

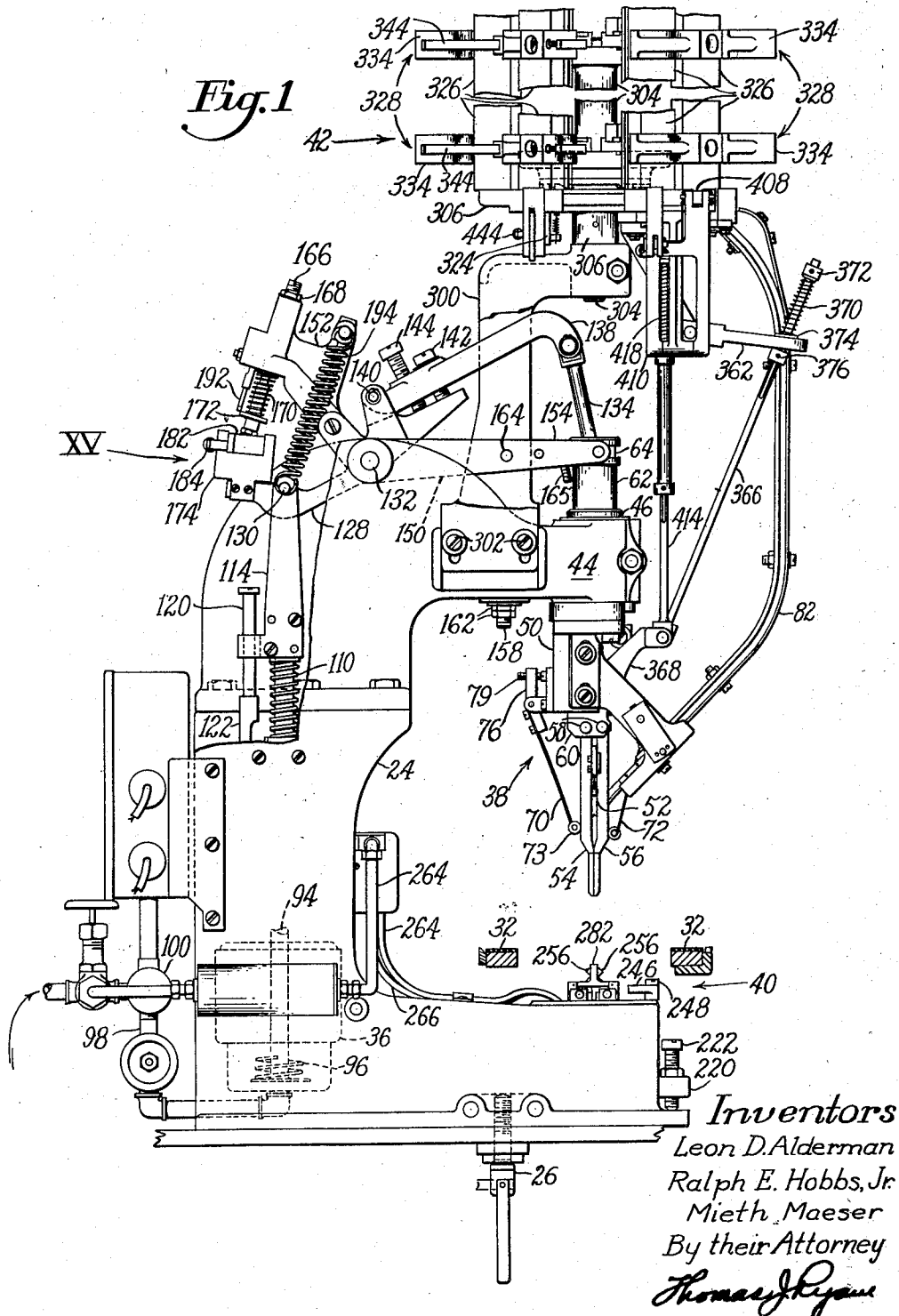
July 28, 1959

L. D. ALDERMAN ET AL
COMPONENT INSERTING MACHINES

2,896,208

Filed Sept. 5, 1956

10 Sheets-Sheet 1



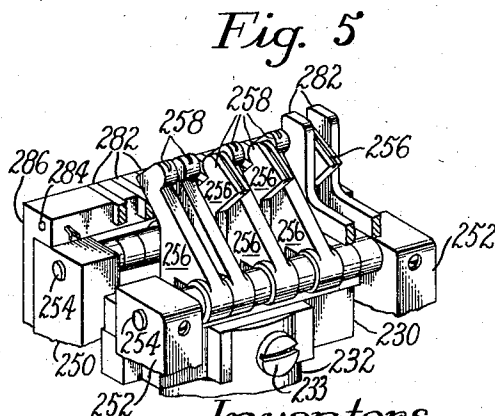
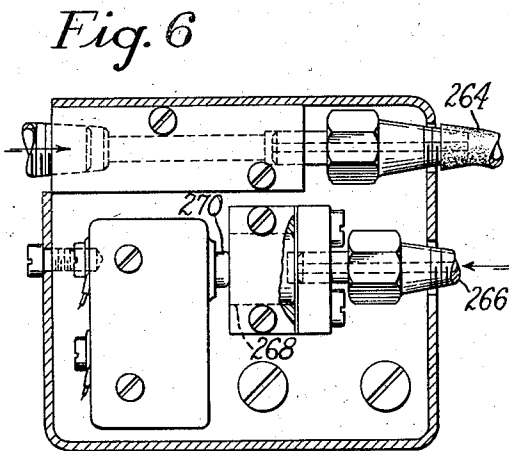
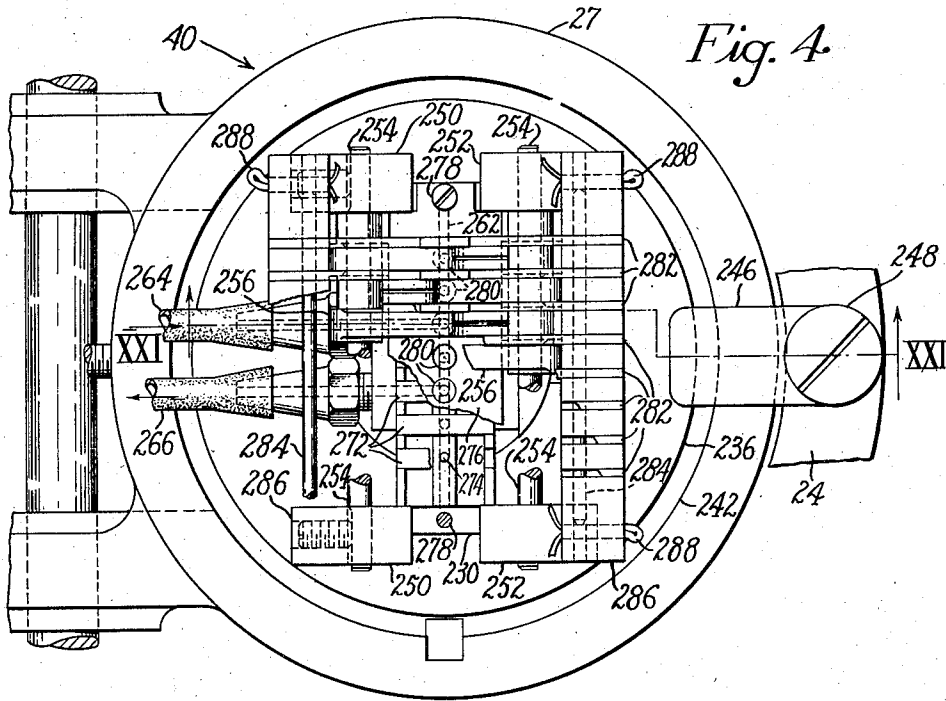
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10 Sheets-Sheet 3



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Fig. 7

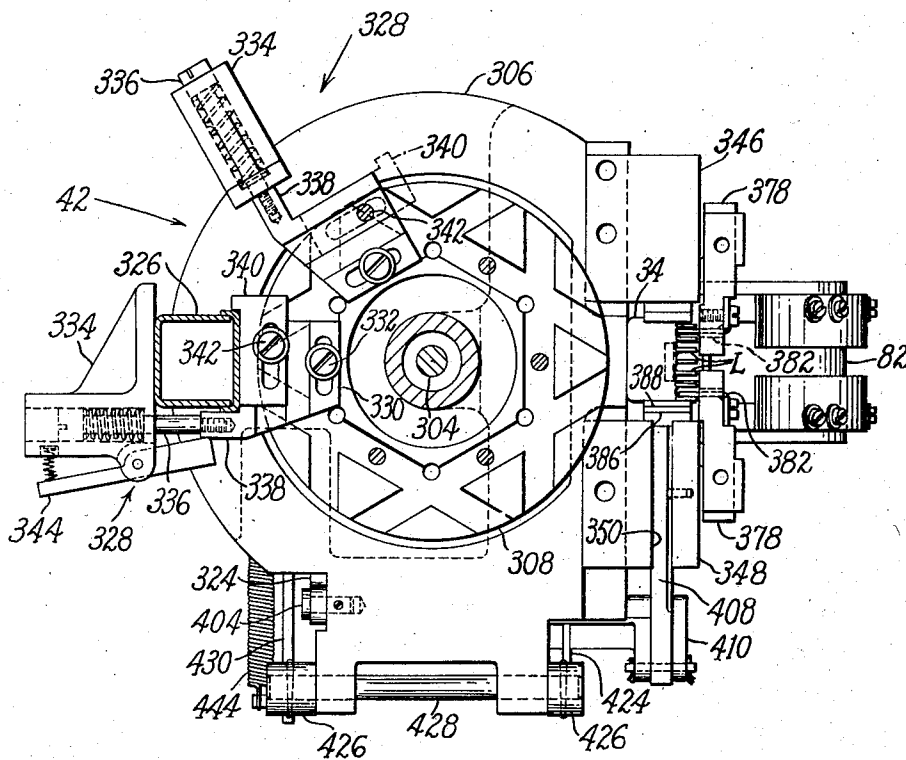
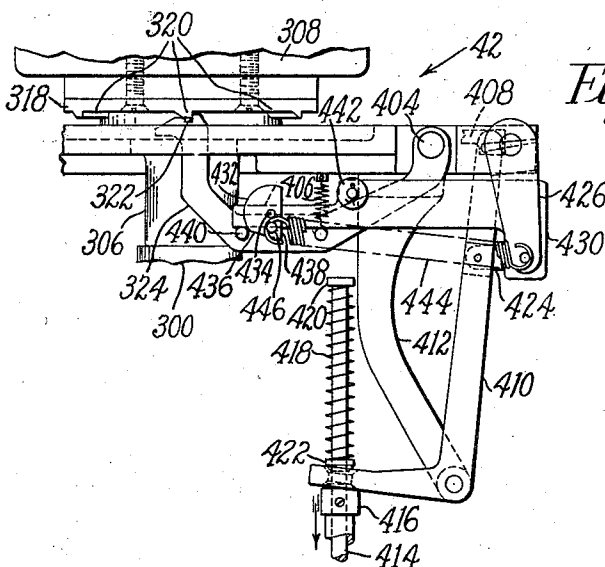


Fig. 8



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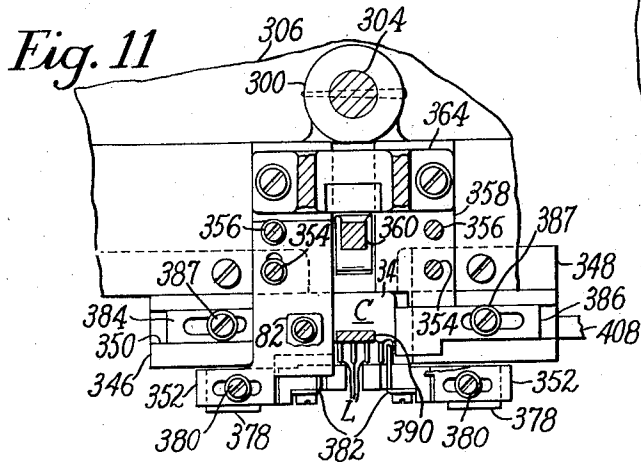
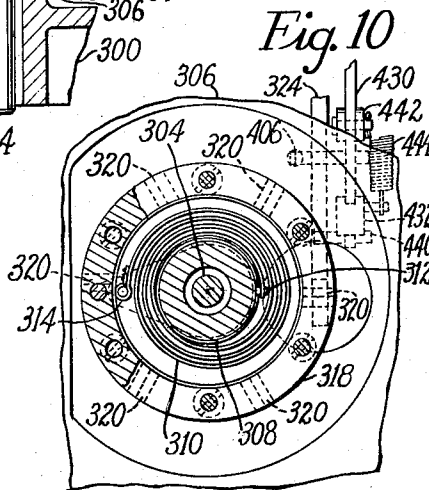
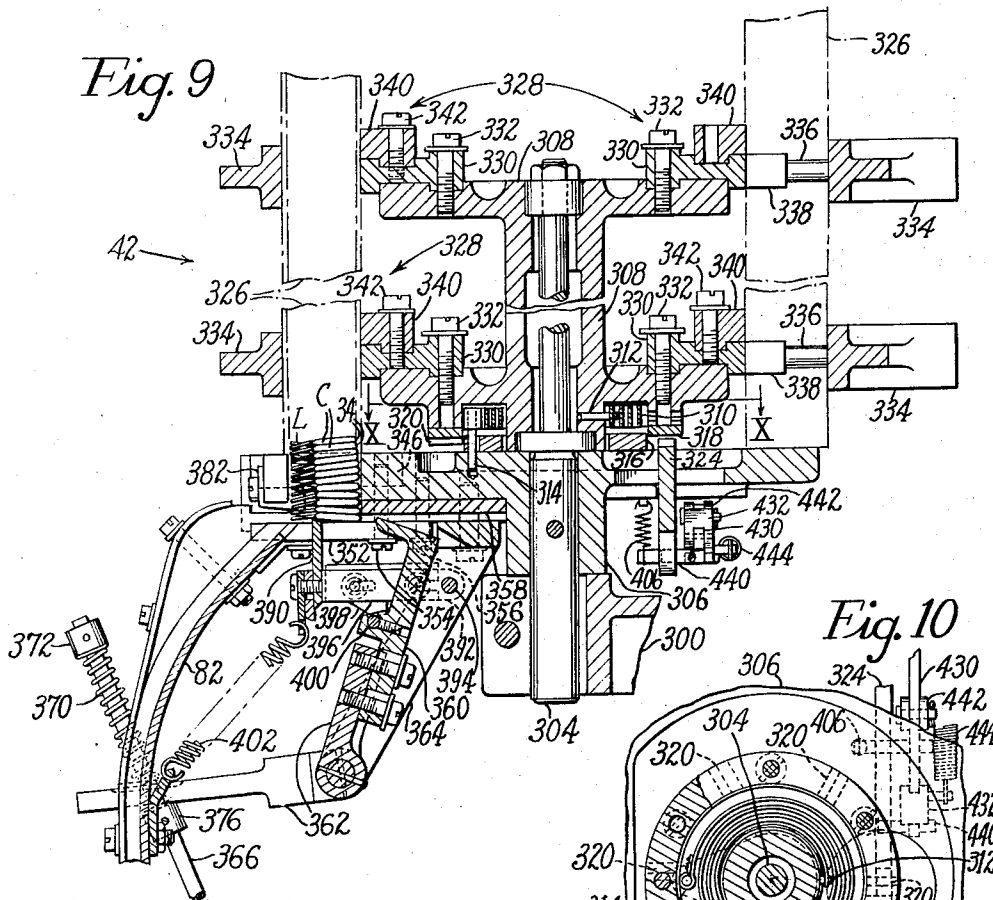
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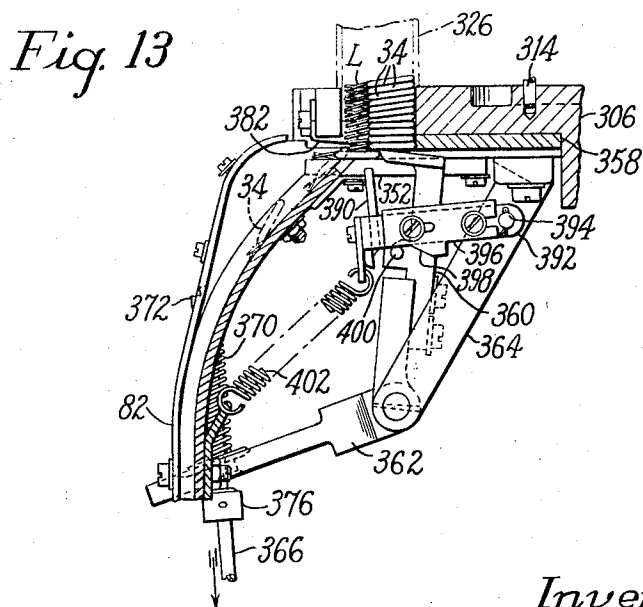
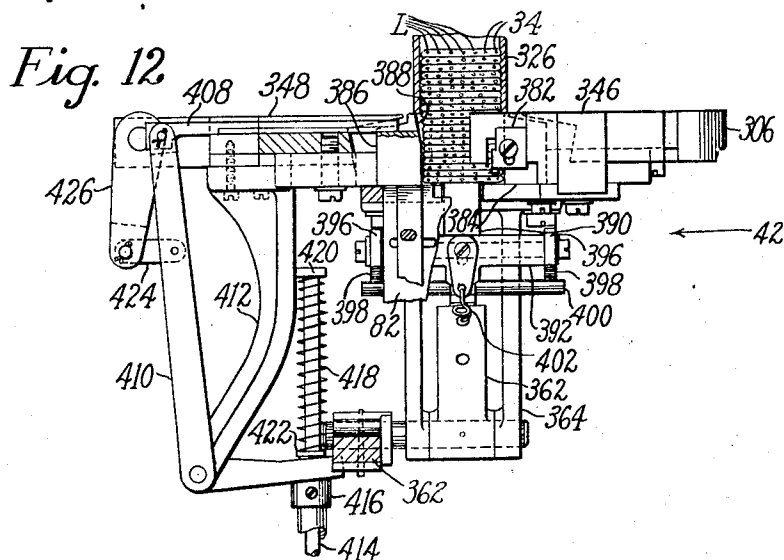
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2,896,208

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Filed Sept. 5, 1956

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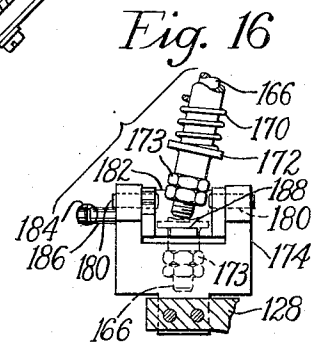
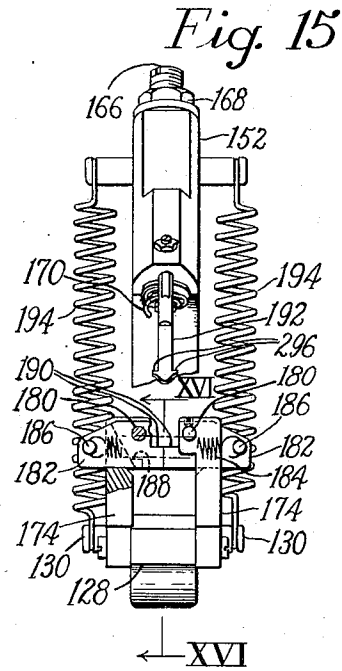
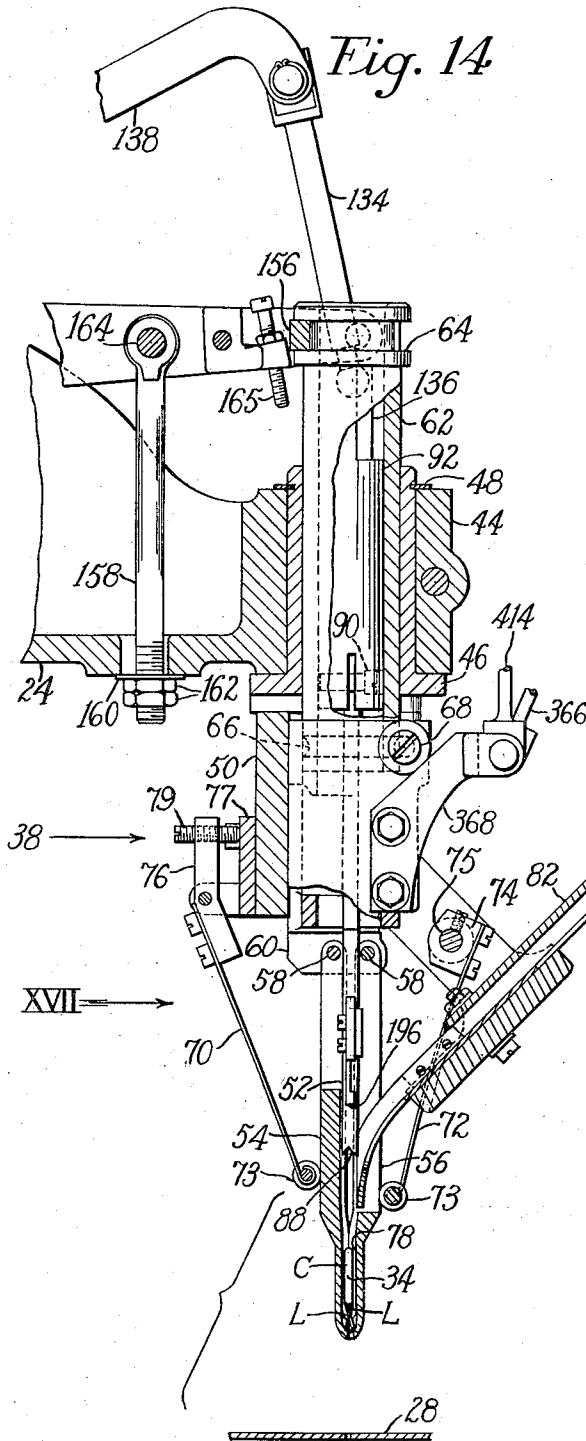
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Filed Sept. 5, 1956

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Fig. 18

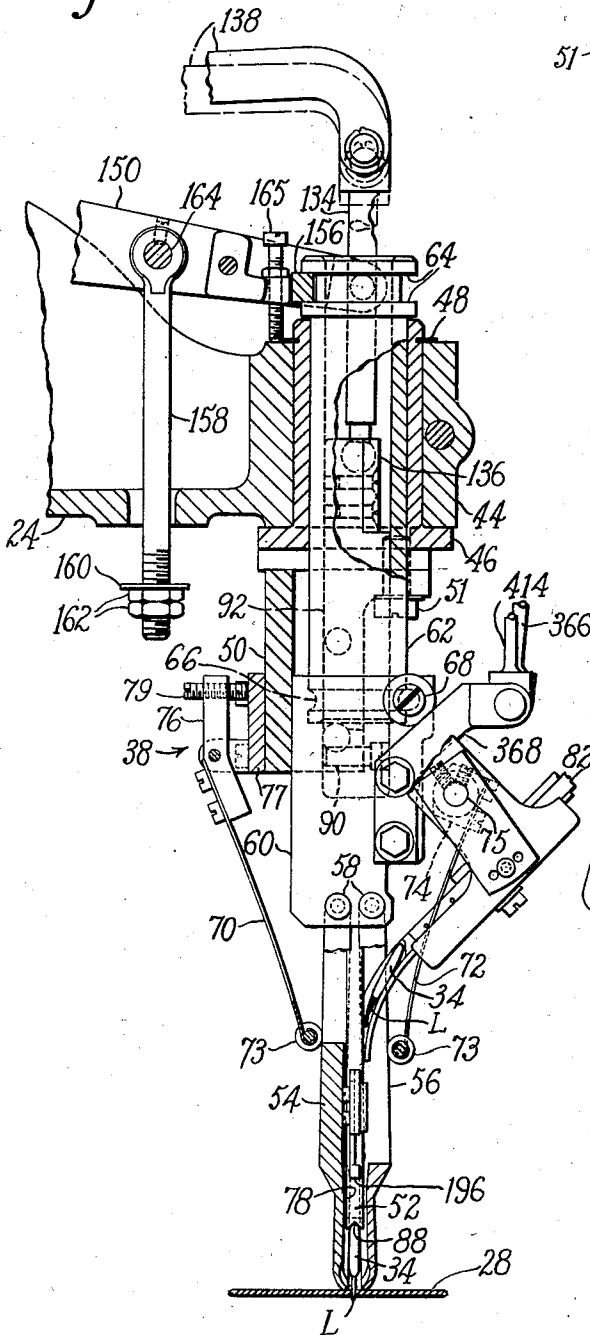
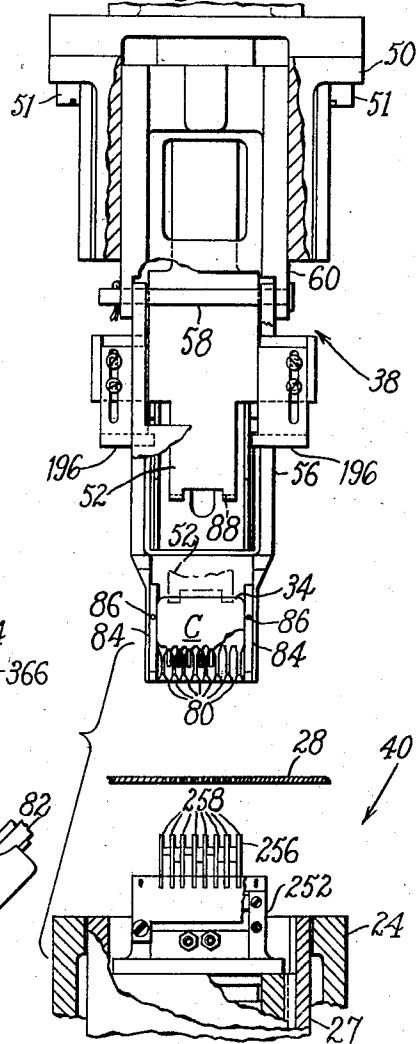


Fig. 17



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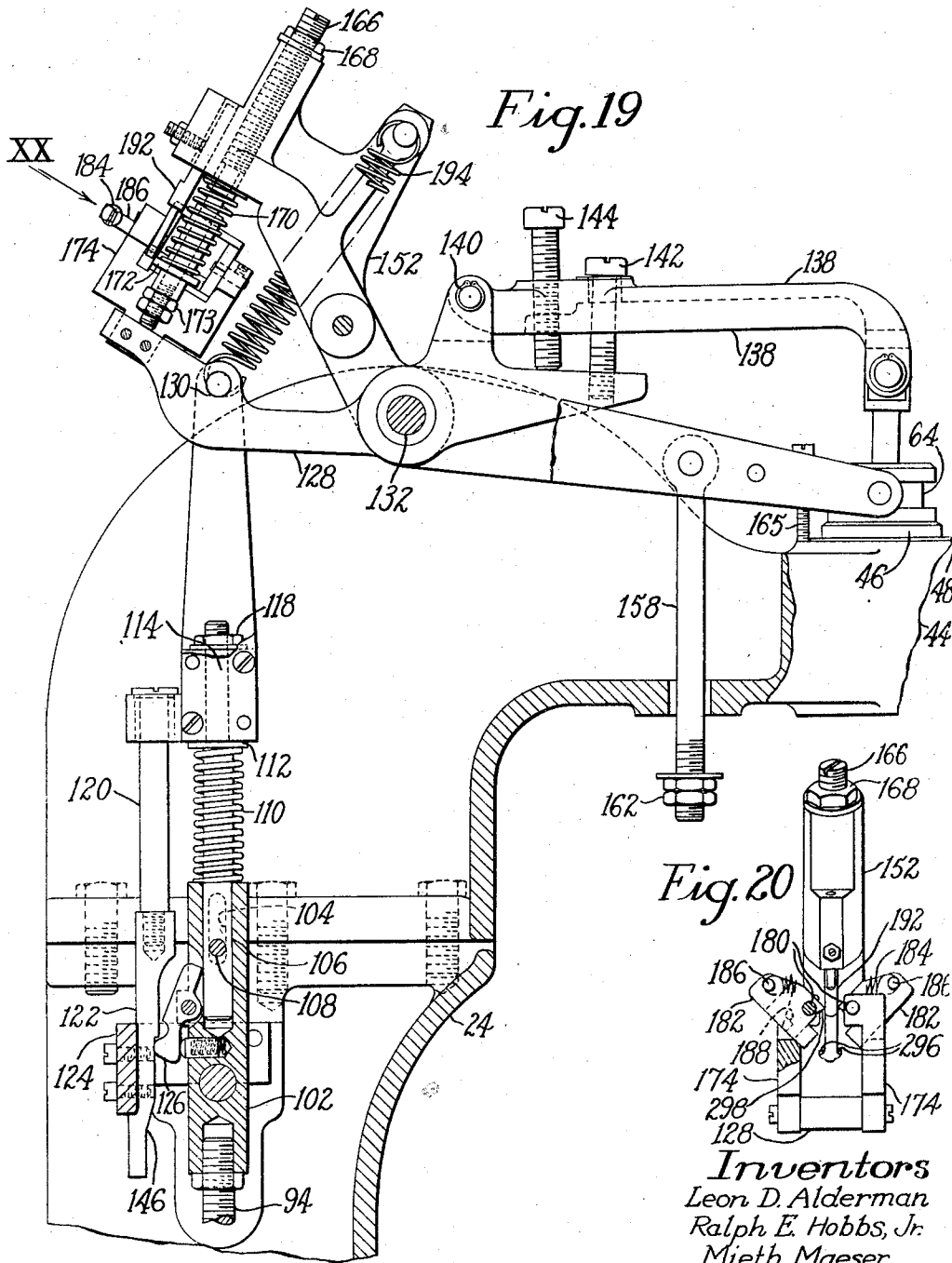
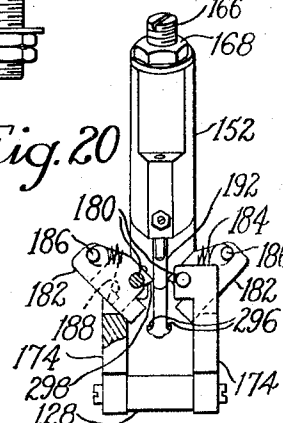


Fig. 19

Fig. 20



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Fig. 21

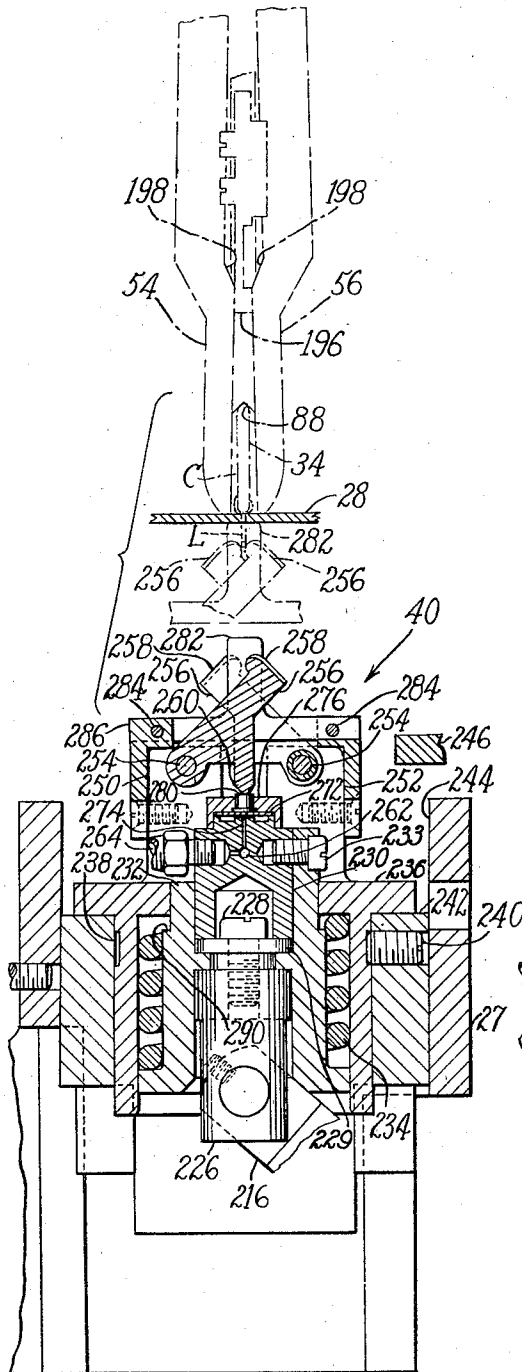
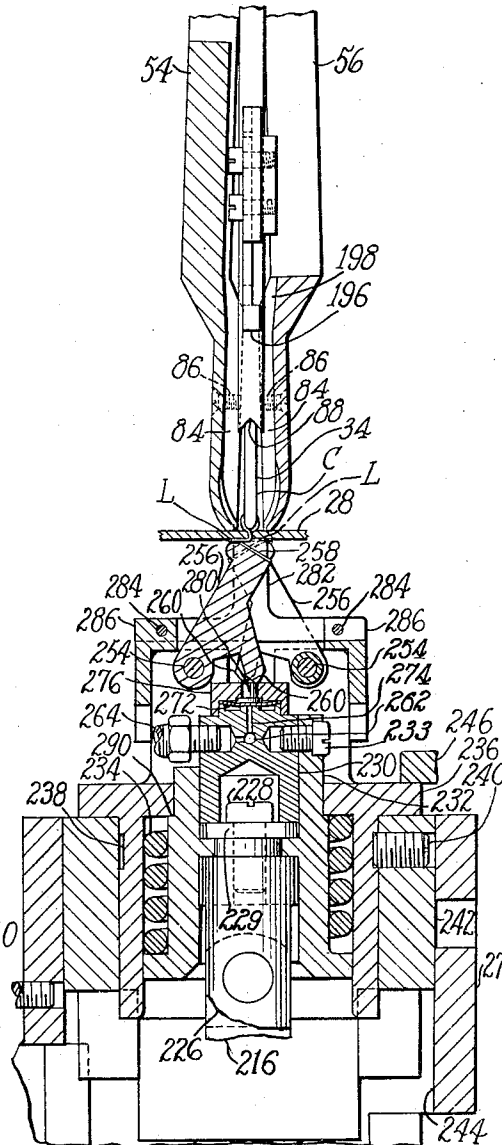


Fig. 22



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Application September 5, 1956, Serial No. 608,131

3 Claims. (Cl. 1—2)

This invention relates to machines for assembling components on work piece. More particularly, the invention is concerned with the provision of a machine for mounting electronic components of the type having a plurality of projections or leads, these terminations to be inserted in, and electrically connected to, predetermined portions of circuits reproduced on chassis. Although the invention is accordingly herein illustrated as applied to a machine for securing on printed wiring boards components of the type having generally parallel terminations and sometimes known, for instance, as couplates, or printed wiring or module assemblies, the terminations being inserted endwise and then usually clinched, it will be understood that in various aspects the invention is not thus limited.

A rather large variety of electronic components and component assemblies have a series of tabs, leads, or other bendable terminations (which hereinafter may simply be termed "leads") projecting from an edge or face of their respective bodies. The latter may also be of different shapes and sizes. A widely used type of so-called printed assembly or couplate, for example, has a flat, rectangular body of ceramic or other non-conducting material in which two or more printed and electrically connected components are encapsulated, the required terminations (generally from two to nine in number) normally being staggered and projecting in two generally parallel rows. These components can be mounted manually and clinched by a hand tool, although the task becomes an arduous and tedious one, especially in view of the large quantities employed, the large numbers of terminations per assembly, and the high degree of reliability required in effecting terminal connections in correct relation to the circuitry. If the chassis for receiving the components be resilient as is the case with plastic wiring boards, for example, the receiving zone may be easily displaced heightwise of the leads during insertions, unless precaution be taken, and hence make difficult an accurate and reliable installation by mechanical means.

In view of the foregoing, it is an object of this invention to provide a dependable and improved machine for mounting on chassis, components having a plurality of generally parallel terminations to be accurately secured thereto. To this end, and in accordance with a feature of the invention, the illustrative machine is provided with novel mechanism for insuring insertion of the leads of successive components in their respective receiving holes, each of which affords only a few thousands of an inch in clearance, said mechanism including a pair of oppositely disposed reciprocable jaws for releasably holding the bodies of successive components with their respective leads projecting generally toward the work piece into which they are to be inserted, the ends of said jaws being formed with lead-guiding channels adapted to receive the respective leads, a reciprocable inserting tool mounted for movement between said jaws to engage said successive bodies to seat the leads in their channels while the jaws serve as holddowns in engagement with the work piece and then to thrust the leads into the work pieces, and

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means associated with said tool for opening said jaws in the course of the insertion of the leads into the work piece to release the inserted component and for holding said jaws open during their retraction from the work piece.

A further feature of the invention is to be recognized in the novel clinching mechanism provided herein for cooperation, for example, with said inserting mechanism. As herein illustrated, this clinching mechanism is embodied in a novel combination for securing leads substantially in row formation comprising a plurality of lead-clinching anvils arranged in side-by-side relation, some of said anvils being pivotally mounted for movement about one of two parallel axes between an inoperative and a clinching position, means for moving the anvils to and from a fixed distance from a chassis against which the leads are to be clinched, and means movable between the axes for substantially simultaneous engagement with the respective anvils to swing them into clinching position when said axes are adjacent to the chassis, whereby leads are simultaneously wiped against the chassis in opposite directions.

The above and other features of the invention, including pneumatic means for indicating a failure of any individual anvil to clinch as required, together with novel details of construction and arrangement of parts, will now be described with more particularly in connection with an illustrative embodiment thereof and with reference to the accompanying drawings, in which:

Fig. 1 is a view in side elevation of an exemplary machine in which the invention is embodied, portions of the machine frame and a magazine turret being broken away, and the machine being shown in rest position and as adapted to install components of the 7-terminal couplate variety in chassis such as wiring boards;

Fig. 2 is an enlarged view of the lower portion of the machine shown in Fig. 1, portions of the frame being broken away to indicate anvil-operating mechanism;

Fig. 3 is a schematic wiring diagram indicating electrical means for controlling operation of the machine;

Fig. 4 is a plan view, with portions broken away, of anvil mechanism shown in Figs. 1 and 2;

Fig. 5 is a perspective view of interdigitated anvil wiping fingers and portions of chassis-engaging spacers shown in Fig. 4;

Fig. 6 is a sectional view of a switch indicated in Fig. 2 and having operative connection with the anvil mechanism;

Fig. 7 is a plan view of the base of the magazine turret and its indexing mechanism;

Fig. 8 is a view in elevation of details of the turret indexing mechanism shown in Fig. 7, the parts being shown in their rest position;

Fig. 9 is a vertical section of the magazine turret and means, shown at rest, for feeding successive couplates into a raceway;

Fig. 10 is a section taken on the line X—X of Fig. 9 and indicating turret-operating means;

Fig. 11 is a bottom view of certain feed and raceway parts shown in Fig. 9;

Fig. 12 is a view in elevation of mechanism for indexing the magazine turret;

Fig. 13 is a view in elevation and partly in section and corresponding to Fig. 9, but showing a component being ejected from the magazine turret;

Fig. 14 is a vertical section of the inserting head of the machine, the operating parts being indicated in their rest positions;

Fig. 15 is a detail view of mechanism as seen when viewed in the direction of the arrow XV in Fig. 1;

Fig. 16 is a section taken on a line XVI—XVI of Fig. 15;

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Fig. 17 is a view in real elevation, i.e., in the direction of the arrow XVII in Fig. 14, with portions broken away, of the lower portion of the inserting head and anvil mechanism, the parts occupying their normal rest positions;

Fig. 18 is a view corresponding to Fig. 14 but showing the head operating parts at that succeeding stage in a cycle of operations when leads of a component have just been partially inserted;

Fig. 19 is a vertical section through the upper portion of the main frame of the machine and showing the relative positions of parts at that later stage in the cycle of operations when leads have been fully inserted;

Fig. 20 is a detail view of certain parts as seen when looking in the direction of the arrow XX in Fig. 19;

Fig. 21 is a section taken on the line XXI—XXI of Fig. 4, showing the anvil mechanism at rest in relation to a wiring board, and indicating in phantom the relative positions of anvil fingers, a component, and the inserting jaws just prior to clinching action; and

Fig. 22 is a view corresponding with Fig. 21, but showing the various elements in their respective positions when clinching action is completed.

The illustrative machine shown herein may be adapted for individual mounting on a bench or for occupying a station in a conveyORIZED assembly line such as is disclosed, for example, in United States Letters Patent No. 2,772,416, granted December 4, 1956, upon an application filed in the names of Adolph S. Dorosz and Thomas W. Snow. For present purposes the machine may be assumed to have its hollow, C-shaped frame 24 adjustably secured in operating position at a station by means of a clamping bolt 26 (Figs. 1 and 2) threaded into a bracket 27 integral with its base, and a chassis herein shown as a wiring board 28 (Fig. 2) mounted on a pallet 30 will be assumed to have been positioned appropriately (by means fully described in said application) above conveyor belts 32, 32 in readiness to receive a multi-terminal type component, for example, a couplate 34 (Figs. 17 and 22). It will be understood that any suitable means for supporting a chassis in appropriately registered position with respect to operating parts of the machine may be employed. The frame 24 houses an air motor 36 having connecting linkage later described for operating a machine head generally designated 38 adjustable about a vertical axis, for actuating anvil mechanism 40 in appropriate time relation to inserting instrumentalities of the head 38, and for operating an indexing magazine turret generally characterized 42, rotatable above the head to supply components successively to said instrumentalities. The body of each couplate may be designated C and its leads or other type of conductive termination identified by the letter L.

For supporting the head 38 (Figs. 1, 14 and 18) for vertical reciprocation from and toward the wiring board 28, an overhanging portion of the frame 24 is provided with confronting clamping cheeks 44, 44 formed to receive a flanged sleeve bearing 46, the latter being peripherally grooved to receive snap ring 48 bearing on the C-frame. A U-shaped guide bracket 50 is fixedly secured, as by bolts 51 (Figs. 17 and 18), to the lower end of the bearing 46 for a purpose shortly to be mentioned. The inserting instrumentalities comprise a vertically disposed, flat driver bar 52 and a pair of cooperative jaws 54, 56, which depend one on each side of the driver bar, the upper ends of the jaws 54, 56 being pivotally supported from parallel pins 58, 58, respectively secured in the lower end of a jaw block 60 coupled to a tubular plunger 62. The latter is slidable in the bearing 46 and formed with an annular slot 64 in its upper end and a peripheral groove 66 (Fig. 18) on its lower end. A screw 68 threaded into the jaw block 60 lies in the groove 66 to couple the block and plunger for vertical movement as a unit, the jaw block being in sliding engagement with, and accordingly guided by, the bracket 50.

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The jaws 54, 56 are yieldingly held against separation by a pair of flat springs 70, 72 which respectively carry at their lower ends a roll 73 arranged to be engaged by an adjacent side of the jaws. The spring 72 is affixed at its upper end to a block 74 which is adjustably mounted on a horizontal pin 75 supported in means for holding a stationary raceway 82. The spring 70 is affixed to a lever 76 pivotally connected to a member 77 secured to the guide bracket 50. Threaded through the upper end of the lever 76 is a screw 79 anchored against endwise movement in the member 77. Rotation of the screw will accordingly adjust gripping pressure of the jaws as cooperatively exerted via the rolls 73. As shown in Fig. 14, the closed jaws are formed at their slender lower end portions to provide an internal pocket 78 adapted to receive and hold upright the body C of a component to be installed, the leads L then respectively extending downward and only partly into semi-conical channels or guide groove 80 (Fig. 17). The latter are formed and spaced to straighten (if necessary) and position the leads L for accurate register with the proper preformed receiving holes of the positioned wiring board 28. When said driver bar is retracted relatively to the jaws by means later explained, a side of the jaw 56 is open above the pocket portion for communication with the lower end of the fixed raceway or supply chute 82 through which the components to be installed are successively fed. It should be noted that at the start of a normal cycle of operations one component 34 already occupies the pocket 78, as shown in Fig. 14, and the driver bar is in its retracted position. More exactly to insure accurate register of leads L with the guide grooves 80 for any particular form of component 34, two spacers 84 (Figs. 17 and 22) are removably mounted on each of the jaws 54, 56, as by screws 86. When necessary, these spacers are changed for others of appropriate shape to adapt them to engage, respectively, an end-face or corner portion of other differently shaped bodies C to be fed into the pocket 78. The lower end of the driver bar 52 is preferably formed with a V-shaper centering notch 88 (Figs. 14 and 17) adapted to bear on the upper portion of each body C, and the upper end of the driver bar is connected by means of a screw 90 (Figs. 14 and 18) to the lower end of a cylindrical slide 92, the screw being recessed in the latter to permit relative vertical movement of the slide within the plunger 62.

For actuating the just-mentioned inserting instrumentalities of the head in a cycle of operations, and for operating the anvil mechanism 40 and the turret 42, as will later be described, a piston rod 94 (Figs. 1, 2, and 19) is caused by the motor 36 and a return spring 96 to be moved upwardly in a single, continuous operating stroke and then allowed to descend to its lower or starting position. The motor is connected to a source of air under pressure by means of a pipe 98 (Fig. 1), and admission of air under pressure via the pipe to the motor is controlled by a two-way solenoid valve 100 (Figs. 1 and 3). The upper end of the rod 94 threadedly carries a coupling 102 (Fig. 2), the upper end of which is formed with a vertical bore and a pair of oppositely disposed vertical slots 104. Mounted for relative heightwise movement in the just-mentioned bore is the lower end of a rod 106 carrying a pin 108 which projects through the slots 104 to limit the heightwise movement. The pin 108 is normally caused yieldingly to engage the upper ends of the slots 104, as shown in Fig. 2, by means of a compression spring 110, the lower end of which abuts the coupling 102 and the upper end of which abuts a washer 112 (Fig. 19). A pair of spaced, parallel actuating arms 114, 114 engaged by the washer is fixedly secured on the rod 106 by means of a nut 118 threaded on the upper end of this rod. For adjustably determining the limit of upward movement of the actuating arms 114 a vertical stop screw 120 (Figs. 2 and 19) extends through a bore formed in a spacer secured between the

arms 114 and is threaded into a bracket 122 secured by screws to a U-shaped support 124 mounted in the main frame 24. When the piston rod 94 is in its lowermost or rest position, as shown in Fig. 2, the lower end of a spring-pressed detent 126 pivotally carried by the coupling 102 is biased clockwise against the bracket 122 so that the upper end of the detent extends into the bore formed in the coupling and engages the lower end of the rod 106, thus normally maintaining the pin 108 in engagement with the upper ends of the slots 104. Upon energization of the solenoid valve 100, for example by the means hereinafter to be described, the piston rod 94 is caused by air pressure to move upward, the actuating arms 114 accordingly being thereafter moved upwardly, as will next be explained, to effect insertion of a component by the head 38.

In the first portion of the upward movement of the piston rod 94 the detent 126 rides upwardly in engagement with the bracket 122 and the rod 106, the latter accordingly acting to elevate the arms 114 and thereby pivot clockwise (as viewed in Fig. 1) a head-operating lever 128 (Figs. 1 and 19). This lever is connected by means of a pin 130 to the upper end of the arms 114, and is fulcrumed on a pivot pin 132 journaled in the frame 24. By reason of linkage connecting the lever 128 with the cylindrical slide 92, as will now be described, the initial upward movement of the rod 94 is effective to move the driver bar 52 downward from its position shown in Fig. 1 and into engagement with the top of the component 34 in the pocket 78, as shown in phantom in Fig. 17. Thus, the slide 92 is formed at its upper end with a spherical recess for receiving the lower ball-shaped end of a link 134, the ball joint being secured by a clamping plate 136 (Fig. 18) screwed to slide and recessed to accommodate a portion of said ball-shaped end. The upper end of the link 134 has pivotal connection with the front end of a link 138 pivotally connected at 140 (Figs. 1 and 19) to an upstanding forked arm of the head-operating lever 128. A bolt 142 (Figs. 1 and 19) extending through a bore formed in the link 138 is threaded into the front end of the lever 128 to enable the angular relation between the latter and the link 138 to be adjusted as desired. A bolt 144 threaded through the link 138 extends to engage the lever 128 endwise and accordingly serves adjustably to limit clockwise (as seen in Figs. 1 and 19) movement of the link 138 with respect to the lever 128, the head of the bolt 142 serving to limit relative counterclockwise movement of the link 138.

Next in the course of the machine cycle the driver bar 52 and the inserting jaws 54, 56 are caused to move downward as a unit with the component 34 which is to be inserted. Thus, the lower end of the detent 126 rides up on an inclined portion 146 of the bracket 122 causing the detent to be moved counterclockwise, as viewed in Figs. 2 and 19. The detent is accordingly disengaged from the lower end of the rod 106, and the upward thrust of the piston rod 94 is now yieldingly imparted to the head-operating arms 114 through the spring 110. For controlling heightwise movement of the jaws 54, 56 by means of the heightwise movement of the arms 114, connections now to be described are provided. A composite forked lever 150 (Figs. 1 and 19) mounted on the pivot pin 132 comprises, for purposes of ease in construction and assembly, a pair of parallel levers 152, 154 pivoted on the pin 132 and spaced to straddle the lever 128. The front ends of the levers 152, 154 respectively carry trunnion blocks 156 (Figs. 14 and 18) arranged to be received in the slot 64 in the plunger 62. The normal rest position and upper limit of movement of the latter and the jaws is adjustably determined by means of an eyebolt 158 (Fig. 14) carrying a washer 160 and nuts 162, 162, the washer being engageable with the frame 24 and the eyebolt slidably extending through a bore in the frame from a supporting pin 164 bridging

the levers 152, 154. The lower limit of movement of the jaws 54, 56 (which corresponds with their engagement with the upper surface of the wiring board) is adjustably determined by a stop screw 165 (Figs. 14 and 18) threaded through the lever 150 and engageable endwise with the frame 24. Threadedly extending in a bore formed in the rearward end of the lever 152 is a rod 166 (Figs. 1, 15 and 19) threadedly carrying at its upper end a lock nut 168 engageable with the lever 152. As indicated in Fig. 19, a compression spring 170 is mounted on the lower end of the rod 166, the upper end of this spring abutting the lever 152 and the lower end abutting a flange 172 of a sleeve on the rod 166. Heightwise positioning of the sleeve on the rod to adjust the compression of the spring 170 is effected by means of a nut 173. The rearward end of the head-operating lever 128 has secured thereto a pair of spaced bracket arms 174, 174 (Figs. 15, 16 and 20). Each of the arms 174 is forked at its upper end pivotally to support on coaxial pins 180 a toggle lever 182. By means of a tension spring 184 having its ends connected respectively to pins 186 in the levers 182, respectively, the latter are normally maintained in a straightened condition, their adjacent edge faces abutting as shown in Fig. 15. With the driver bar engaging the component and while the levers 182 are thus in unbroken toggle relation, their respectively recessed seats 188 (Figs. 16 and 20) are positioned subsequently to engage the flange 172, as indicated in phantom in Fig. 16. The upwardly moving seats 188 upon engaging the flange 172 act yieldingly on the lever 152 through the spring 170 to urge the lever 152 clockwise, as viewed in Fig. 1, and thereby cause the stop screw 165 to descend to its lower limit of movement, as shown in Fig. 18. Accordingly, after the jaws 54, 56 have engaged the wiring board thus to serve as hold-downs and cannot be further lowered, the spring 170 is loaded, and the driver bar 52 is yieldingly urged to move the component downward to cause its leads to be thrust through the straightening grooves 80 and part way into the wiring board holes. Adjoining shoulders 190 of the levers 182, when in straightened condition, are disposed to be engaged by the rounded lower end of a toggle-actuating bar 192 (Figs. 1, 15, and 19) adjustably secured in a bore formed in the lever 152. The last portion of the upward stroke of the arms 114 is effective through the spring 170 to complete the downward inserting stroke of the driver bar, the component leads thus being fully thrust through the wiring board to install the component as indicated by phantom lines in Fig. 21. The arrangement is such that just as the driver bar has thus fully descended the spring 170 has become further compressed until the toggle-actuating bar 192 bearing on the shoulders 190 will overcome the resistance of the spring 184 and break the toggle relation of the levers 182, pivoting them, as shown in Fig. 20, and permitting the spring 170 to be decompressed as the flange 172 descends below the seats 188. At this time the rod 166 engages endwise the lever 128 to permit the jaws 54, 56 to be positively held in their hold down positions. The rod 166 is adjusted heightwise so that its engagement with the lever 128 is timed to occur at substantially the same time as the head of the stop screw 120 is engaged by the arms 114. In completing its inserting stroke, the driver bar carries into engagement with internal shoulders 198, 198 formed on the jaws, a pair of cams 196, 196 which operate to spread the jaws apart and release the component as they bear on the wiring board. As shown in Fig. 17 each cam 196 is adjustably secured heightwise to a lateral wing of the driver bar 52. A pair of preloaded tension springs 194, 194 (Figs. 1, 15 and 19), have their lower ends connected to the pin 130 and their upper ends connected to an arm of the lever 152 for a purpose later mentioned.

The upward movement of the piston rod 94 is now further continued to its upper limit during compression

of the spring 110 to actuate the anvil clinching mechanism 40. Referring to Fig. 2, a pin 200 extending transversely through the coupling 102 carries at each of its extremities a depending link 202. A bell crank lever 204 pivoted in the frame 24 at 206 has forked arms 208 respectively provided with pin-and-slot connection with the lower ends of the links 202. A spring 210 connecting the links 202 with the arms 208 insures an initial upward lost motion of the links relatively to the bell crank lever 204. The latter has pin-and-slot connection with one end of a pair of parallel toggle-operating links 212 (one shown in Fig. 2), the other end of which is pivotally connected to a knee pin 214 connecting toggle links 216, 218. The lower end of the link 218 is pivotally carried by an adjusting lever 220, one end of which is pivoted in the bracket 27 of the machine frame 24 and the other end of which threadedly receives a vertical set screw 222 engageable endwise with a hardened insert 224 in the frame. By means of the screw 222 the heightwise operating range of clinching mechanism to be described, and which is carried by the toggle link 216, is determined. The upper end of the link 216 has pivotal connection with a plunger 226 (Figs. 21 and 22) that is secured by means of a screw 228 and a washer 229 to an internal shoulder formed on a tubular sleeve 232. A valve block 230 is secured to the tubular sleeve 232 by a screw 233. During toggle straightening a flange of the sleeve bears upwardly on one end of a compression spring 234 that engages at its other end an intumed shoulder of a cylindrical anvil support 236. The latter is adjustable about a vertical axis to provide for clinching, as will be described, and as angularly appropriate in the event that the machine head is also adjusted about a corresponding vertical axis. Thus the support 236 is provided with an annular recess 238 for receiving endwise a locking screw 240 which is threaded through a bore formed in a cylindrical spacer 242. This spacer is slidable heightwise in a bearing 244 formed in the bracket 27, the spacer moving upward with the support 236 until the latter engages a stop 246 (Figs. 1, 2 and 22) adjustably secured by a screw 248 to the front of the frame 24. Integral with the support 236 and disposed at opposite ends of the block 230 are two pairs of upstanding arms 250, 250 and 252, 252 (Figs. 4, 5 and 21), each pair of arms being bored to support a fulcrum pin 254 on which is pivotally mounted in parallel relation a plurality of anvil fingers 256. Each finger has an upwardly extending rounded and grooved clinching end 258 arranged to engage an inserted termination, and a downwardly extending projection 260.

For a purpose soon to be explained the block 230 is provided with a central, horizontal bore 262 having connection with tubing 264 (Figs. 4 and 6) in communication with a source (not shown) of air under pressure and with an outlet conduit 266 connecting with a button 268 (Fig. 6) for operating a microswitch spring-pressed contact 270. The upper surface of the block 230 is recessed, and is spanned at intervals of its length by normally flat leaf springs 272 (Figs. 4, 21 and 22). The mid-point of each leaf spring overlies, but does not normally contact, the upper end of a vertical passageway 274 connecting with the bore 262. A cover 276 secured to the block 230 by screws 278 (Fig. 4) retains the leaf springs and is slidably fitted with a series of hardened inserts 280 which have their lower flanged ends respectively in engagement with the central portion of a leaf spring. Each insert 280 is normally arranged to engage an anvil finger projection 260, as shown in Fig. 21, and, as indicated by phantom lines therein, when the support 236 engages the stop 246, the clinching finger ends 258 have not quite reached the level of the underside of the wiring board, but a series of spaced board-backing members 282 has just come into contact with the wiring board to reinforce it against downward pressure which might be exerted by the inserting head. The

members 282 are of inverted T-shape, their opposite ends being mounted on pins 284, 284, respectively held in coaxial bores formed in holders 286, 286 screwed to opposite sides of the support 236. The pins 284 are contained in their holders by cotter pins 288 (Fig. 4).

Upon final straightening of the toggle 216, 218, the spring 234 is compressed, and the block 230 is yieldingly elevated relative to the support 236 until a stop shoulder 290 (Figs. 21 and 22) on the sleeve 232 engages the support 236, the inserts 280 thus being caused to bear upwardly on the respective projections 260 and swing the anvil fingers 256 simultaneously from their inoperative positions into lead-wiping positions. The grooved ends 258 of fingers pivoting on one pin 254 clinch their leads in a direction opposite to that effected by the ends 258 of anvil fingers pivoted on the other pin 254. The construction of the anvil operating means described is such that this final toggle straightening wherein clinching occurs is timed to follow immediately after the completion of lead insertion by the machine head and while the driver bar and separated jaws 54, 56 serve as hold-downs. A tension spring 292 (Fig. 2) connecting the bracket 27 and a spacer secured between the links 212 operates, when air from the motor 36 is allowed by the valve 100 to exhaust, to restore the toggle 216, 218 to normal broken condition in readiness for the next installation. The anvil fingers 256 normally resume their starting positions by reason of their own weight, though light springs (not shown) may be employed to insure their return if desired; in certain instances heavier return springs (not shown) are applied to selected anvil fingers for a purpose later explained.

In the course of the clinching of the seven leads of a component 34 the seven leaf springs 272 are depressed by the reaction of the inserts 280 with the anvil fingers and hence the passageways 274 are all closed thereby, the full pressure of inlet air accordingly being effective through the conduit 266 to move the button 268 (to the left as viewed in Fig. 6) and close the contact 270. For present purposes of description it may be assumed that the machine is under the control of an operator who will cause a normally open main switch 294 (Fig. 3) to be closed throughout an operating cycle. By closing the switch 294 the solenoid valve 100 is energized through a normally closed contact K1-A. Consequently, a relay K1 is energized upon closure of the anvil switch 270 through the means just described, the relay K1 then being effective to open the contact K1-A, deenergize the solenoid valve 100, and close a contact K1-B. The motor return spring 96 is accordingly permitted by the deenergized valve 100 to retract the anvil and head-operating parts to their starting positions. If, however, one or more of the leads of a component being installed was missing or did not get fully thrust through its wiring board hole so that a leaf spring 272 did not during the clinching action close off its passageway 274, there would be no build-up in the air pressure in the conduit 266 effective to displace the button 268, and the anvil switch 270 would accordingly remain open. In these circumstances the relay K1 does not get energized, and hence the solenoid valve 100 remains reenergized with the anvil and head-operating parts remaining in extended position adjacent to or in contact with the wiring board until the main switch 294 is reopened and the component installation corrected. Thus, the machine may be provided with automatic pneumatic means for indicating non-insertion of a required lead, this means being omitted when not considered to be a necessary or desirable precaution. If components having a smaller number of leads substantially in a row are to be installed by the illustrative machine, the heavier return springs above referred to may be connected between the no longer needed anvil fingers 256 and suitable straps (not shown) extending between arms 250, 250 and 252, 252 to hold the proper inserts

280 and leaf springs 272 permanently depressed and thus not impair the effectiveness of the pneumatic testing mechanism. Upon release of air from the motor 36 through the valve 100 the driver bar retracts upwardly along with the jaws 54, 56 by reason of the counter-clockwise movement (as viewed in Fig. 19) of the levers 128 and 138. It is to be noted that preferably the springs 194 are not of sufficient strength to overcome the springs 170, but are of sufficient strength to raise the jaws while open as the driver bar is being retracted. In the course of the final retraction of the head-operating parts to their starting positions by the spring 96 as above mentioned, when the lever 150 can no longer pivot due to engagement of the washer 160 with the frame 24, retraction of the jaws 54, 56 is arrested and thereafter the bar 192 is raised relatively to the toggle levers 182, and accordingly projections 296, 296 (Fig. 20) on the bar 192 contact shoulders 298, 298, respectively formed on the toggle levers to pivot and restore them to their normal straightened condition.

For automatically supplying a component 34 from a magazine supply to the raceway 82 each time the jaws 54, 56 descend, means about to be described is provided. The forked lower end of an upright bracket 300 (Figs. 1 and 9) is secured to the machine frame 24 by screws 302, and its upper end is vertically bored to provide a split bearing for a spindle 304 (Figs. 7, 9 and 10). Mounted on this spindle is a base 306 on which a turret 308 is mounted for rotation as permitted by indexing means to be described. Thus, a coil or clock spring 310 (Fig. 9) recessed in the bottom of the turret has its inner end secured by a pin 312 to the turret and an outer end coupled by a pin 314 to the base 306, the pin 314 extending through a bore formed in a spring-retaining spacer 316 which floats on the base. A disk 318 (Figs. 8, 9 and 10) screwed to the underside of the turret is formed with six equally spaced and radial indexing teeth 320. Trailing faces of these teeth are inclined to the horizontal, and their leading faces extend vertically to serve as stops when engaging an abutment surface 322 (Fig. 8) formed on a lever 324. By automatic means later explained this lever 324 is actuated to release the surface 322 from a tooth 320 when a turret-mounted magazine 326 (Figs. 1, 7, 9 and 12) in register with the upper end of the raceway 82 becomes empty, the coil spring 310 thus being permitted to rotate the turret 308 to bring an adjacent magazine 326 loaded with components into register with the raceway. Each of the six magazines 326 is open-ended and similarly detachably mounted, as will next be described, the vertical stack of components in each magazine being supported on the base 306 in each instance until a magazine is in register with the raceway and the stack there being allowed to descend past the base for feeding. Referring to Figs. 7 and 9, each magazine 326 is releasably secured to an upper and a lower disk portion of the turret 308 by a pair of manually operable clamping devices generally designated 328, 328. Each device consists of an arm 330 secured by a screw 332 to the turret, an L-shaped clamp 334 for normally engaging the outer face of a magazine and yieldingly slidable on a spring-pressed stud 336 threaded into a portion 338 of the arm 330, and an L-shaped block 340 for engaging the inner face and a part of one side of the magazine, the block 340 being adjustably secured to the arm 330 by a rabbit joint and by means of a screw 342 extending through a slot in the block and thus affording accommodation for different sizes of magazines. Conveniently to release a magazine for re-loading, its clamps 334 may be grasped, one in each hand, and retracted from the magazine against resistance of the springs on the studs 336 and then turned 90° (i.e., from the clamping position shown in Fig. 7 to the release position there shown), a spring-backed detent lever 344 pivoted to each clamp 334 thus being swung around the axis of the adjacent stud 336 to a position wherein

the detent is permitted to engage endwise the portion 338 and thereby hold the clamps retracted until a loading magazine can be remounted.

The magazine 326 in register with the receiving end of the raceway rests on a pair of spaced blocks 346, 348 flush with the base 306 and secured thereto, the block 348 being formed with a slot 350 for a purpose later mentioned. For supporting the stack of components to be fed a pair of spaced rests 352 engageable with opposite margins of the bottommost component is adjustably secured by screws 354, 356 (Fig. 11) extending through slots in the rests, the screws 354 being threaded upwardly into blocks 346, 348, respectively, and the screws 356 being threaded upwardly into the turret base 306, all of said screws extending through, and thus clamping, a U-shaped spacer 358 to the base 306. Successive bottommost components 34 of the stack are fed into the raceway by means of parts shown in their rest positions in Fig. 9, and indicated in their relative feeding positions in Fig. 13. Thus, an oscillatory feeding finger 360 (Figs. 9, 11, 12, and 13) has a rather thin upper end arranged to engage only the body of the lowermost component to eject it, the finger 360 being adjustably secured to an arm of a bell crank lever 362 which is fulcrumed on a forked bracket 364 screwed to the base 306. For swinging the finger 360 to feed components in time relation to the inserting operations of the head, the lever 362 is bored slidably to receive a feed rod 36 movable endwise by reason of the pivotal connection of its lower end with an arm 368 (Fig. 1) mounted on the jaw block 60. A compression spring 370 of the rod 366 abuts at its upper end a stop collar 372 and at its lower end a washer 374 which is thus yieldingly held in engagement with the lever 362, the limit of downward movement of the latter relatively to the rod 366 being adjustably determined by a collar 376.

Better to insure reliable feeding of the successive components by the finger 360 in view of irregularities in the shape of component bodies supplied commercially and in view of the fact that the bodies often occur in a form, for instance tapered, such as to tend to yield an unwieldy stack, means now to be described are preferably provided. A supporting block 378 (Figs. 7 and 11) is adjustably secured to each of the rests 352 by means of a screw 380 extending through slots in the respective rests, and to each block 378 is secured an L-shaped retaining guide 382, a thin upstanding edge of which is adapted to extend between selected corresponding leads of several of the components in the stack just above the bottommost component. To align opposite ends of the lower components in the stack with the raceway 82, a pair of guide blocks 384, 386 (Figs. 11 and 12), respectively arranged to extend in guide slots of the blocks 346, 348, is each adjustably secured thereto by a screw 387, the block 386 having an inclined face 388 (Figs. 7 and 12), to urge descending components into stacked vertical alinement. For assuring that the lower components remain free of one another and that the bottommost component assumes a position on the rests 352 such that the feeding finger can properly engage it, a reciprocable pusher 390 (Figs. 9 and 13) is actuated, as will now be described. The upper end of this pusher is disposed to engage each bottommost component adjacent to its leads, as indicated in Fig. 11, and its lower end is secured to a U-shaped lever 392 pivoted at 394 on the bracket 364. Adjustably secured to each leg of the lever 392 is a piece 396 having a cam 398 formed thereon. The cams 398 are disposed to ride on an actuating pin 400 carried by the feed finger 360, cooperative relation between the cams and the pin being yieldingly maintained by a tension spring 402 coupling the lever 392 with the raceway 82. The lever 324 is pivoted at one end on a pin 404 (Figs. 7 and 8) fixed in the turret base 306 and yieldingly suspended from the base by a spring 406. In order to operate this lever 324 and thereby cause the turret 308 to swing an empty magazine 326 from deliv-

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ery position and move a loaded magazine into the delivery position, means now to be explained is provided. A horizontally reciprocable probe 408 (Figs. 7, 8 and 12) is reciprocally mounted in the slot 350 and has one end arranged to engage and displace to the right, as viewed in Fig. 12, each component 34, if any, just beneath the lower end of the magazine in delivery position. The other end of this probe is connected to the upper arm of a bell crank lever 410 fulcrumed on a bracket 412 affixed to the turret base. The lower arm of the lever 410 slidably receives a vertical rod 414, the limit of downward movement of the lever relative to the rod being fixed by a stop collar 416 adjustably mounted thereon. The lever 410 is yieldingly biased counterclockwise (as viewed in Fig. 8) into engagement with the collar 416 by means of a compression spring 418, the upper end of which engages a head 420 formed on the rod 414 and the lower end of which engages a washer 422 on the rod. The lower end of the rod 414 has operative connection with the arm 368, and accordingly each descent of the jaws 54, 56 with a component to be installed is effective, both to rock the feed finger 360 to supply a component to the raceway in position next to be installed and yieldingly to operate the probe 408. The lever 410 is connected by a link 424 (Figs. 8 and 12) to one of two parallel depending crank arms 426 (Figs. 7, 8 and 12) of a composite, forked bell crank lever 428, the other arm 426 having pivotal connection with a latch-operating lever 430. The bell crank lever 428 is pivotally carried by the turret base 306.

When the probe 408 does not engage a component in the stack, as when the magazine supply is exhausted, the probe is permitted to travel in a longer stroke, the spring 418 compressing to a lesser extent than normal, and accordingly the latch-operating lever 430 will be moved more to the left (as viewed in Fig. 8) than normal. In so moving, a member 432 pivoted at 434 on the lever 430 and having both a cam surface 436 and a detent surface 438 will be carried to the left, the cam surface 436 riding over a pin 440 fixed in the lever 324 to depress it and so unlatch its abutment surface 322 from engagement with a tooth 320. The latch-operating lever 430 carries a snubber roll 442 disposed to ride, if need be, on a machined undersurface of the base 306. As indicated in Fig. 8, the member 432 is yieldingly prevented from pivoting clockwise during the action of the cam 436 in depressing the lever 324 by a tension spring 444 connecting the adjacent arm 426 with a pin 446 in the member 432. The arrangement is such that, as soon as the cam surface 436 has passed the pin 440, the spring 406 causes the pin 440 to rise in contact with the detent surface 438 to the extent permitted by the undersurface of the latch-operating lever 430, the abutting surface 322 now being positioned to contact and index the next tooth 320. In the course of the retractive stroke of the jaws 54, 56 the lever 430 is returned to the right (as viewed in Fig. 8) to its normal position, the member 432 accordingly now bearing on the pin 440 and thus being caused to pivot clockwise against the resistance of the spring 444 and thereby freeing the pin 440 and the member 432 for return to their normal relative positions shown in Fig. 8.

Briefly to review a cycle of operations of the illustrative machine, assuming its magazines 326 are loaded and a wiring board is suitably positioned, as shown in Fig. 14, to receive the terminals of a component 34 held by the jaws 54, 56, an operator will close the main switch 294 (Fig. 3) and reopen it at the close of that cycle, or hold it closed for continuous cyclical operation. It will be understood that an automatic control circuit of the type disclosed in the above-cited Dorosz et al. patent preferably is employed in the case of a conveyORIZED mounting of the machine, the circuit shown

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in Fig. 3 being here disclosed mainly for the purpose of explaining simply the operation of the anvil testing means. The piston rod 94, as a consequence of the admission of air under pressure to the motor 36, which is permitted by the energized valve 100, moves upward in a continuous operating stroke against the resistance of the return spring 96. In the first portion of this upward stroke, head operation occurs until the stop screw 120 prevents further upward movement of the arms 114, 114, the jaws 54, 56 being caused to descend with the driver bar and the component from the position shown in Fig. 14 to that shown in Fig. 18. The jaws are then at their lower limit of movement determined by the screw 165, and the leads are inserted into the jaws. Prior to lead insertion, it should be noted, the members 282 will have been raised into contact with the board 28 closely adjacent to the localities of insertion to resist any undue depression thereof by reason of thrust from above. Because of lost motion connections no movement of the toggle links 216, 218 had been derived from initial upstroke of the piston rod 94; but thereafter (through the spring 210 and the pin and slot connection of the lever 208) these links had been partly straightened to lift the plunger 226 and hence carry the support 236 upwardly to engage the stop 246 at the same time as, or very shortly after, the members 282 reached the board. Thus the jaws 52, 54 and the members 282 cooperate accurately to position the wiring board localities heightwise prior to insertion and clinching, an especially advantageous feature should a board be warped. The grooves 80 act on the respective leads to straighten them, if necessary, as they are funneled into their wiring board holes. In the last portion of the upward movement of the arms 114, 114 the driver bar 52 is caused by upward pressure of the seats 188 acting on the lever 152 fully to insert the leads, and the spring 170 is stiffened to the extent that the toggle relation of the levers 182 is broken by the bar 192. Though the jaws 54, 56 are now spread by the cams 196, 196 to release the component, the rod 166 is now engaged endwise by the lever 128 to maintain the jaws in their holddown positions and thus prevent the inserting zone of the wiring board from rising on the inserted leads during clinching. Accordingly, the wiring board is prevented from breaking the component body by exerting an excessive pressure thereon and better control is obtained of the tightness of lead clinch.

With the driver bar continuing to bear downward on the inserted component, and the jaws bearing on the work piece, and other head-operating parts for the moment being stationary, the remainder of the upward stroke of the piston rod 94 is utilized to operate the lead-clinching anvils as described. Final straightening of the toggle 216, 218 causes the anvil fingers 256 to be swung about their respective pins 254, selected fingers thus clinching to the left, as viewed in Fig. 22, and the other fingers clinching to the right securely to anchor the component. During the downward movement of the jaws 54, 56, to install the component in the pocket 78, corresponding movement of the jaw block 60 and the feed rod 366 is effective to oscillate the finger 360 and thus thrust the bottommost component from beneath the supply magazine 326 and into the raceway, this component thus assuming a position indicated in Fig. 18 wherein the leads are in contact with a side of the driver bar. Thereafter, when the spring 96 is permitted to effect return movements, as upon a signal from the anvil switch 270, the jaws, the driver bar, the jaw block, and the rod 366 are raised, and accordingly the component next to be installed is allowed to enter the empty jaw pocket 78, and the feed finger 360 returns to its initial position. Simultaneously with the feeding action, the rod 414 is operated to reciprocate the probe 408 and thus determines, by the means above explained, if the indexing mechanism should, through the spring 310, rotate the

turret to substitute a full magazine for an empty one in the delivery position.

From the foregoing description it will be apparent that this invention affords a reliable and versatile machine for installing large quantities of multi-terminal type components successively, uniformly and accurately.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In a machine for mounting electrical components respectively having leads projecting from corresponding portions of their bodies, a pair of jaws movable into and away from engagement with a work piece on which a component is to be mounted, said jaws being yieldable separable from the component and formed to provide a pocket for receiving and slidably carrying the body of the component and to provide individual channels for guiding its leads, means for feeding a component into the pocket when said jaws are retracted from the work piece, a driver bar operable between said jaws to thrust the leads of a component in said pocket through their respective channels and into the work piece while said jaws are in engagement with the work piece, a surface formed on the driver and arranged thereafter to interact with at least one of said jaws to separate them laterally from that component while the jaws are thus engaging and determining the lead-receiving level of the work piece and while being retracted, and means for thus operating said jaws and driver bar.

2. In a machine for mounting electrical components on work pieces, a main frame, means for supporting a work piece provided with preformed holes in position to receive the leads of a component, a pair of cooperative jaws mounted on the frame for movement toward and from engagement with a work piece supported by said means, said jaws being formed to guide the leads of successive components endwise into said work piece holes, a driver bar mounted for relative movement between said jaws and toward and from said supported work piece, means for controlling the relative movements of said driver bar and jaws, and mechanism including a cam formed on the driver bar and responsive to operation

of the last mentioned means for causing said jaws to be released from a component as it is being inserted by the driver bar, said mechanism holding said jaws separated during the latter portion of their engagement with the work piece and during their retraction therefrom.

3. In a machine for mounting electrical components on work pieces, and having a driver bar movable to eject each component, leads foremost, from the formed guide-way afforded by a pair of cooperative jaws, a frame, cam means adjustably mounted on the driver bar, a pair of levers pivotally mounted on the frame, one of which is operatively connected to said jaws and the other of which is operatively connected to said driver bar, means for sequentially pivoting said levers, first to cause the jaws and driver bar to carry a component to a work piece and then to cause the driver bar to thrust the leads of the component into the work piece, and means for arresting the lever operating said jaws as they engage the work piece to serve as holddowns, said cam means being arranged to spread the jaws as the driver bar ejects the component therefrom.

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