a socket made in said cover at the side of said hollow cylinder, said socket receiving clearance-free said striking means when the latter is being returned to its initial position and preventing the fluid from flowing into the space between said striking means and said cover from said housing hydropneumatic cylinder hydraulic portion when said fluid is fed thereto; a through hole in said cover and connecting said socket with said housing hydropneumatic cylinder hydraulic portion during a working stroke of said striking means; a hole made in said floating piston; a movable hollow rod extending through said floating piston hole, one end of said movable hollow rod entering clearance-free said cover through hole for preventing the fluid from flowing into said cover sprocket from said housing hydropneumatic cylinder hydraulic portion via said cover through hole when the pressure is built up within said housing hydropneumatic cylinder hydraulic portion, and leaving said cover through hole

for communicating said cover socket with said housing hydropneumatic cylinder hydraulic portion during a working stroke of said striking means; ports in said movable hollow rod, said movable hollow rod cavity communicating with said cover through hole and said housing hydropneumatic cylinder hydraulic portion via said rod ports; shoulders provided at the outer surface of said movable hollow rod and spaced at some distance from each other, one of said shoulders being adapted for restricting the travel of said rod in said cover through hole and the other one being adapted for interacting with said floating piston so that during a working stroke of said striking means said piston moves up and draws said rod out of said cover through hole; a spring-loaded check valve arranged in said rod cavity and opening one of said rod ports running into said cover through hole for drawing the fluid therethrough from said cover socket when said striking means is being returned to its initial position; a pressure main line connected with said housing hydropneumatic cylinder hydraulic portion for feeding the fluid thereinto.

7. A single-shot riveting device comprising: a housing; a hollow cylinder arranged in said housing and having two end faces; a striking means travelling in said hollow cylinder cavity for effecting clinching; a rivet set means adapted for upsetting rivet heads arranged at one end face of said hollow cylinder; ports made in said hollow cylinder in the vicinity of said rivet set means; a cavity made in said housing and connected with said cylinder cavity via said ports and with a compressed gas source for returning said striking means to its initial position; a hydropneumatic cylinder arranged in said housing and having a high-pressure compressed gas pneumatic portion adapted for storing the compressed gas energy and effecting a working stroke of said striking means, and a hydraulic portion communicating with said hollow cylinder cavity during the travel of said striking means; a floating piston separating said pneumatic and hydraulic portions of said housing hydropneumatic cylinder and moving in said housing hydropneumatic cylinder whereby the compressed gas pressure in said housing hydropneumatic cylinder pneumatic portion is increased to a greater extent for effecting said compressed gas energy storage when the fluid is fed into said housing hydropneumatic cylinder hydraulic portion; a cover arranged at the other end face of said hollow cylinder and fixedly connected with said housing; a socket made in said cover at the side of said hollow cylinder, said socket receiving clearance-free said striking means when the latter is being returned to its initial position and preventing the fluid from flowing into the space between said striking means and said cover from said housing hydropneumatic cylinder hydraulic portion when said fluid is fed thereto; an extension provided at said cover; a through hole made in said cover so that it passes through said extension and connects said cover socket when said housing hydropneumatic cylinder hydraulic portion during a working stroke of said striking means; a socket made in said floating piston, said extension entering clearance-free said piston socket and thereby preventing the fluid from flowing into said cover socket via said cover through hole when said fluid is fed into said housing hydropneumatic cylinder hydraulic portion and leaving said piston socket for communicating said cover socket with said housing hydropneumatic cylinder hydraulic

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portion during a working stroke of said striking means and travel of said floating piston; a cavity in said cover; ports made in said cover and connecting said cavity with said housing hydropneumatic cylinder hydraulic portion and with said cover socket; a spring-loaded check valve arranged in said cover cavity and opening one of said cover ports running into said cover socket

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for communicating said cover socket with said housing hydropneumatic cylinder hydraulic portion when said striking means is being returned to its initial position; a pressure main line connected with said housing hydropneumatic cylinder hydraulic portion for feeding the fluid therein.

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