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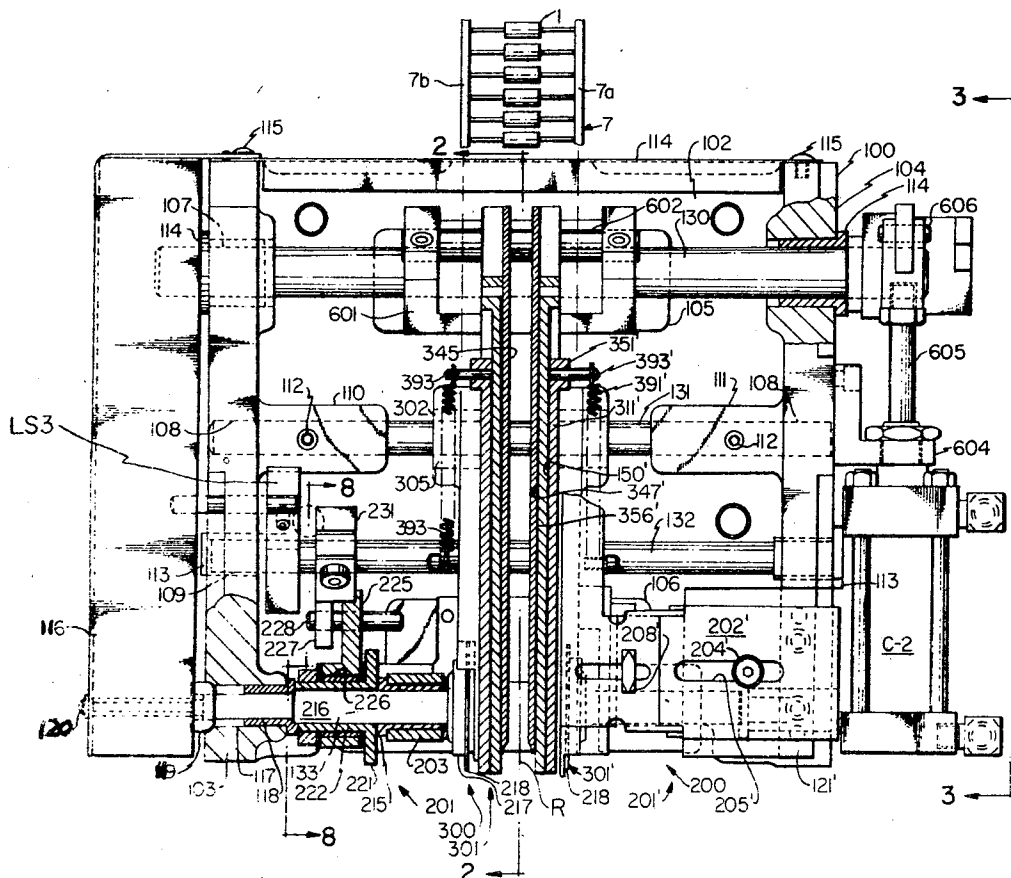
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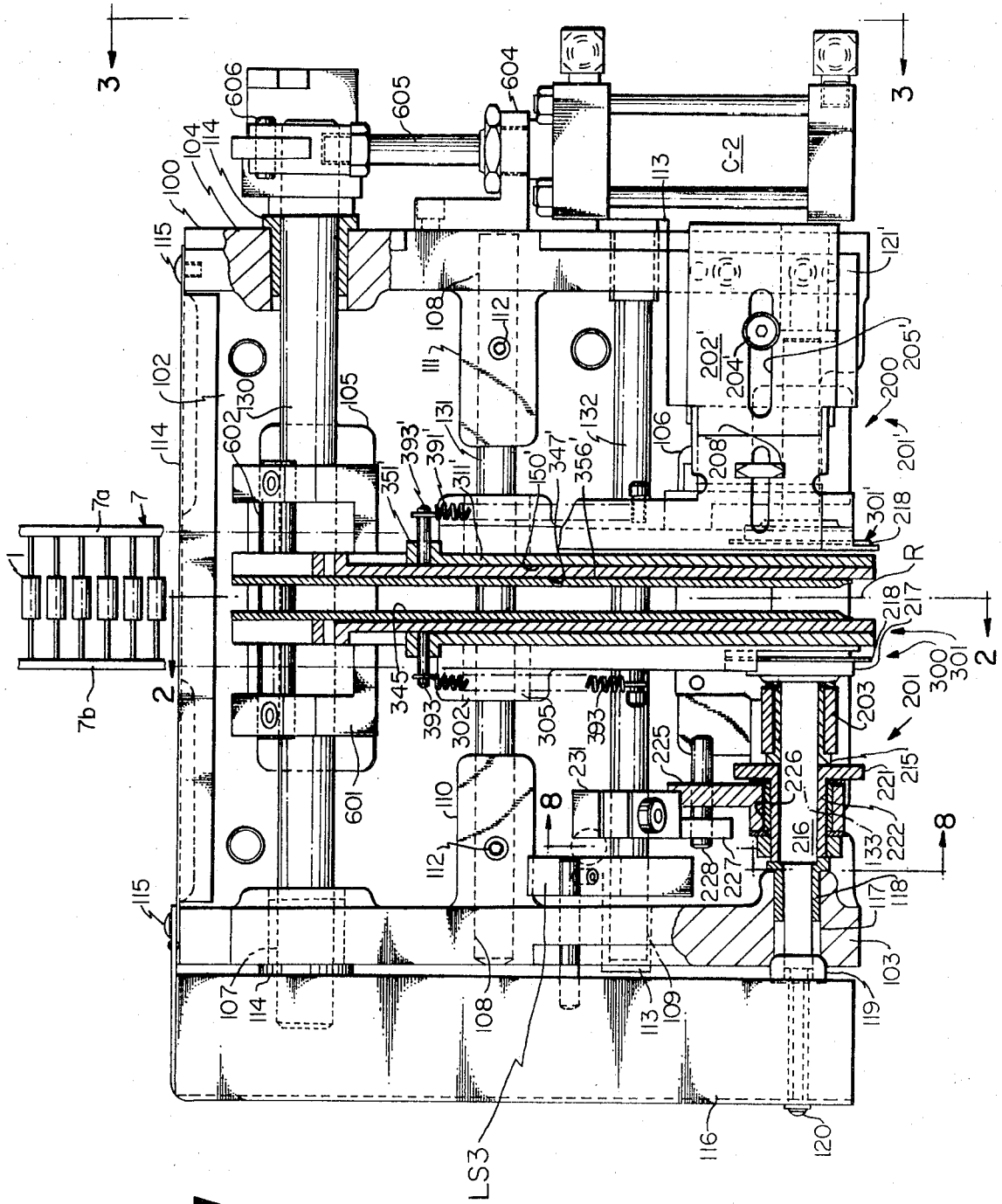
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Attorney—Fidelman, Wolfe & Leitner

[54] **MULTISIZE DUAL CENTER DISTANCE
ELECTRONIC COMPONENT INSERTION
MACHINE**
17 Claims, 23 Drawing Figs.

[52] **U.S. Cl.**..... 29/203 B,
29/203 D
[51] **Int. Cl.**..... **H05k 13/04,**
H01r 43/04, B27f 27/06
[50] **Field of Search**..... 29/203 R,
203 DT, 203 B; 227/2

ABSTRACT: An electronic component insertion apparatus having an insertion head assembly automatically adjustable to accommodate axial lead components having body portions of variable diameter and lengths. The apparatus includes lead end cutters and bending assemblies and spacing means therefor with integrated control means operable to actuate the spacing means to provide two predetermined spacing settings for the varying size components.





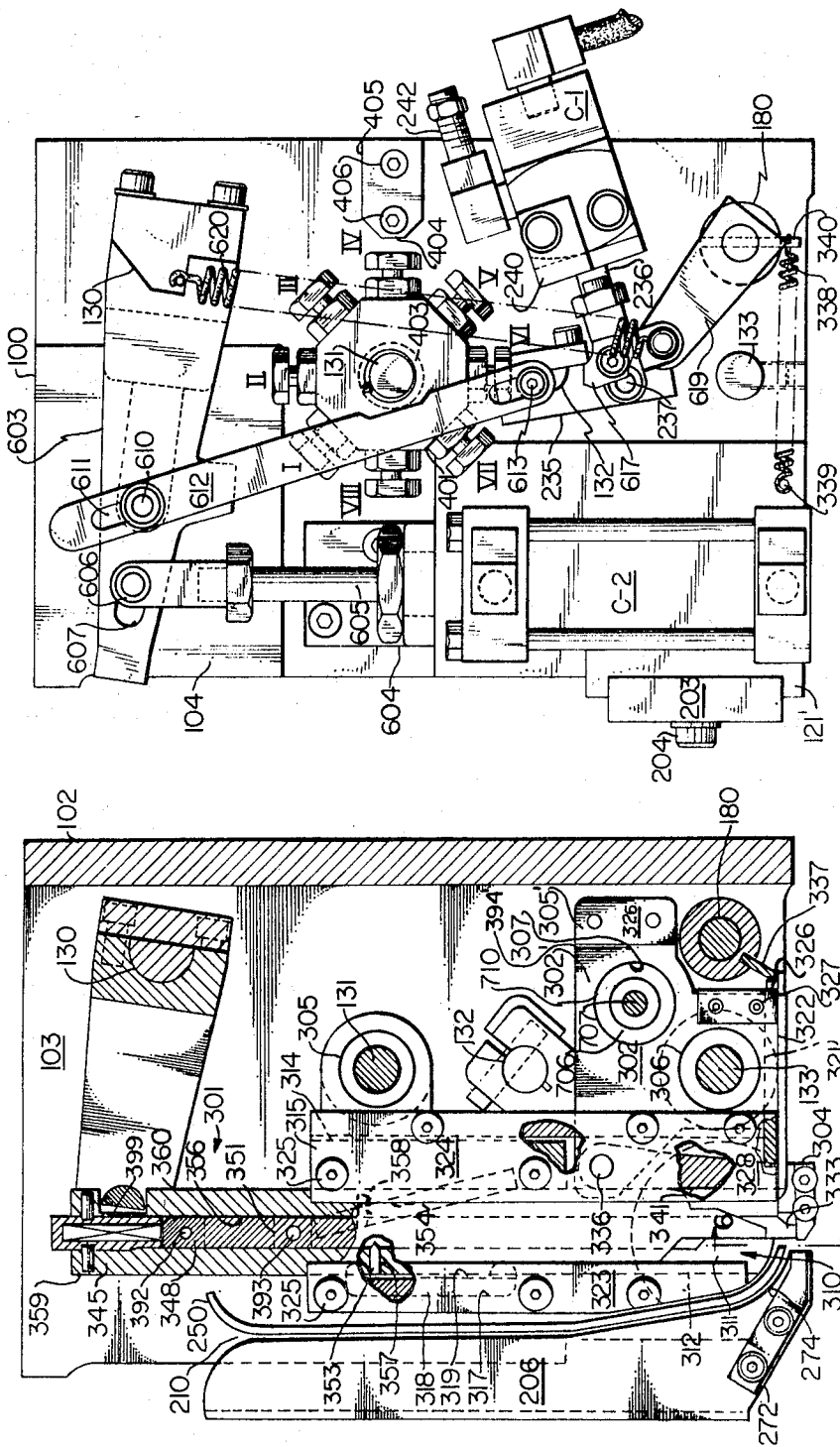


FIG. 3

FIG. 2

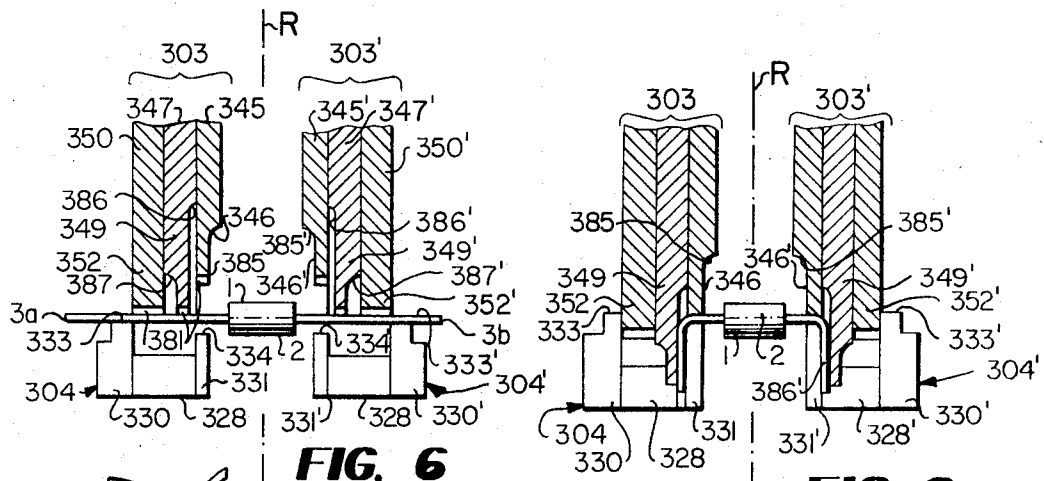
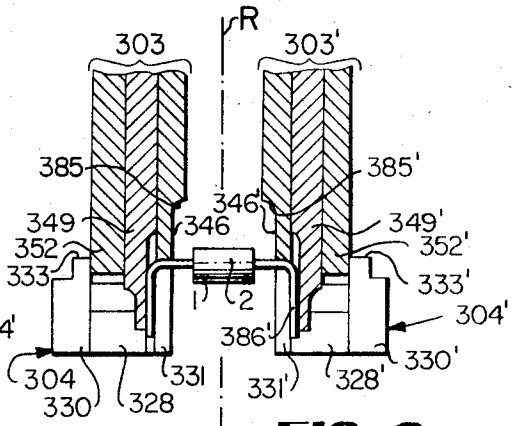
**FIG. 6**

FIG. 6a

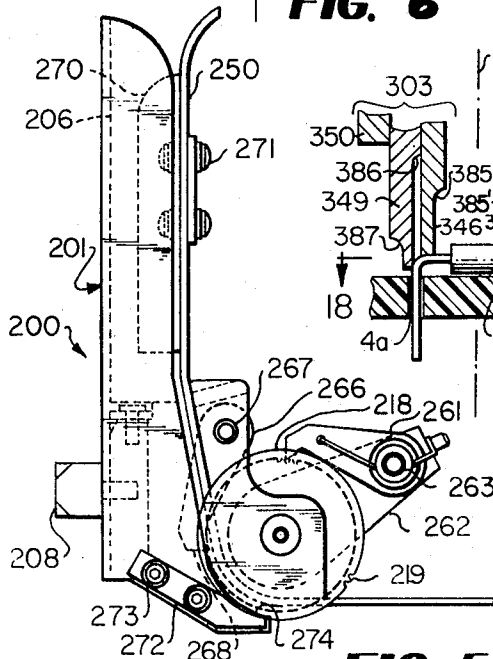


FIG. 5

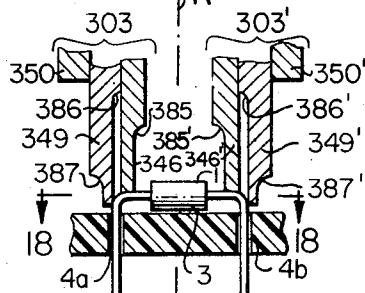


FIG. 6b

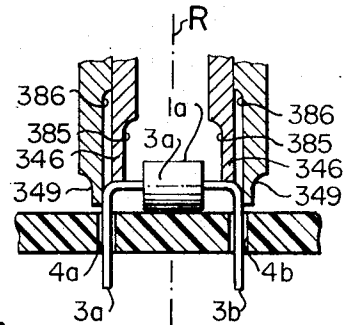


FIG. 6c

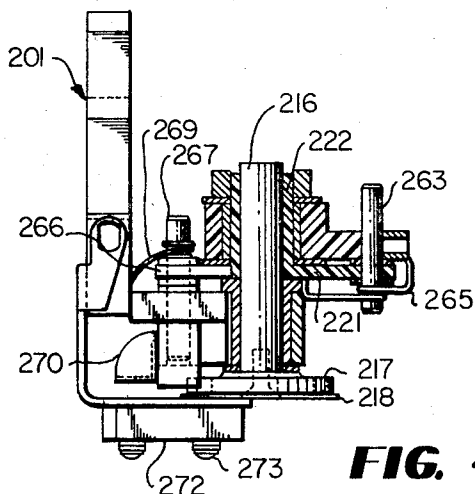
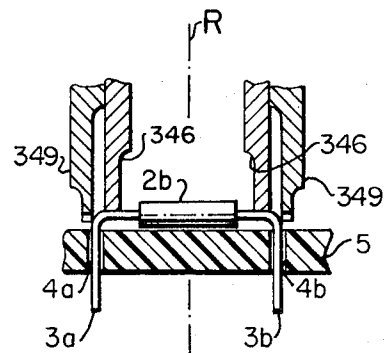
**FIG. 4**

FIG. 6d

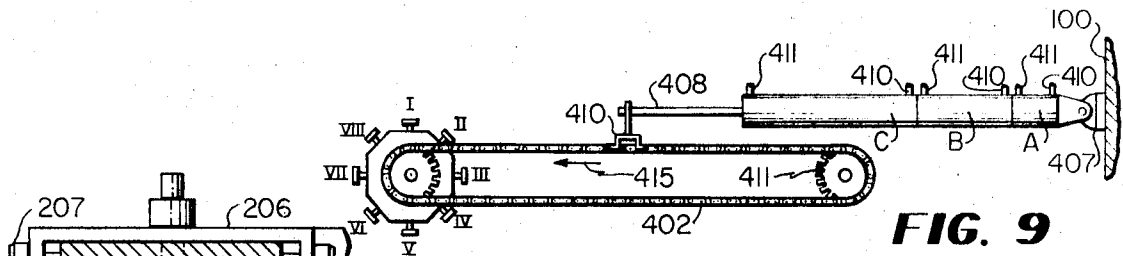


FIG. 9

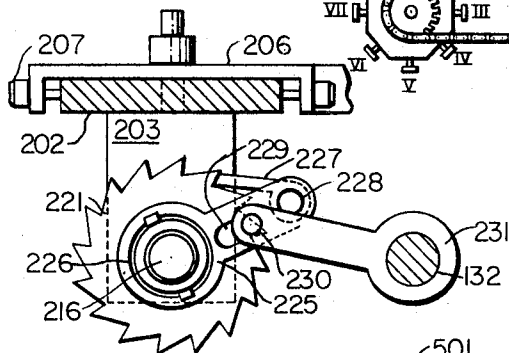


FIG. 8

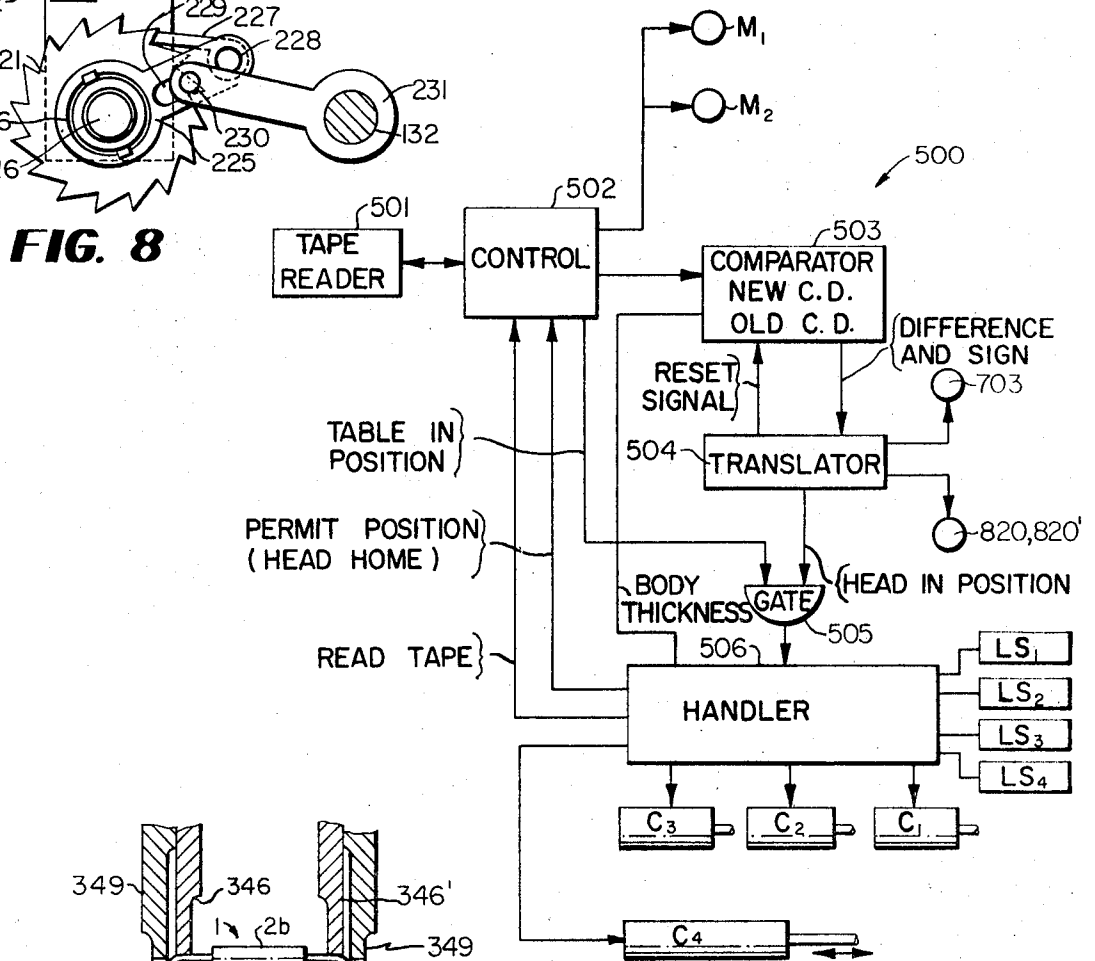


FIG. 10

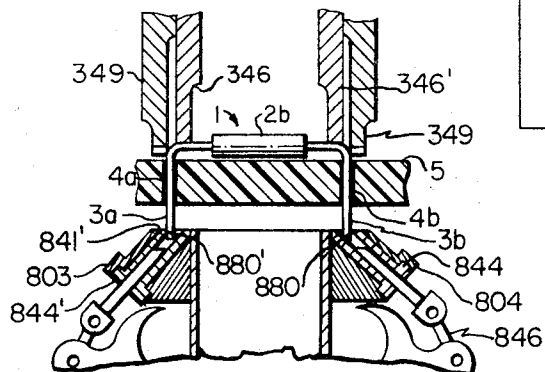


FIG. 7

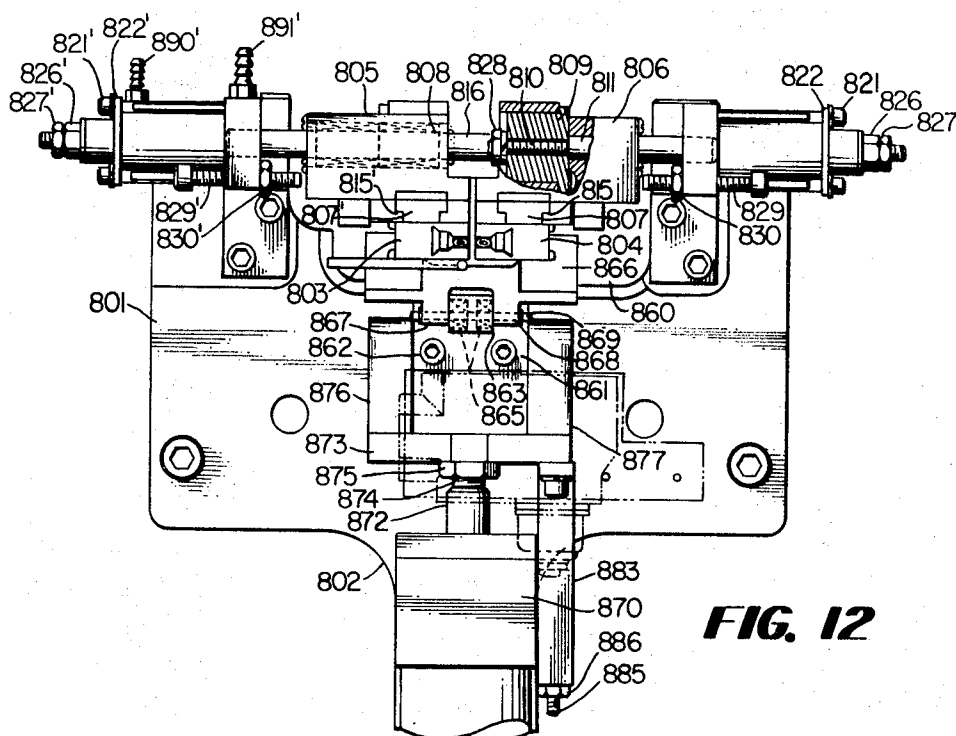


FIG. 12

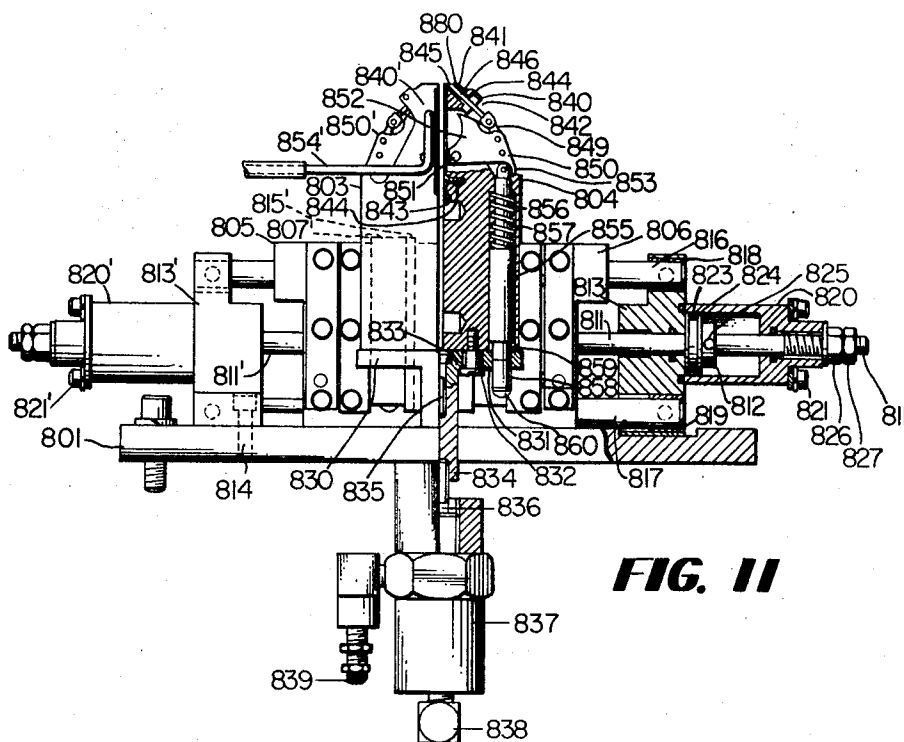


FIG. 11

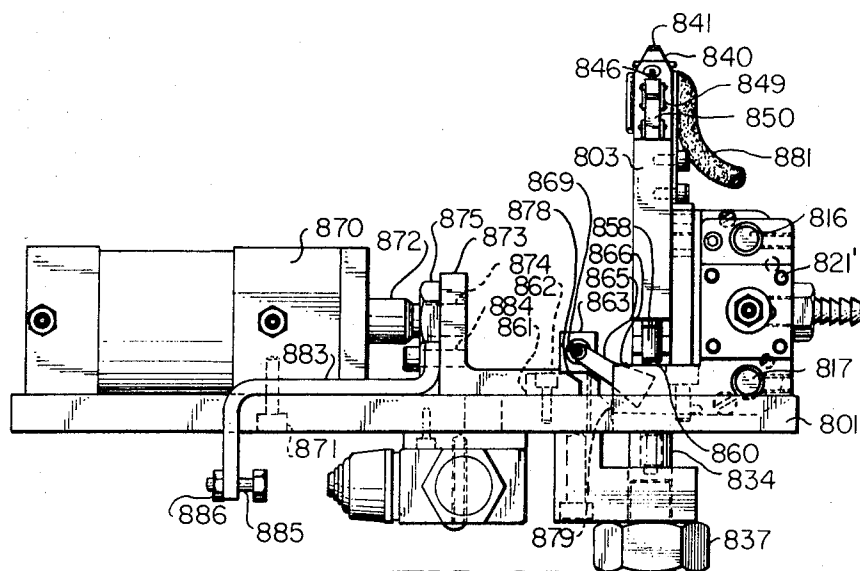


FIG. 13

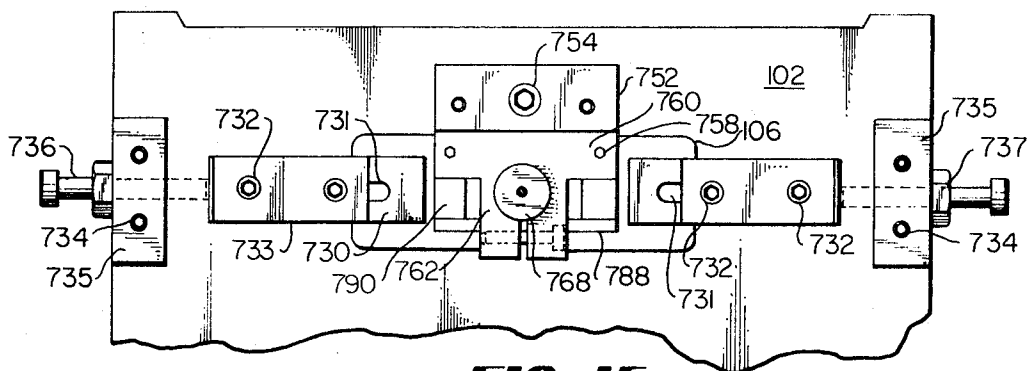


FIG. 15

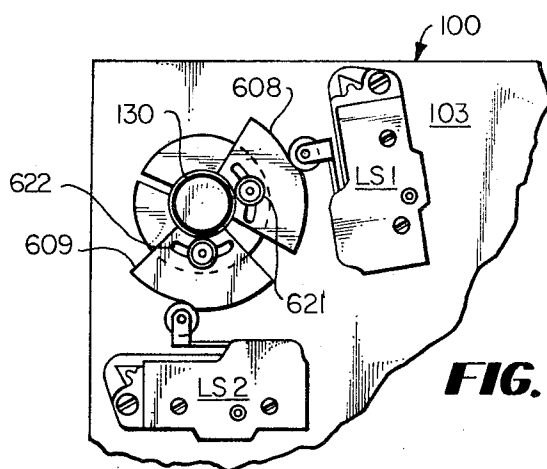


FIG. 19

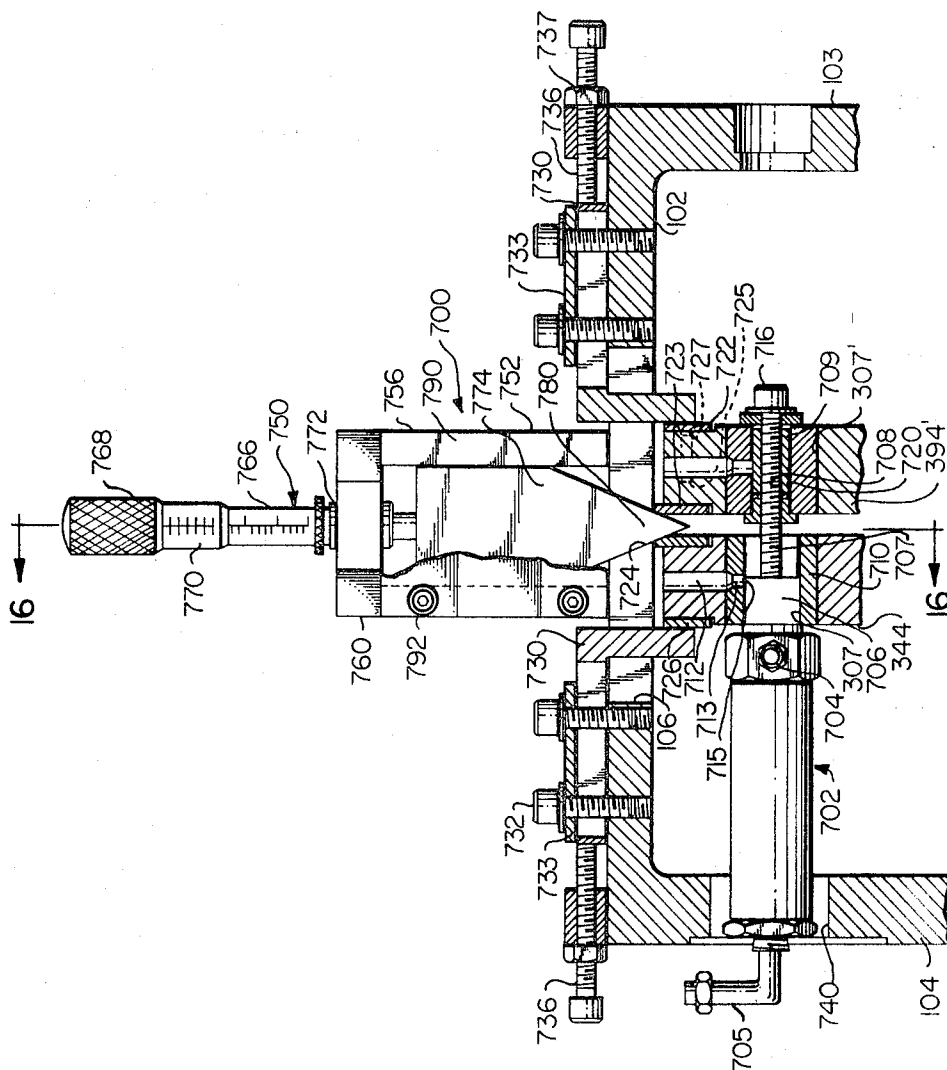


FIG. 14

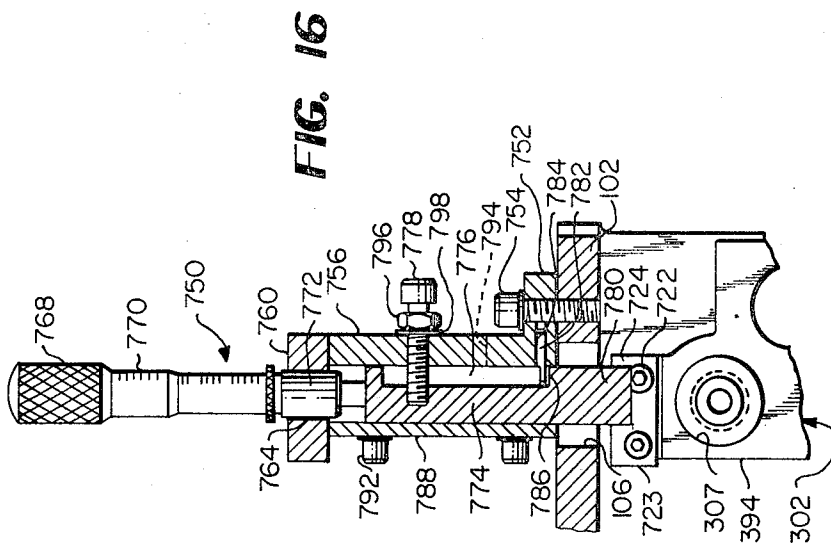
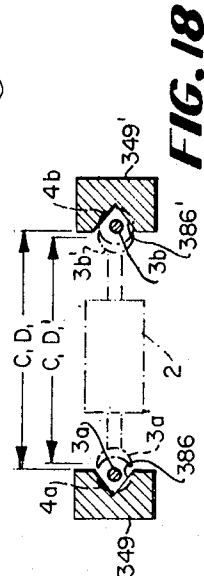
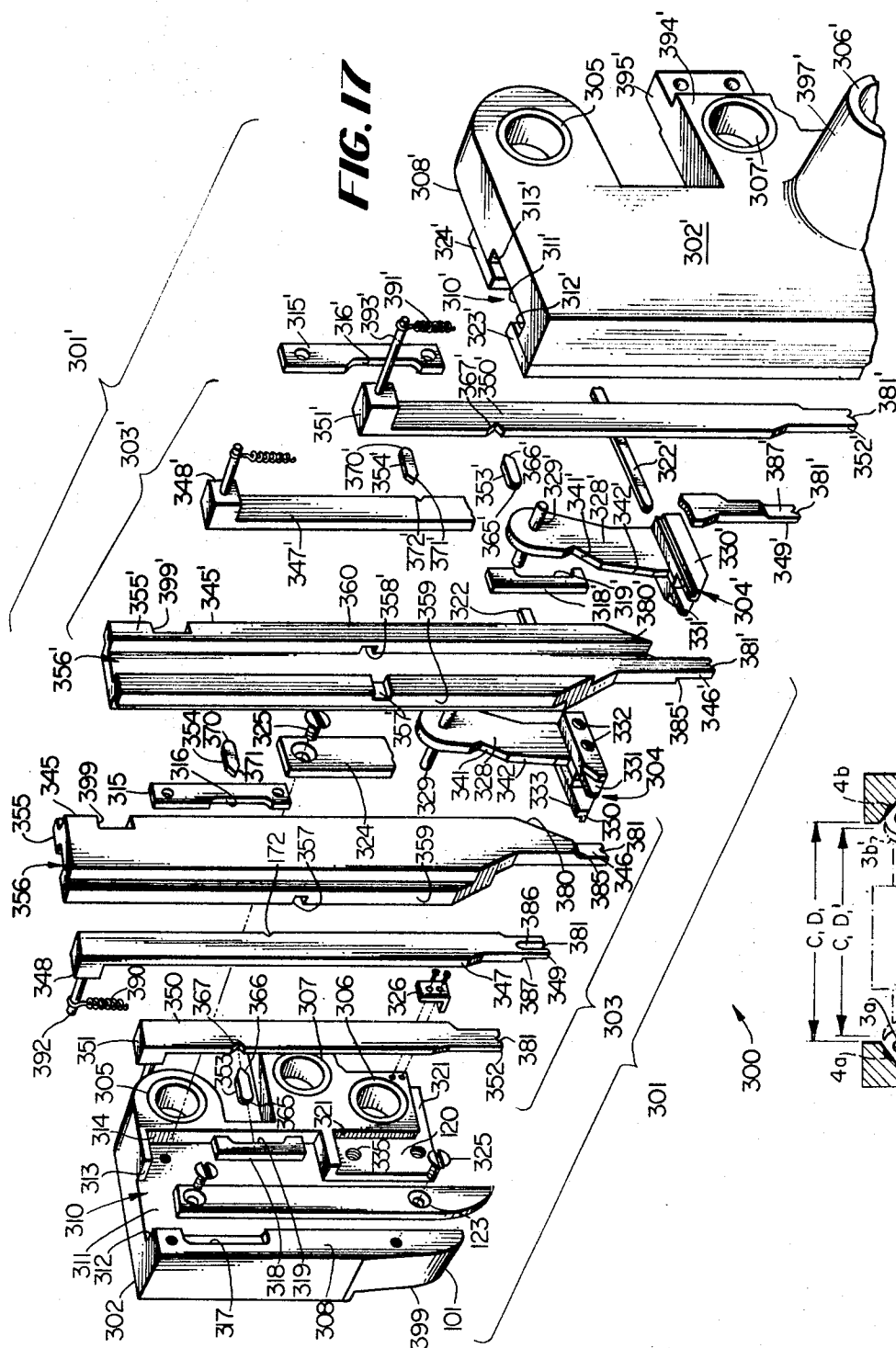


FIG. 16



MULTISIZE DUAL CENTER DISTANCE ELECTRONIC COMPONENT INSERTION MACHINE

The present invention is directed towards an improved insertion apparatus for axial lead components and more particularly to an insertion apparatus having an insertion head adapted to be automatically adjusted to accommodate axial lead components having body portions of varying diameters and lengths.

Heretofore, it has been proposed to feed tape carried axial lead components to an insertion head, which is adapted in sequence to sever the leads of a present component in order to separate such component from a pair of spaced carrier tapes; bend the severed leads at right angles to the axis of the separated component; and finally drive the bent leads into preformed apertures provided in a circuit board disposed below the insertion head.

Prior insertion apparatus of this type employ fixed insertion heads, wherein the component lead severing, bending and driving tools incorporated within the insertion head are not relatively adjustable, and include taped component feeding mechanisms which are adapted to accommodate carrier tapes having a preset spacing between components. Thus, a given fixed insertion head is required to insert all components into a circuit board on a fixed lead center, designated as C.D., i.e. the distance between the axes of inserted leads, regardless of the body lengths of such components, and with a fixed spacing between the board surface and the axis of the components regardless of the component body diameter or thickness. Also, with present fixed head apparatus, it has not been possible to insure proper orientation of the component leads with respect to preformed circuit board apertures regardless of lead diameter, or to selectively accommodate carrier or supply tapes having variable spacing between components.

The limitations inherent in fixed insertion head apparatus not only limit the maximum possible density of components on a given board, but severely limit the versatility of circuit board design and terminal arrangement.

Application Ser. No. 755,233, filed Aug. 26, 1968, now U.S. Pat. No. 3,539,086 issued Nov. 10, 1970 entitled Multi Size Variable Center Electronic Component Insertion Machine disclosed an insertion head having a pair of insertion head sections which are relatively adjustable, so as to permit a component to be inserted into a board on any desired lead center or C.D. The ability of said disclosed apparatus to insert on variable lead centers not only permits versatility of circuit board design and terminal arrangement, but permits maximum circuit board density due to the fact the lengths of the nondeformed portions of the leads which are arranged parallel to the surface of the circuit board may always be maintained at a minimum. Further, by permitting relative adjustment of the head sections the leads of the components, regardless of lead diameter or size may be accurately positioned with respect to preformed apertures provided in the circuit board.

The Variable Center Distance Electronic Component Insertion Machine additionally contemplates the forming of an insertion head in such a manner that the extent of travel of the driving tools of the inserter may be varied to obtain one of a number of preselected insertion positions, which are determined by the body portion diameters or thicknesses of the components to be inserted. This arrangement permits each component when inserted to be positioned in proper supporting engagement with the surface of the circuit board, and permits the driving tools of the insertion head to be positioned as close to the surface board as possible in order to insure proper clinching of the inserted leads.

The Variable Center Distance application also discloses an adjustable tape-feeding arrangement, which permits the apparatus to process component carrier tapes having either standard nominal 200 or 375 thousands spacing between individual components or to accommodate tapes having variable component spacings along a given carrier tape.

The entire content of the Multi Size Variable Center Electronic Component Insertion Machine, Ser. No. 755,233, filed Aug. 26, 1968, now U.S. Pat. No. 3,539,086 is hereby incorporated by reference into this application.

The present invention includes all the provisions of the Variable Center Distance device but substitutes a two-position adjustment for the infinitely variable position adjustment of the Variable Center Distance device, hereinafter referred to as the VCD apparatus.

The use of the dual position adjustment invention, hereinafter referred to as the DCD apparatus, is due to the common industry usage of two selected insertion spacings which can vary between 300 thousands and 1260 thousands in any desired sequence.

Manufacturers of electronic circuitry have found great efficiency in designs of circuit boards utilizing two different component spacings and components of varying body lengths and diameter and different lead diameters. The DCD machine has been designed to provide for mechanized assembly of such boards.

Another important advantage of the DCD machine is that it can be adjusted to compensate for wear of insertion head parts, particularly outside formers. Thus, a user is able to realize the labor savings involved in mechanized assembly with a minimum expenditure for replacement of nondurable parts.

Accordingly it is a primary object of the present invention to provide an insertion apparatus which provides the above-mentioned advantages.

It is a further object of the present invention to provide an electronic component insertion machine which can automatically insert components in circuit boards utilizing two different component spacings in any desired sequence.

It is an additional object of the present invention to provide a dual center distance insertion machine and a dual center distance lead cutting and clinching mechanism.

It is a still further object of the present invention to provide a novel adjustable cutting and clinching mechanism for an automated insertion machine.

These and other objects of this invention will become more apparent as well as the nature and mode of operation of the instant invention wherein reference is made to the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a front elevational view of the insertion apparatus in accordance with the present invention having parts broken away for purposes of clarity;

FIG. 2 is a sectional view taken generally along line 2-2 of FIG. 1;

FIG. 3 is a side elevational view taken generally along the line 3-3 of FIG. 1;

FIG. 4 is a plan view of the left index wheel assembly having portions broken away for clarity;

FIG. 5 is a side elevational view of the left index wheel assembly shown in FIG. 4;

FIG. 6 is a sectional view taken generally along line 6-6 of FIG. 2 but having portions broken away for clarity;

FIGS. 6a and 6b are sectional views similar to FIG. 6, but illustrating successive steps in the component lead severing, bending and insertion sequence;

FIGS. 6c and 6d are views similar to FIG. 6b showing the component inserter head sections adjusted to accommodate variable size components;

FIG. 7 is a sectional view similar to FIG. 6b but showing the cut and clinch mechanism engaging the leads of a component;

FIG. 8 is a sectional view taken generally along line 8-8 of FIG. 1;

FIG. 9 is a view generally illustrating the insertion head motion-limiting mechanism employed in the practice of the present invention;

FIG. 10 is a diagrammatic view of the electrical and pneumatic circuit employed with the apparatus of the present invention;

FIG. 11 is a front elevational view of the cut and clinch mechanism having portions broken away and in section for clarity;

FIG. 12 is a plan view of the mechanism of FIG. 11;

FIG. 13 is a side elevational view of the mechanism of FIG. 11;

FIG. 14 is a sectional plan view of the dual center distance adjustment mechanism;

FIG. 15 is a rear elevational view of the adjustment mechanism of FIG. 14;

FIG. 16 is a sectional side elevational view of the adjustment mechanism of FIG. 14 taken generally along the line 16-16;

FIG. 17 is an exploded view of the insertion head of the present invention;

FIG. 18 is a sectional view taken generally along the line 18-18 of FIG. 6b; and

FIG. 19 is a partial side elevational view of the apparatus of FIG. taken in the opposite direction from FIG. 2.

The insertion apparatus of the present invention, which is generally designated as 10 in the drawings, is adapted to process axial lead insertion tapes of the type designated as 7 in FIG. 1, wherein a pair of spaced carrier tapes 7a, 7b and employed to support the leads of a plurality of components 1 which are disposed in a spaced-apart relationship along the length of the tape. The axial lead components 1 are generally shown in the drawings as having a body portion 2 and a pair of leads 3a and 3b, which extend axially from opposite ends thereof. For purposes of reference, body portion 2 is considered as having a length measured between the opposite ends thereof and a thickness measured in a direction normal to the axes of leads 3a and 3b. Further, it will be understood that the components to be processed may be of varying body portion thicknesses and lengths, as indicated in FIGS. 6b, 6c and 6d.

As in the case of conventional fixed head insertion machines, the apparatus of the present invention is adapted in sequence to feed insertion tape 7; sever leads 3a and 3b of successively presented components 1 in order to separate a presented component from tapes 7a and 7b; deform the free end portions of the severed leads to provide generally L-shaped leads; and insert the deformed leads into preformed apertures 4a and 4b provided in a circuit board, designated as 4. After insertion of the deformed leads, the free ends thereof, which project below circuit board 4, may be clinched to retain them in inserted position by any suitable clinching mechanism 800.

Circuit board 4 may be adjustably positioned below the insertion apparatus by any conventional supporting apparatus, not shown, which is adapted to be driven in X, Y directions by electric motors M₁ and M₂, shown only in FIG. 10.

MAIN HOUSING 100

Main housing 100 is seen in FIG. 1. It consists generally of a casting having a backwall 102 and sidewalls 103 and 104. Backwall 102 has two generally rectangular openings 105 and 106. Aperture 106 is adapted to receive a micrometer adjustment apparatus 750 therein.

Sidewalls 103 and 104 are adapted to receive shafts 130, 131, and 132 which are positioned in bored apertures 107, 108 and 109, respectively. Cylindrical aperture 108 is bored through sidewalls 103 and 104 and casted sections 110 and 111. Shaft 131 is received in aperture 108 and is held there by setscrews 112. Shaft 132 is received in cylindrical apertures 109 which additionally receive flanged bearings 113. Shaft 130 is received within apertures 107 which additionally receive flanged bearings 118.

A cover plate 114 is fastened to the top of main housing 100 by means of machine screws 115 or the like. A second cover 116 is mounted on the side of housing 100 adjacent sidewall 103 and abuts the end of shaft 133, through rubber bumper 119 held in place by screw 120.

A third shaft 133 is received in apertures 117 in sidewalls 103 and 104 and is held in place therein by flanged bearings 118.

The bottom of walls 103 and 104 provide frame mounting flange portions 121, 121'.

The structural arrangement of main housing 100 is adapted to support an insertion head assembly generally designated as 300; a component tape guide and feeding assembly which is generally designated as 200 and adapted to present a component to head assembly 300 for processing once during each operational cycle of the apparatus; an insertion-head-actuating mechanism which is generally designed as 600 and adapted to operate assembly 300 each time a component is presented thereto; and a center distance adjustment mechanism 700.

TAPE GUIDE AND FEED ASSEMBLY 200

Insertion tape guide and feed assembly 200 included as in the case of insertion head assembly 100, a pair of guiding and feeding sections 201, 201', which are of mirror image construction and disposed on opposite sides of apparatus reference plane R. Referring to FIGS. 1-5, it will be understood that sections 201, 201' are mounted on framework mounting flange portions 121, 121' for adjustment relative to apparatus reference plane R by means of brackets having first and second flange portions 202, 202' and 203, 203', respectively. Bracket flange portions 202, 202' may be locked in a desired adjusted position by means of clamping bolts 204, 204', which are freely received within bracket flange slots 205, 205' and threadedly received within mounting flanges 121, 121'.

By now referring particularly to FIGS. 1, 2 and 3, it will be seen that sections 201, 201' are provided with generally L-shaped lead guides 206, 206', which are pivotally affixed to bracket flanges 202, 202' by means of pin shafts 207, 207' (See FIG. 8). The guides are adapted to be maintained in the position illustrated particularly in the case of guide 206 in FIGS. 1, 2, 4 and 5 by means of thumbscrew 208, 208' which are threadably received within bracket flange portions 202, 202'. Referring particularly to FIG. 2, it will be understood that sections 201, 201' also provided with stationary guides, shown only in the case of guide 250, which are adapted to cooperate with pivotal guides 206, 206' to define a vertically extending component lead guide passageway 210.

Now referring to FIGS. 1 and 8 and particularly to assembly section 201', it will be seen that flange portion 203 is bored to receive a bearing insert 215 in which is journaled a shaft 216 having a component lead advancement wheel 217 carried thereon. As will be clearly seen by reference to FIGS. 1, 4 and 5, advancement wheels of each section are provided with radially extending annular rim portions 218, 218' having a plurality of circumferentially spaced generally V-shaped lead-receiving slots 219, 219', which are disposed in alignment. The lower ends of pivotable guides 206, 206' form continuations of the upwardly facing surfaces 333, 333' of severing blocks 330, 330' and serve to maintain the component leads 3a, 3b within slots 219, 219', as successive components are presented to the insertion assembly by rotation of advancement wheels 217, 217'. Preferably, the spacing between slots 219, 219' corresponds to the minimum standard spacing between components on tape 7.

It will be noted at this point that assembly sections 201, 201' may be adjusted with reference to apparatus reference plane R, so as to permit adjustment wheel rim portions 218, 218' to engage the relatively inwardly facing marginal edges of component carrier tapes 7A and 7B and thereby effect positioning of the components carried by such tapes in proper orientation with respect to apparatus reference plane R, and thus sections 301 and 301' of the insertion head assembly. Also, it will be noted that the insertion section base castings 302 and 302' are each cut out, at 399, 399' (FIG. 18), to freely receive component advancement wheels 217, 217' in order to permit rela-

tive adjustment of sections 301, 301' after the distance between sections 201, 201' has been set for a given width carrier tape.

Component lead advancement wheels 217, 217' may be simultaneously rotated to draw insertion tape 7 downwardly through the lead guide slots by ratchet assemblies shown only in the case of section 201 in FIGS. 1, 4, 5 and 8 as including a ratchet wheel 221 having an integrally formed sleeve section 222 affixed for rotation with shaft 216 by a retaining pin (not shown); a pivot member 225, which is freely supported for rotation with respect to ratchet sleeve 222 by sleeve bushing 226; and a ratchet paw 227 which is carried on pivot member 225. Pivot member 225 is shown in FIG. 8 as having a slot 229 which is adapted to slidably receive pin shaft 230 carried on second member 231 mounted for rotation with insertion tap advancing shaft 132. Preferably, the number of teeth provided on ratchet wheel 221 corresponds to the number of slots on advancement wheel 217.

Now referring to FIG. 3, it will be understood that one end of shaft 132 projects outwardly beyond leg portion 104 and is adapted to carry flange portion 235, which is movably connected to piston rod 236 of pneumatic cylinder C, by means of shaft 237. The extent to which piston rod 236 may be retracted into cylinder C, upon operation thereof and thus the angle through which shaft is rotated is controlled by a stop block 240. Stop block 240 may be moved from the position shown in FIG. 3 in order to permit piston rod 236 to be fully retracted, by loosening locking bolt 242.

By viewing FIGS. 3 and 8 it will be understood that when piston rod 236 is retracted into engagement with stop block 240, ratchet paw 227 is stepped backwardly one tooth on ratchet wheel 221, whereas without stop block in position full retraction of piston rod 236 will cause ratchet paw 227 to step two ratchet teeth. Since the number of ratchet teeth stepped while "cocking" the ratchet assembly determines the degree of feeding rotation of advancement wheels 217, 217' when cylinder C-1 is actuated to extend rod 236, the number of ratchet teeth corresponds to the number of slots on advancement wheels 217 and 217' and the spacing between adjacent wheel slots corresponds to the minimum nominal spacing for standard carrier tapes, it will be apparent that stop block 240 may be employed to adjust the apparatus to handle insertion tapes having either standard nominal 200 thousands or 370 thousands spacing between component leads. In this respect, it will be understood that spacings between component leads of such standard tapes actually approximate 195 thousands and 390 thousands, respectively. If desired, tapes having variable component spacings to conserve tape length where both extremely large and relatively small diameter components are to be employed, may be accommodated by employing remotely controlled means to adjustably position stop block between insertion cycles.

Limit switch LS3, shown in FIG. 1 as being carried in leg portion 103, is employed to sense clockwise rotation of shaft 132, which results in rotation of advancement wheels 217, 217' to present a component to insertion head 300.

Referring again to FIGS. 4 and 5, there is seen a mechanism 260 for biasing the advancing wheel 217 in set position. A biasing arm 261 is mounted on collar member 262 by means of shaft 263. The end of biasing arm 261 has a tooth 264 which is adapted to engage in the slots 219 of the rim portion 218. A spring 265 maintains the wheel 217 in a set position until the wheel is advanced by the mechanism shown in FIG. 8.

A second biasing arm 266 is mounted on shaft 267 and has a projection 268 for engaging slots 219 of rim portion 218. A spring 269 biases the arm 266.

A guide 270 is mounted on guide 250 by bolts 271 to prevent the ends of the taped leads 3 from lateral movement, thus centering the center of a body portion 2 on reference plane R.

A guide member 272 is affixed to the lower end of guide 206 by screws 273 and has a curved surface 274 for forcing

the ends of the leads 3 into engagement with slots 219 of rim portion 218.

INSERTION HEAD ASSEMBLY 300

Insertion head assembly 300 is shown particularly in FIGS. 1, 2 and 17 as including a pair of relatively spaced-apart insertion head sections 301, 301' which are of mirror image construction and disposed on opposite sides of a vertically extending reference plane R. Inasmuch that each of sections 301, 301' include similar elements, primary reference will be made to section 301, it being understood, however, that like elements of section 301' will be indicated by primed numbers.

Sections 301 and 301' are shown particularly in FIGS. 2 and 17 as including a base casting members 302, 302', which are adapted to slidably support lead severing, forming and driver subassemblies 303, 303' and pivotably support component lead support subassemblies 304, 304'.

Base casting member 302 is shown particularly in FIGS. 2 and 18 as having a pair of ball bearing sleeve inserts 305 and 306, which are adapted to slidably receive guide shafts 131 and 133, respectively, and an internally smooth insert 307, which is adapted to receive air cylinder 132 positioning apparatus 702.

Again referring to FIGS. 2 and 18 it will be seen that the facing surface portions 308, 308' of base castings 302, 302' are cut out to provide lengthwise extending slots 310, 310' having a bottom walls 311, 311' and sidewalls 312, 312' and 313, which are adapted to slidably receive subassemblies 303, 303', respectively. The facing portions 308, 308' are further provided as shown particularly in the case of base casting 302 with a first slot side opening recess 314, which is adapted to receive a forming tool cam plate 315 having a camming recess 316; a second slot side opening recess 317, which is adapted to receive severing tool cam plate 318 having a camming recess 319; a third slot side opening recess 320, which is adapted to receive lead support subassembly section 304; and a bottom edge slot 321, which is adapted to slidably receive support subassembly return pin 322. Suitable retention plates 323 and 324 may be affixed to facing surface 308 of base casting member 302 by machine screws 325 for the purpose of maintaining cam plates 315, 318 and subassemblies 303, 304 in position. A generally L-shaped member 326, which is mounted on base casting member 302 by machine screws 327 cooperates with retention plate 324 to maintain return pin 322 within edge slot 321.

In FIGS. 2, 6 and 17 support subassembly 304 is shown as including a pivot arm 328 having a pivot pin shaft 329 affixed adjacent the upper end thereof; a lead-severing block 330; and a lead support block 331. Blocks 330 and 331 may be suitably affixed on opposite sides of the lower or other end of pivot arm 328, as for instance by means of machine screws 332. Preferably, the upwardly facing surface 333 of severing block 330 is disposed vertically above the upwardly facing surface 334 of support block 331 a distance corresponding to the maximum thickness or diameter of the leads of components to be severed. This insures that the component leads will be severed prior to the initiation of the deforming operation in order to prevent undue stressing of the leads.

Subassembly 304 is adapted to be pivotally supported within base casting member recess 320 by means of pivot pin 329, whose ends are received respectively within bore opening 335 of base casting member 302, shown only in FIG. 17, and bore opening 336 of retention plate 323 shown only in FIG. 2. When thus supported, subassembly 304 is adapted to be normally maintained in its supporting position by means of an assembly including return pin 322; abutment 337 carried on return shaft 180 and a tension spring 338, which has its respective ends affixed to leg portion 104 by pin support 339, and return shaft 180 by pin 340. Preferably, subassembly 304 is prevented from being pivoted in a clockwise direction past its supporting position, as viewed in FIG. 2, due to the operation of tension spring 338, by abutting engagement with subas-

sembly 303. It will be understood that abutment 337 and also the corresponding abutment for return pin 322', which is not shown in the drawings, is of sufficient length in a direction measured axially of shaft 180 to insure engagement thereof with return pins 322, 322' in all adjusted positions of head sections 301, 301', respectively.

A pivot arm 328 is provided with cam surfaces 341 and 342, which are adapted to cooperate with subassembly 303 for the purpose of pivoting subassembly 304 from its operative or component supporting position, in a counterclockwise direction into an inoperative position to permit subassembly 303 to move downwardly towards circuit board 5 into a component lead insertion position. In this respect, it will be apparent that when subassembly 304 is pivoted in a counterclockwise direction, return pin 322 is forced to slide within slot 321 thereby forcing abutment 337, return shaft 180 and pin 340 to move in a counterclockwise direction, also as viewed in FIGS. 2 and 3, and placing spring 338 under increased tension.

Lead severing, forming and driver subassembly 303 is shown particularly in FIGS. 1, 2 and 17 as including a lead-driving member 345 having an integrally formed driving tool 346 disposed adjacent the lower end thereof; a lead-forming member 347 having integrally formed abutment 348 and forming tool 349 disposed adjacent upper and lower ends thereof, respectively; a lead-severing member 350 having an integrally formed abutment 351 and severing tool 352 disposed adjacent the upper and lower ends thereof, respectively; and forming and severing member cam pins 353 and 354, respectively.

More specifically, driving member 345 is shown as having a sidewall surface 355 in which is disposed a lengthwise extending slot 356 adapted to slidably receive forming member 347 and severing member 350, which are arranged in a juxtaposed relationship. Further, driving member 345 is provided with relatively offset slots 357, 358, which extend transversely from slot 356 through member front and rear wall surfaces 359, 360, and are adapted to slidably receive cam pins 353 and 354, respectively. It will be understood that when cam pin 353 is slidably disposed within slot 357, its curved end portion 365 is adapted to be selectively projected through member front wall 359, for the purpose of cooperating with camming recess 319 of cam plate 318, and its wedge-shaped end 366 is adapted to be selectively projected into slot 356 for the purpose of cooperating with V-shaped slot recess 367 provided in severing member 350. In like manner, cam pin 354 is provided with a curved end portion 370, which is adapted to be selectively projected through member rear wall surface 360 into cooperating engagement with recess 316 of cam plate 315, and a wedge-shaped portion 371 which is adapted to selectively project into slot 356 into cooperating engagement with a V-shaped slot 372 provided in lead forming member 347.

When subassembly 303 is slidably positioned within base casting member slot 310, driving member sidewall surface 355 and the outwardly facing side surface of severing member 350 are disposed in sliding surface engagement with slot bottom wall 311 as generally indicated in FIGS. 1 and 17 and driving member front and rear wall surfaces 359 and 360 are disposed in sliding surface engagement with slot sidewalls 312 and 313, respectively as generally shown in FIG. 2. When subassembly 303 is thus positioned, camming surface 380 of driving member 345 is operatively aligned with cam follower surfaces 341 and 342 of pivot arm 328, and driving tool 346, forming tool 349 and severing tool 352 are positioned with respect to severing block 330 and support block 331 of subassembly 304 in the manner indicated in FIG. 6.

Tools 346, 349 and 352 are shown primarily in FIGS. 6 and 17 as being provided with aligned, generally V-shaped, downwardly opening slots 381 which are adapted to receive lead 3a of component 1. Also, it will be seen that the surface of tool 346 disposed in a facing relation with respect to reference plane R is machined away, as at 385, to afford clearance between the driving tool and the body portion 2 of

the component. Further, forming tool 349 is shown as having a lead-receiving and guide slot 386, which extends upwardly from adjacent V-shaped groove 381 and is disposed on the surface of tool 349 disposed in sliding engagement with tool 346, and as being machined away as at 387 on the surface thereof which slidably engages severing tool 352 in order to maximize clearance between the forming tool and the leads of a component which has been previously inserted into board 5.

Lead forming members 347, 347' and lead-severing members 350, 350' are normally biased in a vertically downward direction by means of tension springs 390, 390' and 391, 391' respectively. The tension springs may be suitably affixed adjacent the lower ends thereof to any vertically stationary part of the apparatus, such as base castings 302, 302' and adjacent their other or upper ends to pins 392, 392' and 393, 393' carried on lead-forming member and lead-severing member abutments 348, 348' and 351, 351' respectively.

The operational sequence of insertion head assembly 300 will best be understood by reference to FIGS. 6, 6a and 6b. In FIG. 6, subassemblies 303, 303' are shown as being in their upper position and subassemblies 304, 304' are shown as being in their operative or component-supporting positions, wherein a component is lead supported on the upwardly facing shear block surfaces 333, 333' with V-shaped slots 381, 381' or tools 346, 349, 352 and 346', 349', 352 disposed above and in alignment with component leads 3a, 3b, respectively.

Referring only to subassembly 303 for purposes of brevity, it will be understood that in the up position shown in FIG. 6, wedge-shaped end 366 of cam pin 353 is maintained in slot recess 367 of severing member 350 by engagement of its curved end portion 365 with base casting slot sidewall 312 in order to lock severing member 350 for movement with driving member 346. Further, wedge-shaped end 371 of cam pin 354 is maintained in slot recess 372 of forming member 347 by engagement of its curved end portion 370 with base casting slot sidewall 313 in order to lock forming member 347 for movement with driving member 345.

Thereafter, when driving member 345 is driven downwardly in the manner to be described, tool 352 of severing member 350 is driven downwardly into engagement with component lead 3a and below upwardly facing shear block surfaces 333, to effect severing of the lead, where up downwardly moving forming member tool 349 is positioned in engagement with the severed lead to maintain such lead tight against upwardly facing support block surface 334. Immediately thereafter downward movement of severing member 350 is terminated, due to engagement of member abutment 351 with base casting 302; the severing member being disconnected from driving member 345, due to the presence of severing tool cam plate recess 319, which permits cam pin 353 to ride out of slot recess 367. This arrangement prevents interference of severing tool 352 with previously inserted components.

After termination of severing member travel, forming tool 349 and driving tool 346 are moved into the position shown in FIG. 6a, whereat forming of an L-shaped lead has been completed with the free end of such lead preferably projecting downwardly below the end of guide slot 386, and the driving tool has been placed in engagement with the nondeformed or horizontally extending portion of the L-shaped lead.

Upon continued downward movement of tools 346, 349, subassembly 304 is removed from its operable position by the action of driving member cam surface 380 to permit free movement of the tools towards the insertion position shown in FIG. 6b, wherein the free end of the deformed lead is inserted into board aperture 4a.

Preferably, tools 346, 349 move together until tool 349 is immediately adjacent the surface of circuit board 5 to insure accurate insertion of the lead, whereafter movement of tool 349 is terminated due to engagement of forming member abutment 348 with base casting 302; forming member 347 being disconnected from driving member 345, due to the presence of forming tool cam plate recess 316, which permits

cam pin 354 to ride out of slot recess 372. Thereafter, tool 346 continues its downward movement in order to drive the lead downwardly through forming member guide slot 386 into fully inserted position.

It will be understood that although the insertion position of tool 346 may be varied to compensate for variable component body portion thicknesses or diameters, as will hereinafter be described, the insertion position of tool 349 is constant since it depends solely on the positioning of forming tool cam plate recess 316.

Upon return movement of driving member 345, spring 390 functions to initially constrain movement of forming member 347 therewith due to frictional forces, until cam pin 354 is returned into alignment with forming members slot recess 372, whereupon cam pin 354 is forced to ride out of forming tool cam plate recess 316 and be forced back into slot recess 372. In a similar manner, spring 391 functions to constrain severing member 350 until cam pin 353 is again aligned with slot recess 367, whereupon the cam pin 353 is forced back in slot recess 367 as it is forced to ride out of severing tool cam plate recess 319.

The purposes for employing micrometer adjustment apparatus 750 to simultaneously force insertion head sections 301, 301' to move in opposite directions with respect to reference plane R will now become apparent from viewing FIGS. 6b, 6d and 18.

Turning first of FIG. 6b and 6d, it will be understood that the lengths of body portions 2 and 2b of presently available components 2, 2b may vary substantially, and thus a conventional fixed head inserter designed to handle a small 2-sized component can not accommodate large 2b-sized component due to limited spacing between driving tools 346, 346'. Alternatively, if a fixed head inserted were designed to accommodate the larger sized 2b component, not only is the number of components which may be inserted in a given board greatly reduced, but problems of lead damage are oftentimes encountered when small-sized components are inserted, due to excessive lengths of exposed above the board surface. By providing for the two-position selective adjustment of the insertion head in accordance with the present invention, not only may circuit board density be maximized but where desired, the leads of the components may be inserted at board terminal positions specified by a circuit board designer, which presently has been standardized between 0.300 inch and 1.260 inch.

Referring back to FIG. 17 it is seen that member 302' has a portion 394' extending outwardly beyond insert 307' and terminating in a reduced portion 395'. As shown in FIG. 14, inserts 307, 307' receive internally threaded sleeves 710 and 709, respectively, which, in turn, support the air-cylinder-positioning apparatus 702. Holes 396, 396' are furnished to receive machine screws 727 which fasten inserts 726 to portions 395, 395'.

Housing 302, 302' have large flange portions 397, 397' which extend away from said housings around inserts 306, 306'.

In FIG. 18 there is illustrated a problem oftentimes encountered with fixed head inserters, when employing components having leads which vary substantially in diameter. Conventionally, for purposes of convenience and to maximize board strength, the size or diameter of all apertures 4a, 4b for any given board is the same, apertures are positioned on the same C.D., and the apertures are only slightly larger than the maximum lead diameter expected to be employed. Thus, it has been the practice with fixed head inserters to set the spacing between formers 349, 349' so as to position the smallest diameter lead encountered, e.g. 3a, 3b shown in section, as closely adjacent opposites facing sides of apertures 4a, 4b, as possible, with a view to centering large diameter leads e.g. 3a', 3b', shown in phantom, within the apertures. However, as will be apparent from viewing FIG. 18, this procedure often results in improper positioning of large diameter component leads, whose effective C.D. may be significantly smaller than the effective C.D. of leads 3a, 3b. By utilization of the present inven-

tion, the spacing between forming members 349, 349' may be varied to obtain a desired C.D. regardless of component lead diameter, and thus insure accurate orientation of the leads with respect to the board apertures.

MOTION-LIMITING MECHANISM 400

Further, in accordance with the present invention there is provided a motion-limiting mechanism which is generally designated as 400 in FIGS. 3 and 9, and operates to limit the extent through which drive members 345, 345' are reciprocated upon actuation of driver cylinder C₂. Motion-limiting mechanism 400 generally comprises a stop block 401, a ternary pneumatically operated cylinder C₄, and an endless belt 402 which is adapted to transform reciprocating movement of cylinder C₄ into rotational movement of stop block 401.

Stop block 401 is freely mounted for rotation on guide shaft 131 by a ball bearing insert 403 and includes a plurality of threadably adjustable stop elements, as for instance, eight elements indicated in FIGS. 3 and 9 by numerals I—VIII, which are spaced equally about the periphery of stop block 401. Stop elements I—VIII may be individually adjusted with respect to a zero reference surface 404, which is defined by a set block or gauge 405 mounted on leg portion 104 by machine screws 406. Preferably, one of the stop elements, as for instance element I, is adjusted to provide a minimum reference distance between such element and reference surface 404, and another of the stop elements, as for example element VIII, is adjusted to provide a maximum reference distance between such element and reference surface 404. Thereafter, the remaining stop elements are adjusted with respect to reference surface 404, so as to provide for instance an equal and progressive variation between the minimum and maximum reference distances.

The number of stop elements provided for any given insertion apparatus and the reference distances for which they are individually adjusted, will depend on the number of different insertion positions into which it is desired to drive members 345, 345' upon actuation of cylinder C₂; such insertion positions i.e. the distance between tools 346, 346' and the surface of circuit board 5, in turn, depending on the body diameters of the respective components to be inserted. Thus, if a maximum diameter component is to be inserted, e.g. component 2a, 4a of FIG. 6c, stop element I, adjusted to minimum reference distance, would be positioned in the reference stop position shown in FIG. 3 to permit it to be engaged by stop bracket 603, when the latter is pivoted. Since stop element I will permit the minimum degree of stop bracket pivotable movement, it follows that drive members 345, 345' are driven through a minimum distance, so as to permit maximum spacing between tools 346, 346' and circuit board 5. If on the other hand a minimum-diameter component is to be inserted, e.g. component 2 of FIG. 6b, stop element VIII would be moved into the reference stop position in order to maximize the degree of stop bracket movement.

By permitting the insertion position of the drive members to be varied, the positioning of drive member tools 346, 346' is optimized for any given component size from the standpoint of proper lead clinching. Further, the body portions of the components may be placed in desired supporting engagement with the surface of a circuit board regardless of body portion thickness.

In FIG. 9 ternary cylinder C₄ is shown as including three separate pneumatically operated cylinders designated as A, B and C each of which is provided with pressurized air inlet tubes 410 and vent tubes 411. Cylinder C₄ may be affixed adjacent cylinder A to framework 100 by any suitable bracket 407 and be provided with a piston rod 408, which is positively affixed to a link of endless chain 402, as at 410. Chain 402 may be trained about idler sprocket 411' and a suitable sprocket 412 which is affixed for rotation with stop block 401. Thus, it will be seen that when piston rod 408 is extended to

the left, as indicated by arrow 415 in FIG. 9, stop block 401 will be forced to rotate in a counterclockwise direction as indicated by arrow 416, in order successively to bring stop elements II—VIII into the reference stop position. Accordingly, it will be readily apparent that by selectively introducing pressurized gas through inlet tubes 410 into one or more of cylinders A, B and C, stop block 401 may be rotated by a desired amount to position one of the stop elements I—VIII in the reference position shown as being occupied by element I in FIG. 3, wherein it will be engaged by stop bracket 603 when the latter is pivoted.

If by way of example it is assumed that stop elements I—VIII are employed; stop element I is the reference stop element; and that cylinders A, B and C have one-fourth-, one-half- and 1- inch displacements, respectively, there can be developed the following chart showing the interrelation between cylinder actuation and stop block rotation.

Stop element in ref. position	Cylinder A	Cylinder B	Cylinder C	Stop block revolution
I.....	—	—	—	0
II.....	+	—	—	1/8
III.....	—	+	—	1/4
IV.....	+	+	—	3/8
V.....	—	—	+	1/2
VI.....	+	—	+	5/8
VII.....	—	+	+	3/4
VIII.....	+	+	+	7/8

NOTE: — = Cylinder retracted; + = Cylinder extended.

In lieu of using the motion-limiting mechanism, the insertion heads may be spring loaded. I.e., coil springs may be put on the top of each member 345 and 345' to cushion the stroke. The lead-forming members may be also spring loaded. The springs will allow the insertion heads to handle various diameter sizes in component bodies.

ACTUATING MECHANISM 600

Actuating mechanism 600 includes a generally U-shaped driving bracket 601, which is fixed for rotation with drive shaft 130 and provided with a half-round driving pin 602 adapted to be slidably received within transversely extending cutouts 399, 399' of driver members 345, 345'; a stop bracket 603, which is fixed for rotation with one end of drive shaft 130 projecting outwardly through leg portion 104; and a double-acting pneumatic cylinder C-2. Cylinder C-2 is mounted on leg portion 104 by a bracket 604, and includes a piston rod 605 having a connecting pin 606, which is slidably received within stop bracket slot 607. By viewing FIG. 3, it will be apparent that when cylinder C-2 is actuated to retract piston rod 605, stop bracket 603 is pivoted in a counterclockwise direction into the position indicated in phantom to effect driving rotation of drive shaft 130 and thus, reciprocation of drive members 345, 345', towards their insertion position.

The other end of drive shaft 130, which is shown in FIG. 19 as projecting outwardly through sidewall 103, is adapted to carry a pair of cam members 608, 609. Cam members 608, 609 are adapted to cooperated with limit switches LS1 and LS2, respectively, which are mounted on sidewall 103 and employed to indicate to the control circuit of the insertion apparatus shown in FIG. 10 that subassemblies 303, 303' are in either their uppermost or insertion positions.

The cam members 608, 609 are attached to a collar 620 mounted on shaft 130 by means of bolts 621 passing through arcuate slots 622 on the collar.

In FIG. 3, stop bracket 603 is shown as being provided with a pin 610, which is adapted to be slidably received within slot 611 provided adjacent one end of a connecting rod 612. Connecting rod 612 is pivotably supported adjacent the other end thereof by a pin shaft 613, riding in a slot 616 in rod 612. The shaft 613 is supported on a bracket 617 which, in turn, is connected via pin shaft 618 to push arm 619 which is affixed for rotation with shaft 180. Bracket 617 is centrally pivoted on pin shaft 237. A biasing spring 620 extends from an end cap 621 on bracket 603 to pin shaft 237. This arrangement serves to temporarily rotate return shaft 180 in a counterclockwise

direction, as seen in FIG. 2, after component-lead-supporting subassemblies 304, 304' have been initially pivoted towards their inoperative positions by drive member cam surfaces 380, 380', and thus temporarily remove abutments 387, 387' from positive engagement with return pins 323, 323'. Accordingly, subassemblies 304, 304' are freed of the retentions of spring 338 in order to permit drive members 345, 345' to slide on pivot arm cam surfaces 342, 342' with a minimum amount of friction, as the drive members are reciprocated to and from insertion position. Upon the return of stop bracket 603 to its original or full line position, connecting rod 612 is rendered inoperative in order to permit spring 338 to return support assemblies 304, 304' to their original supporting positions.

ADJUSTMENT MECHANISM 700

Since the typical C.D. distances employed in component insertion can vary between 0.300 inch to 1.260 inch, an adjustment mechanism has to be provided for setting two selected insertion spacings for any desired sequence of operation of the machine.

Referring now to FIGS. 14, 15 and 16, there is designated an adjustment mechanism 700. The mechanism 700 consists of an air cylinder positioning apparatus 702 and a micrometer adjustment apparatus 750.

The micrometer adjustment apparatus 750 consists of a mounting bracket 752 mounted to the backwall 102 of main frame member 100 by means of machine screws 754. Bracket 752 has a horizontally extending portion 756. Mounted by machine screws 758 on the extreme edge of portion 756 is a micrometer-holding member 760. Micrometer-holding portion 760, as seen in FIG. 15, is generally T-shaped with a split leg portion 762. Received in an aperture 764 of portion 762 is a micrometer 766 consisting of a knurled adjustment knob 768, indicia-carrying portion 770, retaining portion 772 and set block 774. Set block 774 has an undercut area 776 as seen in FIG. 15 which is adapted to facilitate horizontal adjustment of the set block 774 by an adjustment machine screw 778 which is employed to lock the set block 774 in a desired position. The forward portion of set block 774 comprises a wedge 780 as shown in FIG. 15.

Mounted in bracket 752 for a purpose later to be described is a stop pin 782. It is located in a slot 784 in bracket 752. The pin is adapted to engage a shoulder 786 formed on the underside of set block 774.

A cover plate 788 is mounted on sidewalls 790 of horizontally extending portion 756 of bracket 752 by means of machine screws 792 or the like.

Machine screw 778 is threaded into set block 774 at its extremity and the main portion of the screw rides in slot 794 in portion 756, shown by the dotted lines in 756 in FIG. 16. A locking nut 796 and washer 798 locks the screw and set block to portion 756.

The positioning apparatus 702 consists of a floating air cylinder and piston 703 having an air inlet fittings 704 and 705. A threaded cylindrical portion 706 extends from the operating end of the cylinder 703. Surrounded by portion 706 and extending therefrom is piston rod 707, the end portion 708 of which is threaded.

Threadedly received on threaded portion 708 of rod 707 is an internally threaded sleeve 709. Threadedly received on portion 706 is an internally sleeve 710, which, in turn, is rigidly secured to housing 302 by means of setscrew 712 having a projection 713 which is received in sleeve 711 through a tapered bore 714. Thus, it can be seen that cylinder 703 and sleeve 710 are rigid with respect to each other and with housing insertion housings 301, 301'.

Sleeve 709 has a screw 716 received in the end opposite piston rod 707. The housing 302 is held on the sleeve 709 by means of a flange 717 on one end thereof and a thrust washer 718 mounted between screw 716 and housing 302. A lock washer 719 keeps screw 716 from loosening. A roll pin 720 keeps sleeve 709 from rotating with respect to show portion 709 of piston rod 707. Sleeve 709 is secured in a rigid manner

to housing 302'; leg setscrew 721 is a fashion similar to sleeve 710.

At the edge of each housing 394 and 394' are relieved areas 722. Mounted in the two facing areas 722 are inserts 723 having beveled faces 724 which are complimentary to the angle of wedge portion 780 of set block 774. The inserts 723 are secured to their respective housings by means of machine screws 725. The outwardly facing relieved areas receive inserts 726 which are fastened in said areas by machine screws 727 or the like. Both inserts are hard finished and chrome-plated.

In cutaway area 106 of the backwall 102 of main frame member 100 is an L-shaped outside stop member 730 having a slot 731 in the longer length thereof. The shorter length of members 730 are adapted to abut insert members 726 and prevent housings 302 and 302' from separating any further.

Members 730 are held in place by means of machine screws 732 and strap washers 733. Screws 732 pass through the slotted areas 731 and into backwall 102.

Mounted on backwall 102 by means of machine screws 734 are blocks 735. Each block contains a threaded aperture for receiving a long adjustment screw 736. Jam nuts 737 are used to lock the screws in their adjusted position. The end of each screw 786 abuts against the end of a member 730 so that when the action of the piston tends to force the housings 302 and 302' apart, the short portions of L-shaped members 730 will stop any further movement. As a continuous operation occurs, the setting of the C.D. distance varies with the result that the continued abutting of inserts 726 against members 730 would force some movement of members 730 regardless of how tight screws 732 were. With the screws 736 abutting members 730, however, no such movement occurs.

The two settings for continuing sequential operations are set as follows. The outermost setting is determined by adjusting the micrometer to its desired position. The members 730 are then forced over against inserts 726 after loosening screws 732. When they abut, screws 732 are tightened and screws 736 are turned until the ends thereof abut members 730; whereupon the jam nuts 737 are tightened to lock screws 736 in position.

The micrometer is then backed off to the innermost C.D. setting and locked in position by screw 778. Thus the wedge C.D. setting of the set block 774 acts as the inner stop with inserts 723 abutting thereagainst.

The piston 703 continually acts to either force the housings 302 and 302' apart or pulls them together. Piston 703 is a simple double-action piston and cylinder arrangement. An aperture 740 cut in sidewall 104 of main frame 100 allows the cylinder to move in and out through the wall with housing 302 to which it is rigidly attached.

The micrometer adjustment mechanism is also used to adjust predetermined settings for wear incurring within the machine, particularly the outside formers.

CUT AND CLINCH MECHANISM 800

To clinch and cut the component leads extending through the circuit board after insertion there is provided an apparatus generally designated as 800, as shown in FIGS. 11-13. A support frame 801 is generally square and has an extending portion 802 which supports additional air pressure actuating equipment.

A pair of laterally adjustable clinch members 803 and 804 comprise the cutting and clinching portion of the device. They are vertically slidably mounted to slots 815, 815' in mounting blocks 805 and 806. Blocks 805 and 806 are, in turn, secured to members 808 and 809 which receive the ends of piston rod extensions 810 and 810'. While only one piston will be described, it is understood that the prime designations refer to the corresponding piston. Piston rod extension 810 is connected to piston rod 811 which, in turn, is connected to piston 812.

A pair of vertical members 813, 813' are mounted on support frame 801 and are attached thereto in any suitable manner, such as by machine screws. A pair of shafts 816 and

817 are received in members 813, 813' and are received in bushing sleeves 818, 819, 818' and 819'.

Cylinders 820, 820' are mounted on the outwardly facing surfaces of members 813, 813' in any suitable manner, such as by extension screws 821 passing through flange portions 822, 822' on each of the cylinders and into members 813, 813'.

Piston 812 is shown in FIG. 11 as having two flanges 823 and 824 and a main body portion 825. Piston rod 811 extends through an aperture in the rear of cylinder 820 and is threaded on the end thereof. Two jam nuts 826 and 827 are employed to set the inner limits of the strobe of piston rod 811, thereby determining the spacing between clinch members 803 and 804 at the innermost end of the strobe of both pistons.

The piston rod extensions 810, 810' have nuts 828, 828' secured thereto.

Threadedly received through a corner portion of members 813, 813' are adjustment screws 829, 829' which are used to determine the outer limits of the strobe of the pistons. Threadedly received on the inner portions of screws 829, 829' are jam nuts 830, 830' which are used to fix the screws in a desired position. The ends of screws 829, 829' abut the blocks 805 and 806.

Clinching members 803 and 804, which are slidably attached to blocks 805 and 806 in a vertical manner by T-shaped portions 807, 807' and slots 815, 815', rest on a T-shaped support member 830. Member 830 has slots 831, 831' therein which extend to the ends of the top of the T. A machine screw 832 has a smooth portion 833 riding in the slots and a threaded extremity received in member 804. The screws 832, 832' function to keep the T-shaped support member 830 in abutting engagement with members 803 and 804. Members 803 and 804 thus can slide apart on member 830 while still maintaining engagement therewith.

Member 830 is in two sections, upper portion 833 and lower portion 834, which are connected by machine screw 835. The bottom portion has a threaded aperture which receives the threaded extremity of a piston rod 836 which is operatively connected with cylinder C-3. Cylinder C-3 has air pressure fittings 838 and 839.

Referring now to clinch member 804 with the understanding that similar portions and associated parts on member 803 have a like prime designation. The top of member 804 has a tapered portion 840 which presents a flat surface 841 to the underside of a circuit board. An area 842 is cut away for a purpose to be described. The inner face of member 804 is relieved to receive a plate 843 which is held in place by a screw 844 or the like.

The surface 841 is bored through to cutaway area 842 to receive a hardened metal insert 844 which, in turn, has a cylindrical passage 845. The passage 845 receives an ejection rod 846 having a beveled end 847, which mates with surface 841. The other end of rod 846 has an enlarged portion 848 which is connected by link portions 849 to member 850, which is pivoted at 851 to member 804. Member 850 has an air valve shutoff portion 852 and a stop portion 853. Not shown is an aperture which allows air pressure from lines 854, 854' to enter the area between the clinch members 803 and 804 to blow away any salvage lead portions after the cutting and clinching operation. Portion 853 abuts a portion of member 804 to limit to pivotal movement of member 850. Links 854 connect member 850 to a push rod 865 located in a passage in member 804. Push rod 855 has a reduced portion 856 which is surrounded by a compression spring 857, which biases it in a downward direction. Mounted on the bottom of push rod 855 is a reduced diameter portion 858 which is threaded into a portion 859 of push rod 855. A semicircular cap member 860 is threaded into the bottom of portion 858.

Guide block 861 is mounted to frame member 801 by machine screws 862 or the like. A biased portion 863 of block 861 houses a rod 864 on bushings 865. Pivotaly supported on rod 864 is a camming member 865 which has two forwardly extending wedge portions 866 as best seen in FIGS. 12 and 13. Two identical portions 867 and 868 pivot on rod 864 and hold rod in place by means of snap rings 869. The forward extremities of wedge portions 866 protrude under the bottoms of push rods 855 and cap members 860.

An air cylinder 870 is mounted on the extension portion 802 of frame 801 by machine screws 871 or the like. Piston rod 872 extends from the forward portion of the machine and is connected to a slide block 873 via threaded extremity 874 and a jam nut 875. Slide block 873, as viewed in FIG. 12, has two forwardly projecting members 876 and 877 the forward top edges of which are beveled as at 878 in FIG. 13. The forward portions of wedge members 866 ride in a trough 879 (FIG. 13) in frame member 801.

Actuation of piston 870 forces piston rod 872 to slide member portions 876 and 877 under wedge members 866 which pivot upwardly until they engage cap members 860 on the bottom of push rods 855. Further upward movement of push rods 855, 855' force member 850 to pivot, thus forcing rod 846 to slide up passage 845 in insert 841 until the tip is flush with surface 841.

Referring to FIG. 7, there is shown a component 1 with a component body 2 and bent leads 3a and 3b extending through apertures 4a and 4b in circuit board 5. The component is being held in place by members, 346, 346', 349 and 349'. Clinch and cut members 803 and 804 have moved upwardly due to the action of cylinder C-3 and T-shaped member 830 so that leads 3a and 3b have entered passages and portions 880, 880' of the oval-shaped rim of passageways 845, 845' are in contact with the sides of leads 3a and 3b.

The clinch and cut members 803 and 804 continue to rise and, simultaneously, close together so that the leads are bent inwardly underneath the circuit board 5. During this inward bending of leads 3a and 3b, portions 880 and 880' act both as force transmittal points and as shearing edges. The upward and inward movement of members 803 and 804 continue until machine screws 860, 860' (FIG. 11) reach the innermost limits of slots 31, 31'. At this point, the ends of the leads have been severed and clinched and the waste lead material is in passages 845, 845'. Cylinder 870 is activated when members 803 and 804 begin to return to their initial lower and separated positions. As 803 and 804 lower, the wedge members 866 force biased push rods 855, 855' upwardly, causing the rods 846, 846' to eject the waste lead material from the passages 845, 845'. A source of vacuum is connected via hose 881 (FIG. 13) to the top of members 803 and 804 and draws the waste material away. Air pressure coming from hoses 854, 854' provides a venturi effect which sucks the waste toward an opening (not shown) of hose 881. Mounting screws 889 are provided on plate 801 for attaching the same to a machine base frame.

An angle piece 883 is connected to slide block 873 by means of a machine screw 884 or the like. On the other extremity thereof, an adjustment screw 885 is mounted. A jam nut 886 locks the adjustment nut in position. A solenoid 887 is mounted by machine screws 888 to the bottom of plate 801 and is adapted to be actuated by adjustment screw 885. The solenoid acts to activate the piston to reverse stroke after rods 846, 846' have ejected waste lead material from passages 845, 846' and may inform the handles 506 that clinching is completed.

Cylinders 820, 820' have air pressure inlet pulleys such as 890' and 891', seen in FIG. 12.

OPERATION 500

In operation, a suitable memory element, such as a punched or magnetic tape, is coded to indicate the various component and circuit board parameters for each of the components to be supplied to the insertion apparatus during fabrication of given circuit board. Thus, for each component to be inserted, the tape is coded to indicate a given X-Y board position, a given C.D. or distance between the component lead axes of a given diameter which is required in order to permit the leads to be properly inserted into prepunched board apertures; and the diameter or thickness of the body portion of the component.

The coded tape, not shown, is then employed to control operation of the control circuit of the apparatus, generally designated as 500 in FIG. 9, in the manner now to be described.

Operation is initiated by feeding the coded tape in a step-wise manner past suitable tape reader 501, which signals a control mechanism 502 to begin a component insertion cycle. Control 502 initiates the insertion cycle by actuating circuit board supporting table positioning motors M₁, M₂, to drive the circuit board into a given X-Y position, whereat prepunched board apertures 4a, 4b are disposed in alignment beneath insertion head assembly 300. Control 502 simultaneously supplies comparator 503 with information concerning the new body portion thickness and the new component C.D. Comparator 503 recognizes the new body thickness and signals handler 506 to actuate ternary cylinder C₄ to move stop elements I—VIII into correct position, (as for instance element I into the reference stop position shown in FIG. 3). Comparator 503 also compares the new C.D. with the old C.D. or C.D. of a previously inserted component. If the C.D.'s are different, comparator 503 indicates to translator 504 the sign and difference between C.D.'s whereafter translator 504 actuates clinching mechanism section adjustment cylinders 830, 820' and insertion head section adjustment cylinder 703 to drive the sections into proper position. Translator 504 then sends a reset signal back to comparator 503 to change the C.D. to be used as a reference during a succeeding insertion cycle. When adjustment of the clinching and insertion sections is completed, translator 504 transmits a head in position signal to gate 505 that the insertion cycle may proceed; the gate, upon also receiving a signal from control 502 that the circuit board table is in position, signals handler 506 to proceed.

If, on the other hand, the new C.D. is identical to the old C.D., cylinders 703, 820 and 820' are not actuated and a head in position signal is sent immediately to gate 505.

Handler 506 thereafter initiates operation of control cylinders C₁, C₂ and C₃ in the following sequence. First, C₁ is operated to extend piston rod 236, whereby shaft 132 is rotated in a clockwise direction, when viewed in FIGS. 3 and 8 to effect driving rotation of advancement wheels 217, 217' via the ratchet assemblies to present the leads of a component to be inserted immediately adjacent the upwardly facing shear block surfaces 333, 333', as viewed in FIGS. 1 and 6. Full driving rotation of shaft 132 closes limit switch LS3 to signal handler 506 that component is positioned. Handler 506 then actuates cylinder C₂, which retracts piston rod 605 in order to drive members 345, 345' into their insertion position previously determined by actuation of stop control cylinder C₄. When members 345, 345' are moved into insertion position, cam 608 closes limit switch LS2 to signal the handler that a component has been inserted whereupon the handler actuated cylinder C₃ to drive clinching devices 803 and 804 into lead clinching position and close limit switch LS4. Closing of switch LS4 signals handler 506 to deactivate cylinders C₁, C₂ and C₃ in order to return the feeding, insertion and clinching elements of the insertion apparatus to their original or inoperative positions.

As soon as operation of handler 506 is initiated, the handler signals control 502 to initiate feeding of the coded tape and reading of data corresponding to the next component to be inserted. Upon return members 345, 345' to their original positions at the completion of the insertion cycle, cam 608 closes limit switch LS1, whereupon handler 506 gives a permit signal to control 502 to proceed with a subsequent operational cycle.

While only the preferred embodiment of the present invention has been described in detail, various modifications thereof and additions thereto will become apparent to those skilled in the art in view of the foregoing description. For example, the machine has been described for use specifically with axial lead components having single leads extending from each end thereof while one skilled in the art would recognize that the axial lead component could have more than one lead extending from an end, suitable provision being made in the operating mechanism to cut, bend and insert the multiple leads. Further, it will likely occur to one skilled in the art that the present invention has utility in processing components where it is only desired to trim and deform components to provide processed components which may thereafter be inserted by other insertion apparatus.

Accordingly, the scope of protection for the present invention is to be limited only by the scope of the appended claims.

What I claim is:

1. An apparatus for processing electrical components each having a body portion and a pair of leads extending from opposite ends thereof which comprises: a head assembly having first and second relatively spaced-apart sections; means adapted to actuate said sections during each operational cycle of said apparatus; means adapted to present one of said components to said head assembly during each operational cycle of said apparatus in such a manner that the leads of said presented component are operably positioned one adjacent each of said sections with said component body portion being disposed between said sections, each said section when actuated being adapted to sequentially sever a length from one lead of said presented component to produce a shortened component lead and thereafter deform a free end portion of said shortened lead to produce a generally L-shaped lead; means adapted to vary the spacing between said sections between two predetermined settings and control means operable to actuate said section spacing varying means, whereby the distance measured between the free ends of said deformed leads of components processed during successive operational cycles of said apparatus may be varied in a predetermined manner between said two predetermined settings.

2. An apparatus according to claim 1, wherein said component presenting means includes two relatively spaced-apart axially aligned feed wheels disposed adjacent opposite sides of said head assembly, each said feed wheel having a plurality of equally spaced-apart recesses disposed adjacent the periphery surface thereof, said wheel recesses being arranged to form periphery-spaced pairs of aligned recesses, the respective recesses of each said pair being adapted to engage the respective leads of component to be presented, and means to effect rotation of said feed wheels to present one of said components to said head assembly during each operational cycle of said apparatus.

3. an apparatus according to claim 2, wherein components to be presented to said head assembly are lead supported by a pair of parallel carrier tapes, said feed wheels are provided with radially extending annular guide surfaces, said guide surfaces being adapted to guidingly engage facing marginal edge portions of said carrier tapes to effect desired positioning of said components with respect to said head assembly in a direction lengthwise of said component body portion between said ends thereof, and the means adapted to vary the spacing between said sections between two predetermined settings also is adapted to vary the distance between said feed wheels in accordance with the spacing between said facing marginal edges of said tapes, whereby said spacing is varied between said two predetermined settings.

4. An apparatus according to claim 2, wherein components to be presented to said head assembly are lead supported by a pair of parallel carrier tapes and said means to effect rotation of said feed wheels includes means selectively operable to vary feeding rotation of said feed wheels in accordance with the spacing between components carried on said tapes.

5. An apparatus according to claim 1, wherein said section spacing varying means includes guide means adapted to slidably support said sections for reciprocation along aligned paths of travel, and an actuator means aligned with said path of travel, said actuating means having a first portion attached to one of said sections and second portion attached to the other of said sections, said actuator means including response means adapted to selectively drive said first and second portions apart and to bring them together, whereby said sections are forced to slide on said guide means in opposite directions.

6. An apparatus according to claim 5, wherein said actuator means and response means comprise a fluid-actuable cylinder, piston and piston rod, the cylinder being attached to one of said sections and the piston rod to the other of said sections whereupon actuation of said piston in said cylinder forces the sections to slide on said guide means in opposite directions.

7. An apparatus according to claim 5 wherein there is a spacing adjustment means provided on said apparatus to establish the two predetermined spacing settings of said spaced-apart sections, said adjustment means cooperating with said actuator means to vary the space in between said sections, said adjustment means comprising two adjustable outer stop blocks mounted on said apparatus and adapted to establish the greater spacing between said sections when said sections are forced apart by said actuator means and an adjustable set block means having a centrally positioned wedging portion adapted to cooperate with said actuator means and said section to establish the lesser space in between said sections when said sections are forced together by said actuator means.

8. An apparatus according to claim 1 wherein there is a spacing adjustment means provided on said apparatus to establish the two predetermined spacing settings of said spaced-apart sections, said adjustment means cooperating with said means adapted to vary the spacing between said sections to set the amount of spacing between each of said two predetermined settings, said adjustment means comprising two adjustable outer stop blocks mounted on said apparatus and adapted to establish one of said predetermined settings and an adjustable set block means having a centrally positioned wedging portion adapted to establish the other of said predetermined settings.

9. An apparatus according to claim 8, wherein said adjustable set block includes a micrometer adjustment means whereby very close settings may be established for the two predetermined settings.

10. An apparatus according to claim 1, wherein said component body portion has a thickness when measured normal to a line extending between said ends thereof, said sections including means adapted when moved into a position adjacent a circuit board to insert said free ends of said deformed L-shaped leads into preformed apertures formed in said circuit board, and including means to adjustably vary said insertion position of said insertion means between either of said two predetermined settings and means are provided to adjustably vary said insertion position of said insertion means in accordance with said thickness of said presented component.

11. An electrical component insertion apparatus comprising a housing, a pair of insertion means mounted on said housing for lateral movement relative to each other and to the housing, said insertion means including means to sever leads of said component, bend the remaining lead portions at a right angle to the component body and to insert the bent portions of said leads into a circuit board, means adapted to present a component to said pair of insertion means during each operation cycle of said apparatus, power means adapted to actuate said insertion means to perform said severing, bending and insertion of said component leads, actuation means adapted to force said insertion means to move in opposite directions to one of two predetermined spacing settings, whereby said insertion means is adapted to handle components of varying length as measured between the axes of the bent portions said leads.

12. An apparatus according to claim 11, wherein said section spacing varying means includes a fluid actuable cylinder and piston and a piston rod operatively connected with said piston, said cylinder being operatively connected to one of said sections and said piston rod being operatively connected to the other of said sections, said cylinder and piston adapted to force said sections to move in opposite directions.

13. An apparatus according to claim 11, wherein there is a spacing adjustment means provided on said apparatus to establish two predetermined spacing settings of said insertion means, said adjustment means cooperating with said insertion means to limit the lateral movement of said insertion means.

14. An apparatus as in claim 11 wherein there is provided a lead clinching and cutting means mounted directly below, said means adapted to bend the leads of said components which extend below a circuit board inwards towards each other and

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at right angles to the remainder of the leads, said means also adapted to sever surplus end portions of said leads during the clinching operation.

15. An apparatus as in claim 14 wherein said lead clinching and cutting means comprises two horizontally and vertically movable lead-engaging heads, said heads having means to engage the lead ends and to sever them during the clinching operation.

16. An apparatus as in claim 15 wherein said means to engage and sever the lead ends comprises elongated apertures in

the top surface of each head, the axes of said apertures being angled and converging with respect to the vertical, the top surface of said heads being flat and coplanar at all times, a portion of the edge formed by the intersection of the surfaces and apertures constituting a cutting means which is adapted to sever excess lead material.

17. An apparatus as in claim 16 wherein said lead-engaging heads include means to eject cut lead material from said apertures.

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