United States Patent

[11] 3,543,985

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[54] MULTIPLE RIVETING MACHINE
11 Claims, 17 Drawing Figs.

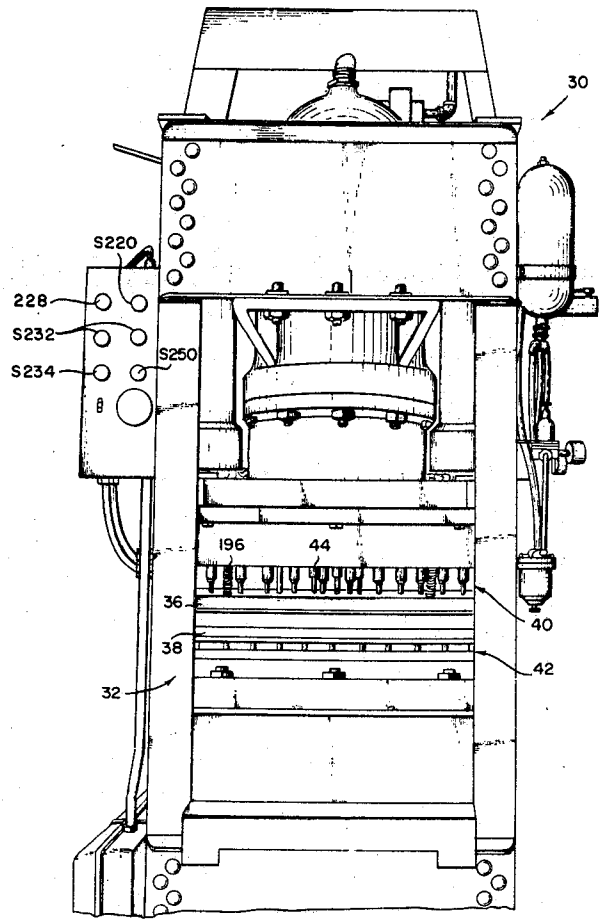
[52] U.S. Cl. 227/7, 227/51, 227/114, 227/153
[51] Int. Cl. B27f 7/06
[50] Field of Search 227/51, 53, 61, 62, 114, 115, 117, 118, 153, 5, 6, 7

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Primary Examiner—Granville Y. Custer, Jr.
Attorney—Strauch, Nolan, Neale, Nies & Kurz

ABSTRACT: A multiple riveting machine having an arrangement for feeding a predetermined number of rivets into a workpiece to be riveted and then heading said rivets.



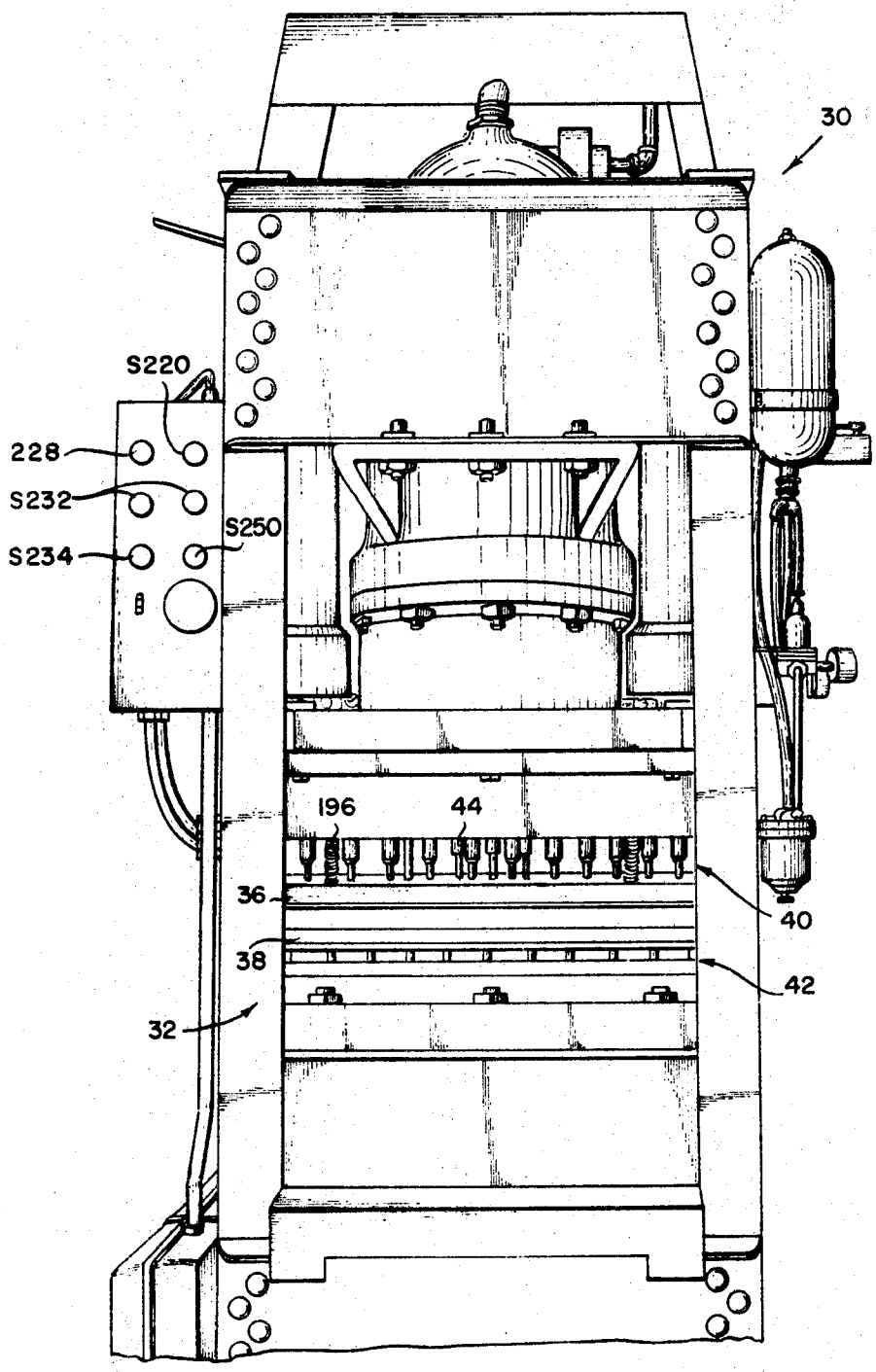


fig. 1

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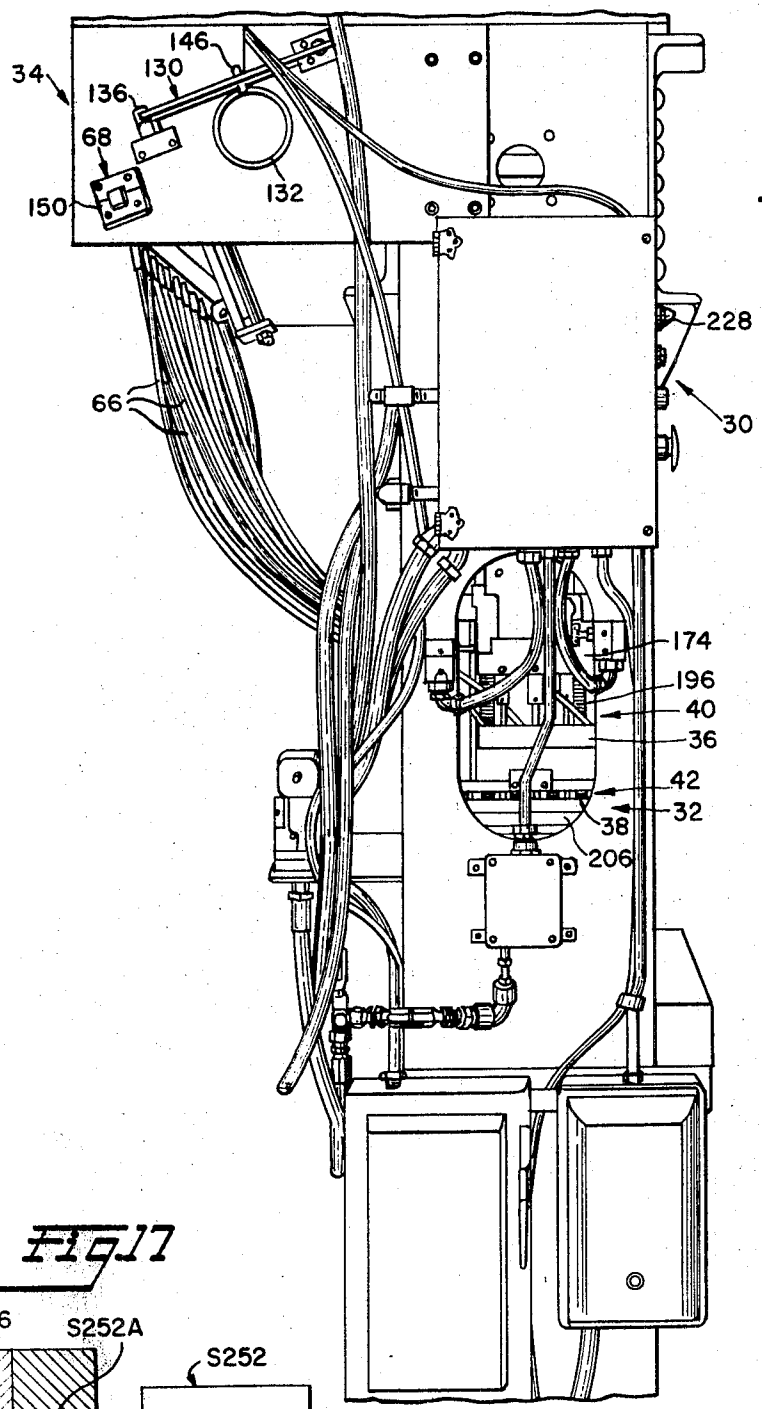
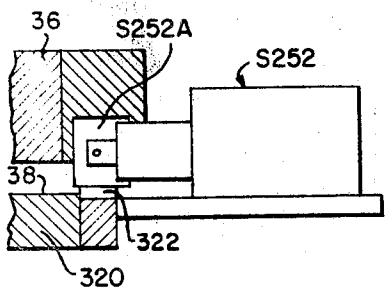


Fig. 2

Fig. 17



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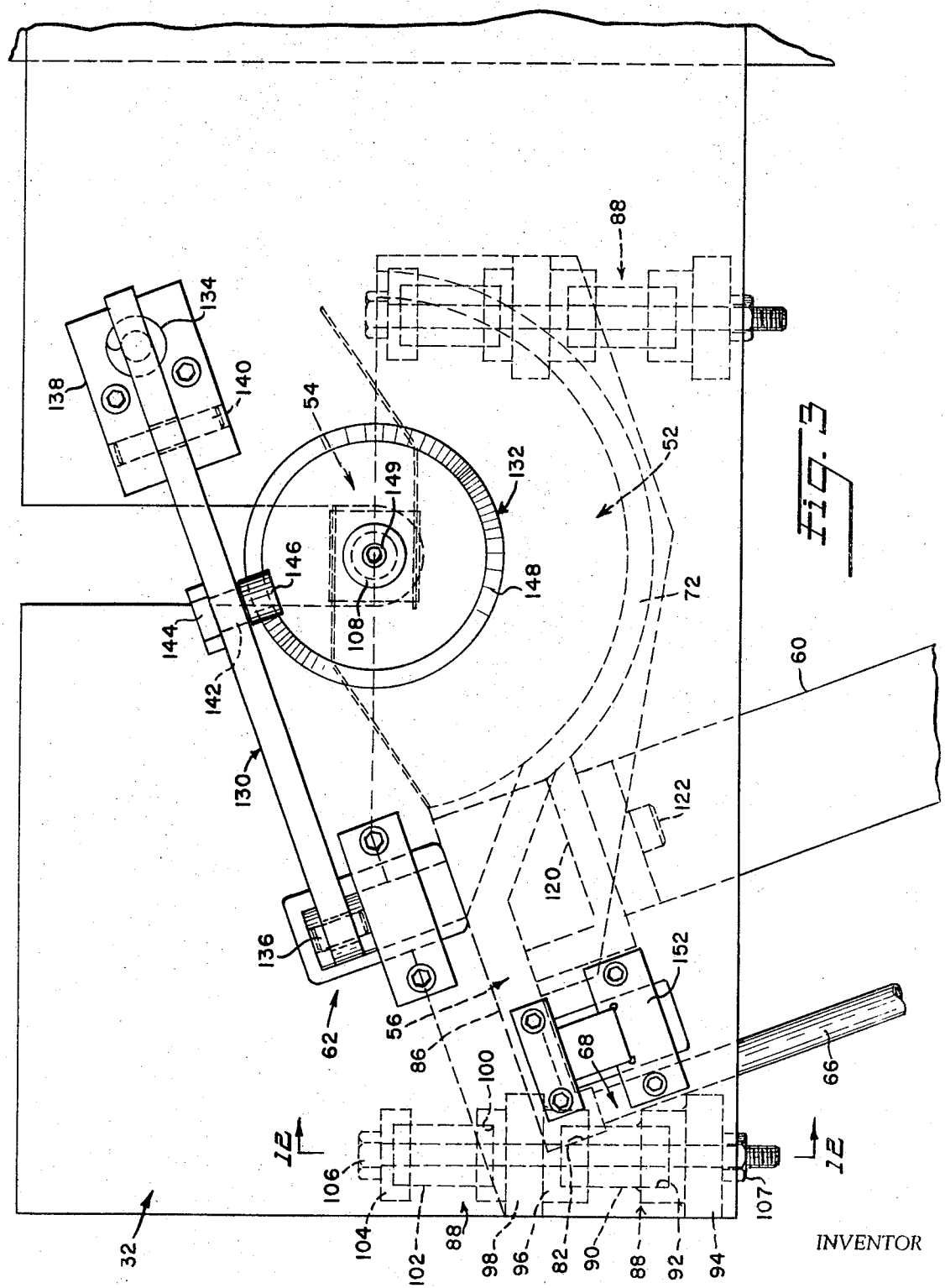


FIG. 3

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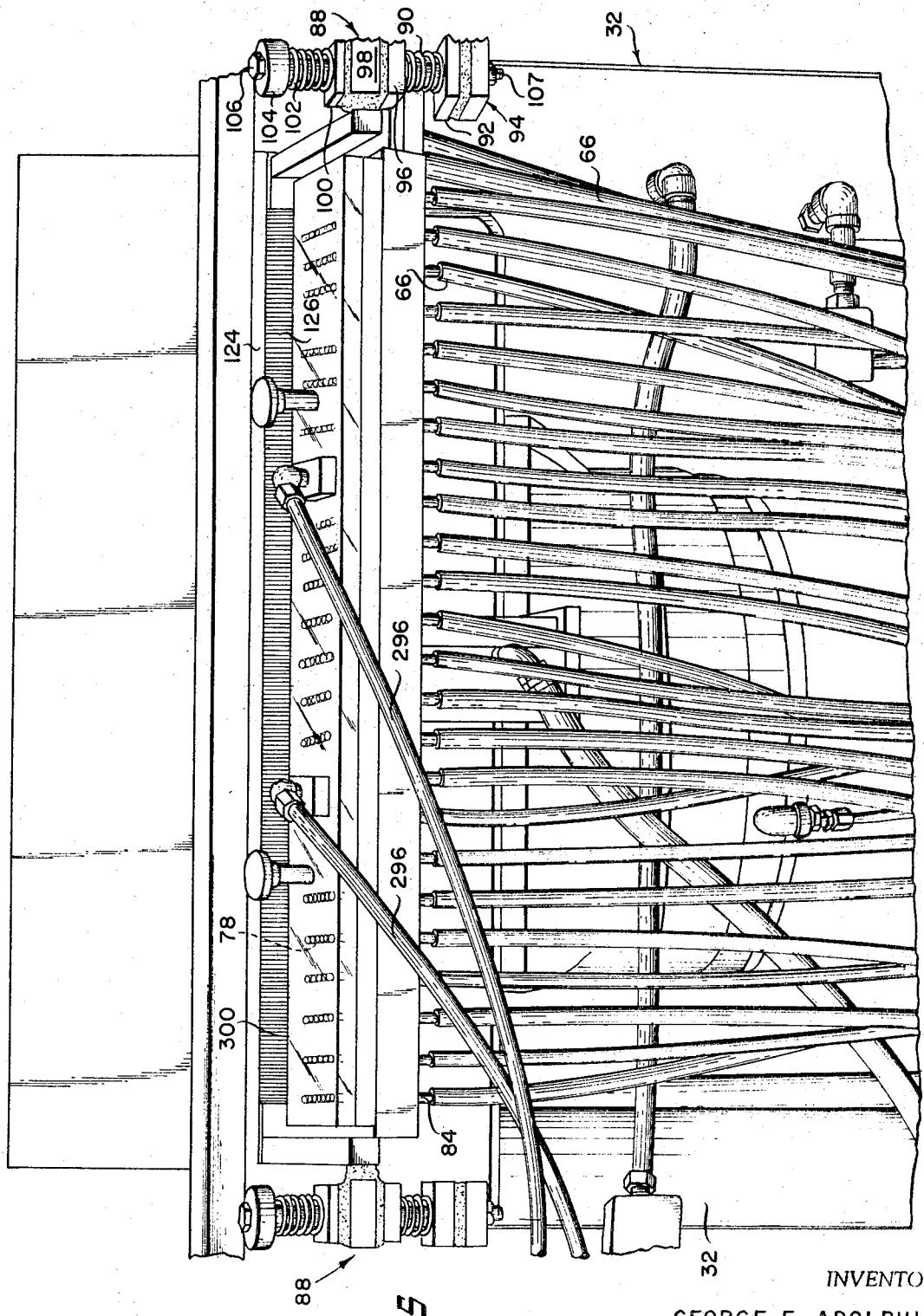


FIG. 5

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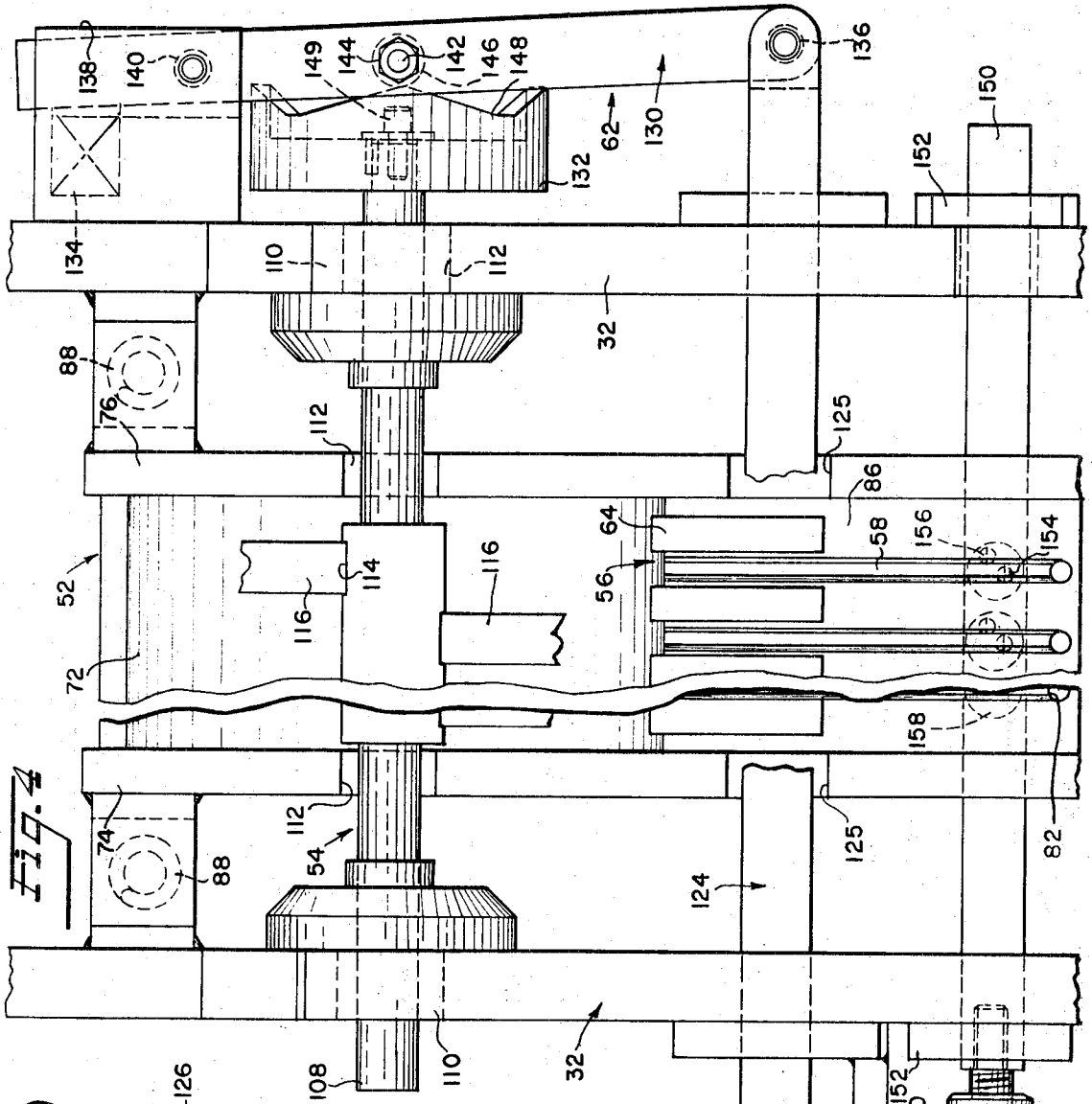


Fig. 4

Fig. 7

Fig. 8

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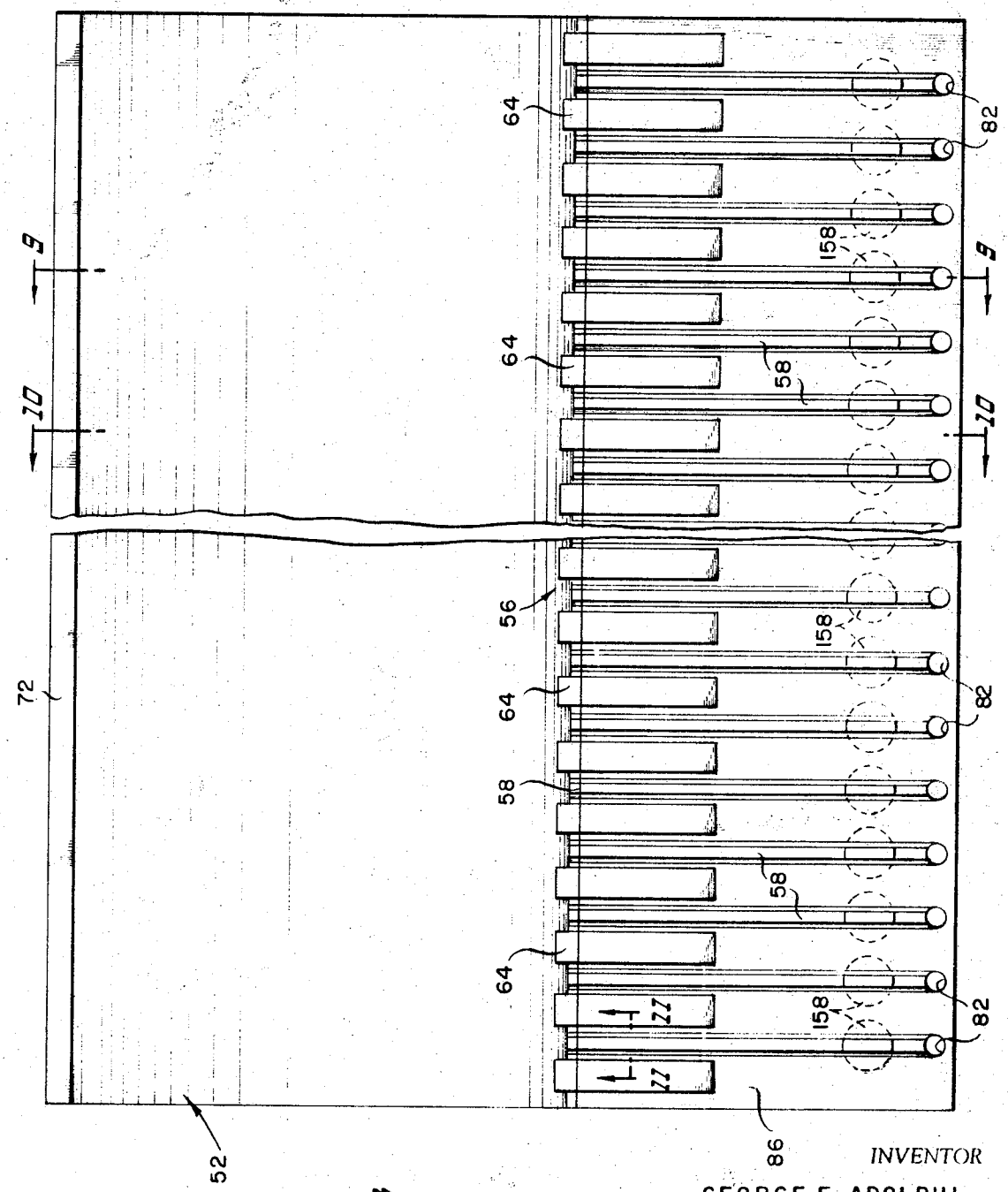


FIG. 8

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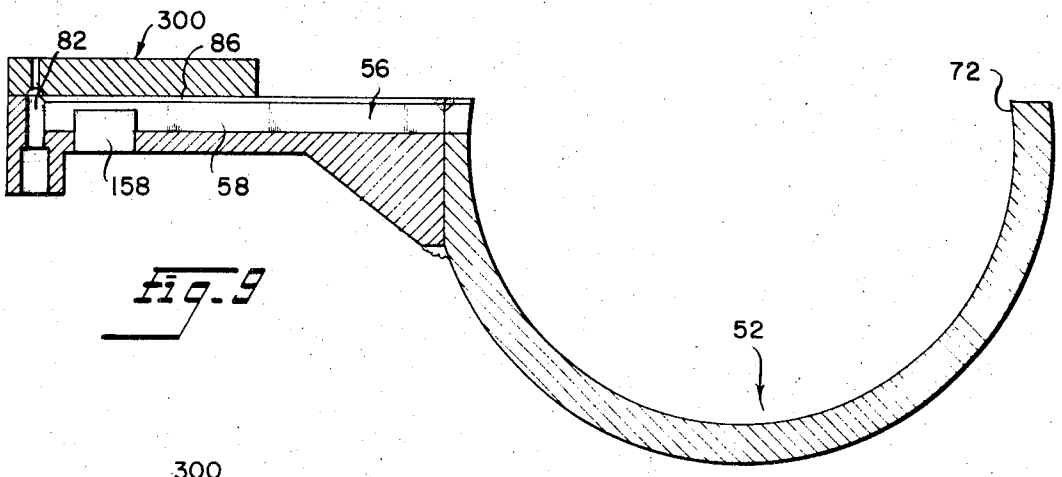


Fig. 9

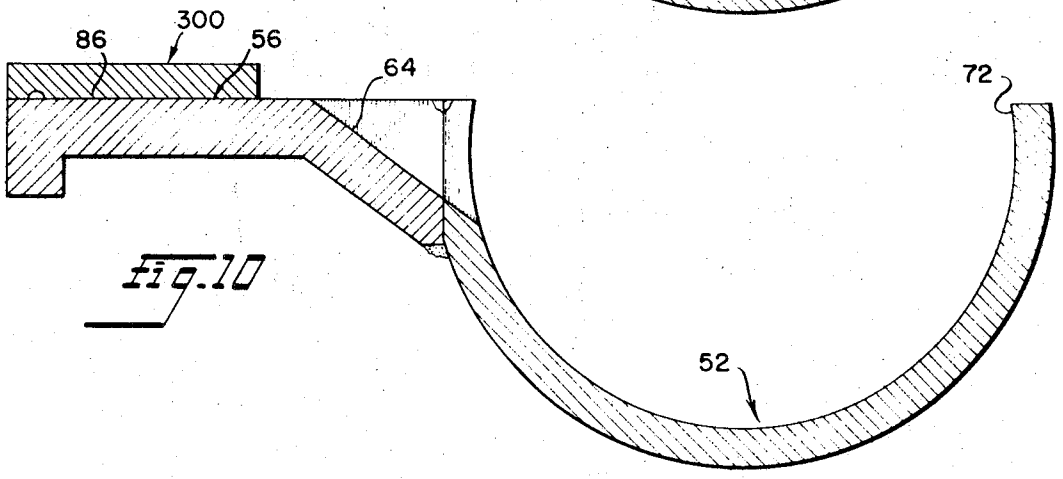


Fig. 10

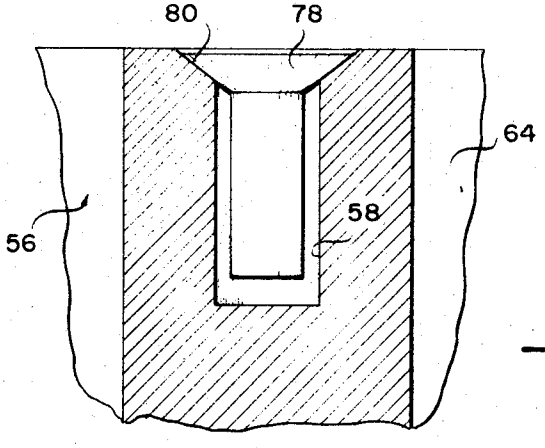


Fig. 11

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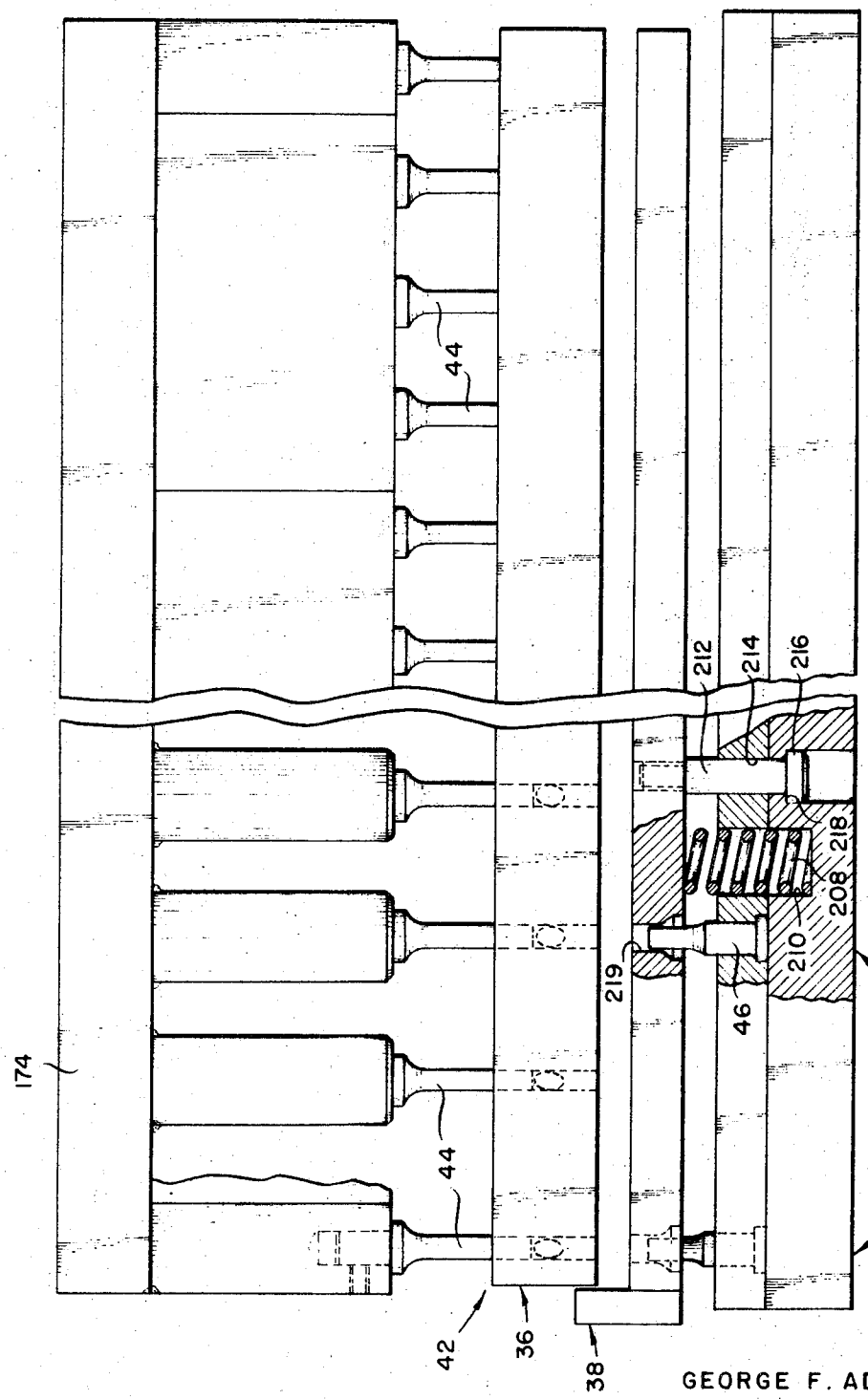


Fig. 13

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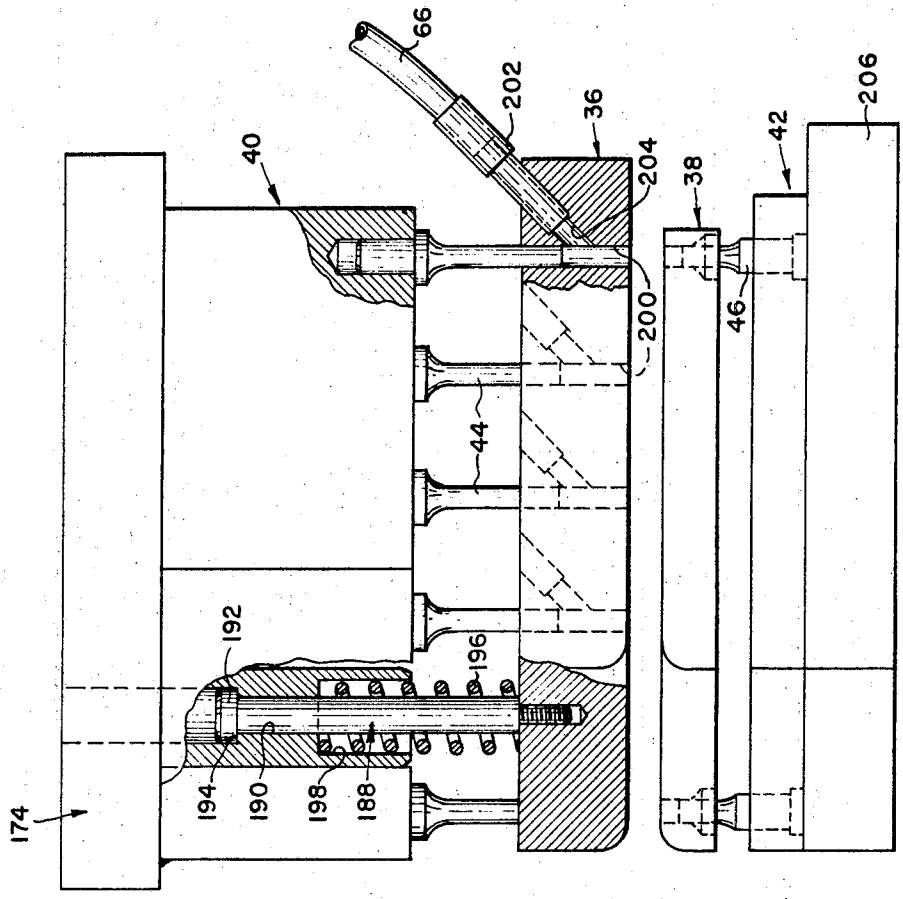


FIG. 14

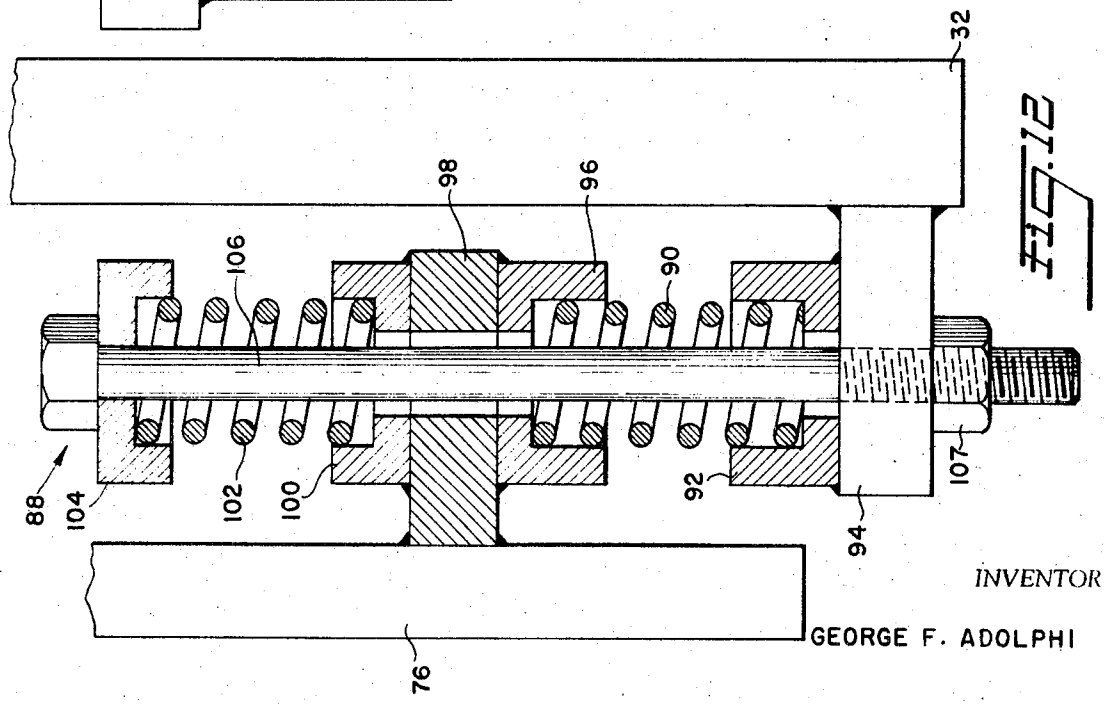


FIG. 12

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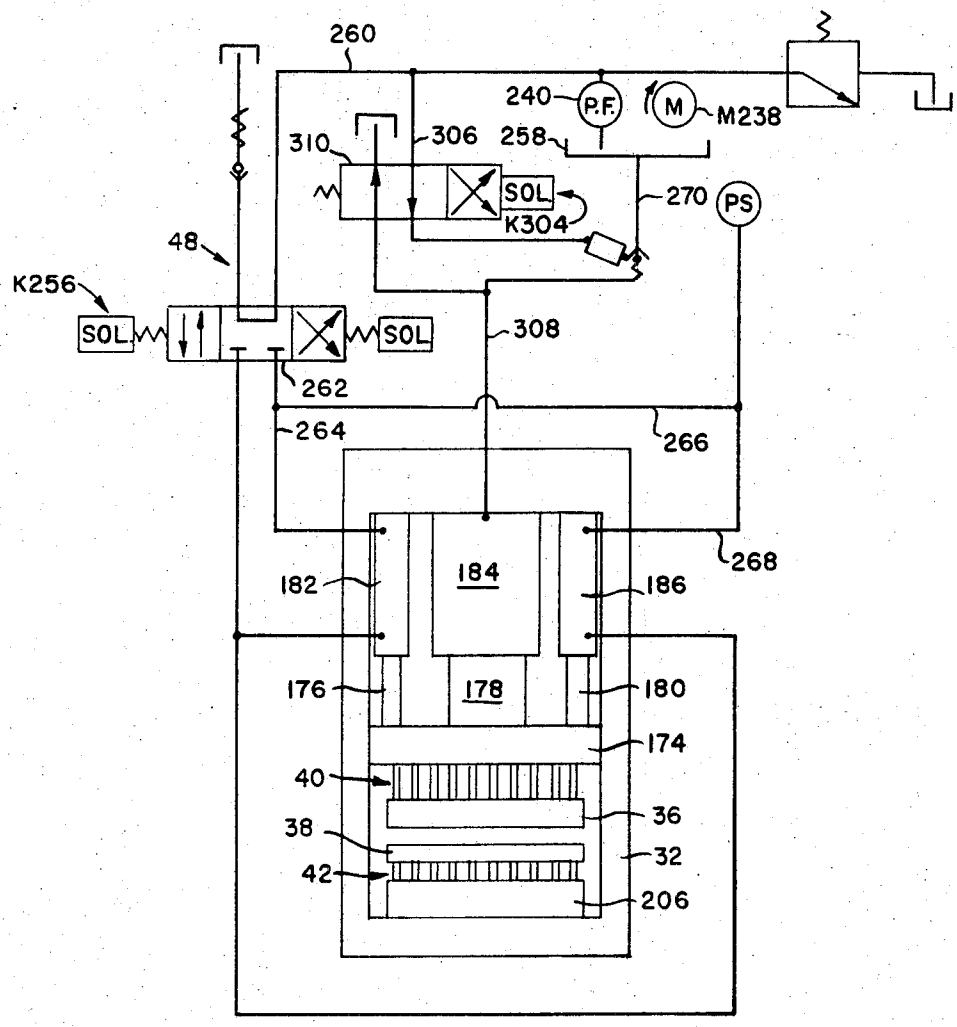


Fig. 15

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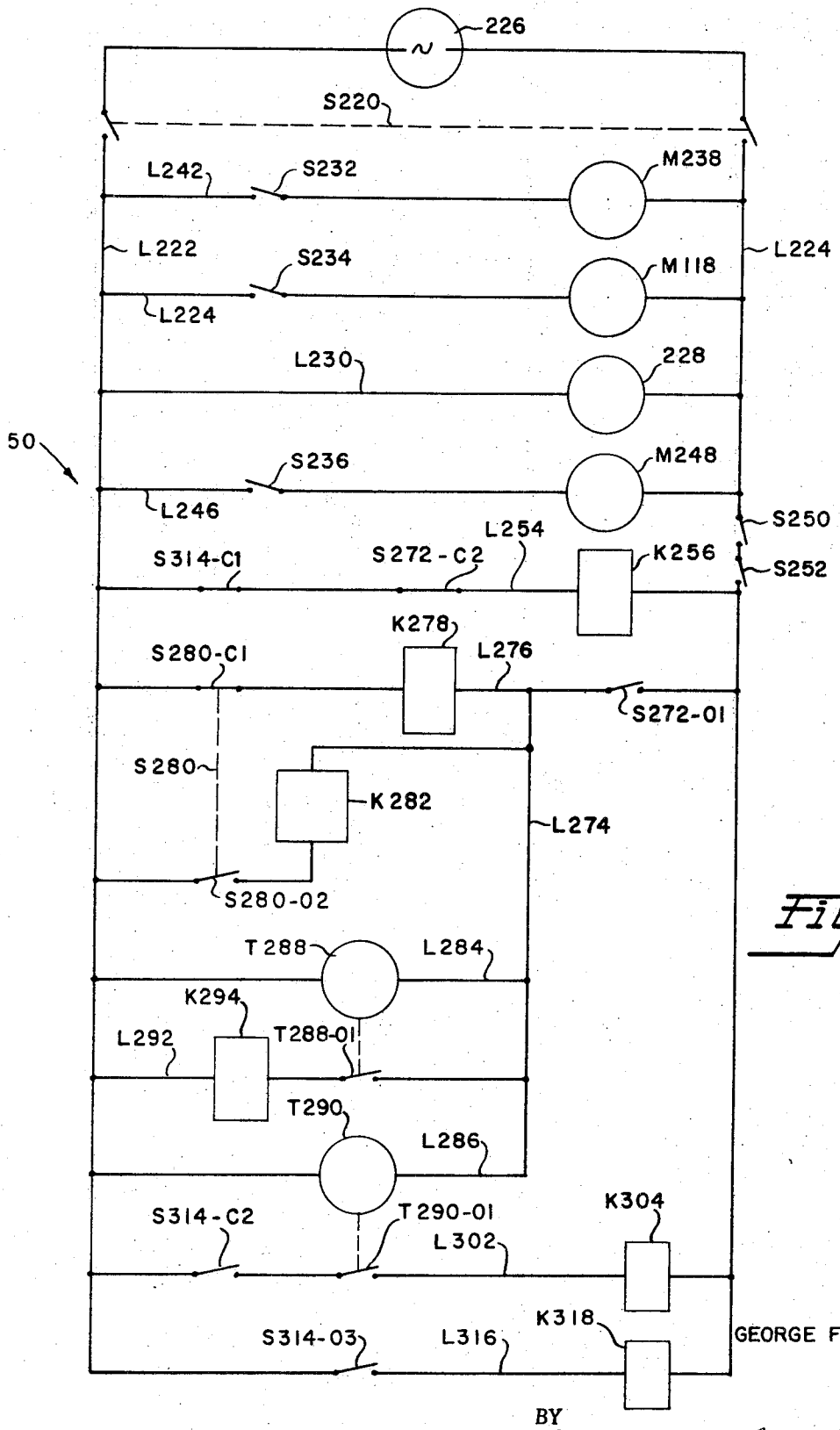


Fig. 16

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MULTIPLE RIVETING MACHINE

BACKGROUND, SUMMARY, AND OBJECTS OF THE INVENTION

This invention relates to riveting machines and, more specifically, to a novel multiple riveting machine capable of delivering a plurality of rivets to and positioning them in preformed apertures in the workpiece to be riveted and then simultaneously forming heads on all of said rivets to complete the riveting cycle.

Heretofore, operations involving the forming of multiple rivets in a workpiece have been carried out by transferring the workpiece seriatim through a series of riveting machines or stations corresponding to the number of rivets to be formed with one rivet being formed at each station. This conventional operation is expensive because it is slow, because it requires a large in large investment in riveting machines and in their maintenance and operation, and because considerable manpower and/or handling equipment is needed to transfer the workpiece from one station to the next.

Applicant has now invented a novel riveting machine which is capable of positioning and forming a plurality of rivets in a single riveting cycle. In the preferred embodiment of the invention this cycle is manually initiated and thereafter automatically continued and is typically completed in as little as 7 seconds.

The major advantage of applicant's novel riveting machine is the large reduction in the cost of a multiple riveting operation it provides. Since only one as opposed to a number of machines are required and as this machine is not particularly complex, the cost of purchasing, operating, and maintaining the necessary equipment is reduced to a small fraction of that heretofore required. Moreover, labor and/or material handling equipment costs are drastically reduced since there are no transfers of the workpiece from station to another. Further reductions in cost result from the marked decrease in the time required to complete a multiple riveting operation.

From the foregoing it will be apparent that one important and primary object of the present invention is the provision of novel machines capable of materially reducing the cost of multiple riveting operations.

Another important and primary object of the present invention is the provision of novel riveting machines capable of simultaneously positioning and forming a plurality of rivets and thereby reducing the time and labor and/or handling equipment needed to perform a multiple riveting operation.

Other important but more specific objects of the present invention will become apparent from the appended claims and from the ensuing detailed description and discussion of the invention taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. **1** is a generally pictorial front view of a multiple riveting machine constructed in accord with the principles of the present invention;

FIG. **2** is a side view of the riveting machine of FIG. **1**;

FIG. **3** is a partial side view of a novel rivet aligning and supplying system employed in the riveting machine of FIGS. **1** and **2**;

FIG. **4** is a plan view of the riveting aligning and supplying mechanism of FIG. **3**;

FIG. **5** is a pictorial view of the mechanism of FIGS. **3** and **4** and of the upper portion of the riveting machine;

FIG. **6** is a partial front elevation of a mechanism employed in the riveting aligning and supplying mechanism of the machine of FIGS. **1** and **2**;

FIG. **7** is a partial top view of a notched brush utilized in the mechanism of FIG. **6**;

FIG. **8** is a plan view of a hopper and platform incorporated in the mechanism depicted in FIGS. **3**—**5**;

FIG. **9** is a section through the hopper and platform of FIG. **8** taken substantially along line **9**–**9** of FIG. **8**;

FIG. **10** is a view similar to FIG. **9**, but taken substantially along line **10**–**10** of FIG. **8**;

FIG. **11** is a section through the platform taken substantially along line **11**–**11** of FIG. **8**;

FIG. **12** is a view taken substantially along line **12**–**12** of FIG. **3**, showing the mechanism for supporting the rivet aligning and supplying arrangement from the frame of the riveting machine;

FIG. **13** is a partly sectioned front view of a ram assembly and a cooperating pressure pad assembly provided in the riveting machine of FIGS. **1** and **2** for feeding the rivets into apertures formed in a workpiece disposed between the assemblies and then heading the rivets;

FIG. **14** is a partly sectioned side view of the mechanism shown in FIG. **13**;

FIG. **15** is a schematic of a hydraulic system employed in the riveting machine of FIGS. **1** and **2**;

FIG. **16** is a schematic of a control system for the machine of FIGS. **1** and **2**; and

FIG. **17** is a partial section through the cooperating ram and pressure pad assemblies incorporated in the machine of FIGS. **1** and **2** and shows a novel switch arrangement provided to insure that the riveting cycle is not initiated unless the workpiece is properly positioned.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawing, FIGS. **1** and **2** depict a novel riveting machine **30** constructed in accord with the principles of the present invention which is capable of feeding a plurality of rivets to and positioning them in preformed apertures in a workpiece to be riveted and then simultaneously forming heads on the rivets to complete the riveting cycle. Among the major components of multiple riveting machine **30** are a frame **32**, a novel system **34** for aligning the rivets and feeding them at appropriate intervals through a die **36** into preformed apertures in a workpiece positioned on a pressure pad **38**. Die **36** is incorporated in a ram assembly **40** which is movable toward a pressure pad assembly **42** in which pressure pad **38** is incorporated to compress the rivets between punches **44** in the ram assembly and anvils **46** in the pressure pad assembly and thereby form heads on the rivets. The movement of ram assembly **40** is accomplished through a hydraulic system **48** (see FIG. **15**). Operation of the hydraulic system and other components of machine **30** is controlled by an electrical system identified by reference character **50** in FIG. **16**.

Referring now particularly to FIGS. **3**—**5**, the major components of the rivet aligning and delivery system **34** are: (*a*) a hopper **52**; (*b*) a pickup mechanism **54**, which scoops the rivets out of hopper **52** onto a platform **56** provided with a series of parallel, spaced apart slots **58** in which the rivets are oriented and stored; (*c*) a vibrator **60** (shown in FIG. **3** but not FIGS. **4** and **5**) for agitating the rivets on platform **56** so that they will fall into slots **58**; (*d*) a sweep mechanism **62** for brushing improperly oriented rivets onto ramps **64** on the platform down which they travel back into hopper **52**; (*e*) a series of flexible conduits **66** extending from platform **56** to die **36**; and (*f*) an escapement mechanism **68** actuatable to permit rivets to escape from the slots **58** into the associated flexible conduits **66**.

As best shown in FIGS. **3**, **4**, **9**, and **10**, hopper **52** has a U-sectioned main body member **72** and two planar end members **74** and **76** welded or otherwise fixed to member **72**. In one exemplary embodiment of the invention hopper **52** is eight inches in diameter and 25 inches long.

Turning now specifically to FIGS. **8**—**10**, the platform **56** to which the rivets are transferred from hopper **52** is a flat, elongated member substantially equal in length to hopper **52** with the rivet orienting and retaining slots **58** and rivet return ramps **64** mentioned previously formed in its upper surface. Ramps **64** are alternated with slots **58** as best shown in FIG. **8**.

Referring next to FIG. 11, the lower portions of the slots 58 in platform 56 have generally the same cross-sectional configuration as the rivets 78 which they are provided to hold but are slightly wider and deeper than the rivets. This permits the rivets to more readily fall into the slots. The length/diameter ratio of the lower slot portions must nevertheless be sufficiently large to keep the rivets from turning over in the slots. On the other hand, the upper portions 80 of the slots are configured to match the contour of the rivet heads to precisely locate and orient the rivets.

As best shown in FIGS. 8 and 9, slots 58 continue from platform 56 through the wall of hopper main body member 72 and, accordingly, extend from the interior of the hopper to points adjacent the edge of the platform most removed from the hopper. At this edge of the platform the slots communicate with apertures 82 through the platform. Apertures 82 in turn communicate with the flexible rivet supply conduits 66 through tubular fittings 84 (see FIG. 5). Apertures 82 also have a length/diameter ratio sufficiently large to prevent the rivets from turning over as they fall through the apertures to maintain them in the proper orientation.

Referring now to FIGS. 8 and 10, ramps 64 are formed by cutting away platform 56 adjacent hopper 52 and the adjoining portion of hopper member 72 at an angle typically on the order of 45° to the upper surface 86 of the platform. Accordingly, as shown in FIG. 10, the inner or lower ends of ramps 64 communicate with the interior of the hopper; and returning rivets can migrate down the ramps directly into the hopper.

Turning next to FIGS. 4, 9, and 10, hopper 52 and platform 56 are joined as by welding into a unitary structure. This unit is mounted at an angle to the horizontal from the frame 32 of riveting machine 30 (see FIG. 3) so that ramps 64 are inclined downwardly toward the interior of hopper 52 and slots 58 are inclined downwardly toward the apertures 82 through which the rivets pass into conduits 66.

Referring now specifically to FIGS. 3, 5, and 12, the unitary structure of hopper 52 and platform 56 is supported from the framework 32 of machine 30 by four substantially identical spring ty mounting assemblies 88. Each of these assemblies includes a first spring 90 supported in a spring seat 92 fixed to a bracket 94 which, in turn, is welded or otherwise fixed to frame 32. The upper end of spring 90 is received in a cap 96 fixed to a bracket 98 attached to an end wall 74 or 76 of hopper 52. On the upper side of and fixed to bracket 98 is a second spring seat 100 in which a second spring 102 is seated. On the upper end of spring 102 is a second spring cap 104. The components just described are maintained in assembled relationship and fixed to brackets 94 and 98 by a bolt 106 extending downwardly through the assembly and a nut 107 on the lower end of the bolt.

Turning again to FIGS. 3 and 4, the mechanism 54 by which the rivets are scooped out of hopper 52 onto platform 56 includes an elongated shaft 108 extending longitudinally through hopper 52 and rotatably supported from riveting machine framework 32 in bearings 110. The apertures 112 in the end walls 74 and 76 of hopper 52 through which the shaft extends are substantially larger in diameter than the shaft. This isolates assembly 54 from the vibration of the hopper produced by the vibrator 60.

Fixed to flats 114 on shaft 108 are a series of flexible pickup fingers 116. Shaft 108 is rotated by an appropriate electric motor M 118 (see FIG. 14). As it rotates, fingers 116 scoop rivets from the hopper onto the upper surface 86 of the platform.

Some of the rivets thus transferred to platform 56 will be properly oriented to fall immediately into the slots 58 in the platform. However, many of the rivets will not be so oriented. Accordingly, as mentioned previously, platform 56 is agitated or vibrated so that at least part of the improper oriented rivets will shift around and fall into the slots. This agitation is effected by vibrator 60, which may be of the conventional, electrically operated type and is fixed to a bracket 120 on the bottom of platform 56 by bolts 122. Vibrator 60 effects a generally upward and downward vibratory movement of the platform which is reinforced by the spring mounting of the latter. This spring mounting also serves to isolate the remainder of the riveting machine from the vibration.

The components just described which hold the rivets in their proper orientation, transfer the rivets to platform 56, and which agitate the platform to shift the rivets and cause them to fall into slots 58 are important features of the present invention. Another feature of the invention of paramount importance is the novel sweep or brush mechanism 62 provided to brush improperly oriented rivets from the upper surface of the platform and from slots 58 onto the ramps 64 down which they migrate into hopper 52. This is essential to prevent improperly oriented rivets from piling up on the platform and jamming slots 58 as this would quickly prevent rivets from entering the slots.

As best shown in FIGS. 3—5, this novel sweep mechanism includes an elongated holder 124 extending longitudinally of platform 56 adjacent the outer or upper ends of ramps 64 through hopper end walls 74 and 76 and journaled for sliding movement in riveting machine frame 32. As shown in FIG. 4, the apertures 125 in the hopper end walls have considerably larger dimensions than the holder to isolate the sweep mechanism form the vibrator of hopper 52 and platform 56.

Supported by holder 124 is a brush 126 oriented so that its bristles extend downwardly and engage the upper surface 86 of platform 56 (see FIG. 6). Generally U-shaped notches 128 are formed in the side of brush 126 facing hopper 52 (see FIGS. 6 and 7). As brush 26 is reciprocated, the projections provided by these notches engage improperly oriented rivets 78 lodged in slots 58 and brush them onto ramps 64 for return to hopper 52 as shown in FIG. 6.

Referring now primarily to FIG. 4, holder 124 and brush 126 are reciprocated by a mechanism including a crank 130, a cam 132, and a compression spring 134. One end of crank 130 is pivotally fixed to holder 124 by pivot member 136. Intermediate its ends, the crank is pivotally fixed to a framework supported bracket 138 by a pivot member 140.

Between pivot members 136 and 140, a cam follower supporting shaft 142 is secured to crank 130 as by a nut 144. Rotatably journaled on shaft 142 is a conventional cam follower 146 adapted to follow a cam surface 148 on the outer end of cam 132. The cam is secured to the end of the shaft 108 described previously, as by a cap screw 149. Spring 134 is mounted between bracket 138 and crank 130 on the opposite side of pivot 140 from cam follower 146.

As shaft 108 rotates, cam follower 146 rides up onto a rise on cam surface 148, pivoting crank 130 in a counterclockwise direction about pivot member 140. This moves holder 124 and brush 126 to the right as shown in FIG. 4 and compresses spring 134. As follower 146 passes the high portion of the cam surface, spring 134 expands, moving the holder and brush in the opposite direction; i.e., to the left as shown in FIG. 4. This novel but simple arrangement has been found to be very effective in sweeping improperly oriented rivets onto ramps 64 and thereby permitting them to return to hopper 52.

By virtue of the structure so far discussed, slots 58 are maintained full of properly oriented rivets 78 as shown in FIG. 5. As mentioned briefly above, at appropriate intervals, rivets are transferred from slots 58 through communicating apertures 82, flexible conduits 66, and the die 36 in ramp assembly 40 into preformed apertures in the workpiece to be riveted. The movement of the rivets from slots 58 into apertures 82 is effected by operation of escapement mechanism 68 as mentioned briefly above.

Referring now to FIGS. 3, 4, and 8, escapement mechanism 68 includes an elongated, rectangularly sectioned member 150 slidably supported in brackets 152 attached to riveting machine framework 32 on opposite sides of hopper 52. Extending upwardly from member 150 are cooperating pairs of stops 154 and 156, one pair of stops being provided for each of the slots 58 in platform 56. These stops are preferably thin

leaf springs oriented to slide between the spaced apart shanks of successive rivets 78 in slots 58 as shown in FIG. 4.

The two stops 154 and 156 in each cooperating pair extend upwardly through an aperture 158 in platform 56 which communicates with the associated slot 58 adjacent the outer end thereof; i.e., near the end remote from hopper 52. With escapement member 150 in its normal position (shown in FIG. 4), the stops 154 in each pair are alined with the associated slots 58 and, accordingly, prevent the rivets therein from migrating down the slot into the cooperating, communicating apertures 82.

To allow a rivet to pass from each of the slots 58 into the cooperating aperture 82, member 150 is moved to the left from the normal position shown in FIG. 4. This removes the restraint on the end rivet in the row in slot 58, allowing the rivet to slide down the slot and into aperture 82. At the same time, as member 150 moves to the left, the second stop 156 in the pair moves into alignment with the associated slot 58, preventing the second and succeeding rivets in each row from following the rivet permitted to escape by stop 154.

Member 150 is then returned to the position shown in FIG. 4, moving stops 156 out of and stops 154 in alignment with the cooperating slots 58, thereby allowing the remaining rivets in the row to move forwardly until they are arrested by stops 154.

The reciprocatory movement of member 150 just described is effected by a double-acting fluid-operated (preferably pneumatic) motor 160 fixed to a bracket 161 extending from riveting machine framework 32 as by a nut 162. The connecting rod 164 of the motor is connected to member 150 by a link 166. Stops 168 and 170 threaded on link 166 are adapted to engage a member 172 extending from bracket 161 as member 150 moves to the right and to the left, respectively, thereby limiting the movement of the rod and insuring that the stop 154 or 156 is properly aligned with the cooperating slot 58 when the movement of member 150 is arrested.

As mentioned above, rivets 78 travel through flexible conduits 66 and the die 36 incorporated in ram assembly 40 into preformed apertures in the workpiece to be riveted. Referring now to FIGS. 13—15, ram assembly 40 includes a base 174 fixed to and supported from the connecting rods 176, 178, and 180 of three fluid-operated, preferably hydraulic, motors 182, 184, and 186 mounted in any convenient fashion on frame 32 of riveting machine 30. Die 36 is supported for movement toward and away from base 174 by elongated guide members 188 which are threaded into die 36 and extend upwardly from it through apertures 190 in base 174. Heads 192 on guide members 188 engage shoulders 194 in apertures 190 to limit the movement of die 36 away from base 174.

Die 36 is biased to this spaced apart relationship by springs 196 which surround guide members 188 and are received in pockets 198 in base 174 at their upper ends.

Also fixed to base 174 are the punches 44 referred to above. These punches extend downwardly from the base into apertures 200 through die 36 with the die and base in the normal, spaced apart relationship shown in FIG. 14. The punches are so dimensioned that, upon movement of die 36 toward base 174 against the bias exerted by springs 196, they protrude through the die. Punches 44 are disposed in vertical alignment with the rivet receiving, preformed apertures in the workpiece to be riveted (not shown).

Referring now specifically to FIG. 14, the rivet supplying flexible conduits 66 communicate through fittings 202 with apertures 204 in die 36. These apertures intersect punch receiving apertures 200 at locations immediately below the lower ends of punches 44 with the die and base 174 in the relative positions shown in FIG. 14. Accordingly, upon actuation of escapement mechanism 68, rivets 78 proceed from the slots 58 in platform 56 through apertures 82, flexible conduits 66, rivet receiving apertures 204 and punch receiving apertures 200 into the preformed holes in the workpiece to be riveted.

Cooperating with ram assembly 40 to form heads on the rivets 78 thus positioned in the workpiece is the pressure pad assembly 42 mentioned briefly above which, in addition to pressure pad or work support 38, includes a base 206 mounted on riveting machine frame 32. Pressure pad 38 is supported and biased upwardly away from base 42 by spring 208 which are mounted in pockets 210 in the base and extend upwardly from the latter. Guide members 212 extending through apertures 214 in the base and threaded into the pressure plate at their upper ends permit the pressure plate to move toward and away from the base, but constrain this movement to a rectilinear path. Heads 216 on guide members 212 engage shoulders 218 in apertures 214 to limit the spring biased movement of pressure pad 38 away from base 42.

Also mounted on base 206 directly below the punches 44 in ram assembly 40 are the anvils 46 mentioned above which are so dimensioned that they will protrude through anvil-receiving apertures 219 in pressure pad 38 as ram assembly 40 descends and forces the pressure pad toward base 206 against the bias of springs 208. As discussed above, anvils 46 cooperate with punches 44 to upset and form heads on the rivets in the workpiece being riveted.

Referring now to FIGS. 15 and 16 of the drawing, operation of the novel riveting machine 30 just described is initiated by closing a master power switch S 220. This connects main leads L 222 and L 224 across electrical power source 226, thereby energizing indicator lamp 228 which is connected across the main power leads by lead L 230. Manual switches S 232, S 234, and S 236 are then closed (if they are not already closed).

The closing of switch S 232 energizes the motor M 238 of hydraulic pump 240 as the motor is connected across main leads L 222 and L 224 by lead L 242. The closing of switch S 234 energizes motor M 118, which is connected across the main power leads by lead L 244. As mentioned previously, motor M 118 is drive-connected to the shaft 108 which operates rivet transfer mechanism 54 and rivet return or sweep mechanism 62 and accordingly actuates these two mechanisms.

The closing of the third switch S 236 completes a circuit between leads L 222 and L 224 through lead L 246 and, accordingly, energizes the motor M 248 of vibrator 60. This causes the vibrator to agitate platform 56 and reorient the rivets 78 thereon so that they will shift about and fall into the slots 58 in platform 56 in the manner described above.

With the foregoing mechanism in operation, the riveting cycle may be initiated. This is accomplished manually and then continued automatically as mentioned above. Specifically, the cycle is initiated by closing a normally open switch S 250 in main power lead L 224. With serially arranged switch S 252 closed (the function of switch S 252 will be explained later) this completes a circuit between leads L 222 and L 224 through lead L 254, energizing solenoid K 256. As shown in FIG. 15, this permits hydraulic fluid to be pumped from reservoir 258 through hydraulic line 260, valve 262, and hydraulic lines 264, 266, and 268 into the upper ends of double-acting hydraulic motors 182 and 186. This moves the pistons (not shown) of the two motors downwardly, extending connecting rods 176 and 180 and moving ram assembly 40 down toward pressure pad assembly 42. At the same time, the connecting rod 178 of hydraulic motor 184 moves downwardly, allowing hydraulic fluid to flow into this motor through hydraulic line 270.

As ram assembly 40 descends, it engages the actuator (not shown) of a microswitch having a normally open contact S 272-01 in lead L 274 and a normally closed contact S 272-C2 in lead L 254. The opening of normally closed switch S 272-C2 interrupts the continuity in lead L 254, deenergizing solenoid K 256 and shutting off the flow of hydraulic fluid to motors 182 and 186. This stops the descent of the ram assembly.

The simultaneous closing of switch contact S 272-01 performs three functions. First, it completes a circuit across the main power leads L 222 and L 224 through branch leads L 274 and L 276, energizing solenoid K 278. This connects the right-hand end of the pneumatic motor 160 in escapement

mechanism 68 to a source of compressed air (not shown), driving the connecting rod 164 of the motor and escapement member 150 to the right as shown in FIG. 4. As discussed above, this permits the end rivet in the row in each of the slots 58 in platform 56 to move from the slot through the communicating aperture 82 into the associated flexible rivet delivery conduit 66.

When member 150 reaches the limit of its travel in the left-hand direction as shown in FIG. 4, it engages a microswitch S 280, opening the normally closed contact S 280-C1 of the switch and closing its normally open contact S 280-02. This respectively deenergizes solenoid K 278, interrupting the communication between the compressed air source and the left-hand of motor 160 and energizes solenoid K 282 which is connected across leads L 276 and L 222 by lead L 285. The energization of solenoid K 282 connects the right-hand end of the motor to the compressed air source. Connecting rod 164 of the motor accordingly then moves to the right, restoring member 150 to the position shown in FIG. 4. At this point microswitch S 280 is restored to the configuration shown in FIG. 16 in which contact S 280-C1 is closed and contact S 280-02 is open.

At the same time that it initiates the operation of the escapement mechanism just described, the closing of switch contact S 272-01 also connects main power lead L 224 to main power lead L 222 through leads L 284 and L 286, energizing timers T 288 and T 290. Referring now primarily to FIGS. 5, 14 and 16, when the time for which timer T 288 is set expires, normally open contact T 288-01 closes, completing the continuity in a lead L 292 connected across main power leads L 222 and L 224 and thereby energizing solenoid K 294. This connects the compressed air source to pneumatic lines 296, which communicate with the space between platform 56 and a cover 300 over the platform, producing a blast of compressed air which propels rivets 78 delivered through tube 66 and the apertures 204 and 200 in die 36 into the preformed apertures in the workpiece to be riveted. Thereafter, timer T 288 automatically resets, opening contact T 288-01 and discontinuing the compressed air blast.

The time on timer T 290 then expires and its normally open contact T 290-01 closes, completing the continuity in a lead L 302 connected between main power leads L 222 and L 224.

This energizes a solenoid K 304, connecting the upper end of the larger and more powerful hydraulic motor 184 to the output side of hydraulic pump 240 through hydraulic lines 260, 306, and 308 and valve 310, extending its connecting rod 178; and the downward movement of ram assembly 40 resumes. As the ram assembly continues this downward movement, die 36 moves toward base 174 of the ram assembly; and pressure pad 38 moves toward base 206 of assembly 42. This extends punches 44 downwardly through apertures 200 in die 36 and anvils 46 upwardly through the anvil receiving apertures 219 in base 206. The rivets 78 in the workpiece are accordingly longitudinally compressed between the punches 44 and anvils 46, heading them in the customary manner except that all of the rivets are headed simultaneously.

Exertion of a specified, predetermined pressure on rivets 78 will result in their being properly headed. When this pressure is reached, a pressure responsive switch is actuated, opening its normally closed contact S 314-C1 in lead L 254, and its normally closed contact S 314-C2 in lead L 302 and closing its normally open contact S 314-03 in lead L 316. This deenergizes solenoids K 256 and K 304 and energizes solenoid K 318.

The energization and deenergization of solenoids K 256, K 304, and K 318 interrupts the connections between hydraulic pump 240 and the upper ends of motors 182, 184, and 186 and connects the pump to the lower ends of motors 182 and 186. The hydraulic fluid accordingly pushes the pistons (not shown) of these two motors upwardly, raising ram assembly 40 to its "starting" position. At the same time, the hydraulic fluid in motor 184 drains back into the reservoir, and timer T 290 resets. As the ram assembly reaches the upper limit of movement, pressure switch S 314 is reset, interrupting the flow of hydraulic fluid to motors 182 and 186 and stopping the movement of the ram assembly. This completes the riveting cycle which may then be repeated.

The entire cycle just described may be completed in as little as 7 seconds. This drastically reduces the time necessary to complete multiple riveting operations in comparison to that required for the conventional stepwise operation described above.

As mentioned briefly above, a microswitch S 252 is connected in series with the switch S 250 by which the cycle described above is initiated. A jig 320 of appropriate configuration (see FIG. 17) is typically fixed to pressure pad 38 to aid in properly locating the workpiece to be riveted. Microswitch S 252 is so located on the pressure pad with respect to the jig that, unless the workpiece is properly positioned, its actuator S 252A, which protrudes through an opening 322 in the jig, will not be engaged to close the switch contacts. Accordingly, the riveting cycle cannot be initiated unless the workpiece is properly positioned.

While only one microswitch S 252 is shown, more than one can be used if necessary to insure that the workpieces are properly positioned. If plural switches are employed for this purpose, they are connected in series with switch S 252 in the control system 50 of FIG. 16.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

I claim:

1. A riveting machine comprising work supporting means; a ram assembly movable from an initial position toward and away from said work supporting means, said ram assembly including a die having a plurality of rivet receiving apertures therein for guiding rivets into holes formed in a workpiece to be riveted; selectively actuatable means for supplying rivets to the apertures in said die; punches extendible through the apertures in said die; and means for sequentially moving said ram assembly toward said work supporting means, arresting the movement of said ram assembly and actuating said rivet supplying means to thereby effect a movement of rivets to and through the apertures in said die and into the holes in the workpiece, continuing the movement of said ram assembly toward said work supporting means to such an extent that said punches engage said rivets with sufficient force to form heads thereon, and moving said ram assembly away from said work supporting means to facilitate removal of the riveted workpiece.

2. The riveting machine of claim 1, wherein the means for moving the ram assembly toward said workpiece comprises first and second fluid motor means; selectively operable means for actuating the first motor means; automatically operated switch means for thereafter deactuating said first motor means to arrest the movement of the ram assembly and effect the movement of the rivets through the ram assembly die and into the workpiece; a first timer means activated by the actuation of said switch means for actuating said second fluid motor means to continue the downward movement of said ram assembly to such an extent that the rivets are headed; and fluid pressure responsive means for arresting the downward movement of said ram assembly and reversely actuating one of said motor means to return the ram assembly to its initial position.

3. The riveting machine of claim 2, together with a second timer means activated by the actuation of said automatically operated switch means and means actuatable by said second timer means to pneumatically propel said rivets through said rivet supplying means and said die into the holes in the workpiece.

4. The riveting machine of claim 1, together with means for positioning the workpiece on the work supporting means and means associated with said workpiece positioning means for preventing actuation of said automatically operating ram assembly moving means until the workpiece to be riveted is properly disposed relative to said work positioning means.

5. The riveting machine of claim 4 wherein the means for initiating the operation of said ram assembly moving means comprises selectively actuatable switch means and said actuation preventing means comprises normally open switch means in series with said selectively actuatable switch means and having an actuator adapted to be engaged by the workpiece.

6. A ram assembly for a riveting machine or the like comprising base means; die means having rivet receiving apertures therein for guiding rivets supplied thereto into holes formed in a workpiece to be riveted; means supporting said die means for movement toward and away from said support means; means biasing said die means away from said support means; and rivet forming punches extendible through said apertures upon movement of said die means toward said support means against the force exerted by said biasing means, said punches being fixed to said die means.

7. The ram assembly of claim 6, together with guide members fixed to said die means and extending through apertures in the ram assembly base means whereby said guide members permit but confine said die means to rectilinear movement toward and away from said base means said guide members having stop means cooperable with said base means to limit the movement of the die means away from the base means; and spring means biasing said die means away from said base means.

8. Rivet setting means comprising a ram assembly as defined in claim 6, a base; apertured work supporting means supported by and movable toward and away from said base, the apertures in said work supporting means being aligned with the apertures in the die means of the ram assembly; means biasing said work supporting means away from said base; anvils extendible through the apertures in said work supporting means upon movement of said work supporting means toward said base against the force exerted by said biasing means; and means for moving said ram assembly toward said base with sufficient force to move both said die means and said work supporting means toward the components from which they are supported and engage said punches and anvils with opposite ends of rivets in a workpiece on said work supporting means and aligned with said punches and anvils to thereby head said rivets.

9. The rivet setting means of claim 8, together with apertures in said base means and guide members fixed to said work supporting means and extending through the apertures in the base means whereby said guide members permit but confine said work supporting means to rectilinear movement toward and away from said base means, said guide members having stop means cooperable with said base means to limit the movement of the work supporting means away from the base means; and wherein said biasing means comprises spring means disposed between said work supporting means and said base means and said anvils are fixed to said base means and extend therefrom into the apertures in said work supporting means.

10. In a riveting machine or the like, a rivet delivery system comprising means for holding rivets in a specified orientation; die means provided with at least one rivet receiving aperture for guiding a rivet into a hole formed in a workpiece to be riveted; a conduit means between said rivet holding means and said rivet receiving aperture; means selectively actuatable to effect transfer of a rivet from said rivet holding means to said conduit means; and means for propelling the rivet supplied through said conduit means and said rivet receiving aperture into said workpiece.

11. The riveting machine of claim 10, wherein said die means is incorporated in a ram assembly movable toward and away from the workpiece to be riveted and wherein said die means has at least one aperture therethrough and a punch extendible through said aperture upon movement of said ram assembly toward said workpiece, said rivet receiving aperture communicating with said punch receiving aperture intermediate the ends thereof, whereby said rivet is guided into said workpiece in a position in which it is aligned with said punch.