Sept. 21, 1943. H. R. FISCHER 2,329,709

HYDRAULIC RIVETER

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Fig. 5.

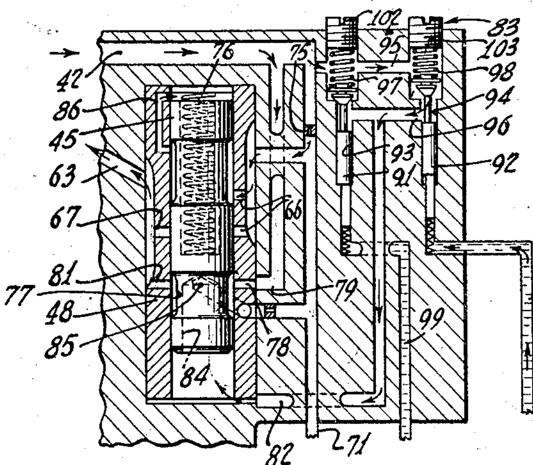
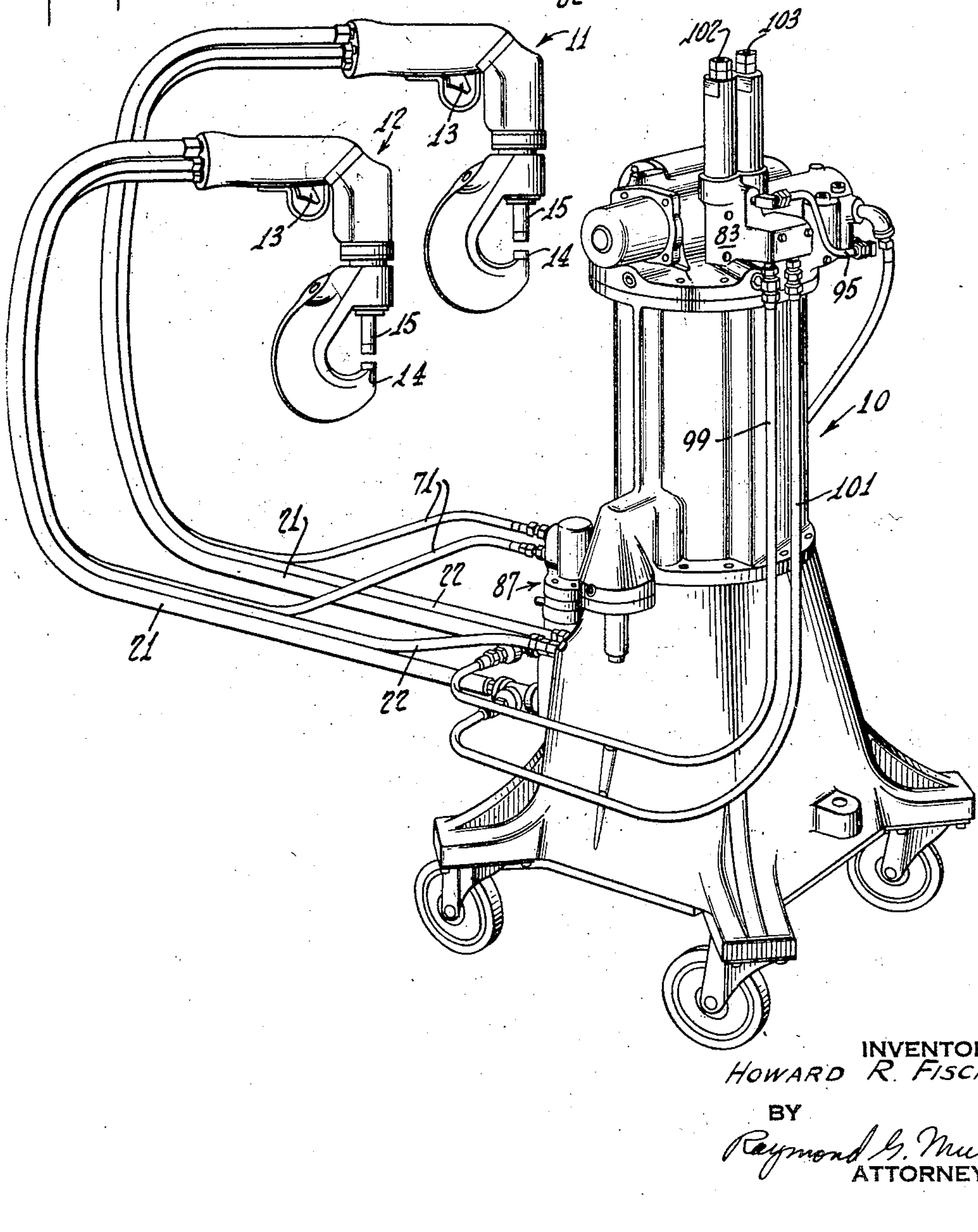


Fig. 1.



INVENTOR
HOWARD R. FISCHER
BY
Raymond G. Mullee
ATTORNEY

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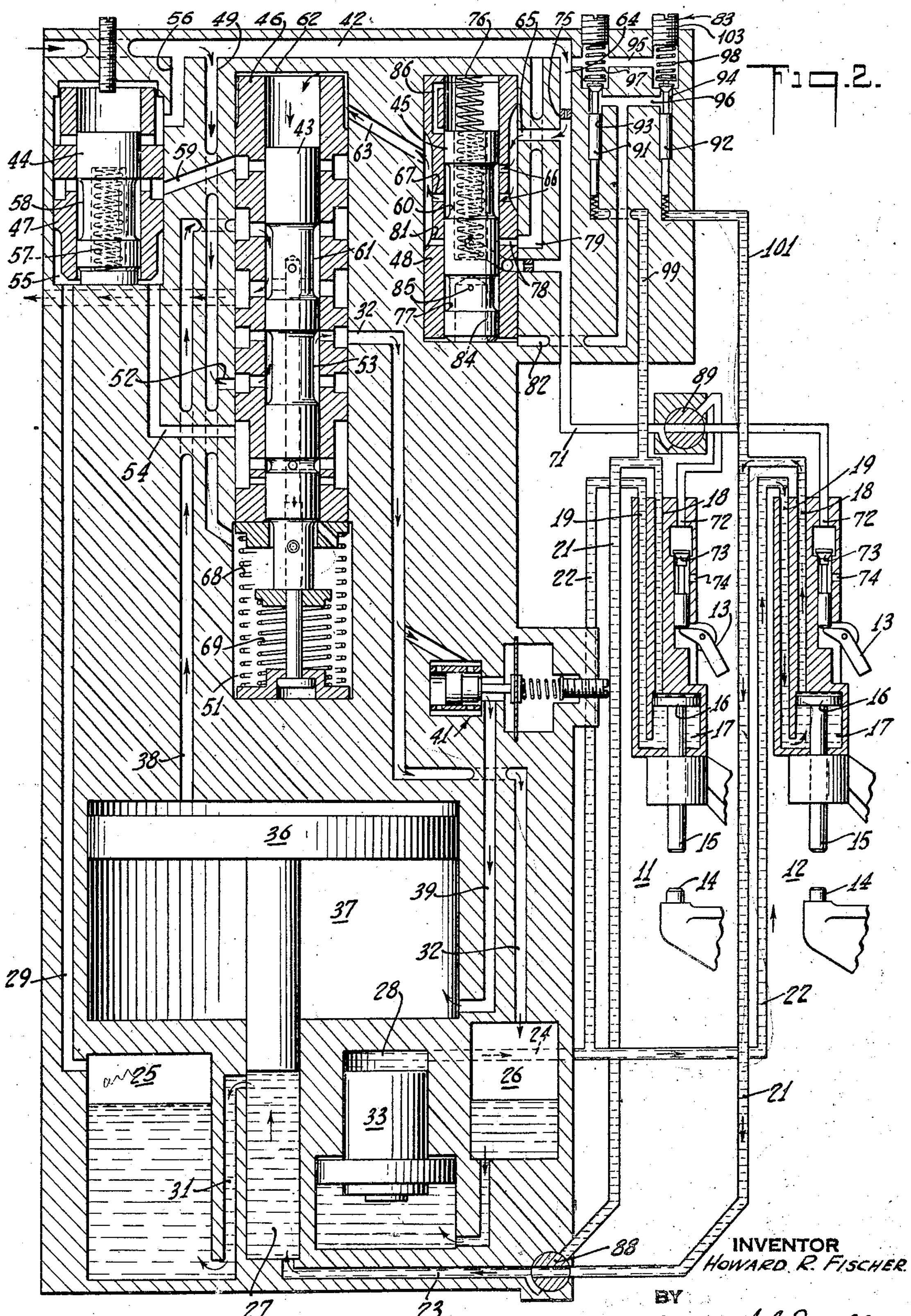
Fig. 2.



INVENTOR
HOWARD R. FISCHER

BY

Raymond G. Mullee
ATTORNEY

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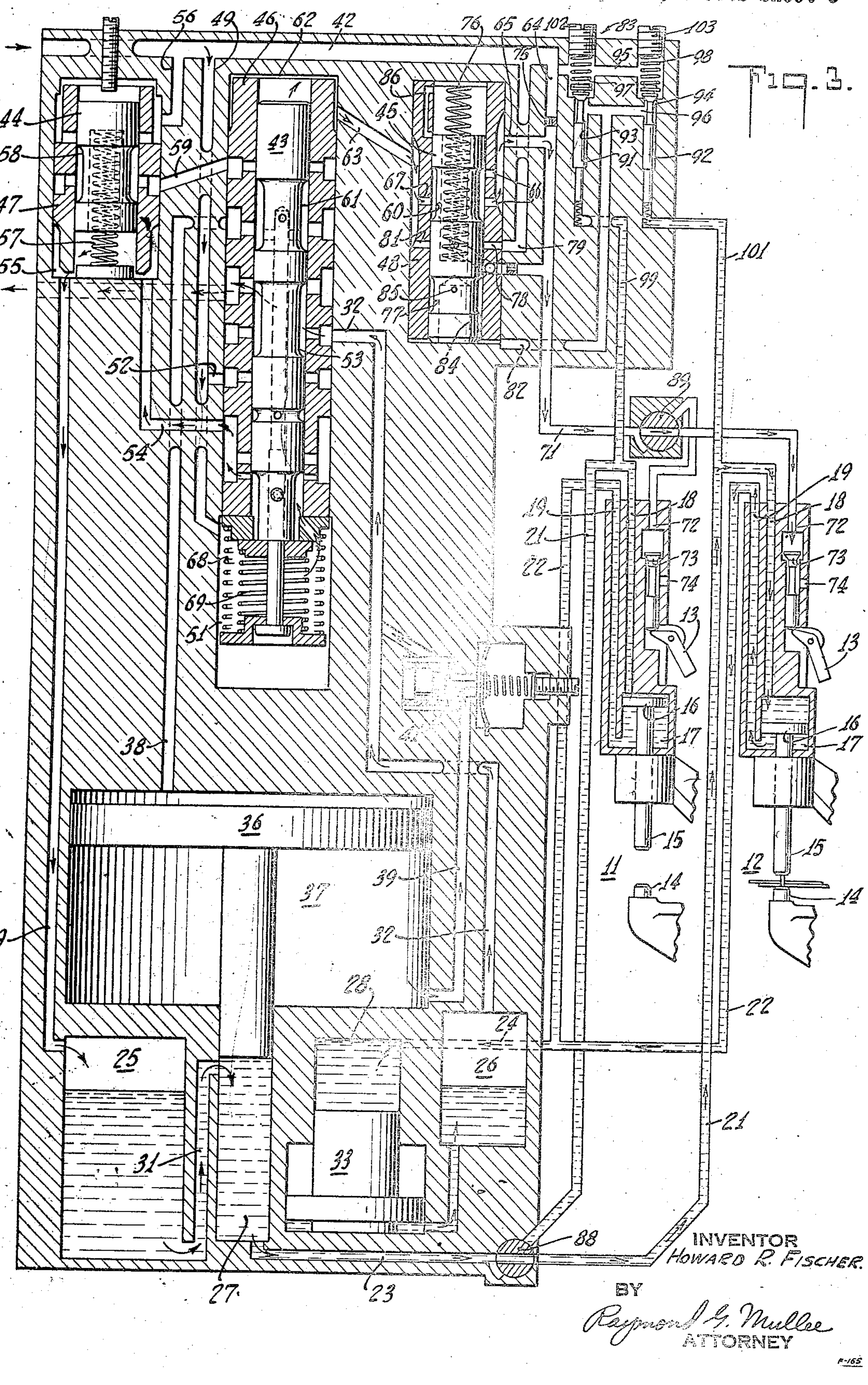
Fig. 3.



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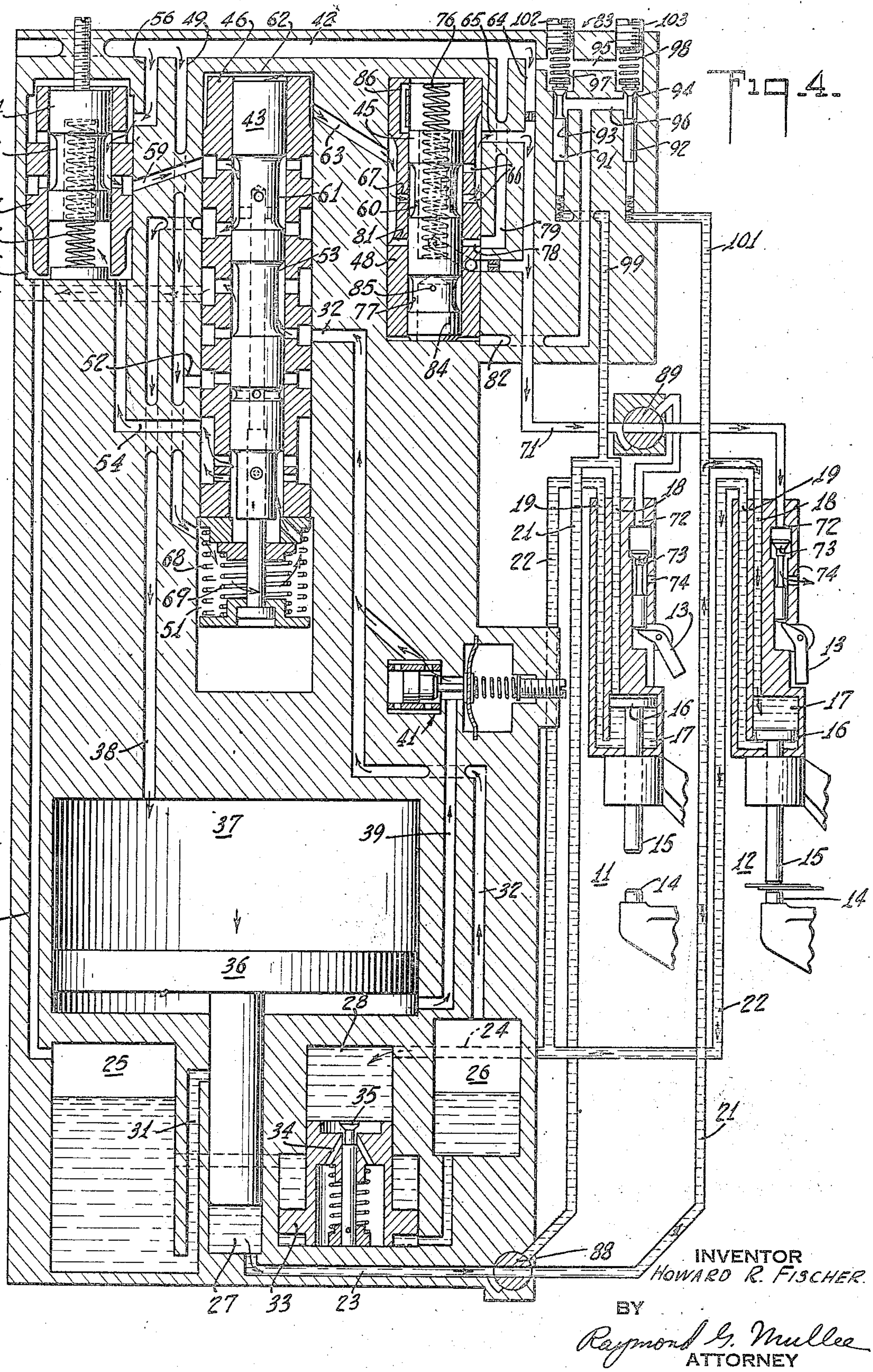

INVENTOR
HOWARD R. FISCHER
BY
Raymond G. Mullee
ATTORNEY

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2,329,709

HYDRAULIC RIVETER

Howard R. Fischer, Detroit, Mich., assignor to Chicago Pneumatic Tool Company, New York, N. Y., a corporation of New Jersey

Application November 23, 1940, Serial No. 366,793

4 Claims. (Cl. 60—54.5)

This invention relates generally to compression riveting and like machines and more particularly to an assembly of this class comprising a power generating unit and a plurality of selectively operable riveting units connected to the power unit.

The principal object of the invention is to obtain such independent pressure control of the several riveting units as to enable each unit to deliver a maximum pressure different from that delivered by the other units.

Another object of the invention is to enable the maximum pressure capabilities of each riveting unit to be varied without affecting the pressure capabilities of any other unit.

A more specific object of the invention is to control the pressure developing means of the power unit through a valve assembly comprising a plurality of independently operable valves each adapted when actuated to disable the pressure developing means, and each controlled by the fluid pressures within a respective riveting unit.

Other objects and structural details of the invention will be more apparent from the following description when read in conjunction with the accompanying drawings, wherein:

Fig. 1 is a perspective view of a riveting assembly of the class described, embodying the mechanism of the invention;

Figs. 2, 3 and 4 are diagrammatic views showing the assembly in its respective normal, intermediate, and fully actuated positions of operation; and

Fig. 5 is a detail diagrammatic view, of an automatic control element and the valve assembly of the invention, showing one of the valves comprised in the assembly in actuated position.

A riveting assembly embodying the invention is shown in Fig. 1 and is seen to comprise a power generating unit 10, and a pair of riveting units 11 and 12 connected to the power unit by separate sets of flexible fluid conducting hose lines. The units 11 and 12 are adapted for manual manipulation, independently of the power unit, and are selected for use alternatively according to the requirements of the work. There may be more than two riveting units, if desired. The power unit 10 operates under the remote control of a trigger 13, one of which is located in each unit 11 and 12, and, during a cycle of operation, delivers oil, or other hydraulic fluid, in two stages of pressure to a selected one of the riveting units. During the first, or low pressure, stage of the cycle the rivet is gripped between stationary and movable dies 14 and 15, and set, while during the second stage the pressure acting on the movable die 15 is intensified and the rivet thereby headed. Restoration of the parts to normal is accomplished automatically when a predetermined pressure is reached within the riveting unit.

Except for the novel features of the present invention the assembly disclosed herein is similar in construction and mode of operation to the assembly disclosed and claimed in the application by H. R. Fischer and E. W. Stevens, Serial No. 305,204, filed November 18, 1939. The principal elements of the old assembly and their general operation are described briefly below. In this summary reference is had to only one riveting unit.

Referring to the diagrammatic drawings, Figs. 2, 3 and 4, the movable die, or rivet set, 15 is illustrated as formed integrally with a pressure responsive piston 16 movable within a chamber 17 in the riveting unit. Opening into the opposite ends of the chamber 17 are passages 18 and 19 through which oil is supplied to the chamber to effect reciprocation of the piston 16. The passages 18 and 19 communicate through associated hose lines 21 and 22 with respective passageways 23 and 24 in the base of the power unit 10. The passageways 23 and 24 serve as outlets for a pair of oil reservoirs 25 and 26 and communicate therewith through respective intermediate piston chambers 27 and 28. Thus, a column of oil originating in the reservoir 25 may be forced from the outlet 23, through the hose line 21 and supply passage 18, to the rear of chamber 17 where it acts on the rivet set piston 16 in a direction to drive it toward the stationary die 14. Similarly, a column of oil originating in the reservoir 26 may be forced from the outlet 24, through the hose line 22 and supply passage 19 to the front of chamber 17 to effect a return movement of the piston 16 away from the stationary die 14.

The hydraulic columns terminating in the rivet set piston chamber 17 are actuated by compressed air acting directly on the oil in the reservoirs 25 and 26. Air is admitted to the upper end of the reservoir 25 through a passage 29 and forces oil through a passage 31 to the pressure chamber 27 from which it passes to the outlet 23. Air is admitted to the upper end of reservoir 26 through a passage 32 and oil is forced into the communicating lower end of the pressure chamber 28 where it actuates a piston 33 to drive the oil ahead of the piston to the outlet 24. As shown in Fig. 4, a set of longitudinal ports 34 in the piston 33 ordinarily permits a free flow of oil between the opposite ends of the chamber 28. A valve 35 closes the ports 34 during actuation of the piston. While the pressure of compressed air acting on the surface of the oil in reservoir 25 is sufficient to move the die 15 into engagement with the rivet it is insufficient to cause the die to upset or head the rivet. Therefore, the pressure developing means includes a booster device in the form of a piston 36 the stem of which extends into the pressure chamber 27 for the purpose of intensifying the pressure of the oil flowing from outlet 23. The relatively large head of the piston 36 moves within a chamber 37 to the upper end of which air may be directed through a passage 38. Operation of the piston 36 serves to force the oil from chamber 27 with great pressure, which pressure is transmitted to the riveting piston 16 through the passages connecting chamber 27 to the rear of piston chamber 17. In the normal retracted position of the piston 36 (Fig. 2) the lower end of the stem thereof lies just above the point of communication between chamber 27 and passage 31. Thus, preparatory to actuation of the intensifying piston, the chamber 27 and connecting passages may be filled with oil and the movable die 15 brought into contact with the rivet by admitting air to the reservoir 25. To return the piston 36 air is introduced into the front of the chamber 37 through a passage 39, this passage being a branch of the previously mentioned passage 32. A pressure reducing valve assembly 41 is disposed in the passage 39 to effect a saving of compressed air.

The flow of air to the reservoirs 25 and 26 and the large compression chamber 37 is controlled by a distributing system acting to initiate automatically the several steps of a riveting operation. Included in the distributing system is a feed line 42, to which compressed air is constantly supplied, and a valve mechanism comprising a distributing valve 43, and a pair of valves 44 and 45, termed the prefill and automatic return valves for reasons which will hereinafter more clearly appear. The valves 43, 44 and 45 are shiftable longitudinally within respective bushings 46, 47 and 48 and settable to a plurality of control positions with respect to passages leading from the supply line 42. One passage so controlled is indicated at 49 and is seen to open into a chamber 51 receiving the lower end of distributing valve 43. A branch 52 of passage 49 registers with a set of ports in bushing 46, and, in the normal position (Fig. 2) of valve 43, directs air around a reduced portion 53 of the valve, and through another set of bushing ports to the passage 32 leading to the return oil reservoir 26. Also, the valve 43 serves normally to close the bushing ports connecting the chamber 51 to a passage 54. The passage 54 leads to a chamber 55 surrounding the lower end of prefill valve 44 and is in constant communication with the passage 29 leading to the reservoir 25. Upon movement of the valve 43 upward to the positions of Figs. 3 and 4 the passage 54, chamber 55 and passage 29 are connected to the live air source through the chamber 51. The passage 38, leading to the intensifier chamber 37, is controlled jointly by the distributing valve 43 and the prefill valve 44. The valve 44 is normally held in the lower position of Fig. 2 by the pressure of air above the valve delivered there by a live air conduit 56 through a narrow opening separating the upper end of the valve bushing 47 from the wall of the enclosing valve chamber. When air is introduced within the chamber 55, below the valve 44, the pressure therein increases and tends to balance the pressure above the valve. When approximate equality of balance is attained, a spring 57 forces the valve upward, this movement being retarded by reason of the necessarily slow displacement of air through the narrow opening around the upper end of bushing 47. As the valve 44 reaches the position shown in Fig. 4, the head thereof uncovers a set of bushing ports communicating with the conduit 56 and air is permitted to flow around a reduced portion 58 of the valve and out another set of ports to a passage 59. The passage 59 conducts the air to a set of ports in the bushing 46 near the upper end thereof. In the uppermost position (Fig. 4) of the distributing valve 43, the air from passage 59 is admitted to the interior of the bushing 46 and directed around a reduced portion 61 of the valve and out another set of ports to the passage 38.

The variable adjustment of the distributing valve 43 is obtained by unbalancing the air pressures at the opposite ends of the valve. A chamber 62 encloses the upper end of valve 43 and bushing 46, and receives live air through a passage 63 connected to the supply line 42 through a series of ports and passages controlled by the automatic return valve 45. A passage 64 leads from the supply line 42 and communicates through a branch 65 and set of ports 66, in the bushing 48, with the interior of the bushing. In the normal lower position (Fig. 2) of the valve 45 a reduced portion 60 thereof lies opposite the ports 66 and air from passage 64 passes around the valve and out a port 67 to the passage 63 and chamber 62. The air pressures above and below the valve 43 being thus normally balanced, a spring 68 is provided in the chamber 51 to urge the valve to the downward position of Fig. 2. In this position of the distributing valve the passages 29 and 38, leading respectively to the reservoir 25 and the upper end of piston chamber 37, are closed while passage 32 and branch 39 thereof are open to hold the respective pistons 16 and 36 in retracted position. If, now, the pressure in chamber 62 above valve 43 be reduced, the valve will be forced upward against the pressure of spring 68. A movement of the valve from Fig. 2 position to the intermediate position of Fig. 3 and fully actuated position of Fig. 4 serves to cut off the passages 32 and branch 39 from the live air source and to permit the flow of air from chamber 51 through passage 54 to chamber 55 and passage 29, leading to reservoir 25. At this time the prefill of the passageways leading to the rear of riveting unit chamber 17 takes place and continues during the period that the prefill valve 44 is moved upward by spring 57. When the valve 44 reaches the open position of Fig. 4 air flows from the conduit 56 to the passage 59 and is permitted to pass around the valve 43 to the passage 38 if this valve has reached fully actuated position. It will be noted that in the intermediate position of Fig. 3 the distributing valve has not reached open position with respect to passage 59 so that air may not be directed to chamber 37 at this time irrespective of the position of the prefill valve 44. It is sometimes desirable that the valve 43 be momentarily held in its intermediate position to insure completion of the prefill operation before actuation of the intensifier piston 36. Therefore, an auxiliary spring 69 is arranged within the chamber 51 and is so disposed with respect to the valve 43 as to be ineffective until the valve reaches intermediate position. At this point the force of the auxiliary spring 69 supplements that of the spring 68 in urging the valve 43 downward. Thus, a greater disparity in pressure at the opposite ends of the valve 43 is necessary to move the valve from intermediate to fully actuated position than is required to move it from normal to intermediate position.

Pressure reductions within the chamber 62 are brought about through exhaust means controlled by the trigger 13 on the riveting unit. The previously mentioned passage 64, leading from supply line 42, is also connected to an air hose 71 placing the supply line in communication with a passage 72 in the riveting unit. A valve 73 is disposed within the passage 72 and is movable by trigger 13 to open position with respect to an exhaust port 74. When the valve 73 is actuated by trigger 13 the air flowing to the riveting unit is free to pass to atmosphere through the port 74. Within the passage 64 and placed between the branch passage 65 and supply line 42 is a metering valve 75 which substantially reduces the rate of air flow to the chamber 62 and the riveting unit. Therefore, when exhaust valve 73 is opened the air escapes from port 74 more rapidly than it can pass through metering valve 75 with the result that a drop in pressure occurs in the air lines between the metering valve and the riveting unit. Chamber 62 communicates with passage 64 at a point within the area of reduced pressure so that the pressure drop is reflected also in the ports and passages leading to the chamber, and in the chamber itself. The extent of pressure reduction in chamber 62 is determined by the extent of actuation given the trigger 13. In initiating a cycle of machine operation the trigger may be fully actuated in a single motion or it may be momentarily held in the partly actuated position of Fig. 3 before completing the full stroke. In the latter instance the initial movement of the trigger will permit movement of the distributing valve 43 to its intermediate position but the pressure drop in chamber 62 will be insufficient to overcome the combined opposing pressures of springs 68 and 69. The valve will remain in intermediate position, therefore, until the trigger 13 is fully actuated and the pressure in chamber 62 thereby further reduced.

In terminating a cycle of operation the return valve 45 is moved upwards from the position shown in Figs. 2, 3 and 4 to the position shown in Fig. 5. This movement is accomplished against the pressure of a spring 76 and serves to place a lower reduced portion 77 of the valve opposite a port 78 aligned with a passage 79 leading from supply line 42. Air at line pressure immediately passes around the valve 45 and out a port 81 communicating with passage 63 and chamber 62. The chamber 62 being thus supplied with live air the pressure therein rises and quickly equals that within chamber 51, whereupon the springs 68 and 69 return the distributing valve 43 to the lower normal position of Fig. 2. This movement serves to cut off the flow of pressure fluid to the passages 29 and 38 and re-establishes the flow through passage 32 and branch 39 to restore the pistons 16 and 36 to their retracted positions. Movement of the return valve 45 to upper position takes place automatically while the trigger 13 is held actuated and is initiated by means forming a part of the invention. This means includes a pressure fluid conducting passage 82 opening into the area surrounding the lower end of the valve 45 and controlled by a valve assembly 83 later to be described.

Pressure from the passage 82 is applied only momentarily to the lower end of the return valve and it is desirable that an auxiliary holding pressure be introduced below the valve in order that the valve may not return to normal prematurely and initiate automatically a second cycle of operation. Holding pressure for this purpose is applied through a longitudinal bore 84, in the lower end of valve 45, to which air is admitted through an opening 85 located in reduced portion 77 of the valve. Thus, live air from the auxiliary passage 79 is directed also below the valve 45 and prevents return of the valve by spring 76. As shown in Fig. 5, while the valve 45 is held in actuated position the upper reduced portion 60 thereof connects the upper one of the pair of ports 66 to a passage 86 opening into the area surrounding the upper end of the valve. By this means the reduced pressure within hose line 71 is established also above the valve 45. The combined force of the spring 76 and reduced air pressure is insufficient to overcome the line pressure below the valve 45 and the valve remains in actuated position as long as the exhaust valve 73 is held open. Upon release of the trigger 13, however, the exhaust valve closes and the pressure in hose line 71 and connecting passages rapidly builds up to full line pressure, whereupon the air pressures at the opposite ends of the valve 45 are balanced and the spring 76 is permitted to return the valve downward to normal position. It is apparent, therefore, that if the operator holds the control valve 73 open longer than necessary, the riveting piston 16 will be restored to normal position but will not start on a new power stroke until the operator closes and then reopens the valve 73.

The selection of one or the other of the riveting units 11 and 12 for use is performed by manual manipulation of a two-way valve assembly 87 (Fig. 1) comprising separate valves 88 and 89 (Figs. 2–4). The valve 88 controls the flow of oil from the high pressure outlet 23 and operates in a conventional manner to connect one or the other of the hose lines 21 to the outlet. The valve 89 is interposed between the compressed air supply line 42 and the riveting units 11 and 12 and is settable like valve 88 to direct air alternatively to the units. Both of the hose lines 22 may be open constantly to receive oil from the return reservoir 26. In the drawings, the valves 88 and 89 are set to condition the unit 12 for operation.

In the riveting assembly disclosed in the prior application above identified a means is provided for actuating the automatic return valve 45 when a predetermined pressure is reached within the intensifier chamber 37. This method of initiating the return stroke, while generally satisfactory, has the disadvantage of limiting both riveting units 11 and 12 to the same peak pressure. Thus when changing from one riveting unit to the other it is necessary to re-adjust the pressure control means if the pressure requirements of the work also change. In order to eliminate to a large extent the necessity for frequent adjustment of the pressure control means, the old control means has been replaced by a new mechanism permitting independent pressure control of each riveting unit. This mechanism includes the valve assembly 83 (Figs. 2–4) comprising a pair of valves 91 and 92 movable within respective bores 93 and 94 communicating through a common passage 95 with the supply line 42. A second passage 96, common to the bores 93 and 94, is connected to the previously mentioned passage 82 and the valves 91 and 92 serve to control the flow of air from passage 95 to the passage 96. Each valve is pressed to the seated or closed position of Figs. 2–4 by a respective spring 97 and 98 and so normally prevents the flow of air through passage 82 to the lower end of return valve 45. The shank or stem of each valve 91 and 92 is formed as a plunger and has a sliding fit within its respective bore 93 and 94. Opening into the lower end of the bores 93 and 94 are respective passages 99 and 101 communicating at their opposite ends with the high pressure oil hose lines 21, the passage 99 being connected to the hose line associated with riveting unit 11 while passage 101 is connected to the hose line associated with unit 12. During the prefill operation, therefore, one of the passages 99 or 101 is filled with oil and the subsequent intensified pressure delivered through the hose line 21 is reflected also in the communicating passage 99 or 101. When the pressure within this passage becomes sufficiently high to unseat its associated valve 91 or 92, live air is permitted to pass from the supply line 42 to the area below the valve 45 whereby this valve is shifted upward and the return stroke initiated in the manner previously described. The valves 91 and 92 may thus be termed pressure relief valves since their operation terminates the application of intensified pressure within the riveting unit. Actuation of the relief valves is resisted by the springs 97 and 98 and the pressure of these springs may be independently increased or diminished at will through adjustment of respective associated set screws 102 and 103. Thus, a variable resistance may be imparted to each valve 91 and 92. By way of example the valve 91 might be caused to resist actuation until a pressure of 5,000 pounds per square inch is reached in the piston chamber 17 of unit 11, while the valve 92 is set for actuation when the pressure within unit 12 reaches 1,250 pounds per square inch.

The above pressure control mechanism is shown also in Fig. 1 where the pressure relief valve assembly 83 is shown mounted on the head of the power unit 10. The passages 99 and 101 are represented, in this embodiment of the invention, as pipe lines arranged outside the unit and connected to the hose lines 21 beyond the two-way valve assembly 87. The passage 95 for conducting live air to the valve assembly 83 is also indicated as a conduit outside the unit.

While the invention has been disclosed with particular reference to a riveting machine, it is susceptible of embodiment in machines for other uses, such as pressing, pulling, crushing, punching and embossing.

What is claimed is:

1. A riveting assembly, comprising a hydraulic system for effecting operation of said assembly, said system terminating in separate pressure fluid conduits, a pressure fluid operated booster device within said hydraulic system, means for terminating operation of said booster device to release the pressure in said system, said means including a control element adapted when actuated to condition said means for operation, a passageway leading to said control element to permit actuation of said element by the force of pressure fluid, a valve assembly controlling the flow of pressure fluid through said passageway, said assembly comprising a plurality of independently operable valves each adapted when operated to open said passageway to the flow of pressure fluid, and pressure responsive means associated with each of said valves and communicating with a respective one of said separate pressure fluid conduits for operating said valves.

2. A riveting assembly according to claim 1 characterized by independently operable means associated with each of said valves for imposing a variable resistance to the operation thereof.

3. A riveting assembly, comprising a plurality of piston chambers, a source of pressure fluid, separate pressure fluid conducting lines leading from said source to said piston chambers, a booster device for intensifying the pressure in said fluid lines and thereby in said piston chambers, settable means for controlling said booster device adapted in a first position to initiate operation of said device and in a second position to terminate operation of said device, pressure fluid means for moving said settable means to its said second position, a pilot valve for controlling said pressure fluid means, and pressure responsive independently operable means communicating with each of said piston chambers for initiating actuation of said pilot valve when the pressure in its associated piston chamber reaches a predetermined peak.

4. A riveting assembly, comprising a plurality of piston chambers, a source of pressure fluid, separate pressure fluid conducting lines leading from said source to said piston chambers, a pressure fluid operated booster device for intensifying the pressure in said fluid lines and thereby in said piston chambers, a distributing valve having a normal position in which it disconnects said fluid lines from the pressure fluid source and prevents the supply of fluid to said booster device, said distributing valve being settable in step-by-step fashion to first and second positions and acting on the first step to connect said fluid lines to said pressure fluid source and acting on the second step to admit pressure fluid to said booster device, means for returning said distributing valve to normal in a single step to release the pressure in said fluid lines, a control element adapted when actuated to initiate return movement of said distributing valve, pressure fluid means for actuating said control element, a valve assembly controlling the flow of pressure fluid to said control element, said assembly comprising a plurality of independently operable valves each adapted when operated to permit the flow of fluid to said control element, and pressure responsive means associated with each of said valves and communicating with a respective one of said piston chambers for operating said valves.

HOWARD R. FISCHER.