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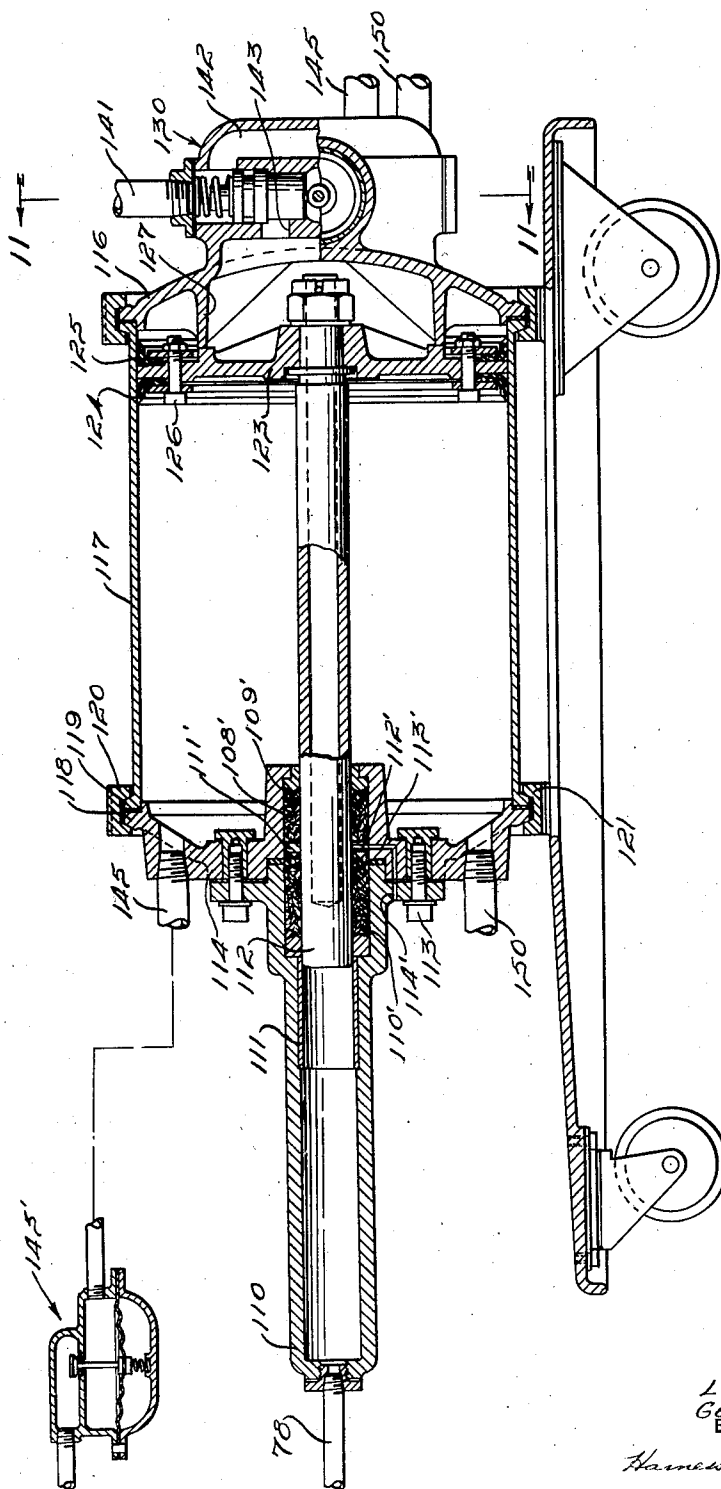
L. C. HUCK ET AL

2,053,718

RIVET SETTING MACHINE

Original Filed June 6, 1932

3 Sheets-Sheet 2



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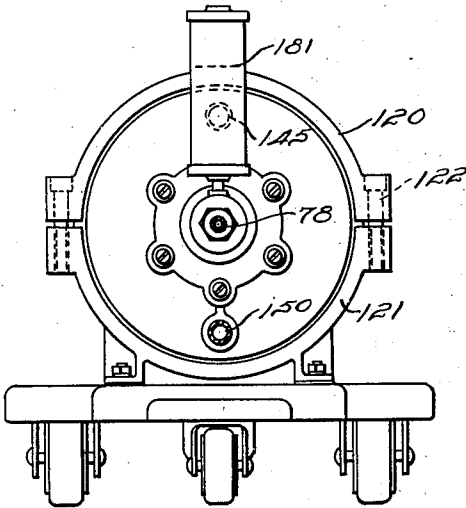


FIG. 9.

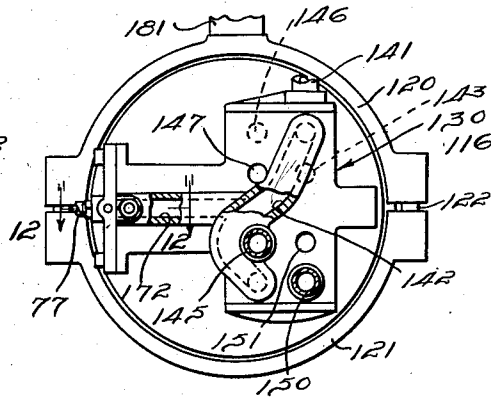


FIG. 10.

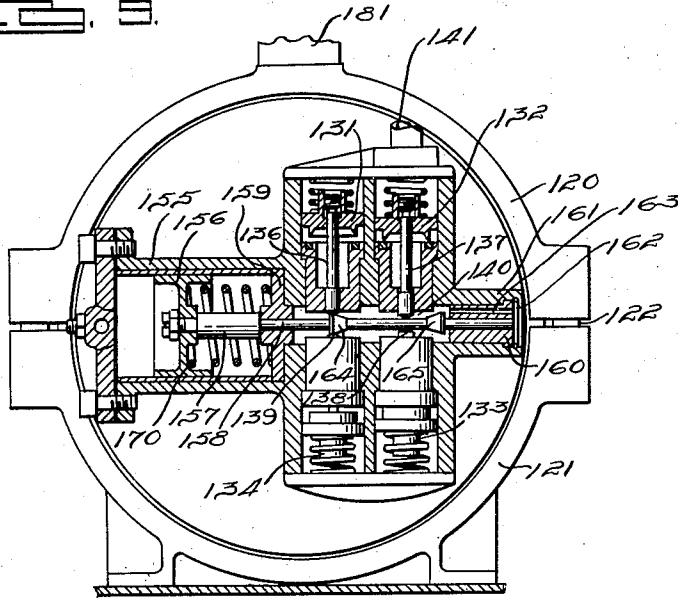


FIG. 11.

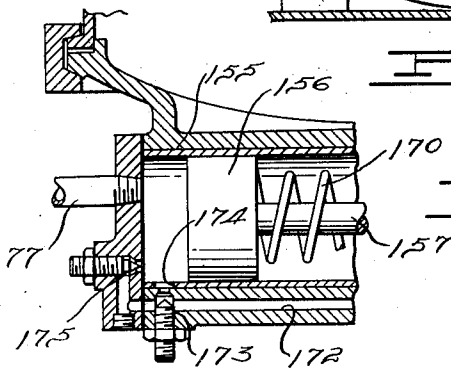


FIG. 12.

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UNITED STATES PATENT OFFICE

2,053,718

RIVET SETTING MACHINE

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Application June 6, 1932, Serial No. 615,544
Renewed November 25, 1935

36 Claims. (Cl. 218—19)

The invention relates to fastening mechanisms and it has particular relation to an apparatus for applying rivets to structural elements for securing them together.

5 The machine illustrated and hereinafter described particularly is adapted to set rivets of the general type shown and described in the co-
10 pending application for patent of Louis C. Huck relating to rivets, Serial No. 545,004, filed June 17, 1931. The rivet may comprise a female member having a tubular body portion and a rivet
15 head preferably initially formed at one end thereof, which cooperates with a male member extending longitudinally therethrough and which
20 has a head at one end engaging that part of the female member opposite the head thereon. The rivet as thus assembled may be inserted through openings in a plurality of structural elements to be connected thereby, until the rivet
25 head, on the female member engages the side of the structure adjacent thereto. The shank of the male member projects outwardly from the rivet head of the female member and by pulling it
30 through the female member in a direction outwardly from the head of the latter, and applying the reactionary force of such manipulation to the
35 head of the female member, the end body portion of the latter may be formed with a head at the opposite side of the structure.

One of the objects of the present invention is to provide a light, compact and sturdy rivet-
40 setting machine or gun for setting rivets of the general character previously described, which may be readily and easily supported and manipulated with the hand, so that an operator may set
45 rivets particularly of large size, rapidly without requiring the exercise of fatiguing manipulation. A machine or gun of this character will enable
50 one operator to set a very large number of rivets without necessitating periodic cessations of operation and accordingly will reduce the riveting expense considerably.

Another object of the invention is to provide a fluid pressure booster system for a rivet setting mechanism, to the end that fluid under an
45 extremely high pressure may be supplied to a small rivet setting gun, to thereby avoid the use of an unwieldy, larger, and heavier gun that would operate under a very much smaller fluid
50 pressure to obtain generally the same results.

Another object of the invention is to provide a rivet setting mechanism employing fluid under pressure, which is so constructed and arranged
55 that there will be a minimum loss of the fluid during rivet setting operations.

Another object of the invention is to provide a rivet-setting system in which a small, light, and compact rivet setting gun may be employed, using fluid under very high pressure to attain the necessary rivet setting force with a small, 5
light gun, by providing a booster system that does not have to be carried by the hand of the operator, for greatly increasing the effective pressure of the fluid in an ordinary fluid supply line, from which it follows that the gun may have 10
minimum size and weight and hence may be used more efficiently for setting rivets without tiring the operator.

Another object of the invention is to provide a system of the last mentioned character which 15
may be entirely governed by control means on the rivet setting gun and accordingly controlled at will by the operator manipulating the gun regardless of the location of the booster or pressure increasing mechanism. 20

And in general it is an object of the invention to provide a rivet setting apparatus and system which enables making the rivet setting gun as small and light as possible, while still practically obtaining the necessary forces required for set- 25
ting rivets particularly of large size, to the end that an operator of the gun may set rivets rapidly and with precision without tiring and fatiguing manipulation of the gun.

For a better understanding of the invention, 30
reference may be had to the accompanying drawings, constituting a part of the specification, in which:

Figure 1 is a longitudinal cross-sectional view of a rivet setting gun constructed according to 35
one form of the invention;

Fig. 2 is an end view of the gun shown by Fig. 1, as seen from the left end thereof;

Fig. 3 is a cross-sectional view on a larger scale taken substantially along the line 3—3 of Fig. 1; 40

Fig. 4 is a cross-sectional view on a larger scale taken substantially along the line 4—4 of Fig. 1;

Fig. 5 is a similar cross-sectional view taken substantially along the line 5—5 of Fig. 1;

Fig. 6 is a cross-sectional view on a larger scale, 45
taken substantially along the line 6—6 of Fig. 1;

Fig. 7 is a cross-sectional view illustrating one form of rivet which may be set by the gun shown in Fig. 1, and the manner in which the rivet is initially associated with the structure to be 50
riveted;

Fig. 8 is a longitudinal cross-sectional view of a booster mechanism for obtaining a higher fluid pressure for operating the rivet gun, than that ordinarily present in usual fluid pressure lines; 55

Fig. 9 is an end view of the construction shown by Fig. 8, as seen from the left end thereof;

Fig. 10 is a fragmentary view of the other end of the mechanism shown by Fig. 8, with certain parts broken away and shown in cross section for the purposes of clarity;

Fig. 11 is a cross-sectional view on a larger scale taken substantially on the line 11—11 of Fig. 8;

Fig. 12 is a cross-sectional view on a larger scale, taken substantially along the line 12—12 of Fig. 10;

Fig. 13 is a cross-sectional view on a larger scale, taken substantially along line 13—13 of Fig. 1.

A form of rivet which may be set by using the mechanism illustrated is shown by Fig. 7, and comprises a tubular female member 10 having a head 11 at one end, and a male member 12 extending through the female member and having a head 13 engaging that end of the latter opposite the head 11. Such male member projects beyond the head 11 and is provided with a grooved or threaded gripping portion 14, by means of which the male member may be pulled relative to the female member while holding the head 11 stationary and against the structure being riveted. In this instance the structure being riveted comprises plates 15 and 16 having coinciding openings adapted to receive the rivet and it will be understood that the rivet may be inserted through such openings from the outer side of plate 15 and that it may be set from the same side of the structure by pulling the male member and holding the head 11 against the structure. When this operation is effected a bulb 17 shown in broken lines, is formed from the tubular portion of the female member between the head 13 and the plate 16 which serves as a head against the inner side of the structure. It might be added that in the construction illustrated, the female member is provided with an end portion 18 of reduced radial thickness which is initially bulbed during the rivet setting operation as indicated at 19, to provide a reinforcement for the end of the female member during formation of the bulb 17. The male member also has a groove 20 which ordinarily will be located substantially at the outer surface of the head 11 on the female member after the rivet is set and this groove is provided to so weaken the male member at this point, that a continued pull thereon will break it substantially at the outer surface of the head 11.

Now, referring to Fig. 1, the rivet setting gun, comprises a casting 22 having a cup-shaped portion 23, the side wall of which receives a cylinder bearing sleeve 24. A reciprocatory rod 25 projecting into the cylinder and through a piston 26 has a head 27 at its inner end engaging one side of the piston, and a threaded portion 28 at the other side of the piston. A lock nut 29 threaded on the portion 28 serves to hold the piston against the head 27, and such nut may be prevented from accidental turning by means of a wire extending partially around the nut in a groove therein, and projecting radially there-through and into an opening in the threaded portion of the rod. Cup washers 31 and 32 mounted on the outer marginal portion of the piston and secured thereto by bolts or fastening means 33, engage the bearing sleeve 24 in the cylinder. Outwardly of the cylinder, the rod 25 slidably projects through a casting 35, secured by bolts 36 to the marginal, open end portion of the cylinder, and such casting has a central opening substan-

tially larger than the rod to accommodate sealing packing 37 which is held in place and contracted about the rod by means of a collar 38 in the inner end of the casting, and a bushing 40 threaded into the casting and against the pack-

ing. A casting 41 and a barrel 42 are secured to casting 35 by bolts 43 and within the barrel, the end of rod 25 is threaded into a head 44 having an enlarged cylindrical portion 45 slidable in the barrel. At this time, attention is directed to the provision of radial openings 39' in piston 26 which open outwardly to the cylinder wall 24 between the cup washers 31 and 32, and a peripheral groove 40' on the rod 25 within the piston, which communicates with the radial openings. A radial opening 41' also is provided in the rod at this point, which communicates with groove 40' and an elongated opening 42' in the rod, terminating at the left of packing 38 in a radial opening 43' opening into the barrel. An opening 44' in the barrel permits communication of all of these openings to the atmosphere, and particularly results in atmospheric pressure between cup washers 31 and 32, so that any air at the right side of piston 26 getting past washer 32 will become atmospheric in pressure, and would then not normally get past washer 31 into the oil.

The enlarged portion 45 of head 44 as shown by Fig. 13, has a side opening slot 46 at its opposite end, which is enlarged at its inner terminus as indicated at 46' for releasably receiving a pin 47 having a head 48 disposed in the enlarged portion of the slot. It will be noted that the axial length of the head 48 of pin 47 is less than the axial length of the enlarged portion 46' of the slot so that the head 44 may have limited axial movement relative to the pin. The pin is threaded into a member 49 in such relation thereto that when the head 44 engages the left side of the head 48, as when the rod 25 is pulled to the right, a space 50 will be provided between the head and member 49, which is at least as long axially as the space indicated at 50' between the head 48 and the right end of the enlarged part 46' of slot 46. For normally urging the member 49 and pin 47 away from the left end of head 44, a spring 51 is provided between the bushing 40 and the portion 45 of the head, which engages a loose collar 52 at the inner side of the portion 45, and this collar in turn presses against the ends of pins 53 loosely passing through such portion and engaging the end of member 49. The inner end of the member 49 has its outer surface threaded to receive the internally threaded end of a sleeve 54, which in its normal position abuts a collar 55 on the inner end of the member. To prevent turning of the sleeve 54 with respect to the member 49 and also to prevent turning of the sleeve and rod with respect to the barrel 42, a key 56 is slidably mounted in a keyway 57 formed in the inner surface of the barrel, and coinciding keyways in the collar 55 on member 49 and in the end wall of the sleeve 54 adjacent thereto.

The outer end of the sleeve 54 as best shown by Fig. 3, has three jaw receiving sockets 58, 59 and 60, each of which is defined by a surface of cylindrical character. The surfaces defining these sockets, while cylindrical, have their respective axes inclined with respect to the center line of the sleeve 54, and converging toward the outer end of the sleeve. Furthermore, the outer end of each socket preferably is defined by an arc less than semi-cylindrical, whereas inwardly of the end and as shown by Fig. 4, each socket is

defined by a gradually larger arc, which for a substantial distance is greater than semi-cylindrical. Each of the sockets receives a jaw 60' having an inner, curved gripping surface 61 having annular or spiral threads or grooves for gripping the threaded or grooved portion 14 of the male rivet member, and an outer cylindrical surface substantially complementary to the socket in which it is disposed. Like the socket, the cylindrical surface of the jaw preferably has a portion of greater than semi-cylindrical character so that the jaw is dovetailed into its socket. It should be understood therefore, that each jaw may move longitudinally in its socket parallel to the axis of the latter and that during such movement, the gripping surface 61 will be maintained parallel to the axis of the sleeve.

As shown by Figs. 1 and 5, the jaws are normally urged toward the outer ends of their sockets, by means of a three-legged stool 62 having legs 62' projecting into the respective sockets and engaging the jaws. For urging the stool in such direction that the legs thereon urge the jaws toward the outer end of the sleeve, a helical spring 63 is provided between the sleeve 54 and the inner end of the member 49, and around a reduced portion 64 of the latter, and this spring abuts the member 49 at one end and the stool at its other end. The outer end of the barrel 42 is provided with an anvil 65 retained within the end of the barrel by swaging or spinning a flange on the latter indicated at 65', around the side wall of the anvil. The anvil has a central opening 66, the axis of which coincides with the axis of the sleeve 54 and the axis of the assembled jaws 60', and at the outer extremity of this opening, it has a conical recess 67. In setting one of the rivets, the rivet is either initially associated with the gun or with the structural plates 15 and 16, and then the gun is brought into its operative position with respect to the structure and when the parts are thus arranged, the portion of the male member projecting beyond the head 11, extends through the opening 66 in the anvil plate and between the jaws 60'. The conical recess 67 is adapted to engage the head 11 on the female member. Normally when the male rivet member is inserted through the anvil plate and between the jaws, it will first push the jaws rearwardly against the action of the spring 63, and in view of the dovetail arrangement of jaws and sockets, the jaws may expand until the male member is properly disposed between them and then the grooves on the jaws and male member will properly engage each other. The spring 63 applies slight gripping pressure to the jaws 60' and then when the piston 26 moves to the right, the jaws are tightly clamped about the male rivet member and then moved with the sleeve 54, while the reactionary force is applied to the barrel and anvil 65 to the head 11 on the female member. As a consequence the bulbs 19 and 17 are formed from the tubular portion at the inner side of the structure and after their formation the jaws continue to pull the male member until it breaks at the groove 20 as previously described. For removing the broken part of the male member, the stool 62 has a central aperture, the member 49 has a similar aperture, and the sleeve 54 and barrel 42 have apertures 68 and 69 in their side walls through which the broken rivet member may fall. The recoil of the jaws after the male member breaks will assist in freeing them from binding engagement with member 54, and in fact such recoil may be sufficient to so throw the broken male

part into the recess in the member 49 that it may fall out of the barrel, but ordinarily the broken male member will be retained between the jaws and it and the jaws may be pushed rearwardly without difficulty upon inserting another rivet thereinto to expand the jaws and allow the broken part to pass on through the jaws. In either event the broken male member portion passes through the jaws, stool and member 49 and then laterally through the sleeve 54 and barrel 42. It may be noted that the anvil 65 has a boss on its inner surface indicated at 70 which may be employed to limit the outward movement of the jaws although normally when the rivet is between them the jaws will not be in engagement with the boss.

Normally the parts are so related and arranged that with the sleeve 54 substantially engaging the anvil 65, the piston 26 will be spaced from the casting 35, as indicated at 70', with the head 44 engaging the pin head 48 as shown, to leave spaces 50 and 50' at the right side of the member 49 and head 48 respectively, so that the piston could move to the left the axial length of the space 70' without striking a stop. This position of the piston is preferred as will hereinafter be explained.

For operating the piston 26 in the cylinder, an arrangement has been provided in which preferably oil or similar fluid will be allowed to flow into the cylinder at the left side of the piston, under extremely high pressure, to operate the rivet gun in setting a rivet, whereas the opposite side of the piston preferably will be in communication with a fluid pressure line such as a compressed air line. This air line and oil line are indicated respectively at 75 and 76 and together form a part of the casting 22, and communicate at their other ends with flexible conduits 77 and 78 respectively. The casting 22 also includes a part 79 which in conjunction with the portion of the casting in which the air line 75 is located, constitutes a handle 80 for manual manipulation of the gun. Hand and finger grips 81 and 82 may be provided for enabling an operator to handle the gun efficiently. For controlling the air line, a trigger 84 is provided which is pivoted as indicated at 85 to lugs on the casting, and such trigger is normally held in its inoperative position by means of a spring 86. Adjacent its pivot, the trigger is provided with a cam portion 87 which, when the trigger is pulled, is adapted to engage and push a valve pin 88 forming part of a valve 89. The opposite end of the pin is adjustably threaded as indicated at 90 into a valve disc 91 having a marginal edge 92 of sharp character adapted to engage a sealing ring 93 disposed in a groove in a valve seat and valve sleeve member 94. This sleeve and valve seat element is held in place in an opening in the casting provided therefor by means of a threaded cap 95 which has openings 96 at opposite sides to avoid interruption of the air line 75. The valve 91 at circumferentially spaced points has side ribs 97 adapted to slidably engage the inner surface of the sleeve 94, and to permit fluid to flow through the valve. The outer end of the pin 88 engages a screw head 99 threaded into the disc 91 so that the pin and disc may be locked in any adjusted position. Normally, the valve is held in a closed position by means of a helical spring 100 seating against the cap 95 and against the outer face of the valve disc 91. Below the valve seat the sleeve 94 has a laterally extending opening 101 communicating with the atmosphere so that when 75

the valve is open the air line 75 is open to the atmosphere.

Now referring to Fig. 8, it will be noted that the oil line 78 is connected to one end of an elongated, relatively small barrel 110, and the latter, the conduit 78, the passageway 76 in the gun, and the space at the left side of the piston 26, normally are filled with the oil or a suitable other liquid. Adjacent its opposite end, the barrel has a bearing sleeve 111 which serves as a bearing for a plunger 112 reciprocatory in the barrel, and such barrel is secured by means of bolts 113 to a cylinder head 114. A second cylinder head 116 is spaced from the head 114 and between the heads, a cylinder wall 117 is secured, by means of outwardly turned flanges 118 and 119, having outwardly converging side surfaces, and semi-circular clamping rings 120 and 121 employed to draw the wall and cylinder head tightly together. The rings 120 and 121 as shown by Figs. 9, 10 and 11, are clamped together at their ends by means of bolts 122.

Packing 108' is provided in the barrel and cylinder head along the plunger to prevent the escape of fluid along the latter, and this packing preferably includes several rings 109', concave in cross section, disposed next to cylinder 117, and several reversely disposed rings 110' next to the barrel 110. The rings 109' are peculiarly adapted to prevent air in cylinder 117 from flowing past the plunger into the barrel 110, whereas rings 110' are better adapted to prevent the escape of oil into the cylinder 117. To further assist in preventing air from cylinder 117 from flowing into the barrel 110, a metal ring 111', radially apertured as indicated at 112' is disposed between certain of the rings 109' and the apertures 112' communicate by means of openings 113' and 114' in the cylinder head 114 and barrel flange to the atmosphere. Accordingly, should air from cylinder 117 flow past some of the packing rings 109', it would then become atmospheric in pressure. Accordingly, any air tending to get past packing rings 110' will be atmospheric in pressure, and normally such packing rings will prevent air under such pressure from entering the barrel.

When the plunger 112 is moving to the left, the oil will be under considerable pressure, and this pressure naturally would also prevent air from passing packing rings 110'. When the plunger is moving to the right, the oil in the barrel may be under pressure also as a result of air pressure at the right of piston 26, subjecting the oil at the left thereof to similar pressure, and forcing it into the barrel 110. This pressure ordinarily may be more than atmospheric, but even if it were less, the packing 110' would prevent the atmospheric air around openings 112' in collar 111' from getting into the barrel.

Referring again to Fig. 8, the inner end of plunger 112 is secured to a piston 123 which at its outer margin is provided with leather or other suitable cup washers 124 and 125 secured to the margin of the piston by means of bolts 126. It will be noted that the piston 123 in its extreme right end position may engage abutments 127 on the inner side of the head 116, and that a space is provided between the piston and head.

It might be explained at this time that the area of the piston 123 is very much greater than the area of the end face of the plunger 112 in the barrel 110, and it follows that if fluid under pressure flows into the space between the head 116 and the piston 123, to move the piston to the left,

the pressure on the oil or fluid in the barrel 110 and hence at the left side of the piston 26 in the rivet gun shown by Fig. 1, will be very much greater. In this manner an air pressure at the right side of piston 123 may be transformed into a pressure on the oil in the barrel at a very much higher pressure, as for example, from an 80 pound per square inch air pressure to a three thousand pound per square inch oil pressure in the barrel.

Now referring to Figs. 8, 10 and 11, it will be noted that the cylinder head 116 is integral with a valve housing 130 located at its outer side, and this housing encloses four valves 131, 132, 133 and 134, the valves 131 and 132 being disposed above and spaced with respect to the valves 133 and 134. Such valves are similar to the valve employed in the rivet gun previously described, and include pins 136, 137, 138 and 139, the ends of which project into an elongated space 140 between the valves. The space in valve 132 above the valve seat therein, is in communication with a flexible air pressure line 141 which may be connected to any suitable source of compressed air or for that matter other fluid pressure. Now as best shown by Figs. 8 and 10, the space above the valve seat in valve 132 also communicates by means of a by-pass 142 to the space at the lower side of the valve seat in valve 134. Therefore, both valves 132 and 134 at that side of the valve opposite the valve seat, are in direct communication with the air supply line 141. The space in valve 132 below the valve seat therein, communicates by means of a passageway 143 shown by Figs. 8 and 10, directly with the space between the cylinder head 115 and the piston 123. The space at the upper side of the valve seat in valve 134 communicates by means of a pipe 145 with the space at the left side of the piston 123, as seen by Fig. 8, and preferably a pressure reducing valve 145' will be used in this line, to minimize the amount of air used in moving piston 123 to the right, following the rivet setting operation. The space at the upper side of the valve seat in valve 131 communicates directly with the space at the inner side of the cylinder head 116, by means of an opening 146, shown by Fig. 10, extending through the valve casing wall to the inner side of the cylinder head, similarly to the opening 143. The space at the lower side of the valve seat in valve 131 communicates directly with the atmosphere by means of an opening 147 as shown by Fig. 10. The space at the lower side of the valve seat in valve 133 communicates by means of a conduit 150 with the left side of the cylinder 123 as shown by Fig. 8, while the space at the opposite side of the valve seat in this valve, communicates directly with the atmosphere by means of an opening 151 shown by Fig. 10.

For operating the valve as seen in Fig. 11, a portion of the valve casting 130 comprises a cylinder 155 having a piston 156 therein, connected to a piston rod 157. The latter has a reduced portion 158 slidably extending through a bearing plate 159 at the right end of the cylinder, and such reduced portion extends through the space 140 between the upper pair and lower pairs of valve stems. The opposite end of the stem is slidably mounted in a bushing 160, releasably secured in an offset portion 161 of the valve housing, by means of a split ring 162 seated in a groove in the wall of the offset portion. To prevent the building up of any air pressures in the space 140, the bushing 160 has a vent 163 communicating with such space and the atmosphere. In such space 140, the reduced rod portion 158 is provided

with oppositely disposed conical portions 164 and 165 so spaced that the portion 164 may engage and open the valves 131 and 134 while the other valves remain closed, and the portion 165 may open the valves 132 and 133 while leaving the valves 131 and 134 closed. A spring 170 at the right side of the piston 156 normally tends to urge it to the left end of the cylinder and hence to open valves 132 and 133 and to close valves 131 and 134. The space in the cylinder 155 at the left side of the piston as best shown by Figs. 10 and 12, communicates with the conduit 77 extending to the air line 75 of the rivet gun. Also through a wall of this cylinder at the left end thereof, air under pressure may flow from the by-pass 142 in the valve shown by Fig. 10, through a passageway 172 and an adjustable valve 173 controlling the effective size of an opening 174 in the wall of the cylinder. The passageway 172 also communicates with a metering valve 175 which permits a very small flow of air into the left end of the cylinder. It will be noted that the passageway 174 will be closed when the piston 156 has moved a certain distance to the left and when this is closed, it will be apparent that the metering valve 175 will still permit a small flow of air into the space at the left side of the piston.

It should be understood that the space at the left of piston 26, the passageway 78, the conduit 73 and barrel 110 are filled with oil, and this may be effected by removing a plug 180 threaded into casting 35. When the oil space is filled, it is preferred, as stated previously, that piston 26 be spaced as indicated at 70', from casting 35 as this relation allows member 54 in the barrel 42 to substantially engage anvil 65. While a greater space 70' would result in member 54 slightly leaving the anvil 65, this would still normally permit operation of the gun. The space 70' permits, if necessary, movement of the piston 26 to the left, to compensate for any oil loss, although normally little if any oil will escape. Should oil escape, it may be readily replaced through plug 180, so that at practically all times the desirable amount of oil in the system may be maintained. Having an arrangement and quantity of oil which leaves piston 26 spaced from casting 35 when piston 123 is at the right end of its stroke, also insures that the oil at the left of piston 26 will be under pressure when air is moving the latter piston to the left. While this pressure on the oil then is similar to the air pressure at the right of piston 26, it is greater than atmospheric pressure and accordingly any air getting between the cup washers 31 and 32 will be kept out of the oil space at the left of the piston. Keeping air out of the oil system is preferable as the fluid therein may then be maintained substantially incompressible.

The operation of the system will now be described, assuming that the parts are in their respective positions as shown in the figures and a rivet to be set has been inserted between the jaws of the gun and through the openings in the structure to be riveted. The piston 26 in the gun is to the left of the cylinder 24 while the piston 123 in the booster shown by Fig. 8 is at the right end of the cylinder. Also it will be noted that the air under pressure line 141 through the by-pass 142, and the passageway 172 as shown by Fig. 10, is connected to the conduit 77 and hence air under pressure is at the right side of the piston 26 in the rivet gun. Now upon pulling the trigger 84 of the gun, the valve disc 91 is unseated thus connecting the passage 75 to the atmosphere through the opening 101. This will allow air

to exhaust from the right side of the piston 26, and from the passageway 75 and cylinder 155 and hence for an instant will directly connect the air line 141 with the atmosphere. The reduction in pressure that follows at the left side of the piston 156 is such that the spring 170 causes the piston to move to the left and this movement will occur until the piston practically reaches the left end of the cylinder, although a slight air pressure may prevent engagement of the piston with the end of the cylinder. This movement of the piston closes the port 174 and therefore prevents the escape of any large quantity of air under pressure to the atmosphere although the air line still will be connected to the atmosphere through the small metering valve 175 but this is not objectionable because the amount of air escaping will be small. The movement of the piston causes the piston rod 157 and hence the valve operating elements 164 and 165 to move to the left and this will result in a closing of valves 131 and 134 and an opening of valves 132 and 133. As valve 132 opens, the air line is connected directly to the right side of the piston 123 while the left side of the piston through the conduit 150 will be opened to the atmosphere. Air under pressure then will flow against the piston 123 and cause it to move to the left and the oil in the barrel 110 and in the parts of the rivet gun at the left of the piston 26 will be subjected to pressure by the plunger 112. The high pressure of the oil naturally will cause the piston 26 to move to the right and during its movement the rivet will be set in the manner previously indicated. Following setting of the rivet, and release of the trigger 84, the valve 91 will close thus closing the opening 101 to the atmosphere which allowed the air in the conduit 77 and at the left side of the piston 156 to exhaust. Shortly thereafter, enough air will have metered through the valve 175 to move the piston 156 to the right sufficiently to open the port 174 when a more rapid movement of the piston against the action of the spring 170 will occur and as a result valves 132 and 133 will close and valves 131 and 134 will open. As valve 134 opens, air under pressure flows through the conduit 145 to the left side of the piston 123 and air at the right side of the piston 123 will exhaust through the opening 146, then through the valve and through the opening 151 communicating with the atmosphere. As a result the piston 123 will move to the right and owing partly to this movement, and to the air pressure on the right side of piston 26, the latter will move to the left and the oil will flow in a reverse direction into the barrel 110 as the plunger moves to the right end thereof. It is manifest that little pressure will be required to move the piston 123 to the right and that the pressure of the fluid need not be high, and that in reducing the pressure of the fluid as it flows through the valve 145', a very much smaller quantity of air is used to return the parts to their normal and inoperative positions.

It will be evident from the foregoing description that a highly efficient system for applying rivets of the general character described has been provided to the end that rivets may be set efficiently and rapidly by a single operator. It is apparent that the rivet gun provided may be very light, small, and compact, and that it may be readily operated by a single operator who may hold it without difficulty. It is also apparent that an extremely high pressure for operating the rivet gun may be obtained and this is also instrumental in permitting the use of a light, compact

gun inasmuch as the piston and cylinder in the gun need not be large because of the extremely high oil pressure obtainable. It is moreover apparent that the operation of the entire system is controlled by a single trigger which the operator may manipulate by the same hand that grips the gun. In a system of this character it is quite probable that the gun will be operated at a considerable distance from the booster shown by Fig. 8 although the latter may be moved along by means of a platform and a castor and wheels upon which it may be mounted. In lieu of mounting the booster shown by Fig. 8 on a platform or other support, it is quite possible that it might be carried by the operator on his back although ordinarily it probably will be mounted so that it may be moved from place to place without difficulty. The system of course is highly advantageous in that a single operator may set rivets large or small with maximum speed for the reason that he has a highly efficient type of gun, and that it is light, wieldy and readily manipulated without fatiguing effort.

Although only one form of the invention has been described and illustrated in detail it will be apparent to those skilled in the art that various modifications may be made without departing from the scope of the appended claims.

We claim:

1. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, fluid pressure responsive means in the mechanism for gripping the shank and pulling it, means on the mechanism for applying the reactionary force to the tubular member, a fluid pressure supply line, a remote pressure boosting device connected to the supply line, fluid pressure line connections between the device and mechanism, and means on the mechanism for controlling the rivet setting operation and operation of the pressure boosting device.

2. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, fluid pressure responsive means in the mechanism for gripping the shank and pulling it, means on the mechanism for applying the reactionary force to the tubular member, a conduit connected to the mechanism at one side of the fluid pressure responsive means, fluid receiving means remote with respect to the mechanism and connected to the conduit, means cooperating with the last means for forcing the fluid therefrom or drawing the fluid thereinto, to operate the fluid pressure responsive means in the mechanism, and means on the mechanism for governing such cooperating means.

3. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, fluid pressure responsive means in the mechanism for pulling the shank, means on the mechanism for applying the reactionary force to the tubular member, a conduit connected to the mechanism at one side of the fluid pressure responsive means, means remote with respect to the mechanism and connected to the conduit for receiving fluid under pressure, means cooperating with the last means for causing a reciprocatory movement of the same fluid in the conduit, and means on the mechanism for controlling the flow of said fluid.

4. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubu-

lar member and a shank extending therethrough, fluid pressure responsive means in the mechanism for gripping and pulling the shank, means on the mechanism for applying the reactionary force to the tubular member, fluid pressure responsive means remote with respect to the mechanism, a fluid pressure supply line connected to the last means at one side thereof, a conduit connected to said last means at the other side thereof and also connected to the fluid pressure responsive means in the mechanism, and means for controlling operation of the remote fluid pressure responsive means including an operable element on the mechanism.

5. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, movable means in the mechanism for gripping the shank and pulling it, means for applying the reactionary force to the tubular member, fluid pressure responsive means connected to the movable means, a pressure boosting device positioned remotely with respect to the mechanism, a fluid under pressure supply line connected to the device, and fluid conducting means connected to the device and mechanism, and means for controlling the operation of the boosting device.

6. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, movable means in the mechanism for gripping the shank and pulling it, means for applying the reactionary force to the tubular member, fluid pressure responsive means connected to the movable means, a pressure boosting device positioned remotely with respect to the mechanism, a fluid under pressure supply line connected to the device, fluid conducting means connected to the device and mechanism, and means on the mechanism for controlling the operation of the booster device.

7. A rivet setting apparatus for setting a rivet including a tubular member and a shank extending therethrough, which comprises movable means in the apparatus for gripping and pulling the shank of the rivet, means for applying the reactionary force to the tubular member, fluid pressure responsive means connected to the movable means, a pressure boosting device, a fluid pressure supply line connected to the device, fluid conducting means connected to the device and to the mechanism one side of the fluid pressure responsive means, and means on the mechanism for controlling the operation of the boosting device.

8. A fluid pressure operated riveting apparatus comprising a riveting mechanism, fluid pressure responsive means in the mechanism, a remotely located pressure boosting device, a fluid pressure supply line connected to the boosting device, a conduit connected to the boosting device and to the mechanism in communication with the space at one side of the fluid pressure responsive means, means operatively connecting the fluid pressure supply line to a passageway in the mechanism, and means for controlling operating of the boosting device through actuation of a single manually operated valve adapted to connect or disconnect such passageway with respect to the atmosphere.

9. A rivet setting apparatus comprising a riveting mechanism, fluid pressure responsive means in the mechanism, a pressure boosting device located remotely with respect to the mechanism,

a conduit connecting the pressure boosting device to the mechanism at one side of the fluid pressure responsive means, a fluid pressure supply line connected to the pressure boosting device, means operatively connecting the fluid pressure supply line to a passageway in the mechanism, and means for controlling operation of the boosting device through actuation of a single manually operated means on the mechanism adapted to connect or disconnect such passageway with respect to the atmosphere.

10. A rivet setting apparatus for setting a rivet including a tubular member and a shank extending therethrough which is set by pulling the shank and applying the reactionary force to one end of the tubular member, which comprises a casing, fluid pressure responsive means in the casing, means operatively connected to the fluid pressure responsive means for gripping and pulling the shank, means on the casing for applying the reactionary force to one end of the tubular member, means for supplying fluid under pressure to one side of the fluid pressure responsive means, and means supplying fluid under a different pressure to the other side of said fluid responsive means.

11. A rivet setting apparatus for setting a rivet including a tubular member and a shank extending therethrough which is set by pulling the shank and applying the reactionary force to one of the tubular members, which comprises a casing, fluid pressure responsive means in the casing, means operatively connected to the fluid pressure responsive means for gripping and pulling the shank, means on the casing for applying the reactionary force to one end of the tubular member, means for supplying liquid under pressure to one side of the fluid pressure responsive means, and means for supplying fluid under a different pressure to the opposite side of said fluid pressure responsive means.

12. A rivet setting apparatus for setting a rivet including a tubular member and a shank extending therethrough which is set by pulling the shank and applying the reactionary force to one end of the tubular member, which comprises a casing, fluid pressure responsive means in the casing, means operatively connected to the fluid pressure responsive means for gripping and pulling the shank, means on the casing for applying the reactionary force to one end of the tubular member, a fluid pressure supply line, means operatively connecting the supply line to the casing including a fluid pressure boosting device, and means operatively mounted on the casing for controlling the operation of the fluid responsive means and the boosting device.

13. A rivet setting apparatus for setting a rivet including a tubular member and a shank extending therethrough which is set by pulling the shank and applying the reactionary force to one end of the tubular member, which comprises a mechanism adapted to be supported by the hand, a fluid pressure supply line, a remote pressure boosting device connected to the supply line, fluid pressure responsive means in the mechanism, means operatively connected to the fluid pressure responsive means for gripping and pulling the shank, means on the mechanism for applying the reactionary force to one end of the tubular member, flexible fluid pressure line connections between the device and mechanism, and means on the mechanism for controlling the rivet setting operation and operation of the pressure boosting device.

14. A rivet setting apparatus comprising a rivet setting mechanism, fluid pressure responsive means in the mechanism, a fluid pressure boosting device, fluid conducting connections between the booster device and mechanism, a fluid pressure supply line for supplying fluid to the booster device, and means for controlling the operation of the boosting device through actuation of a single manually controlled means for communicating said supply line with the atmosphere.

15. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending through the tubular member, fluid pressure responsive means in the mechanism for pulling the shank, means on the mechanism for applying the reactionary force to the tubular member, a fluid pressure boosting device, fluid conducting connections between the booster device and the mechanism, a fluid pressure supply line for supplying fluid to the booster device, a valve on the booster device for controlling its operation, and means rendering said valve operable by fluid pressure.

16. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending through the tubular member, fluid pressure responsive means in the mechanism for pulling the shank, means on the mechanism for applying the reactionary force to the tubular member, a fluid pressure boosting device, fluid conducting connections between the booster device and mechanism, a fluid pressure supply line for supplying fluid to the booster device, and means operable by fluid pressure for controlling the supplying of fluid under pressure to the booster device.

17. A fluid pressure operated riveting apparatus for setting a rivet including a tubular member and a shank extending therethrough, comprising a mechanism for setting the rivet, fluid pressure responsive means in the mechanism for pulling the shank, means on the mechanism for applying the reactionary force to the tubular member, a remotely located pressure boosting device, a fluid pressure supply line connected to the booster device, means on the booster device for controlling the supplying of fluid under pressure to the boosting device, and means on the mechanism and operatively connected to the last mentioned means for remotely controlling operation of the latter.

18. A fluid pressure operated riveting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, fluid pressure responsive means in the mechanism for pulling the shank, means on the mechanism for applying the reactionary force to the tubular member, a remotely located pressure boosting device, a fluid pressure supply line connected to the booster device, fluid pressure operative means on the booster device for controlling the supplying of fluid under pressure to the booster device, and means on the mechanism and operatively connected to the last mentioned means for remotely controlling operation of the latter.

19. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, fluid pressure responsive means in the mechanism for pulling the shank, means on the mechanism for applying the reactionary force to the tubular member, a remotely located fluid pressure boosting device, a fluid connecting line between the booster device and the mechanism for supplying fluid under pressure to the fluid pressure re-

sponsive means, and means including a fluid conducting line extending between the booster device and mechanism for controlling operation of the device and the mechanism.

20. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, fluid pressure responsive means in the mechanism for pulling the shank, means on the mechanism for applying the reactionary force to the tubular member, a remotely located fluid pressure boosting device, a fluid connecting line between the booster device and the mechanism for supplying fluid under pressure to the fluid pressure responsive means, a fluid pressure supply line, a valve for controlling the supply of fluid from said supply line to the booster, a fluid conducting line connecting the valve and the mechanism, control means on the mechanism for opening and closing said last mentioned fluid line to the atmosphere, and means operatively connecting the valve and the fluid pressure supply line to cause operation of the valve upon operation of said control means on the mechanism.

21. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, fluid pressure responsive means in the mechanism for pulling the shank, means on the mechanism for applying the reactionary force to the tubular member, a remotely located fluid pressure boosting device, a fluid conducting line extending between the boosting device and mechanism, a movable valve on the booster device for controlling the supplying of fluid under pressure thereto, a fluid pressure supply line connected to the valve, balanced pressure means for holding the valve in one position, and means for changing the balanced pressure condition so as to cause movement of the valve, said last mentioned means including a control element on the mechanism.

22. A rivet setting apparatus comprising a rivet setting mechanism, fluid pressure responsive means in the mechanism, a fluid pressure boosting device, a fluid conducting line connecting the high pressure side of the booster device to one side of the fluid pressure responsive means, a fluid pressure supply line connected to the low side of the booster device, a fluid conducting line operatively connected to said fluid pressure supply line and to the opposite side of the fluid pressure responsive means in the mechanism, and means for governing operation of the booster device through changing of the pressure in said fluid conducting line connected to said opposite side of the fluid pressure responsive means in the mechanism.

23. A rivet setting apparatus comprising a rivet setting mechanism, fluid pressure responsive means in the mechanism, a fluid pressure boosting device a fluid conducting line connecting the high pressure side of the booster device to one side of the fluid pressure responsive means, a fluid pressure supply line connected to the low side of the booster device, a fluid conducting line operatively connected to said fluid pressure supply line and to the opposite side of the fluid pressure responsive means in the mechanism, and means for governing operation of the booster device through changing of the pressure in said fluid conducting line connected to said opposite side of the fluid pressure responsive means in the mechanism, said last mentioned governing means including a valve on the mechanism for opening or closing the line to exhaust.

24. A rivet setting apparatus comprising a rivet setting mechanism, fluid pressure responsive means in the mechanism, a fluid pressure boosting device, a fluid conducting line connecting the high pressure side of the booster device to one side of the fluid pressure responsive means, a fluid pressure supply line connected to the low side of the booster device, a fluid conducting line operatively connected to said fluid pressure supply line and to the opposite side of the fluid pressure responsive means in the mechanism, and means for governing operation of the booster device through changing of the pressure in said fluid conducting line connected to said opposite side of the fluid pressure responsive means in the mechanism, said last mentioned governing means including a valve on the mechanism for opening or closing the line to exhaust, and a movable valve on the booster device controlled by said change in pressure.

25. A riveting machine for setting a rivet of a type including a tubular member and a shank extending therethrough wherein the shank is adapted to be pulled while applying the reactionary force to one end of the tubular member, which comprises a casing, means on the casing for engaging the end of the tubular member, fluid pressure responsive means in the casing, movable means for gripping the shank, and a play permitting connection between said movable means and the fluid pressure responsive means for enabling limited movement of the fluid pressure responsive means relatively to the gripping means.

26. A rivet setting apparatus comprising a rivet setting mechanism, fluid pressure responsive means in the mechanism, a fluid pressure boosting device, a fluid conducting line connecting the high pressure side of the booster device to one side of the fluid pressure responsive means, a fluid pressure supply line connected to the low side of the booster device, a fluid conducting line operatively connected to said fluid pressure supply line and to the opposite side of the fluid pressure responsive means in the mechanism, means for governing operation of the booster device through changing of the pressure in said fluid conducting line connected to said opposite side of the fluid pressure responsive means in the mechanism, and resilient means normally urging the gripping means away from the fluid pressure responsive means.

27. A rivet setting apparatus comprising a mechanism for setting a rivet including a tubular member and a shank extending therethrough, fluid pressure responsive means in the mechanism, a remotely located fluid pressure boosting device, a fluid conducting line connecting the high pressure side of the booster device to one side of the fluid pressure responsive means, a second fluid conducting line extending from the mechanism to the booster device, and means on the mechanism and associated with the second fluid conducting line for controlling operation of the booster device.

28. A riveting machine for setting a rivet of a type including a tubular member and a shank extending therethrough, wherein the shank is adapted to be pulled while applying the reactionary force to one end of the tubular member, which comprises a casing, means on the casing for engaging the end of the tubular member, fluid pressure responsive means in the casing, movable means for pulling the shank, a play permitting

connection between the movable means and the fluid pressure responsive means, and resilient means normally urging the movable and fluid pressure responsive means into a relation where the play is eliminated.

29. In combination, a fluid actuated riveting mechanism adapted to be manually carried and manipulated, pressure developing means located remotely to the mechanism, flexible fluid line connections between the mechanism and pressure developing means, valve means adjacent the pressure developing means for controlling the supplying of fluid under pressure to the mechanism, and means including a control on the mechanism for governing operation of said valve means, the operation of the mechanism and the supplying of fluid pressure thereto depending only on operation of said control on the mechanism.

30. In combination, a fluid actuated riveting mechanism adapted to be manually carried and manipulated and including fluid pressure responsive means, liquid pressure developing means located remotely to the mechanism, a flexible fluid line connecting the pressure developing means and mechanism and communicating with one side of the fluid pressure responsive means in the mechanism, valve means adjacent the pressure developing means for alternately connecting the fluid line to the pressure side of the pressure developing means or to exhaust, and means including a control element on the mechanism for operating the valve means, the operation of said mechanism and the supplying and exhausting of fluid through said line depending only on operation of said control.

31. In combination, a fluid actuated riveting mechanism adapted to be manually carried and manipulated, pressure developing means located remotely to the mechanism, flexible fluid line connections between the mechanism and pressure developing means, movable means adjacent the pressure developing means for governing the supplying of fluid under pressure to the mechanism, and means including a control on the mechanism for controlling the operation of said movable means, the operation of the mechanism and the supplying of fluid pressure thereto depending only on operation of said control on the mechanism.

32. A rivet setting apparatus comprising a fluid actuated riveting mechanism adapted to be manually carried and manipulated, fluid pressure responsive means in the mechanism for actuating it, flexible fluid conducting means connected to the mechanism and communicating with one side of the fluid pressure responsive means, fluid pressure developing means located remotely to the mechanism, valve means for connecting the pressure developing means to the fluid conducting means so as to either allow fluid under pressure to flow to the mechanism or to exhaust therefrom, and means including a control on the mechanism for operating said valve means by remote control at the mechanism, whereby operation of the

control on the mechanism controls the valve means and therefore operation of the mechanism.

33. In combination, a fluid actuated riveting mechanism adapted to be manually carried and manipulated, fluid pressure responsive means in the mechanism, flexible fluid conducting lines connected to the mechanism at opposite sides of the fluid pressure responsive means, means located remotely to the mechanism for supplying fluid under pressure to the conducting lines, valve means adjacent the latter means and operatively connected to the conducting lines for allowing fluid under pressure to be supplied to either line and simultaneously exhaust from the other, and means including a control on the mechanism for remotely controlling the operation of the valve means.

34. A machine for setting rivets comprising a mechanism including fluid pressure responsive means and parts operated by the latter for applying forces in opposite directions for setting the rivet, a remote source of fluid under pressure, flexible fluid line connections connecting the source to the mechanism for operating the pressure responsive means, a valve at the source for controlling the flow of fluid under pressure through the connections, manually operable control means on the mechanism, and means for causing actuation of the valve upon operation of the manual control means on the mechanism.

35. A rivet setting apparatus comprising a mechanism for setting a rivet and including fluid pressure responsive means in the mechanism, a flexible conduit connected to the mechanism at one side of the fluid pressure responsive means, fluid receiving means remote with respect to the mechanism and connected to the conduit, means cooperating with the last means for forcing fluid therefrom or drawing the fluid thereinto, to operate the fluid pressure responsive means in the mechanism, and means on the mechanism for governing such cooperating means.

36. In combination, fluid pressure boosting means including a cylinder and piston, a second cylinder and piston wherein the piston effects less displacement per unit of travel than the first piston, means for moving the second piston upon movement of the first piston, a source of fluid pressure, valve means adapted to admit fluid under pressure to one side of the first piston or to allow fluid at such side to exhaust, a third cylinder and piston remote with respect to the first and second cylinders and valve means, flexible fluid conduit means connecting the second and third cylinders, and means located on the third cylinder for causing remote operation of said valve means, whereby the valve means can be operated to cause fluid pressure to act against the first piston to displace fluid in the second cylinder through the conduit means so as to actuate the third piston.

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