Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 1

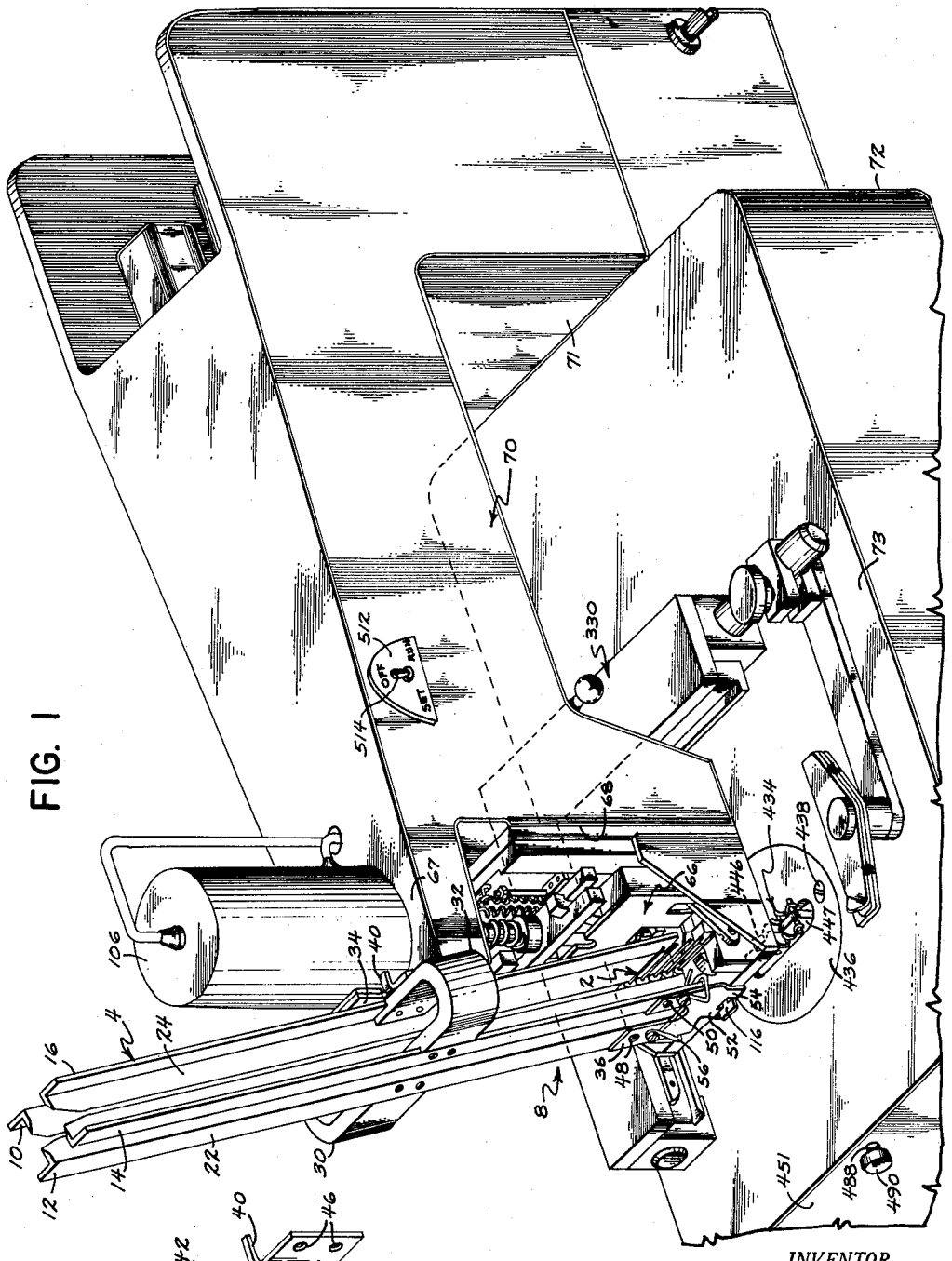


FIG. 1

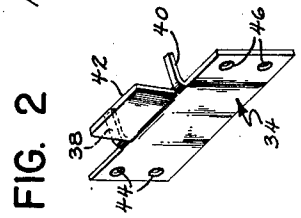


FIG. 2

INVENTOR.
PAUL S. PETERSEN
BY Robert E. Horne
ATTORNEY

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 2

FIG. 3

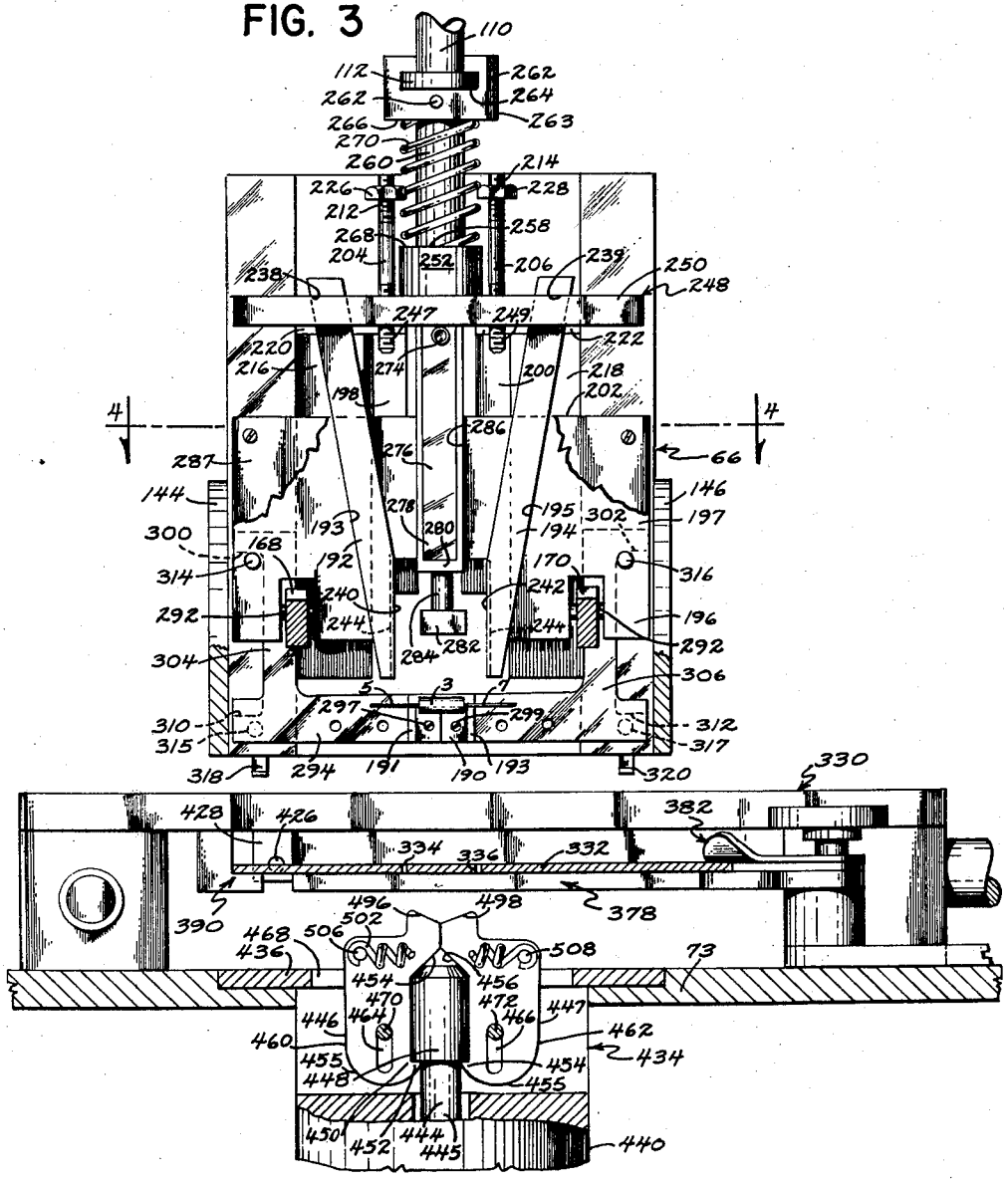
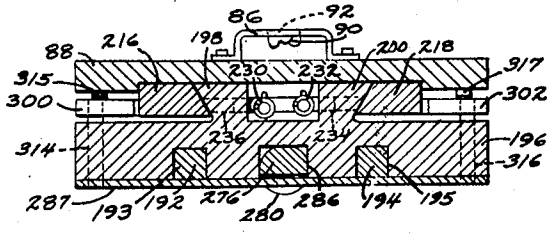


FIG. 4



INVENTOR.
PAUL S. PETERSEN
BY Robert E. Horne
ATTORNEY

Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 3

FIG. 7

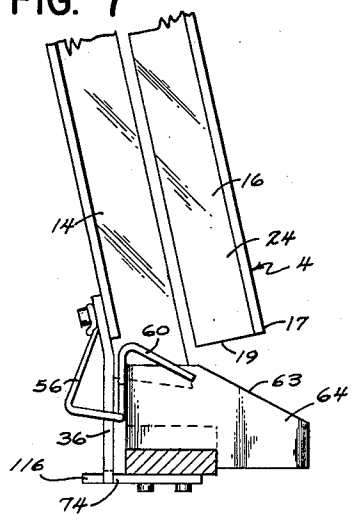


FIG. 5

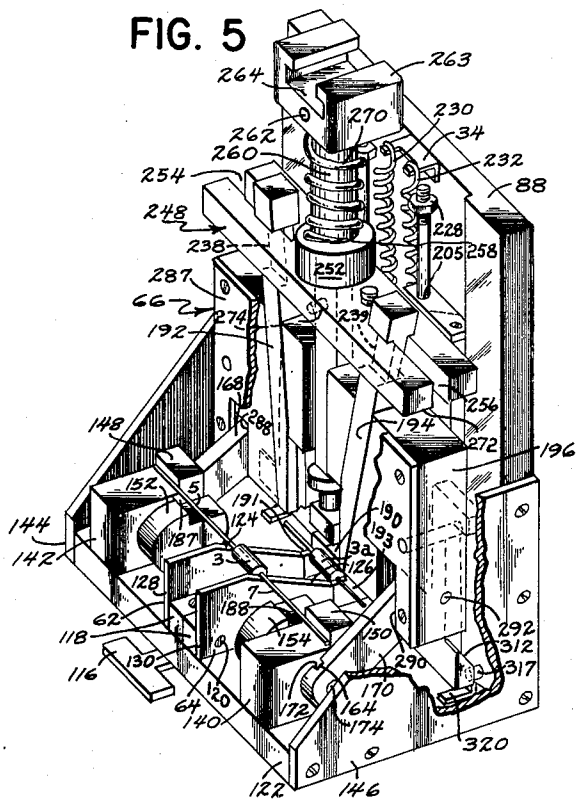


FIG. 8

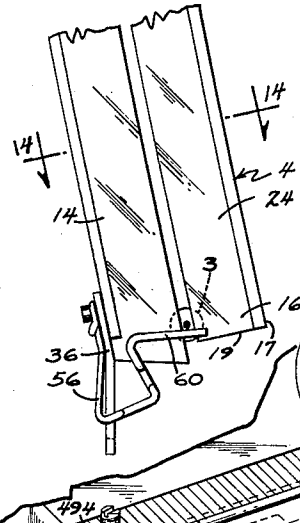


FIG. 6

INVENTOR.
PAUL S. PETERSEN

BY

Robert E. Horne
ATTORNEY

Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 4

FIG. 12

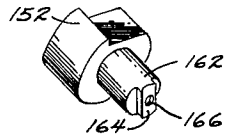


FIG. 11

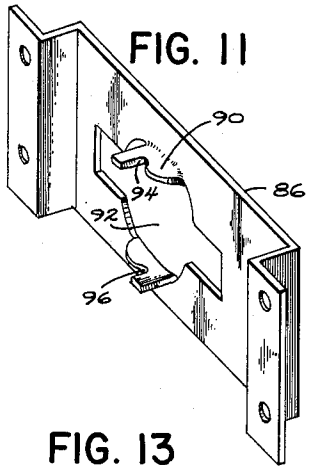


FIG. 10

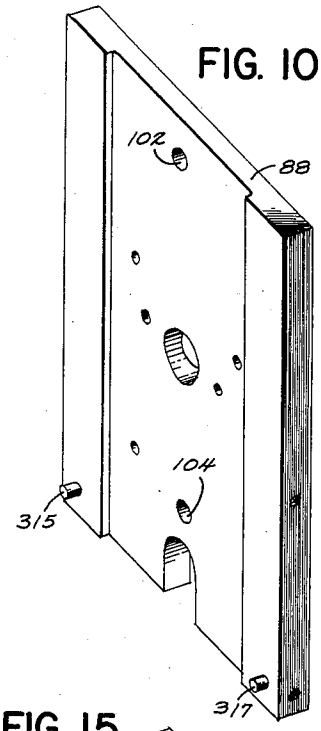


FIG. 14

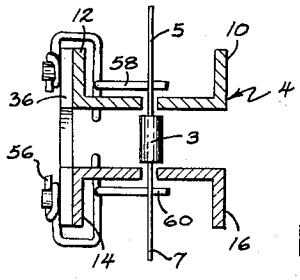


FIG. 13

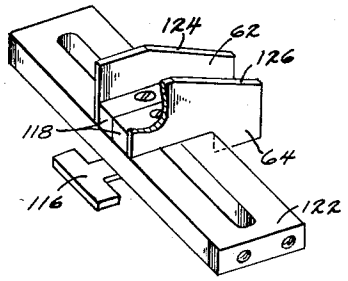


FIG. 9

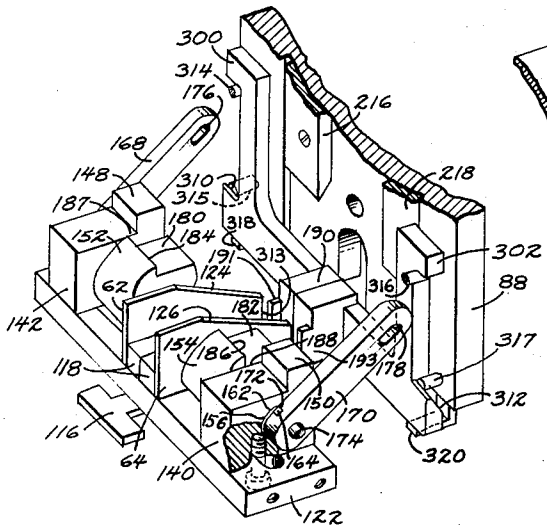


FIG. 15

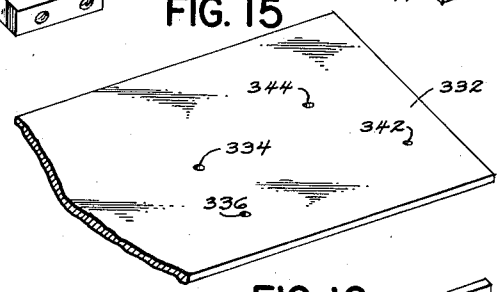
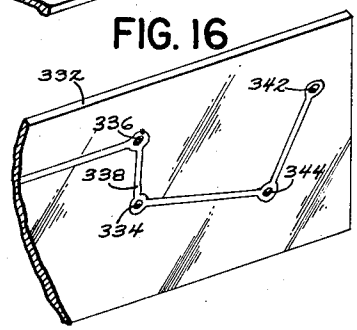


FIG. 16



INVENTOR.
PAUL S. PETERSEN
BY
Robert E. Horne
ATTORNEY

Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 5

FIG. 17

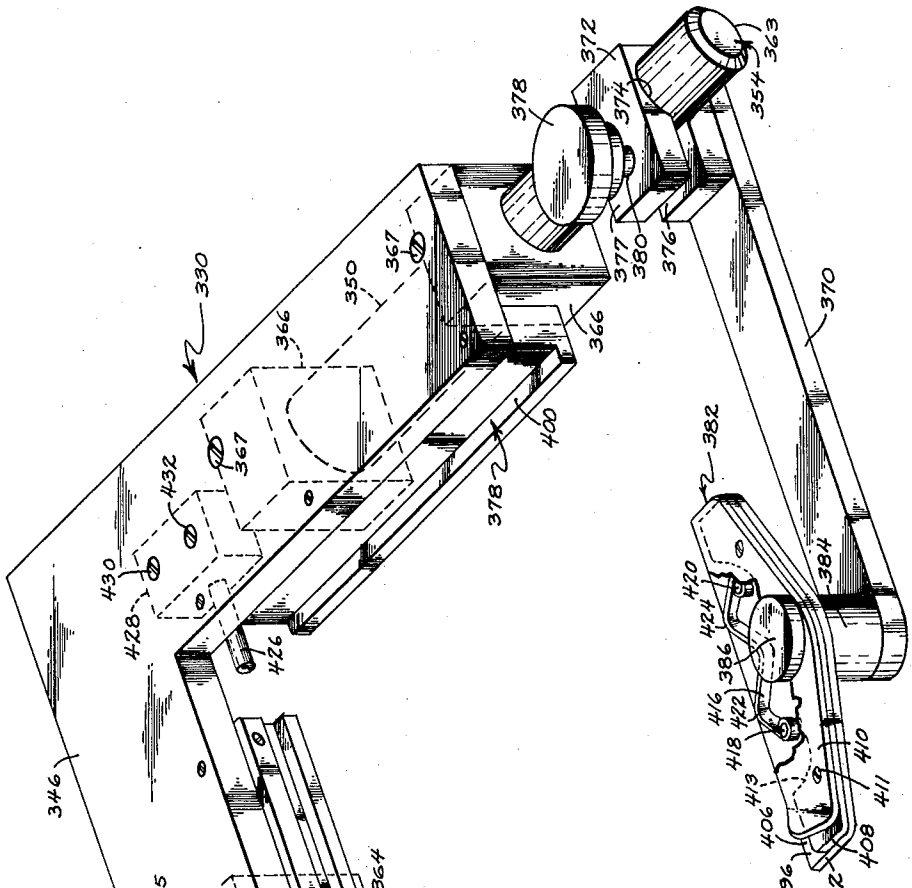
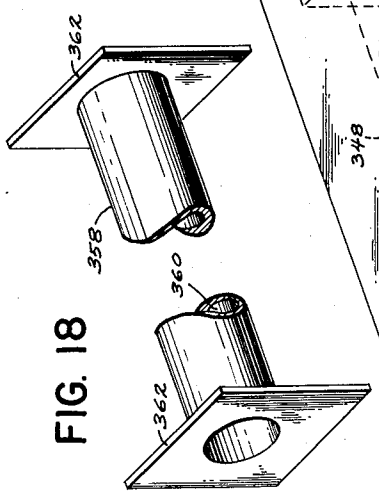


FIG. 18



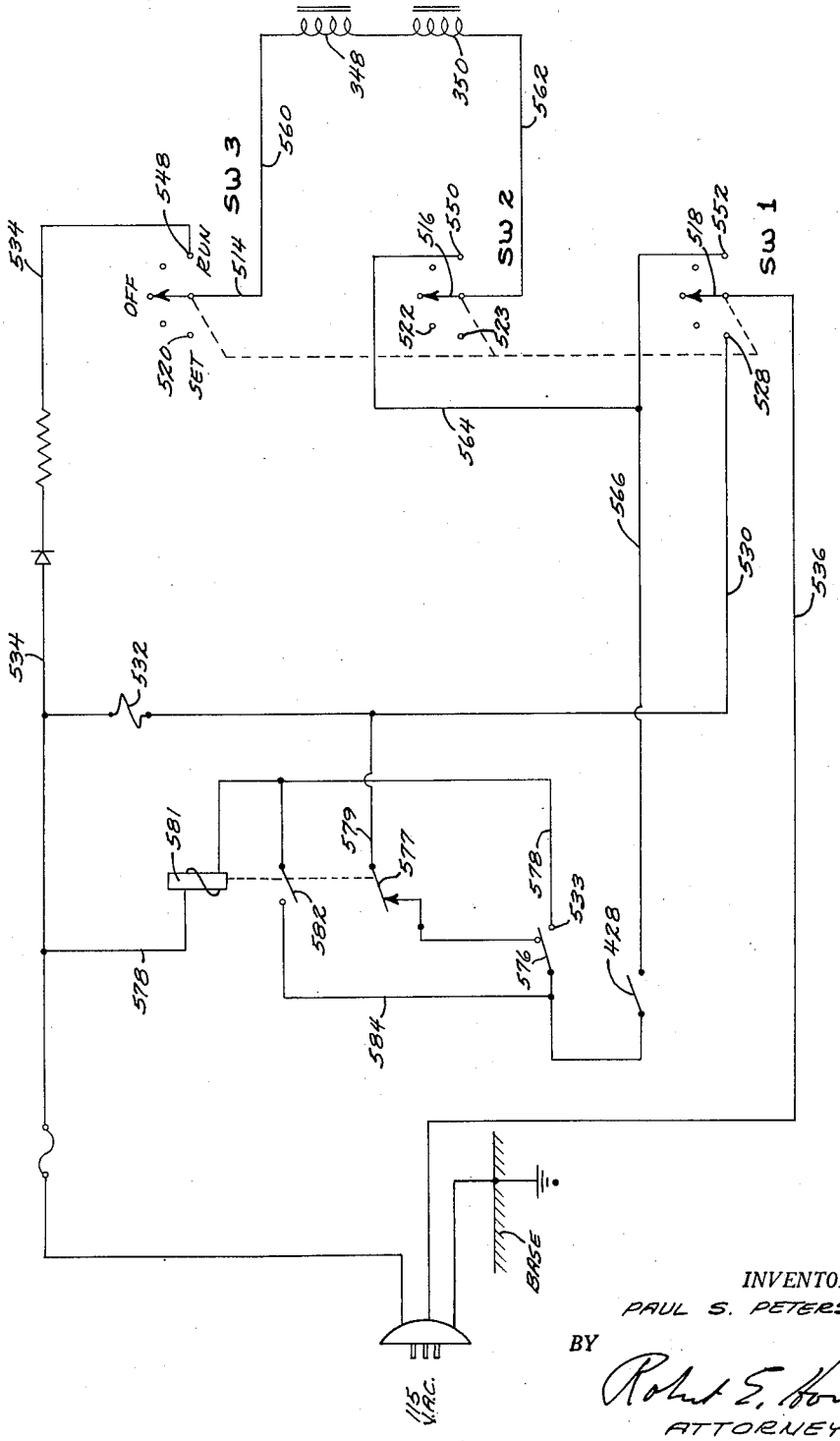
INVENTOR.
PAUL S. PETERSEN
BY Robert E. Horne
ATTORNEY

Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 6

FIG. 19



INVENTOR.
PAUL S. PETERSEN
BY
Robert E. Home
ATTORNEY

Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 7

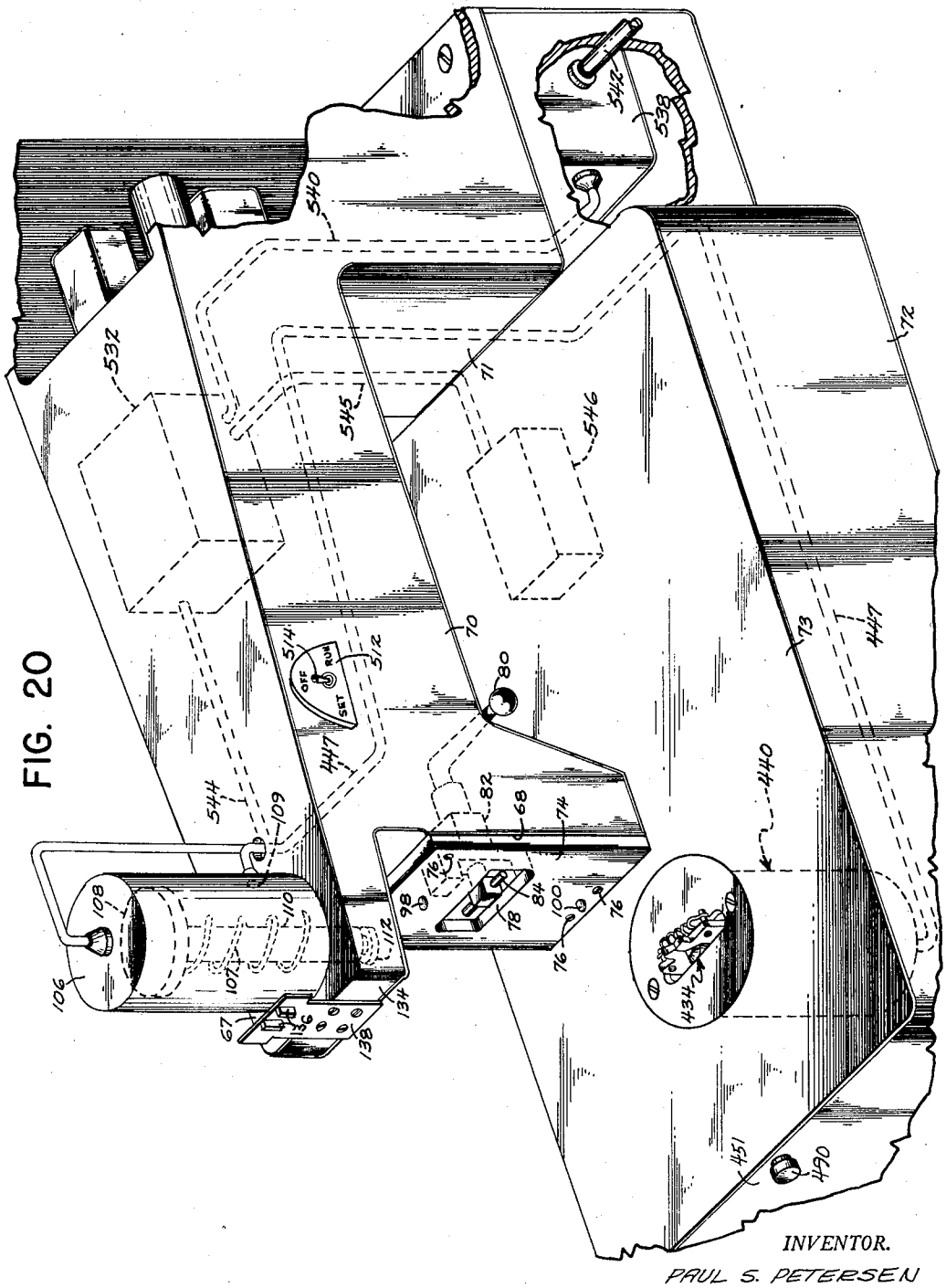


FIG. 20

INVENTOR.
PAUL S. PETERSEN
BY
Robert E. Horne
ATTORNEY

Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 8

FIG. 21

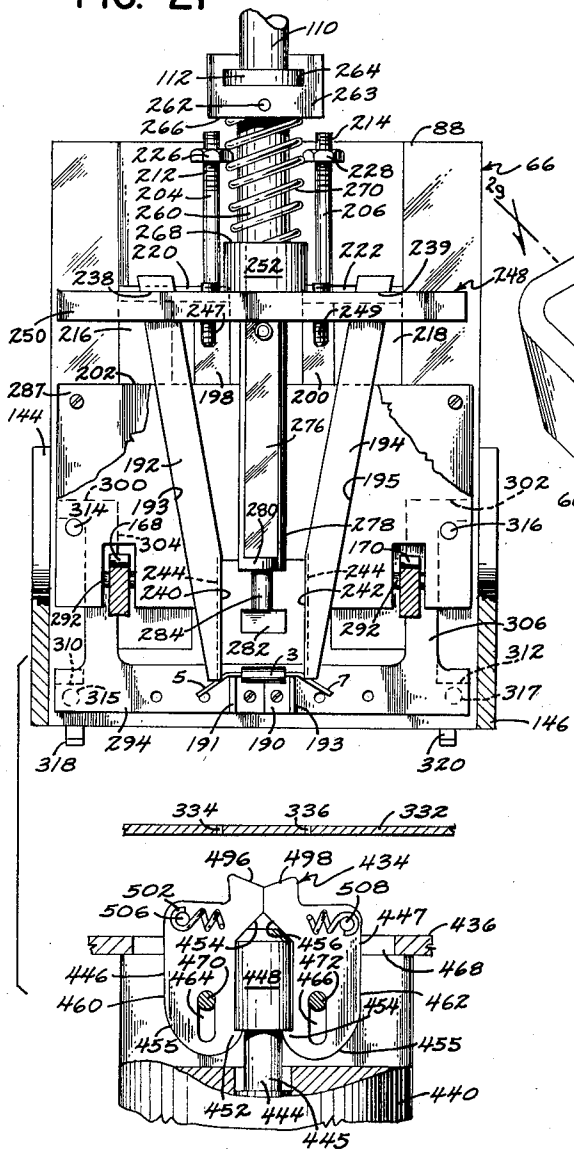


FIG. 27

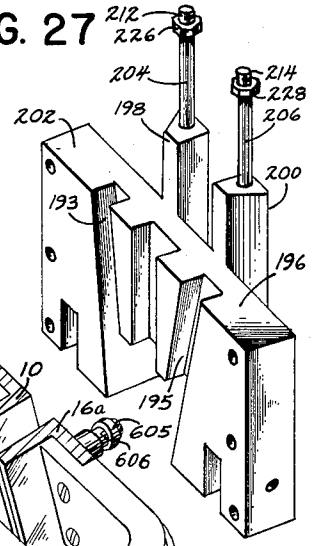
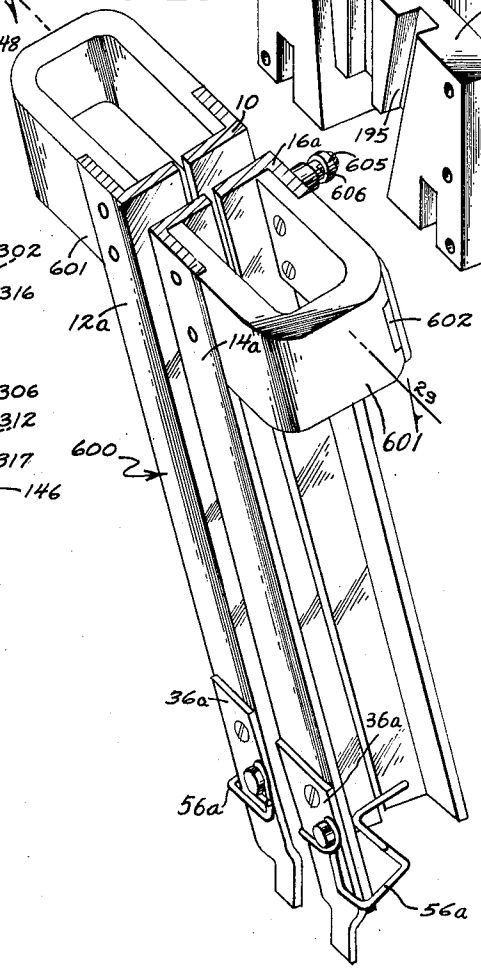


FIG. 28



INVENTOR.
PAUL S. PETERSEN
BY Robert E. Horne
ATTORNEY

Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 9

FIG. 22

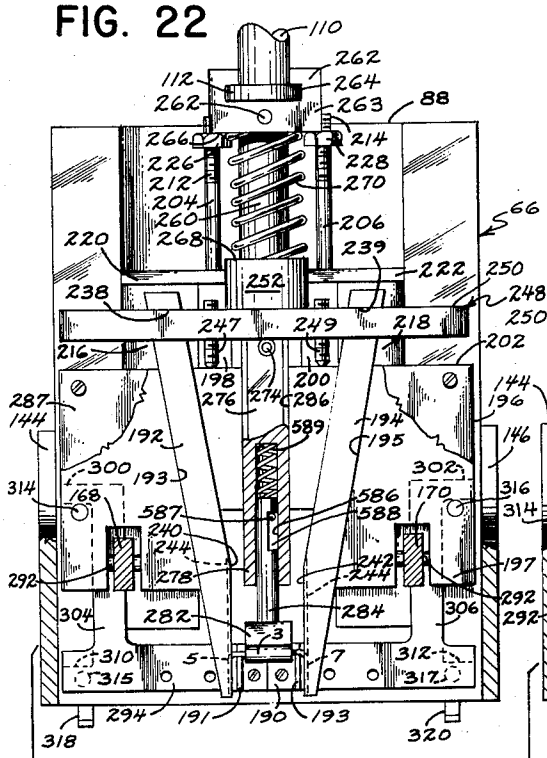
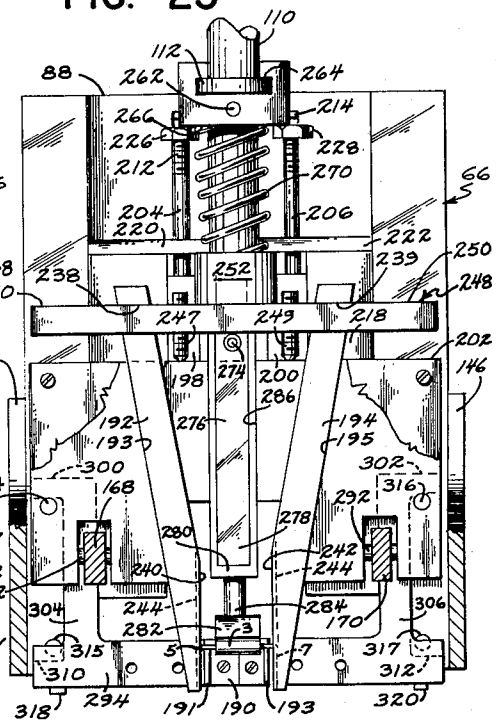
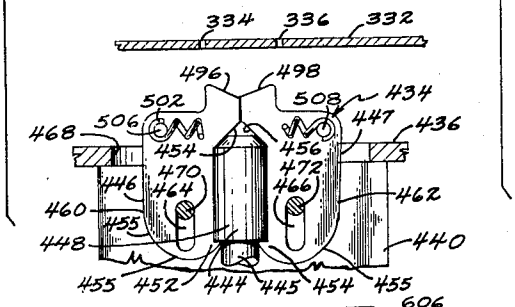


FIG. 23





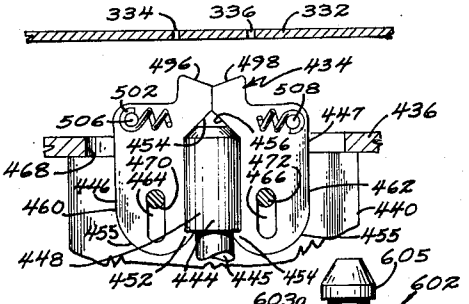


FIG. 29

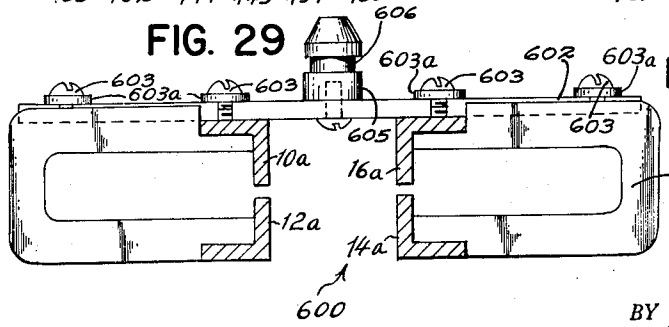
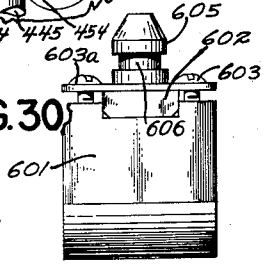


FIG. 30



INVENTOR.
PAUL S. PETERSEN
BY Robert S. Horne
ATTORNEY

Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 10

FIG. 24

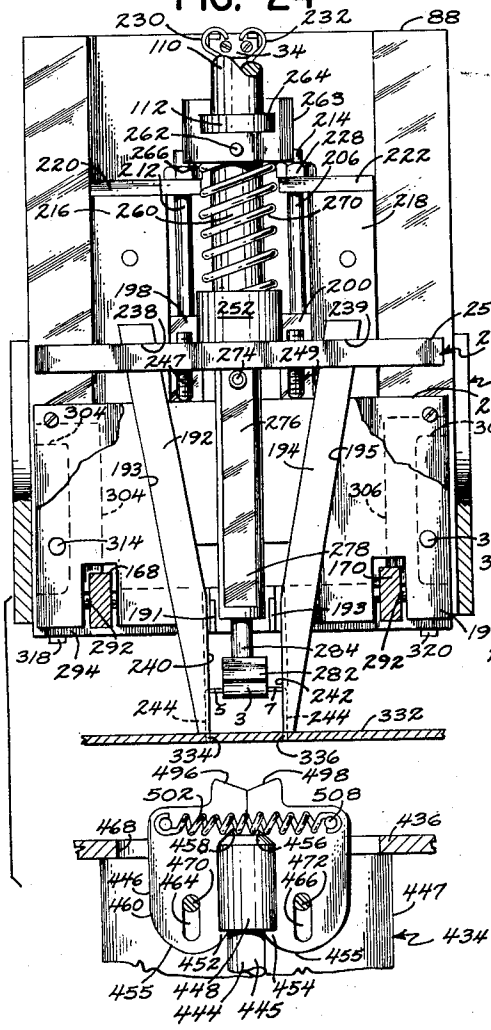


FIG. 25

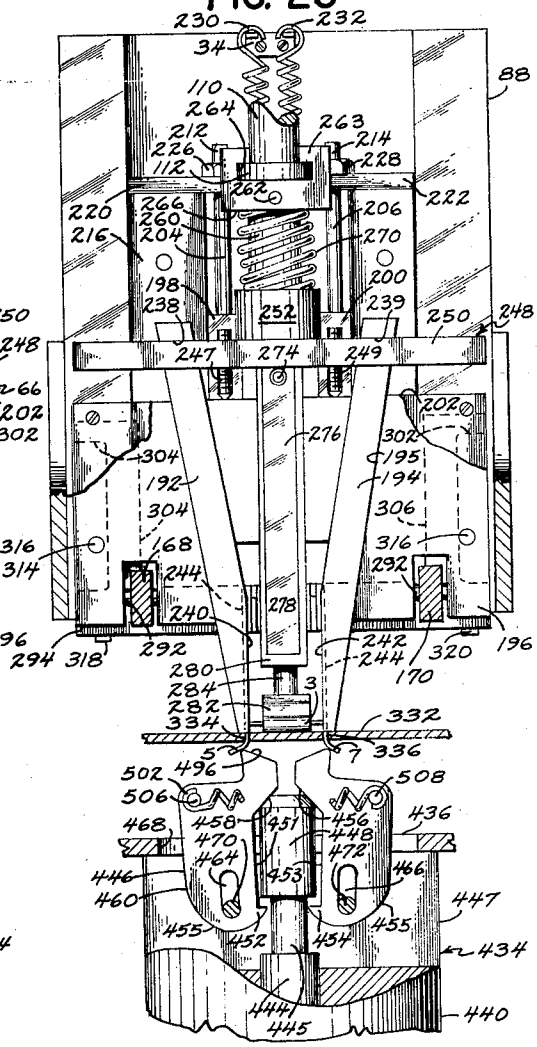
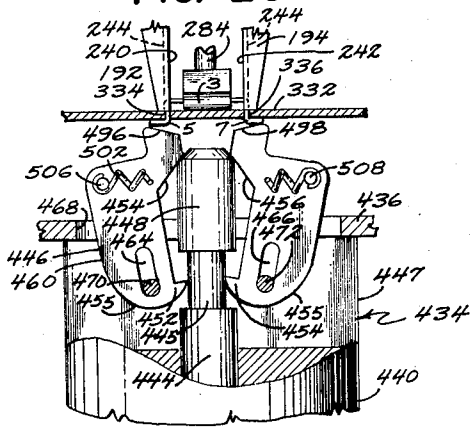


FIG. 26



INVENTOR.
PAUL S. PETERSEN
BY Robert E. Horne
ATTORNEY

Sept. 8, 1959 P. S. PETERSEN 2,902,689

COMPONENT ATTACHING MACHINE

Filed July 1, 1957 11 Sheets-Sheet 11

FIG. 31

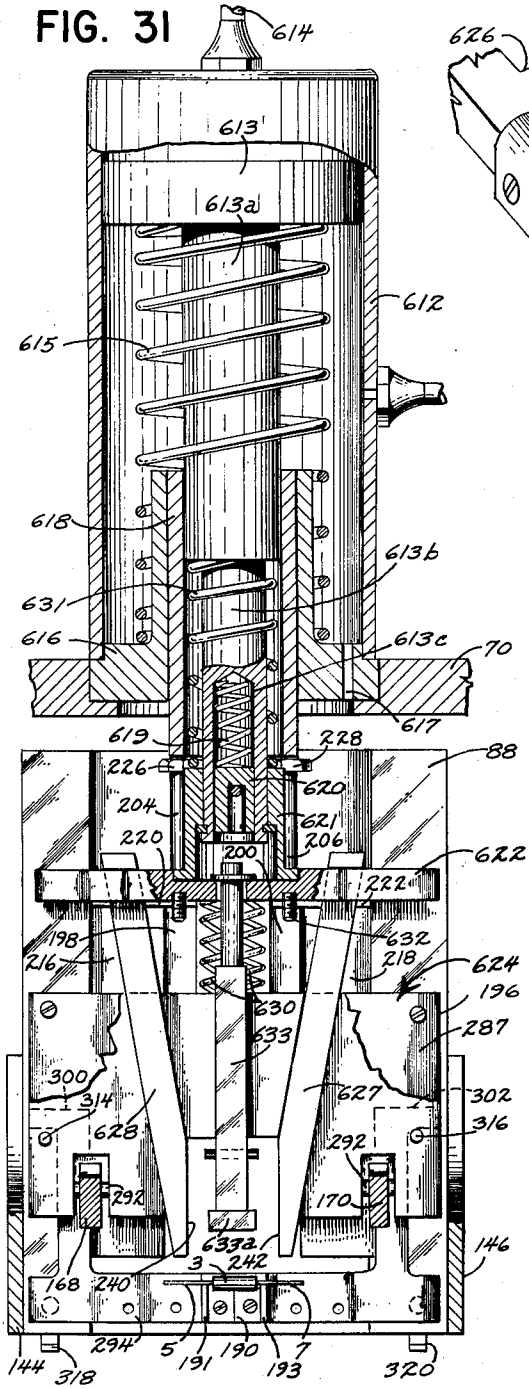


FIG. 32

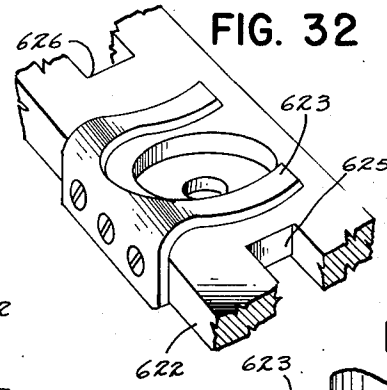


FIG. 33

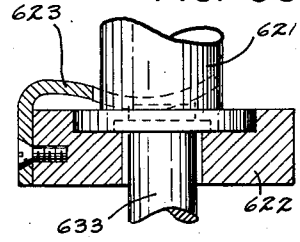
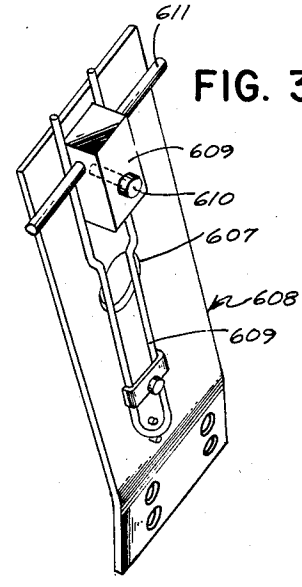


FIG. 34



INVENTOR.
PAUL S. PETERSEN
BY Robert E. Horne
ATTORNEY

United States Patent Office 2,902,689
Patented Sept. 8, 1959

2,902,689

COMPONENT ATTACHING MACHINE

Paul S. Petersen, St. Louis Park, Minn., assignor to General Mills, Inc., a corporation of Delaware

Application July 1, 1957, Serial No. 669,327

13 Claims. (Cl. 1—2)

This invention relates to improvements in machines for attaching electrical components to a circuit board and more particularly to a machine for receiving a circuit board in a component attaching position and actuated to feed, shear, and attach said electrical components to the circuit board.

In the art of automatically attaching electrical components to a circuit board many types of machines have been devised which will continuously feed selected components to a selected type of circuit board. In the prior art devices it is difficult to change the machine to handle different types of circuit boards and different types of components. Such changes are often costly and may require redesign work in some cases.

It has been found desirable to have an attaching tool assembly that is readily detachable from the main frame of the machine. The feature of detachability allows for various sized components to be handled from a single basic machine. The particular embodiment of my invention provides for the removal of an entire attaching tool handling one size of component and replacing it with another attaching tool capable of handling another size electrical component.

The present invention relates to a machine for assembling quantities of circuit boards and is readily adaptable for the attachment of various types and sizes of components for various sized circuit boards.

It is therefore an object of the present invention to provide a relatively inexpensive, versatile, electrical component attaching machine.

Another object of the invention is to provide a circuit board positioning means which will permit the attachment of a component to any desired position on a circuit board.

Another object of the invention is to provide a machine which is actuated by the insertion of a circuit board to feed, shear, and attach the leads of a component thereto.

It is a further object of the invention to provide an attachment tool which is detachable from the frame of an attachment machine; detachable in such a manner that the attachment tool can be readily changed to handle a different sized component.

Another object of the invention is to provide novel bending fingers which converge in a guide block to bend and form the component, then insert the component in a printed circuit board.

A further object of the invention is to provide a pair of bending fingers which converge a predetermined amount to bend and form the leads of an electrical component; then at the predetermined convergence point move vertically downward to insert the component in a printed circuit board.

It is an object of the invention to provide resilient means for initially engaging a block containing converging bending fingers, to bring its bending fingers into engagement with the leads of an electrical component for forming and bending.

It is a further object of the invention to provide a

detachable tool which provides for the cutting, bending, and insertion of an electrical component in one compact unit.

Further objects and advantages will become more fully apparent in the following specification and the appended drawings in which:

Figure 1 is an isometric view of the component attaching machine;

Fig. 2 is an isometric view of the supply chute mounting bracket;

Fig. 3 is a front elevational view of the attaching tool, showing the relationship of the circuit board and crimping means;

Fig. 4 is a sectional view of the attaching tool taken at 4—4 of Fig. 3;

Fig. 5 is an isometric view of the detachable attaching tool;

Fig. 6 is an isometric view of the crimping means;

Fig. 7 is a partial side elevational view of the lower end of the chute when engaged by component guides;

Fig. 8 is a partial side elevational view of the lower end of the chute when not attached to the machine;

Fig. 9 is an isometric view of the shearing means of the attaching tool;

Fig. 10 is an isometric view of the tool support plate;

Fig. 11 is an isometric view of the cam lock bracket for attaching the attaching tool to the machine;

Fig. 12 is an isometric view of the shearing means;

Fig. 13 is an isometric view of the component guides;

Fig. 14 is a sectional view of the supply chute taken at 14—14 of Fig. 8;

Fig. 15 is an isometric view of the upper surface of the circuit board;

Fig. 16 is an isometric view of the lower surface of the circuit board;

Fig. 17 is an isometric view of the magnetic board holder;

Fig. 18 is an isometric view of the insulator used on the magnetic board holder;

Fig. 19 is an electrical schematic wiring diagram which illustrates the electrical system of the machine;

Fig. 20 is an isometric view of the machine with the attaching tool removed;

Fig. 21 is a front elevational view of the attaching tool of Fig. 3 showing the attaching tool engaging and bending the leads of the component;

Fig. 22 is a front elevational view of the attaching tool of Fig. 3 showing the leads of the component completely bent;

Fig. 23 is a front elevational view of the attaching tool continuing its downward movement;

Fig. 24 is the same as Fig. 23 with the bending fingers touching the circuit board;

Fig. 25 is an elevational view showing the leads inserted into the board and the leads being crimped;

Fig. 26 is a partial view of the crimping mechanism completely bending the leads, beneath the circuit board;

Fig. 27 is an isometric view of the block for guiding the bending fingers;

Fig. 28 is an isometric view of the supply chute;

Fig. 29 is a plan view of the chute of Fig. 28;

Fig. 30 is an end view of Fig. 29;

Fig. 31 is an elevational view of another embodiment of the attaching tool;

Fig. 32 is an isometric view of the attaching clip mounted on the attaching tool supporting bar;

Fig. 33 is an elevational view showing the clip of Fig. 32 attaching to the power means for the attaching tool; and

Fig. 34 is an isometric view of the attaching member for the chute of Fig. 28.

The attaching machine of the preferred embodiment

is illustrated in Fig. 1. The machine receives a supply of a selected size or type of electrical components and cuts the leads to a desired length, bends the ends of the leads for insertion and attaches the component to a printed circuit board.

Circuit boards generally are those of the printed circuit type which are made of a non-conducting material having conducting lines of metal, printed, etched, or embedded thereon to form the desired circuitry. The conducting lines of the board terminate at preselected holes in the board and the components are then attached by the machine to complete the circuit.

In Fig. 1, a supply of electrical components 2 having coaxial leads 5, 7 is placed in an inclined chute assembly 4 for machine 8. The chute assembly 4 is constructed of four elongated L shaped longitudinal members 10, 12, 14 and 16, with longitudinal members 10 and 12 forming one side 22 of the chute 4 and longitudinal members 14 and 16 forming the other side 24 of the chute 4. The L shaped members 10 and 12 are held in a spaced parallel relation along their length by a U-shaped connector bar 30 and side 24 of the chute 4 is formed of longitudinal members 14 and 16 held in parallel spaced relation along their length by a U-shaped connector bar 32. The U-shaped connector bars 30 and 32 are secured to the sides 22 and 24 of chute 4 so that the curved portions extend normal to the sides 22 and 24, thus providing space inside the curved portions to allow passage of a component with leads down the chute 4. Only one U-shaped connector is shown in Fig. 1, but more may be used to provide a more rigid chute if deemed necessary.

The sides 22 and 24 of chute 4 are maintained a spaced distance from each other by means of a mounting bracket 34 (see Fig. 2) and a lower attaching bracket 36. The mounting bracket 34 is secured to the sides 22 and 24 near the midportion of the chute and the attaching bracket 36 is secured to the lower end of the sides 22 and 24. The length of the mounting bracket 34 and the attaching bracket 36 is sufficient to provide a spaced relation between the sides 22 and 24 which is slightly greater than the length of the body of the components which are to be supplied through the chute. By varying the size of the mounting bracket 34 and the attaching bracket 36, the chute 4 is adaptable for receiving components of varying body lengths.

The mounting bracket 34 is secured to the sides 22 and 24 and is formed from sheet metal stock substantially rectangular in shape with a pair of arms 38 and 40 centrally located and the arms are spaced apart and bent at right angles to the plate portion. A flange 42 extending upward from the top of the plate portion between the arms 38 and 40 is also provided for engaging a magnet 136 (see Fig. 20) on the frame 70 to fasten the upper portion of the chute to the frame 70. Holes 44 and 46 of bracket 34 are provided for securement of the bracket to the sides 22 and 24 of the chute 4.

The attaching bracket 36 is secured to the sides 22 and 24 at the lower end of the magazine 4 away from the machine 8 as by screws 48 and 50. The attaching plate 36 is also formed of sheet metal stock and has projecting downwardly therefrom a pair of fingers 52 and 54 which secure the lower end of the magazine 4 to the attaching tool assembly.

With the attachment of the mounting plate 34 and the attaching plate 36 to the sides 22 and 24 the magazine 4 is now complete except for structure at the lower end for the discharge of the components 2.

As seen in Figs. 7 and 8, this is accomplished by the magazine 4 having at its lower end a retainer spring 56 provided with a pair of arms 58 and 60 (Fig. 14) which project outward along the sides 22 and 24. The arms 58 and 60 extend across the spaced openings between the L shaped members 10 and 12 and 14 and 16 of the sides 22 and 24 to retain the supply of components 2 in the magazine 4.

When the magazine 4 is attached to the machine 8, the spring 56 is engaged by component guides 62 and 64 on the attaching tool 66 which move the arms 58 and 60 out of the path of the components 2. The forward edge 17 of the lower end of the magazine 4 is cut back so that the distance between its bottom surface 19 and the top surfaces 61 and 63 of the component guides 62 and 64 permit the passage of the leads 5 and 7 of the lowermost component 3 from the chute 4.

The component guides 62 and 64 which engage the spring 56 to release the supply of electrical components 2 are a part of the attaching tool shown generally at 66 of Fig. 5.

Referring now to Fig. 1, the attaching tool 66 is a complete assembly in itself and may be removed or attached to the machine with a minimum amount of time and effort. The attaching tool 66 is secured to the vertical face 68 of an upright frame 70. The frame 70 is mounted at its end 71 opposite the attaching tool 66 to a base casting 72. The base casting 72 is provided with a smooth planar top surface 73.

In Fig. 20 a mounting plate 74 is provided for the positioning and securing of the attaching tool 66 to the frame casting 70. The mounting plate 74 is attached to the face 68 of the frame casting 70 as by screws 76. The mounting plate 74 is provided with a centrally located opening 78 into which projects a laterally extending locking arm 80. The locking arm 80 is rotatably mounted in a suitable bracket 82 which is attached to the mounting plate 74. The end of the locking arm 80 projecting into the opening 78 is provided with a crosspin 84.

In Figs. 4 and 11 a bracket 86 is attached to the rear of tool plate 88. The bracket 86 is provided with a camming surface 90 to be engaged by the crosspin 84 of the locking arm 80 when the crosspin is rotated. The crosspin 84 enters the bracket through the opening 92 and engages the detent notches 94 and 96 when the locking arm 80 is turned counter-clockwise. To release the attaching tool the locking arm 80 is given a turn clockwise to disengage the crosspin 84 from the detent notches 94 and 96.

To accurately position and align the attaching tool 66 in relation to the mounting plate 74, a pair of laterally extending pins 98 and 100 are mounted on the face of the mounting plate 74. Openings 102 and 104 in the tool plate 88 mate with pins 98 and 100 when the attaching tool 66 is fastened to the mounting plate 74 by locking arm 80.

This provides a quick release and locking means for the attaching tool 66 which enables an operator to utilize one such tool for one size component, then quickly remove the tool and replace it with another for a different component size by the simple action of turning the locking arm.

To actuate the attaching tool 66, as in Figs. 1 and 20, an air cylinder 106 is mounted on frame 70 superjacent the attaching tool 66. The air cylinder 106 is provided with a movable piston 108 having a rod 110. The piston rod 110 is provided with a flange 112 which is engaged by a connector block 263 (see Fig. 21) secured to pusher rod 260 by a pin 262. The flanged end 112 of the piston rod 110 is in engagement with the connector block 263 while the attaching tool 66 is secured to the mounting plate 74. However, when the attaching tool 66 is released by turning locking arm 80, it is possible to slidably disengage the connector block 263 from the flange 112 as the attaching tool 66 is removed.

To further clarify the attachment of the attaching tool 66 to the mounting plate 74; the attaching tool 66 is placed against the mounting plate 74 with the tool plate 88 in engagement therewith and the locating pins 98 and 100 enter openings 102 and 104. At the same time the connector block 263 is slidably engaged with the

flanged end 112 of the piston rod 110. When this is accomplished, the cross-pin 84 and the locking arm 80 may be turned, thereby securing the cross-pin 84 in the bracket 86, to complete the attachment of the attaching tool. Thus the attaching tool is attached to an actuating means.

Before describing the operation of the attaching tool 66, the method of attaching the component feeding chute 4 to the machine 8 will be described.

Referring to Figs. 1, 5, and 9, there is located on the lower surface of the forward edge of the attaching tool 66 a T shaped metal plate 116. The T shaped plate 116 extends outwardly from the forward edge of the attaching tool 66 and serves as a support and positioner for the lower end of chute 4. Above the plate 116 are the component guides 62 and 64 so spaced to permit the body of a component to pass between the guides, the spaces between guides depending, of course, upon the size of the component that is to be supplied by the chute 4.

The component guides 62 and 64 are mounted vertically to the sides of mounting blocks 118 as best seen in Fig. 9 such as by screws 120. The mounting blocks 118 in turn are secured to a horizontal support plate 122. The top surfaces of the component guides 62 and 64 are provided with inclined surfaces 124 and 126. The edges 128 and 130 (Figs. 5 and 7) of the component guides 62 and 64 are substantially vertical and engage the spring 56 of the chute 4 when it is in position for attachment.

The top surface 67 of the frame 70 on which the air cylinder 106 is mounted extends forward of the attaching tool 66. A permanent magnet 136 (Fig. 20) is mounted on plate 138 to the vertical face 134 of the frame 70. The magnet 136 is not herein described in detail but may be of any type available that provides sufficient attraction to attract the mounting bracket 34 thereto when the chute 4 is in feeding position.

To attach the chute 4 to the machine 8, the attaching plate 36 is placed in engagement with the T plate 116 so that bifurcated fingers 52 and 54 engage portion 57 of the T plate 116. The upper end of the chute 4 is then swung forward until the mounting bracket 34 is attracted to the magnet 136 with the fingers 38 and 40 projecting along the sides of the magnet 136 to positively position the chute 4.

When the chute 4 is attracted by the magnet 136, the component guides 62 and 64 engage the spring 56 and move its arms 58 and 60 out of the path of the leads of the component 2 thereby permitting the lowermost component 3 to fall from the chute 4 and onto the component guides 62 and 64.

The component guides 62 and 64 as previously stated are centrally located on the support plate 122. The support plate 122 is attached to the forward lower edges of side braces 144 and 146 which extend outward from the sides of the tool plate 88 of the attaching tool 66.

In Fig. 9, mounted to the opposing sides of the component guides 62 and 64 on the support plate 122 are metallic shear blocks 140 and 142. The shear blocks are elongated and have projecting surfaces 148 and 150 which extend above the top edges of the component guides 62 and 64.

The respective inside edges of the shear blocks 140 and 142 in conjunction with the inside edges of surfaces 148 and 150 provide shearing edges against which the leads 5 and 7 of the component 3 are cut to the desired length.

Shear blades 152 and 154 are rotatably mounted in openings 156 of the shear blocks by laterally extending shafts 162. The ends of the shafts 162 (Fig. 12) are provided with a tongue 164 which extends outward from the ends of the shafts and is provided with a tapped hole 166.

Connected to the ends of the shafts 160 and 162 such as by screws 174 are connecting arms 168 and 170 which are provided with mating grooves 172 that engage tongues 164. The opposite ends of the arms 168 and 170 have openings 176 and 178 which are connected to the tool body 196 of the attaching tool 66 as will later be described.

Referring again to the shear blades 152 and 154. The shear blades 152 and 154 are substantially circular in shape except for cutaway portions 180 and 182. The cutaway portions 180 and 182 have vertically extending edges 184 and 186 and are in horizontal alignment with, but slightly below the top surfaces of the shear blocks 140 and 142.

The vertical edges 184 and 186 of the shear blades 152 and 154 are somewhat offset from the projecting surfaces 148 and 150 of the shear blocks 140 and 142 and provide gaps 187 and 188 therebetween.

As previously stated, the lowermost component 3 is released from the chute 4 and its leads 5 and 7 are supported on the component guides 62 and 64 which have downwardly sloping edges 124 and 126. On the opposing sides of the component guides 62 and 64 are upwardly projecting surfaces 148 and 150 of the shear blocks 140 and 142 which stop the leads 5 and 7 of the component 3 at a preset distance away from the body of the component 3. As previously described, the component guides 62 and 64 slope downward along their top surfaces 124 and 126 and the top edges of the shear blades 152 and 154 do not extend above these surfaces. It is seen that at the time the component 3 is stopped by the projecting surfaces 148 and 150, the leads 5 and 7 are located directly in the gaps 187 and 188.

Thus as the connecting arms 168 and 170 are moved downward by the attaching tool 66, as will be described later, the shear blades 152 and 154 are rotated clockwise to shear the leads 5 and 7 against the vertical projecting surfaces 148 and 150 of the shear blocks 140 and 142. The sheared ends of leads 5 and 7 are given relative movement by the cutting action of the shear blades 152 and 154 and drop to the sides of the attaching tool 66 while the component 3 moves down the component guides 62 and 64 (Fig. 5) resting on leads 5 and 7 and is received on the arms 191 and 193 of an anvil 190 which supports the leads 5 and 7 for the bending operation.

Before detailing the lead bending operation, the circuit board 332 (Fig. 15) to which the component 3 is attached will be described, as well as the magnetic card holder 330 (Fig. 17) which supports and positions the board 332 in an attaching position beneath the attaching tool.

The circuit board 332 as seen in Figs. 15 and 16 is formed of a non-conducting material and is provided with holes 334 and 336 through which a portion of the component leads 5 and 7 extend after insertion through the board. The underside of the board 332 is provided with metallic conductors 338 between the holes 334 and 336 to form the circuitry of the board. As will be noted the holes 334 and 336 in the board 332 are not positioned in any particular geometric pattern with respect to the other holes 342 and 344 to which other components will be attached. This is typically true of circuit boards, as the positioning of the components on the board will vary, depending upon the circuitry of the board, the size of the components, and the number of components to be attached to a particular size circuit board.

With the previous statements in view it thus becomes apparent that a means is necessary for properly positioning the board 332 in relation to the attaching tool 66 so that the component can be attached in a desired position. For this purpose the machine 8 is provided with a magnetic board holder 330.

In Fig. 17, the magnetic board holder 330 comprises an L-shaped top plate 346 attached to the electromagnets 348 and 350. The electromagnets 348 and 350 are

formed of soft iron cores 352 and 354 surrounded by phenolic insulators 358 (Fig. 18). The phenolic insulator 358 is provided with a sleeve 360 and opposing vertical end plates 362. The sleeves 360 of the insulators 358 are inserted over the cores 352 and 354 and approximately 8000 turns of wire are wound around them to form the coils of the electromagnets. The ends of the core 352 are secured to metal end blocks 364 which are secured to the lower surface 369 of the top plate 346 by screws 365. These screws also act as set screws to retain the core 352 in position. The core 354 is somewhat longer, however, and its end 363 extends outward beyond the end plate 366 which secures it by a screw 367 to the bottom surface 369 of the end of the top plate 346. Its opposing end is likewise journaled in an end plate 366 and is secured to the bottom surface 369 of the top plate 346 by another set screw 367.

Around the end 363 of the core 354 is clamped an arm 370 extending normal to the core 354 and parallel to the core 352. The arm 370 rests on the base 73 and is clamped to the core 354 by a pinch block 372 having an opening 374 which allows the block 372 to slide over the core 354. The block 372 is also provided with a lateral slot 376 connected to opening 374, through which a thumb screw 378 extends downwardly through a clearance hole 380 and is threaded into the arm 370. By tightening the thumb screw 378 which bears against the top surface 377 of the pinch block 372, the lateral slot 376 is moved toward closure and the opening 374 is reduced to tighten the block against the core 354. Thus lateral adjustment of block 372 along core 354 is made possible by the adjustment of screw 378.

Also mounted on arm 370 at one end thereof is a board guide 382. The board guide 382 is supported on arm 370 by a spacer 384 and a thumb screw 386. The thumb screw 386 is threaded at its lower end into the arm 370 for securing, retaining, and adjusting the board guide 382 relative to arm 370.

Opposite the board guide 382 beneath the longitudinal edge 343 of the top plate 346 is a board guide 390 which is suspended beneath the top plate 346 by vertical wall 391 and is retained by screws 392 to the top plate 346. The board guide 390 has a circuit board support surface 394 in alignment with a horizontal support surface 396 on the board guide 382. It is surfaces 394 and 396 which support the circuit board 332 beneath the attaching tool 66.

Immediately below the forward edge of the top plate 346 parallel to the core 354 is board guide 378 having a guide surface 400 which is in horizontal alignment with the board guide 382 and board guide 390.

Immediately above the board support surface 394 secured to the vertical wall 391 is a longitudinal guide member 402. The guide member 402 is spaced above the supporting surface 394 to form an opening 404 therebetween. The opening 404 is sufficiently wide and permits the thickness of the board 332 to pass therethrough when it is supported on the supporting surface 394.

The board guide 382 opposite the guide 390 is also provided with a longitudinally extending opening 406. The opening 406 is of the same size as the opening 404 and is formed by a centerplate 408 interposed between a cover plate 410 and a support plate 412. The centerplate is retained between the cover plate 410 and the support plate 412 by screws 411. The centerplate is also provided with a recessed central portion 413 to allow the positioning of a spring 416, retained to the support plate 412 by pins 418 and 420. The spring 416 has rounded forward projecting surfaces 422 and 424 which bear against the edge of an inserted board 332 in opening 402 and the opposite edge of the board bears against side wall 391 of the slot 406. During insertion of the board 332 into slots 404 and 406 it is pushed forward until the forward edge is supported in the board guide 378. The board 332 when inserted depresses plunger 426 of a microswitch 428 which is supported beneath the top plate 346 by screws 430 and 432. The plunger 426, as shown in Fig. 17, extends forward of the board guide 378 into the path of the board 332, and upon depression actuates the machine 8 as will be described hereinafter.

The magnetic board holder 330 slides on surface 73, so that when it is not energized it may be moved to any position relative to tool 66. The electromagnets 348 and 350 of board holder 330 are connected in series and when the magnets are energized (as will later be described) the board 330 is in effect locked in position on surface 73.

Referring now to Fig. 3, the attaching tool 66 is mounted as hereinbefore described to the frame 70 and includes a pair of bending fingers 192 and 194 which project downward to bend the leads 5 and 7 of the component 3 and insert them into holes 334 and 336 of the circuit board 332.

The positioning of the magnetic board holder 330 and the circuit board 332 may be accomplished prior to the attachment of the supply chute 4 to the machine 8. Each time the attaching tool 66 is energized it moves downward and the lowermost component 3 is fed from the chute 4 and the leads of the component are sheared of any excess lead length. Following the shearing, the component moves to the support arms 191 and 193 of the supporting anvil 190. Then the leads 5 and 7 of the component 3 are engaged by the bending fingers 192 and 194 of the attaching tool 66 to bend the leads of the component and carry it downward to insert the bent leads 5 and 7 into holes 334 and 336 of the circuit board 332. However, if the board 332 is not properly positioned and the holes 334 and 336 are not in alignment with the leads 5 and 7 of the component 3, the board holder 330 must be moved on surface 73 until the proper alignment of bent leads and circuit board holes is achieved.

A switch panel 512 (Fig. 1) is mounted on frame 70 for controlling the operation of the machine 8 to be described later.

In order that the circuit board 332 and the magnetic board holder 330 be positioned beneath the attaching tool 66, the contact arm 514 is moved to the "Set" position. When the contact arm 514 is moved from the "Off" position to the "Set" position, no energization of the electromagnets occurs; however, a solenoid valve 532 is energized, and air is admitted through a supply line 544 to the upper end of the air cylinder 106 to force the piston 108 to overcome the pressure of the return spring 107 and the piston rod 110 moves downwardly. The bending fingers 192 and 194 are thereby moved until they rest against the top surface of the circuit board 332. The bending fingers 192 and 194 merely touch the circuit board 332 and do not apply pressure thereagainst, and with the bending fingers touching the circuit board 332 the position of the magnetic board holder 330 and board can be changed until the holes 334 and 336 of the circuit card 332 are in visual alignment with the grooves 244 of the bending fingers.

With the circuit board 332 properly placed in the magnetic board holder 330 and the holes 334 and 336 in alignment with the grooves 244 of the bending fingers 192 and 194, the contact arm 514 is moved to the "Off" position causing deenergization of solenoid valve 532 and air is vented from the air cylinder 108 through an air line 545 and noise filter 546 so that the piston rod 110 is returned upwardly by the return spring 107. As the piston rod 110 moves upwardly, the bending fingers 192 and 194 of the attaching tool 66 are also carried upwardly. The circuit board 332 is removed from the magnetic board holder 330 and the contact arm 514 is moved to the "Run" position. This energizes the electromagnets 348 and 350 which secures the magnetic board holder 330 in proper position.

When the contact arm 514 is in the "Run" position the machine is operated each time a circuit board is inserted

into magnetic board holder 330 to depress contact 426 of microswitch 428.

As previously described, air admitted to the air cylinder 106 forces the piston 108 to overcome the pressure of a return spring 107 to move the piston rod 110 downwardly, thereby moving bending fingers 192 and 194 of the attaching tool 66 downwardly also. The grooves 244 of the bending fingers 192 and 194 engage the leads 5 and 7 of the component 3 which is supported on the anvil 190 and bends them at right angles to their original axis. The anvil 190 is then moved out of the path of the component 3 (as will be described in detail later) and the component 3 is carried downward by the bending fingers 192 and 194 and its leads 5 and 7 are inserted into holes 334 and 336 of the circuit board 332.

When the leads 5 and 7 of the component 3 have been inserted into the holes 334 and 336 of the circuit board 332 the piston rod 110 has reached the end of its travel. The piston 108 moves past an orifice 109 in the lower end of the air cylinder 106 and the air pressure is vented through orifice 109 and a supply line 447 to the lower end of an air cylinder 440 of a crimping assembly 434.

The crimping assembly 434 and the air cylinder 440 are attached to surface 73 of the base 72, and are beneath a positioned circuit board.

Referring now to Fig. 6, the air cylinder 440 contains a piston 442 and piston rod 444. As air is admitted to the lower portion of the air cylinder 440 beneath the piston 442, the piston rod 444 engages at its upper end a pair of crimping fingers 446 and 447 which move upwardly between the leads to crimp a portion of them to the underside of the circuit board 332.

As the piston rod 444 reaches the end of its upward travel the piston 442 engages the lower end of a vertical pin 443 which extends downwardly through an opening 447 in the top 445 of the air cylinder 440. The movement of the piston 442 moves the pin 443 into engagement with a switch 576 (see Fig. 19). This moves the switch 576 away from its normally closed contact which is in circuit with the solenoid valve 532. The switch 576 upon breaking the circuit to the solenoid valve 532 engages its other contact 533 which produces a flow of current through connection 578 to a relay 581. When the relay 581 is energized it opens the switch 577 and closes a normally open switch 582 which through connection 584 provides a return line through switch 428 to the connection 566.

However, as the circuit is broken to the solenoid valve 532 by the movement of the switch 576, the air flow which is supplied to the air cylinders 106 and 440 is reversed by the retraction of the solenoid valve 522, and is vented through connection 545 through the noise filter 546.

As the air pressure is released through the noise filter the piston 108 and the piston rod 110 of the upper air cylinder 106 are returned to a normally upward position by the return spring 107 thus retracting the attaching tool 66 to a position above the circuit board 332.

Likewise the piston 442 and the piston rod 444 of the lower air cylinder 440 move downward moving the crimping fingers 446 and 447 away from the circuit board 332.

As the piston 442 moves downward the pin 443 which has moved the switch 576 into engagement with contact 533 moves downward causing the switch 576 to again move to its normally closed position in circuit with the solenoid valve 532.

The circuit to the relay 581 is still complete through the switch 582 and the connection 584, however, which retains the switch 577 in an open position prevents recycling of the solenoid valve 532. Upon removal of the circuit board 332 from the magnetic board holder 330 the switch 428 is opened thus breaking the circuit to the relay 581, causing switch 582 to open and switch 577 to move to its closed position in circuit with the solenoid valve 532.

As should be apparent at this point, upon the insertion of another circuit board in the magnetic board holder 330, the machine will again repeat the previously described cycle to attach a component thereto.

Now to describe the attaching tool 66 of Figs. 3 and 5. When the component 3 is in position on the anvil 190 as seen in Fig. 3, the leads 5 and 7 are ready to be bent at right angles to the component axis and attached to the circuit board 332. To accomplish the bending, the attaching tool 66 includes a pair of slidably mounted bending fingers 192 and 194 which engage the leads 5 and 7 of the component 3. The tool body 196 is slidably mounted on the face of the tool plate 88 by a pair of vertically extending beveled guide rails 198 and 200. The guides 198 and 200 extend above the top surface 202 of the tool body 196 and are provided with vertically extending studs 204 and 206. The studs 204 and 206 are threaded at upper ends 212 and 214.

As seen in Fig. 4 the tool body is retained to the vertical face of the tool plate 88 by a pair of beveled gibs 216 and 218. Horizontal stop plates 220 and 222 are mounted to the upper ends of the beveled gibs 216 and 218 and are provided with holes 205 (Fig. 5) through which the studs 204 and 206 extend.

After securing the gibs 216 and 218 to the tool plate 88 the beveled guides 198 and 200 are slidably engaged with the beveled surfaces of the gibs 216 and 218 by inserting the tool body 196 upward from the lower end of the tool plate 88. The studs 204 and 206 enter the holes 205 of the stop plates 220 and 222 and are retained therein by suitable stop nuts 226 and 228. By releasing the lower end of the tool body 196 it slides downward until the stop nuts 226 and 228 bottom against the stop plates 220 and 222 to limit its downward travel. By adjusting the stop nuts 226 and 228 the amount of downward travel of the tool body 196 may be controlled. As seen best in Fig. 5 the tool body 196 is supported in its uppermost position by a pair of springs 230 and 232. The springs 230 and 232 are located along the vertical axis of the tool plate 88 and are retained thereto by a spring retainer 34. The springs 230 and 232 extend downward between the beveled guides 198 and 200 as seen in Fig. 4 and are retained at the lower edge of the guides by a pin 234 which rests in a slot 236. The tension of the springs 230 and 232 is sufficient to lift the tool body 196 upward until the top surfaces of the beveled guides 198 and 200 contact the lower surfaces of the stop plates 220 and 222 as seen in Fig. 3.

The previously mentioned bending fingers 192 and 194 are positioned in grooves 193 and 195 (Fig. 27) on face 197 of the tool body 196. The grooves 193 and 195 are spaced apart and converge inwardly at the lower end of the tool body 196.

The bending fingers 192 and 194 are identical and are formed of a bar stock material. The bending fingers 192 and 194 are provided at their upper ends with transverse slots 238 and 239 which are machined along the front and back surfaces. When the fingers are inserted into the grooves 193 and 195 of the tool body 196 the slots 238 and 239 are substantially horizontal with its top surface 202.

The lower ends of the bending fingers 192 and 194 are provided with vertical faces 240 and 242 which are located normal to the transverse slots 238 and 239 and face inward toward each other on opposite sides of the anvil 190. The fingers 192 and 194 are also provided with concave grooves 244 which extends upward along the length of the vertical faces 240 and 242.

The bending fingers 192 and 194 are releasably retained at their upper ends by a yoke 248. The yoke 248 comprises a horizontal plate 250 provided with a bushing 252 centrally mounted on the top surface. As seen in Fig. 5 the yoke 248 is provided on each side of the bushing 252 with elongated openings 254 and 256 which engage slots 238 and 239 on the upper ends of the bending fingers

192 and 194. The bushing 252 of the yoke 248 is provided with a vertical opening 258 through which extends a pusher rod 260. The pusher rod 260 is provided at its extreme upper end with a connector 263, having a horizontal grooved slot 264. The connector 263 is secured to the pusher rod 260 such as by a pin 262. Surrounding the pusher rod 260 between the lower surface 266 of the connector 263 and the top surface 268 of the bushing 252 is a compression spring 270.

Immediately below the lower surface 272 of the yoke 248 at a preset distance away from the connector 262 is a stop pin 274. The stop pin 274 is retained on the pusher rod 260 and supports the yoke 248 which is pressed downward against it by the compression spring 270.

The lower end of the pusher rod 260 extends downwardly below the yoke 248 and is provided with a flat vertical face 276. The vertical face 276 ends just short of lower end 278 of the pusher rod 260 and a horizontal flange 280 is provided thereon and extends somewhat forward of the vertical face 276. The lower end 278 of the pusher rod 260 is also provided with a pusher block 282 and a pusher pin 284 which will be described in detail later in the specification.

As stated earlier the bending fingers 192 and 194 are positioned on the front vertical face 197 of the tool body 196 and are engaged at their upper ends by the yoke 248. The pusher rod 260 which extends downwardly through the bushing 252 of the yoke 248 is received in a vertical guide slot 286 between the grooves 193 and 195 which serve to position and guide the bending fingers 192 and 194. The pusher rod 260 and the bending fingers 192 and 194 are retained in their respective positions on the tool body 196 by the provision of a cover plate 287 which is secured to the vertical face of the tool body 196. Thus the pusher rod 260 and the bending fingers 192 and 194 are slidably retained between the cover plate 286 and the tool body 196.

As mentioned earlier in the specification the connector 263 on the upper end of the pusher rod 260 is slidably engaged with the flanged end 112 of the piston rod 110. The piston rod 110 which is connected at its upper end to the piston 108 of the air cylinder 106 is biased in an upward position by a return spring 107.

The return spring 107 supports the piston 108 in a normally upward position and the stop pin 274 on the pusher rod 260 lifts the yoke 248 upwardly also. As the yoke 248 is retracted upward, the bending fingers 192 and 194 which are slidably connected thereto at their upper ends are carried upward until the flanged lower end 280 of the pusher rod 260 engages the lower surface of the cover plate 287. The stop pins 247 and 249 move away from the top surface of the tool body 196 as the yoke 248 is retracted upward and the springs 230 and 232 retract the tool body 196 upward until the top surfaces of the beveled guides 198 and 200 (Fig. 3) are in contact with the lower surface of stop plates 220 and 222.

The tool body 196 is normally retained upward against the stop plates 220 and 222 and is provided with vertically extending transverse slots 288 and 290 which extend upward from its lower surface. As seen in Fig. 5 it is into these slots 288 and 290 that the connecting arms 168 and 170 of the shear blades 152 and 154 extend, and are rotatably retained therein by pins 292. As the tool body 196 is moved downwardly pressure is applied against the connecting arms 168 and 170 by the pins 292 causing the arms to move downwardly. As the connecting arms 168 and 170 move downwardly the shear blades 152 and 154 are rotated toward the shear blocks 148 and 150 to shear the leads 5 and 7 of the component 3.

As the leads 5 and 7 of the component 3 are sheared to the desired length, the component rolls down the inclined surfaces 124 and 126 of the component guides 62 and 64 and is received on an anvil 190. The anvil 190 (Fig. 3) is centrally mounted on an anvil carrier 294 by screws 297 and 299. The anvil 190 extends outwardly normal to the anvil carrier 294 and includes supporting arms 191 and 193 which support the leads of a component when it is in position for bending. The anvil carrier 294 is U-shaped with outwardly extending arms 300 and 302 and vertical side plates 304 and 306. The anvil carrier 294 is also provided with beveled cam surfaces 310 and 312 on its extreme lower ends.

The anvil carrier 294 is positioned between the tool body 196 and the tool plate 88. Pins 314 and 316 support the anvil carrier 294 on arms 300 and 302 when the tool body 196 is urged upwardly by the springs 230 and 232. When the anvil carrier 294 is in the up position a pair of projecting pins 315 and 317 on the lower front face of the tool plate 88 engages the cam surfaces 310 and 312 forcing the support arms 191 and 193 of the anvil 190 forward into abutment with the forward vertical face of the component guides 62 and 64 (Fig. 5). When, however, the tool body 196 moves downward, the arms 300 and 302 are no longer supported by pins 314 and 316 and therefore the anvil carrier 294 moves downward. As the anvil carrier moves downward the pins 315 and 317 on the tool plate 88 slide over the inclined cam surfaces 310 and 312 and the anvil 190 moves slightly rearward permitting the leads 5 and 7 of the component 3 to pass therethrough. The anvil carrier 294 is stopped, however, after the pins 315 and 317 have moved near the edges of the inclined cam surfaces 310 and 312 by stop lugs 318 and 320 which extend outward beneath the tool plate 88.

Before describing the operational sequence of the attaching tool 66, it is to be realized that a component must be in a component attaching position on the supporting anvil 190 as indicated by the component 3*a* of Fig. 5. Since the lowermost component has not yet reached this position, the insertion of the first circuit board does not produce a completed board. The insertion of the circuit board does, however, sequence the attaching tool 66, shearing the leads of the lowermost component. The component then free of the shear blocks 140 and 142 rests on the inclined surfaces 124 and 126 of the component guides 62 and 64, and against the cover plate 287. As the tool body returns to its uppermost position the component rolls down the inclined surfaces 124 and 126 and is received on the supporting anvil 190 in a component attaching position. Thereafter each insertion of a circuit board effectuates the attachment of a successive component.

Referring now to Figs. 3, 21, 22, 23, 24, and 25 to show the sequential operation of the attaching tool 66, after a circuit board is inserted, air is admitted to the upper air cylinder 106 and the piston rod 110 is forced downwardly against the pusher rod 260. At this time the fingers 192 and 194 are immediately above leads 5 and 7 of the component 3 which is supported on the anvil 190. As the pusher rod 260 moves downward the spring 270 is of sufficient strength to carry the yoke 248 downward. The bending fingers 192 and 194 are pushed downward by the yoke 248 and are guided in their guide slots 193 and 195 on the tool body 196. The concave grooves 244 on vertical faces 240 and 242 of the bending fingers 192 and 194 engage the leads 5 and 7 of the component 3 as the bending fingers 192 and 194 move exterior of the side surfaces of the supporting arms 191 and 193 of the anvil 190, bending a portion of the leads 5 and 7 downward at right angles to their original axis.

The pusher rod 260, the yoke 248 and the bending fingers 192 and 194 at this point have moved downward until a pair of vertically extending adjustable stop pins 247 and 249 on the cross member 250 of the yoke 248 engage the top surface 202 of the tool body 196. The pusher rod 260 has at this time engaged the pusher block 282 with the body of the component 3.

Continuous pressure by the connector 262 against the spring 270 causes the yoke 248 and the stop pins 247 and 249 to continue moving downward carrying the tool

body therewith. As the tool body 196 moves downward the pins 314 and 316 which support the anvil carrier 294 also move downward permitting the anvil carrier 294 to drop.

The anvil carrier 294, no longer supported by the pins 314 and 316, permits the pins 315 and 317 on the tool plate 88 to slide over the cam surfaces 310 and 312 on the anvil carrier 294.

As the pins 315 and 317 slide over the cam surfaces 310 and 312 an opening 313 is created between the forward vertical face of the anvil 190 and the component guides 62 as seen in Fig. 9.

The continuing downward movement of the yoke 248 and the tool body 196 permits the pusher block 282 and the bending fingers 292 and 294 to carry the component 3 and its leads 5 and 7 through the opening 313 and downward to the circuit board 332.

The anvil 190 and the anvil carrier 294 are stopped by stop lugs 318 and 320.

The tool body 196 continues downward until the stop nuts 226 and 228 on the studs 204 and 206 engage the stop plates 220 and 222 on the upper end of the gibs 216 and 218.

When the tool body 196 is stopped by the stop plates 220 and 222, the bending fingers 192 and 194 have positioned the leads 5 and 7 of the component 3 above the openings 334 and 336 of the circuit board 332. The bending fingers 192 and 194 have also reached their downward-most position and continuous pressure against the pusher rod 260 causes the spring 270 to be compressed. As the spring 270 is compressed the pusher rod 260 continues to move downward causing the pusher block 282 to push against the body of the component 3 freeing the leads 5 and 7 from the grooves 244 of the bending fingers 192 and 194 and inserting them into the holes 334 and 336 of the circuit board 332.

The pusher block 282 and the pusher pin 284 are slidably retained in an opening 586 in the lower end of the pusher rod 260.

The pusher pin 284 extends upward into the opening 586 and is retained therein by a laterally extending pin 587. The pin 587 extends through a guide slot 588 in the pusher pin 584. In opening 586 is a compression spring 589 which biases the pusher pin downward until the upper end of the slot 588 rests against the pin 584.

The pusher block 282 when inserting the leads 5 and 7 of the component 3 causes the pin 584 to move upwardly in the opening 586 as the pusher rod 260 moves downward and compresses the spring 589 (See Fig. 20). This prevents injury to the component 3 during its insertion into the circuit board 332.

When the leads 5 and 7 of the component 3 have been inserted in the openings 334 and 336, a lead crimping assembly 434 moves upwardly to bend a portion of the leads 5 and 7 beneath the circuit board 332. The crimping assembly 434 (Fig. 6) is mounted directly beneath the bending fingers 192 and 194 of the attaching tool 66 and is secured to the top surface 73 of the base 72 by a circular top plate 436 by screws 438. The screws 438 which secure the top plate 436 to the top surface 73 of the base 72 also support and retain an air cylinder 440. The air cylinder 440 is provided with a piston 442 and an upwardly extending piston rod 444. The upper end of the piston rod 444 has detachably mounted thereto a pair of crimping fingers 446 and 447.

The fingers 446 and 447 are retained to the piston rod 444 opposite each other along the vertical side surface of the piston rod head 448. The head 448 of the piston rod 444 is somewhat larger in diameter than portion 445 and provides a shoulder 450 (Fig. 3) at its lower end.

The crimping fingers 446 and 447 when positioned on the head 448 have at their lower ends tangs 452 and 454 which extend forward of their inside vertical faces 451 and 453 and have forward projecting horizontal surfaces 456 and 458. The horizontal surfaces 456 and 458 engage the shoulder 450 when the fingers are positioned on the head 448. The lower ends of the tangs 452 and 454 blend into a radii 455 which extends from the forward tip of their horizontal top surfaces outward to the outside vertical edges 460 and 462 of the crimping fingers 446 and 447. The crimping fingers 446 and 447 are formed of somewhat flat material and are provided at their lower ends with vertical slots 464 and 466.

When the crimping fingers 446 and 447 are positioned against the vertical surface of the head 448 their lateral positioning is governed by a slot 468 in the top plate 436. The fingers are releasably retained at their lower ends by a pair of locking pins 470 and 472, which extend into slots 464 and 466. The locking pins 470 and 472 are guided toward the slots 464 and 466 by openings 474 and 476 in the vertical sidewall 478 of the upper end of the air cylinder 440.

The locking pins 470 and 472 are secured at their ends by a crosspin 482 located in block 480. Connected to the body block 480 by a threaded end 484 and a lock nut 486 is a connecting arm 488.

The connecting arm 488 extends laterally beneath the top surface 73 of the base 72 and extends through an opening 489 in a forward vertical wall 451. A knob 490 is provided on arm 488 exterior of the vertical wall 451. Pulling outwardly on the knob 490 the connecting arm 488 retracts block 480 and causes the locking pins 470 and 472 to move from the slots 464 and 466. By pushing forward on the knob 490 the locking pins once more enter the slots 464 and 466 of the crimping fingers 446 and 447. To retain the locking pins 470 and 472 in engagement with the slots 464 and 466 and to prevent their accidental release therefrom, the connecting arm 488 is provided with a circular groove 492 which is engaged from above by a ball and spring assembly 494. As the connecting arm 488 is pushed forward to engage the locking pins 470 and 472 in the slots 464 and 466 the ball and spring assembly 494 is retained by the ball in the groove 492. However, when the connecting arm 488 is retracted the ball and spring 494 is forced out of the groove 492 until the locking pins 470 and 472 are again engaged with the slots 464 and 466.

The crimping fingers 446 and 447 are provided at their upper portions with bending surfaces 496 and 498 which are inclined downwardly to a point directly above the vertical axis of the head of the piston rod 444. The inner faces of the crimping fingers extend downwardly from the inclined surfaces 496 and 498, are in contact with each other and are provided at their lower ends with inclined surfaces 454 and 456. The inclined surfaces 454 and 456 rest against the beveled upper edge of the head 448 and are retained thereto by horizontal springs 502 and 504. The springs 502 and 504 extend horizontally along opposite sides of the crimping fingers 446 and 447 above the top plate 436 and are retained at the extreme outer edges of the crimping fingers 446 and 447 by dowel pins 506 and 508.

As described earlier in the specification, when the leads 5 and 7 of the component 3 have been properly inserted in the holes 334 and 336 of the circuit board 332 the piston 108 of the air cylinder 106 has opened a port 109 which admits air through the supply line 447 to the lower air cylinder 440 of crimping assembly 434.

As air is admitted to the lower air cylinder 440 the piston 442 forces the piston rod 444 upward.

As the piston rod 444 is raised, the beveled head 448 pushes against the inclined surfaces 454 and 456 of the crimping fingers 460 and 462. The crimping fingers 460 and 462 are moved upwardly until the locking pins 470 and 472 are engaged with the lower ends of the slots 464 and 466. When the locking pins 470 and 472 have reached this position the inclined surfaces 496 and 498 have moved to their uppermost position between the downwardly projecting leads 5 and 7 of the component 3.

The crimping fingers at this point are retained at the lower ends by the locking pins **470** and **474**.

Continuous pressure by the head **448** against the surfaces **454** and **456** of the crimping fingers **460** and **462** causes them to pivot outwardly at the upper ends thus bending the portion of the leads **5** and **7** against the circuit board **332**.

When a portion of the leads **5** and **7** have been crimped beneath the circuit board **332** the piston **442** in its upward movement trips the switch **576** by engaging the pin **443** and as previously described the air pressure is vented through a noise filter **546** thus returning the crimping assembly to its normal position.

When the air is vented through the noise filter **546** the piston **108** of the upper air cylinder is returned to its normal position in the upper end of the air cylinder **106** by the return spring **107**.

As the piston **108** moves upward, the piston rod **110** causes the pusher rod **260** to be retracted, carrying upward therewith the yoke **248**. The yoke **248** is lifted upward by the pin **274** moving the stop pins **247** and **249** carried thereon, away from the top surface **202** of the tool body **196**. The tool body **196** is lifted upward by the return springs **230** and **232** and by the bending fingers **192** and **194** which are moved upwardly by the yoke **248**.

The tool body **196** moves upward until the guides **198** and **200** engage the stop plates **222** on the gibs **216** and **218**.

The bending fingers **192** and **194** are retracted upward until the flange **280** on the pusher rod **260** engages the lower edge of the cover plate **287**. When the flange **280** engages the cover plate **287** the bending fingers **192** and **194** are once more positioned above the anvil **190**.

During the upward movement of the tool body **196** the pins **314** and **316** are engaged with the lower edge of the arms **304** and **306** on the anvil carrier **294** to lift it upward. As the anvil carrier **294** is lifted upward, cam surfaces **310** and **312** ride over the pins **315** and **317** on the tool plate **88** causing the anvil **190** to move forward. As the anvil **190** moves forward its support arms **191** and **193** engage the forward vertical face of the component guides **62** and **64** and are retained in engagement by the pressure of the pins **115** and **117**.

The tool body **196** has also during the upward movement, lifted the connecting arms **168** and **170** which rotate the shear blades **152** and **154** back to their normal position. The next component from chute **4** is now between the shear blades **152** and **154** and the projecting surfaces **148** and **150** of the shear blocks **140** and **142** which have retained the component by engaging its leads while the previous component **3** has been attached to the circuit card **332**.

The machine **8** is at this point, upon the removal of the circuit board **332**, in position to complete the previous cycle as herein described.

In Figs. 28, 29, 30 is shown a variation of the magazine chute of Fig. 1. The chute **600** is provided with adjustment to allow for various sizes of components. The U shaped brackets **601** (which correspond generally to those of Fig. 1) secure longitudinal members **102** and **12***a*, together to form side member **22***a* and also secure **14***a* and **16***a* together to form side member **24***a*. Adjustment between the side members **22***a* and **24***a* is facilitated by an elongated plate **602** which is secured to the forward face of the U brackets **601** by screws **603** threaded into the U brackets **601**. Retainer plates **603***a* extend transversely across the plate **202** and the screws **603** shoulder against the retainer plates **603***a* when tightened. By loosening the screws **603** the side members **22***a* and **24***a* may be moved closer or farther apart to permit the passage of a desired component between the plates. Also provided at the lower end of the chute **600** are individual mounting plates **36***a*. Thus an unobstructed adjustment is provided along the entire axis of the chute **600**.

Also disclosed in Figs. 28, 29, and 30 is a catch means **605** with a recess **606**. Said catch means **605** is adapted to pass through aperture **607** (see Fig. 34) of mounting bracket **608**. Mounting bracket **608** may be used in place of bracket **138** described in conjunction with Fig. 20. The catch means **605** in passing through aperture **607**, allows recess **606** to be engaged by clamping means **609** which secures the magazine in position in relation to bracket **608**.

For releasing catch means **605**, clamping means **609** is pivoted on pin **610** and a crossbar **611** is provided, which spreads clamping means **609** thereby facilitating the removal of the chute and catch means.

Referring now to Fig. 31, another embodiment of a detachable attaching tool is disclosed. The basic approach in the structure of Fig. 31 is to provide as much of operational equipment as possible that will be the same regardless of the size of the component to be attached, and this structure will in effect form part of the main body of the machine. This means that the cost of the detachable tool portion will be held to a minimum, for less parts will be required in the detachable portion.

Specifically, an air cylinder **612** is mounted on frame **70** as described in conjunction with Fig. 1. A piston **613** and rod **613***a* are adapted to be driven downwardly by air entering at inlet **614**. Resisting the downward movement of piston **613** is a spring **615** which is seated against piston **613** and lower member **616** of the air cylinder, provided with a vent **617**.

Press fitted into member **616** is a cylinder **618** into which rod **613***a* passes. A portion of the rod **613***b* of reduced diameter extends beyond cylinder **618**. The end of the reduced portion **613***b* is provided with a countersunk portion **613***c*, in which is located a spring **619** which acts against the countersunk portion and the end piece **620**. Surrounding the end of reduced portion **613***b* is a collar **621** which fits into supporting bar **622**.

The above described components of Fig. 31, except for bar **622**, represent the components which are in effect a permanent part of the attaching machine, i.e., they are not detachable in the sense that detachable is set out herein.

The joinder between collar **621** and the movable support bar **622** is by spring clip **623** which is secured to bar **622** and engages collar **621** at its lower flange portion. Thus the spring clip **623** allows for connection between a power means and the detachable attaching tool **624**.

The support bar **622** is provided with slots **625** and **626** to allow movement for the bending fingers **627** and **628**, as described herein above in conjunction with the bending fingers of Fig. 3. The bending fingers are guided in block **196** which is resiliently connected to back plate **88** by springs **630**, as described hereinabove.

The operation of the detachable tool of Fig. 31 begins with the downward movement of piston **613** by the admission of air into inlet **614**. A spring **631** is seated against rod **613***a* and the top portion of collar **621** and has such spring rate as to drive support bar **622** and bending fingers **627**, **628** downwardly while block **196** remains in position. Bar **622** is driven downwardly until studs **632** contact the top portion of block **196** to drive the block **196** downwardly and to allow the bending fingers to bend leads **5** and **7** of component **3** as described hereinbefore.

When the bending fingers have reached the furthest downward extent of their travel, the pusher rod **633** engages component **3** for insertion, with the upper portion of rod **633** engaging end piece **620** to cause partial compression of spring **619**.

Thus the basic operation of the structure of Fig. 31 is similar to that of the structure of Fig. 1, but with fewer components comprising the attaching tool itself.

It should be quite readily obvious to one skilled in the art, that the machine herein disclosed is not limited to the attachment of the particular component used for illustration but can be quite readily adapted to supply and as-

semble a variety of electrical components which are provided with coaxial leads.

I have in the drawings and specification presented a detailed disclosure of the preferred embodiments of my invention. It is to be understood that the invention is susceptible to modifications, structural changes and various uses falling within the spirit and scope of the invention and it is not my intention to limit the invention to the particular form disclosed but to cover all modifications and changes falling within the scope of the principles taught by my invention.

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

1. An attaching tool for electrical components including in combination, a tool plate provided with an attachment means, a tool body slideably engaging said attachment means, said tool body provided with a pair of inclined groove means converging at their lower end, bending fingers slideably located in said inclined grooves, a support bar for said bending fingers and moveable therewith, reciprocal power means attached to said support bar for moving said bar and fingers, means on said support bar for contacting said tool body to move it downwardly, component pusher means attached to said support bar and moveable downwardly therewith for engagement with said component, whereby said power means moves said fingers into contact with said component to form the leads and to push the formed leads downwardly.

2. An attaching tool for attaching electrical components provided with leads to a circuit board including in combination, a tool plate provided with an attachment means, a tool body provided with raised portions for slideably engaging said attachment means, said tool body also provided with a pair of inclined grooved surfaces converging at their lower ends, a pair of bending fingers slideably located in said grooves of said tool body, a slotted supporting bar for slideably engaging the bending fingers at their upper ends and moveable therewith, reciprocal actuating means releasably engaging said support bar for positioning said bar and fingers relative to said tool body, said actuating means moving said support bar and fingers through a first predetermined distance to engage said tool body, said support bar positioned by said actuating means engaging said tool body to move said body through a second predetermined distance, anvil means slideably mounted on said tool body to support said component and provided with inclined camming surfaces, pin means attached to said tool plate, said anvil means camming surfaces engaging said pin means to release said component when said tool body is positioned downwardly by said actuating means, said bending fingers moved downwardly by said actuating means to engage and bend said component leads supported on said anvil, a pusher means actuated by said support bar to engage said component after release by said anvil, whereby the downward positioning of the bending fingers carries the formed component to a circuit board and said pusher means completes the insertion of said component leads in said circuit board.

3. An attaching tool for attaching electrical components to a circuit board including in combination, a detachable tool plate provided with attachment means, a tool body slideable on said attachment means, resilient means connected between said tool plate and said tool body, said tool body provided on the face thereof with a pair of inclined channels, a pair of bending fingers slideably located in said inclined channels, a slotted support bar engaging the upper portions of said bending fingers and moveable therewith, pusher bar means releasably supported on said support bar means and extending substantially the same extent as said bending fingers, reciprocal actuating means detachably connected to said support bar means, said actuating means including a fluid pressure piston, a source of fluid pressure, resilient means urging said piston against said fluid pressure, resilient means on said piston for engaging said support bar means, anvil support means engaging an anvil mounted on said tool body for supporting said component, said anvil support means provided with a cam surface for engaging a projecting means on said tool body, whereby said reciprocal power means moves said support bar and bending fingers downwardly until said support bar means engages said tool body thereby moving said block and fingers to bend and form said component on said anvil, wherein continued movement of said fingers and body causes said anvil support means to move from the path of the bending fingers and said component is carried downwardly for attachment by said pusher bar means.

4. The combination of claim 3 including a pair of component guides contiguous said anvil, a pair of shear blocks located on opposing sides of said guides extending into the path of the leads of the component, a shear blade moveably mounted at each shear block and actuated by said tool body to trim the leads of said component.

5. An attaching machine for attaching electrical components to a circuit board including in combination, a main frame, an attaching tool detachably mounted on said frame, a component guide means mounted on said attaching tool for receiving components from a supply chute, shear means on said attaching tool for shearing the leads of a component when released from said supply means, said shearing means advancing said component to an anvil support means of said attaching tool, lead bending means slideably mounted on said attaching tool for bending the leads of said component after shearing, reciprocal power means for actuating said lead bending means, a board holding means holding a board subjacent the lead bending fingers, whereby actuation of said lead bending means forms said component leads and inserts said component leads in said board.

6. The combination of claim 5 wherein said board holding means comprises an electromagnetic means slideable on said frame for moving said board in a component attaching position relative to said attaching tool, and means to energize said electromagnetic means for magnetically maintaining said board holding means in a said position.

7. An attaching tool for attaching electrical components provided with leads to a circuit board including in combination, a tool plate means provided with recesses, a bending finger tool body provided with means for slideably engaging said recesses and provided with a pair of inclined slot means converging at their lower end, stop means mounted on said bending finger tool body engageable with said tool plate means, a pair of bending fingers slideably located in said inclined slots of said guide block, a slotted supporting bar engaging said bending fingers at their upper end and moveable therewith, reciprocal power means actuating said supporting bar means and said bending fingers, resilient means connecting said tool plate means and said bending finger tool body, whereby actuation of said power means moves said supporting bar and bending fingers downwardly wherein said bending finger tool body is moved to the lower extent of its travel to cause said bending fingers to form and insert the leads of an electrical component in said circuit board.

8. The combination of claim 7 wherein the reciprocal power means includes a resilient means for actuating the support bar means, a resilient component inserting bar means mounted on said supporting bar, whereby actuation of the supporting bar means moves the component inserting bar means downwardly to engage the component after said component has been formed by said bending fingers.

9. The combination of claim 7 wherein the bending finger tool body is provided with shear actuating means, a shear block support adjacent said tool plate means, a shear block mounted on said support, shearing means rotatably mounted on said shear block and actuated by

said shear actuating means when said bending finger tool body is actuated by said reciprocal power means.

10. The combination of claim 7 including an anvil member for supporting a component mounted on said bending finger tool body, said anvil member including a cam surface engageable with said tool plate means when said bending finger tool body has moved to its lower extent, thereby camming said anvil member to allow said anvil member to move from the downward path of said bending fingers.

11. An attaching tool for attaching electrical components to a circuit board including in combination, a main frame, a tool plate detachably mounted to said frame, attachment means mounted on the face of said tool plate, a tool body slideably mounted in said attachment means for reciprocal movement in relation to said tool plate, resilient means connecting said tool plate and said tool body, inclined groove means located in said tool body, bending fingers slideably mounted in said inclined groove means and adapted to move relative thereto, power means attached to said bending fingers for moving said bending fingers in relation to said component, said power means also actuating said tool body after said bending fingers have been moved, anvil means attached to said tool body for supporting said component, whereby activation of said power means moves said bending fingers and said tool body to form said component on said anvil.

12. An attaching tool for attaching electrical components to a circuit board including in combination, a main frame, a power means mounted on said frame, said power means including a fluid pressure piston means, a spring means urging against said piston means, resilient means on said piston, a tool plate detachably connected to said frame and provided with a guide means, a tool body slideably mounted in said guide means, said tool body provided with inclined grooves, a spring means interconnecting said tool plate and said tool body, a pair of bending fingers slideably mounted in said inclined grooves of said tool body, slotted bar means interconnecting said bending fingers, said resilient means on said piston acting on said slotted bar means to move said bar and bending fingers downwardly, anvil means for supporting a component in the path of said bending fingers, whereby actuation of said power means moves said bending fingers against said leads to bend and form them on said anvil.

13. The combination of claim 12 wherein said anvil is moveable from the path of said bending fingers after said bending of said component, and a resilient pusher bar means mounted on said support bar contacts said component after bending for insertion into said circuit board.

References Cited in the file of this patent

FOREIGN PATENTS

41,804 Germany ---------- Dec. 10, 1887