March 15, 1960 C. F. CARLZEN ET AL 2,928,165

COMPONENT ASSEMBLY MACHINE AND PROCESS

Filed Oct. 22, 1956 7 Sheets-Sheet 1

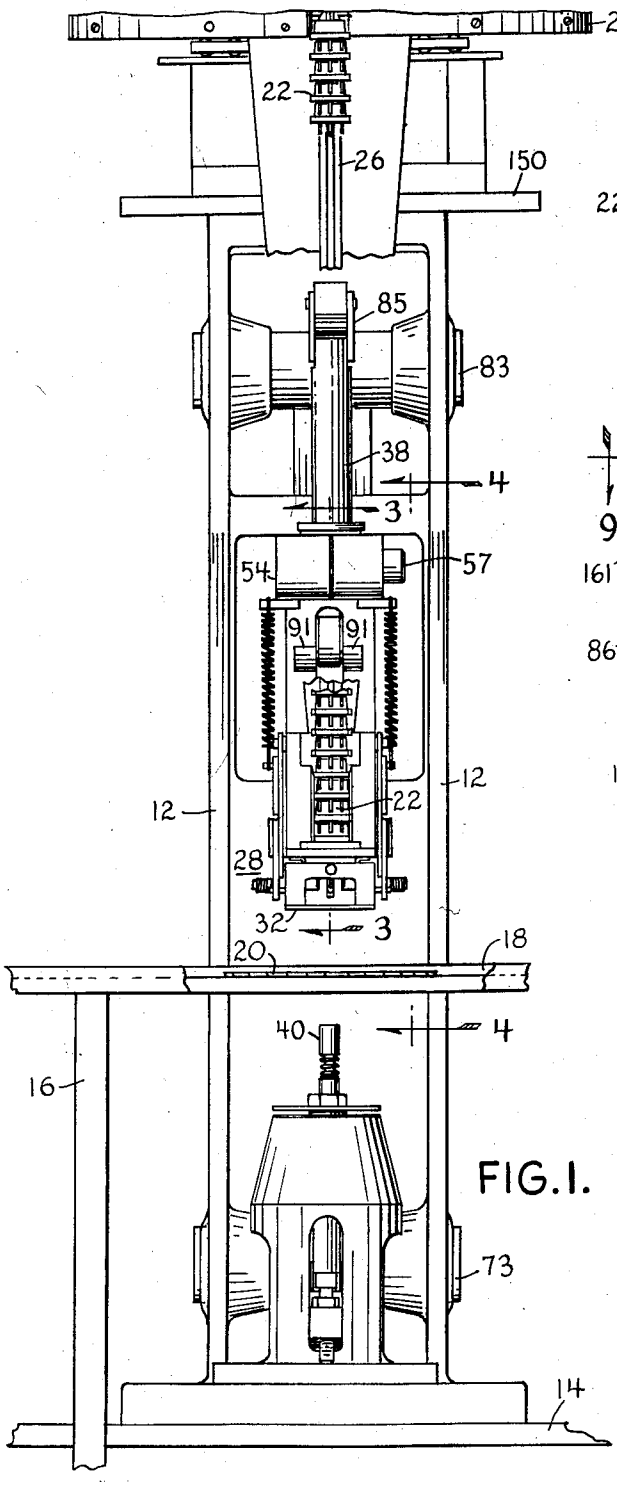

FIG. 1.

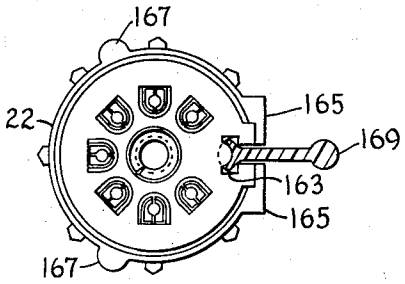

FIG. 9.

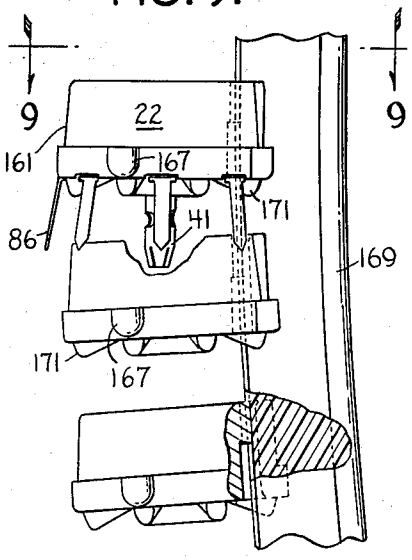

FIG. 10.

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COMPONENT ASSEMBLY MACHINE AND PROCESS

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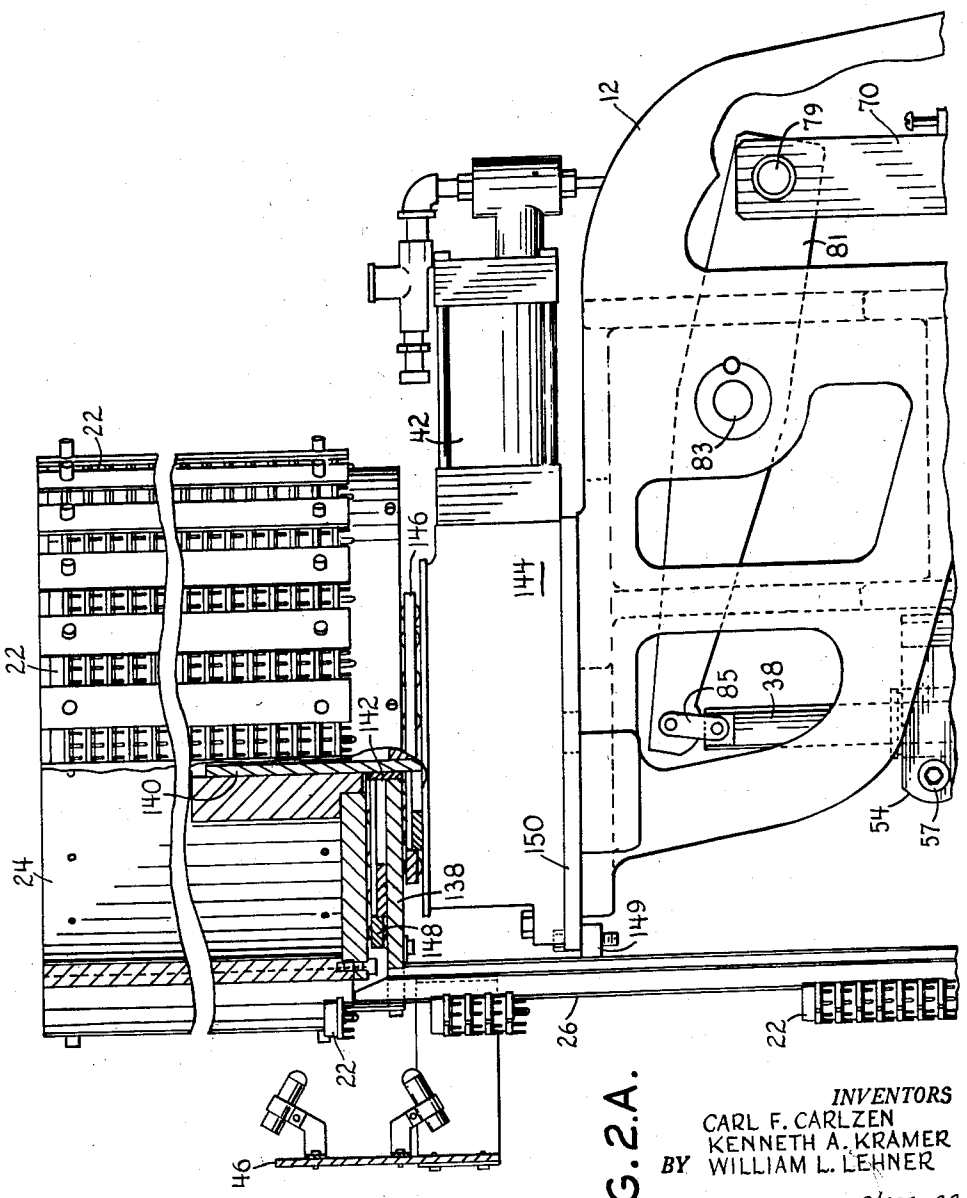

FIG. 2.A.

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COMPONENT ASSEMBLY MACHINE AND PROCESS

Filed Oct. 22, 1956 7 Sheets-Sheet 3

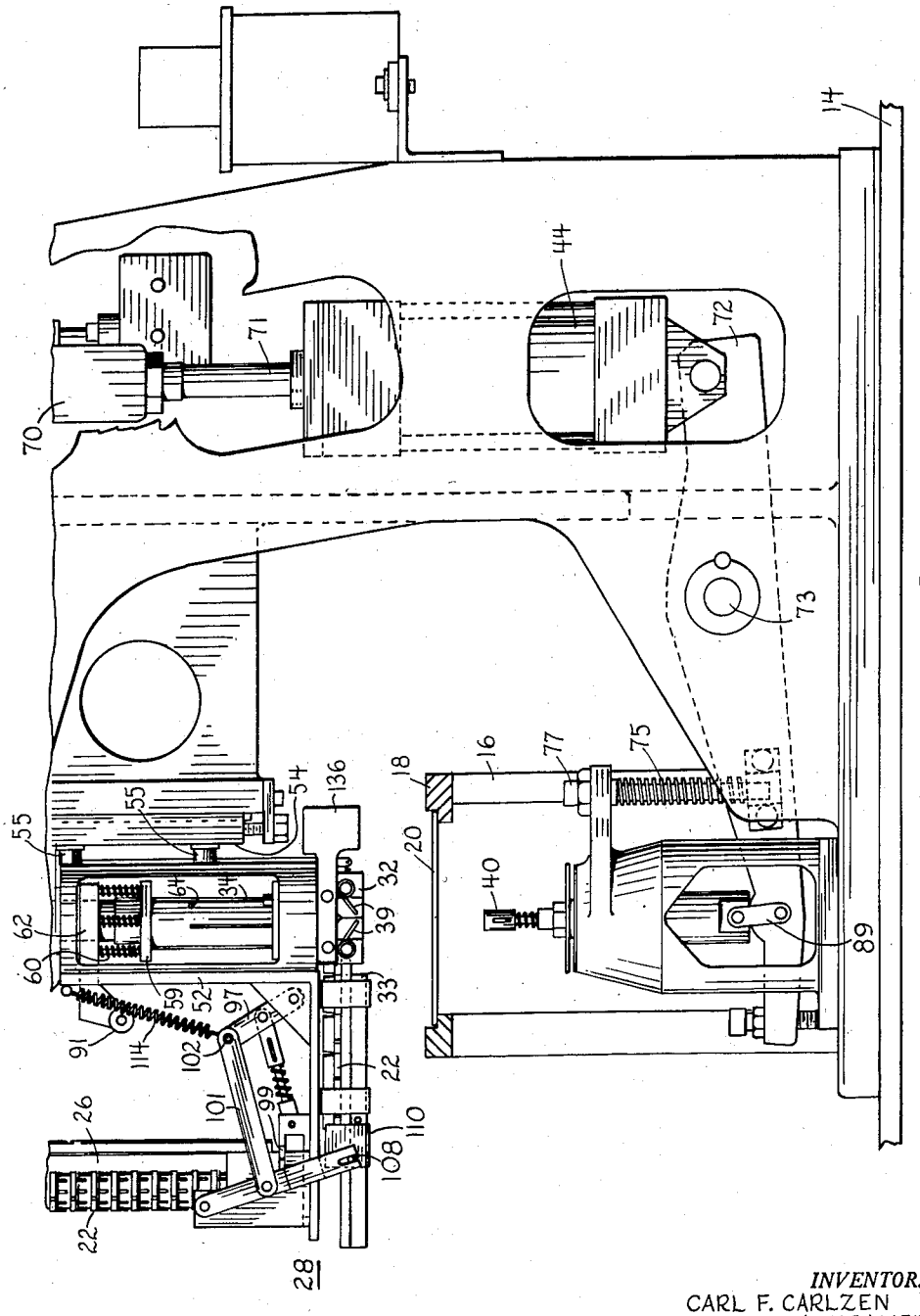

FIG. 2. B.

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COMPONENT ASSEMBLY MACHINE AND PROCESS

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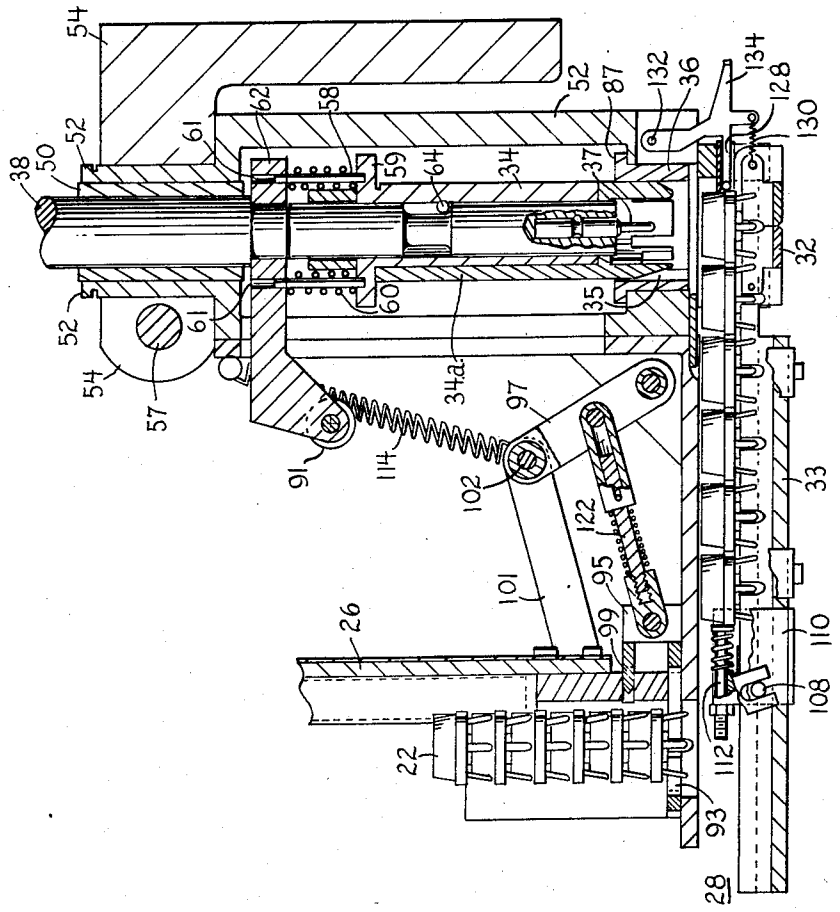

FIG. 3.

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COMPONENT ASSEMBLY MACHINE AND PROCESS

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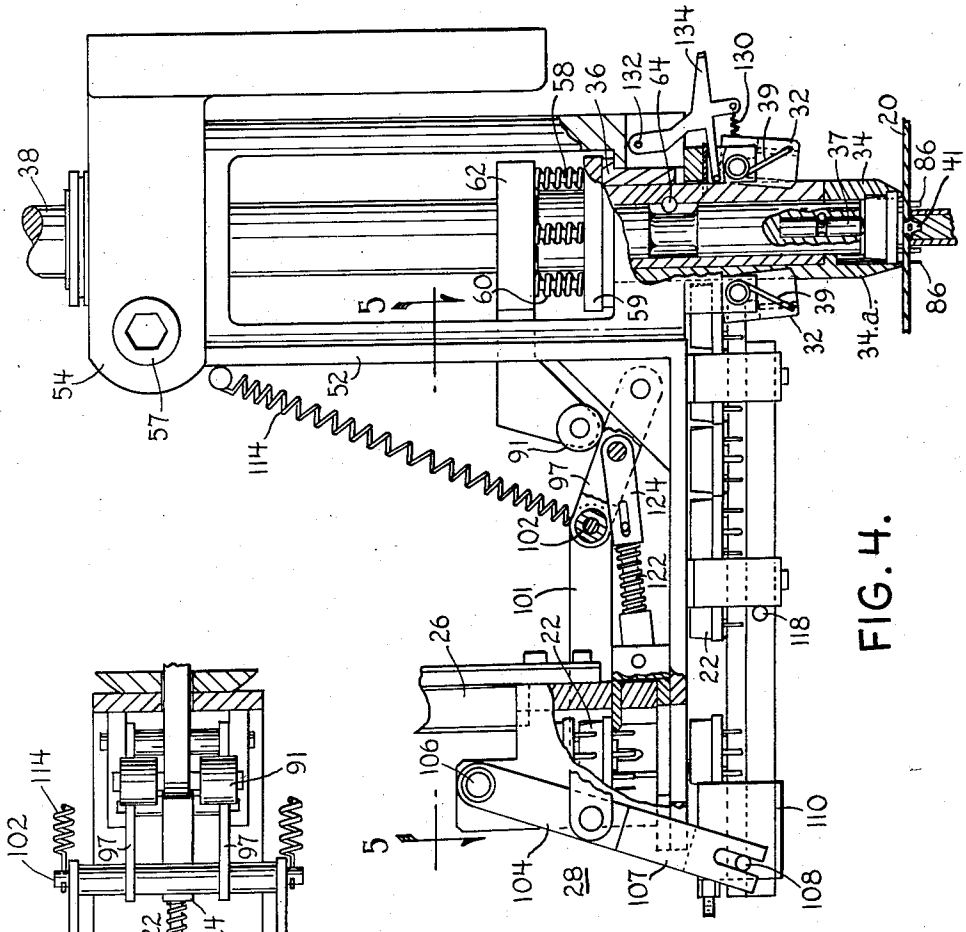

FIG. 4.

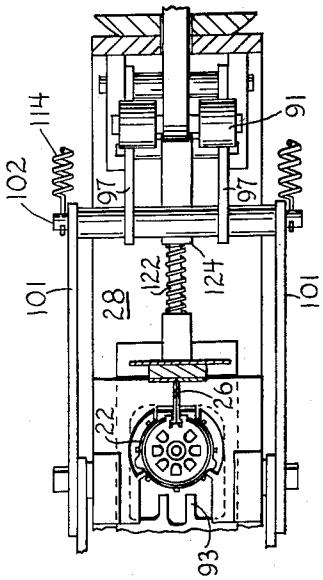

FIG. 5.

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COMPONENT ASSEMBLY MACHINE AND PROCESS

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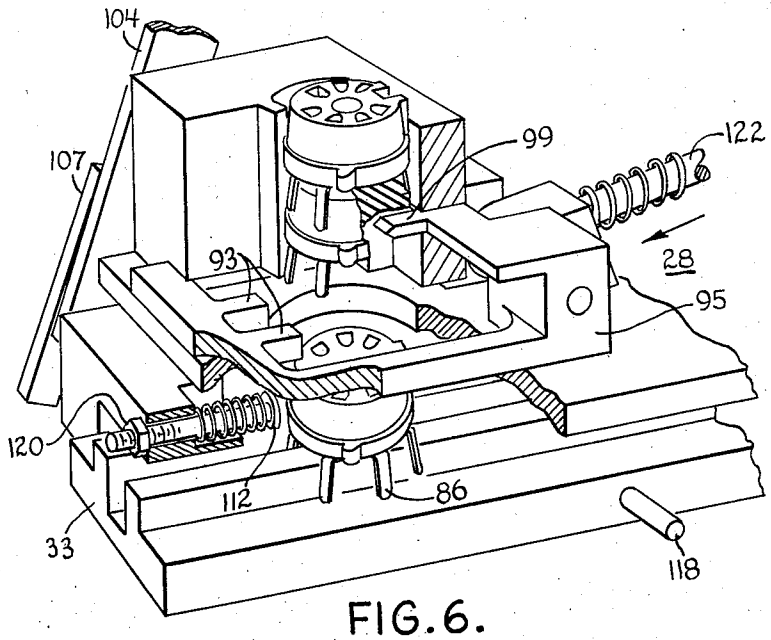

FIG. 6.

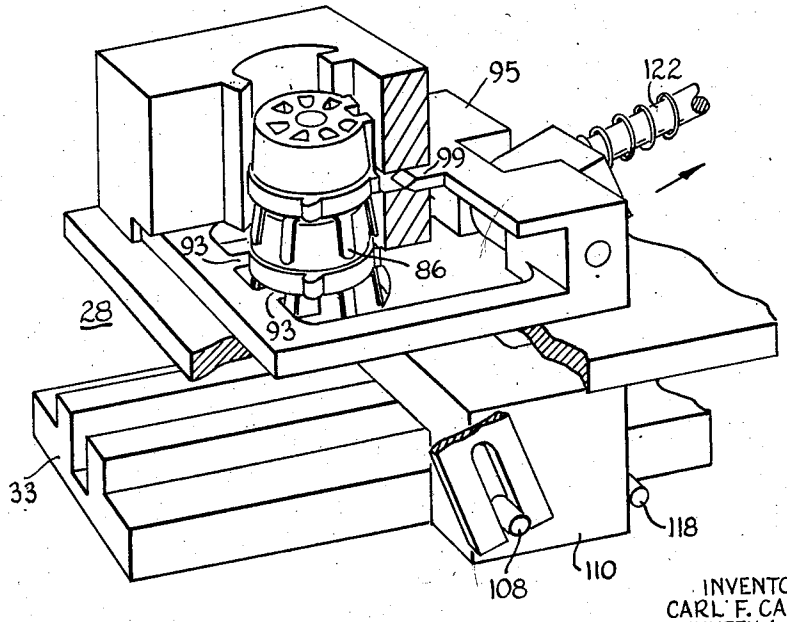

FIG. 7.

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COMPONENT ASSEMBLY MACHINE AND PROCESS

Filed Oct. 22, 1956 7 Sheets-Sheet 7

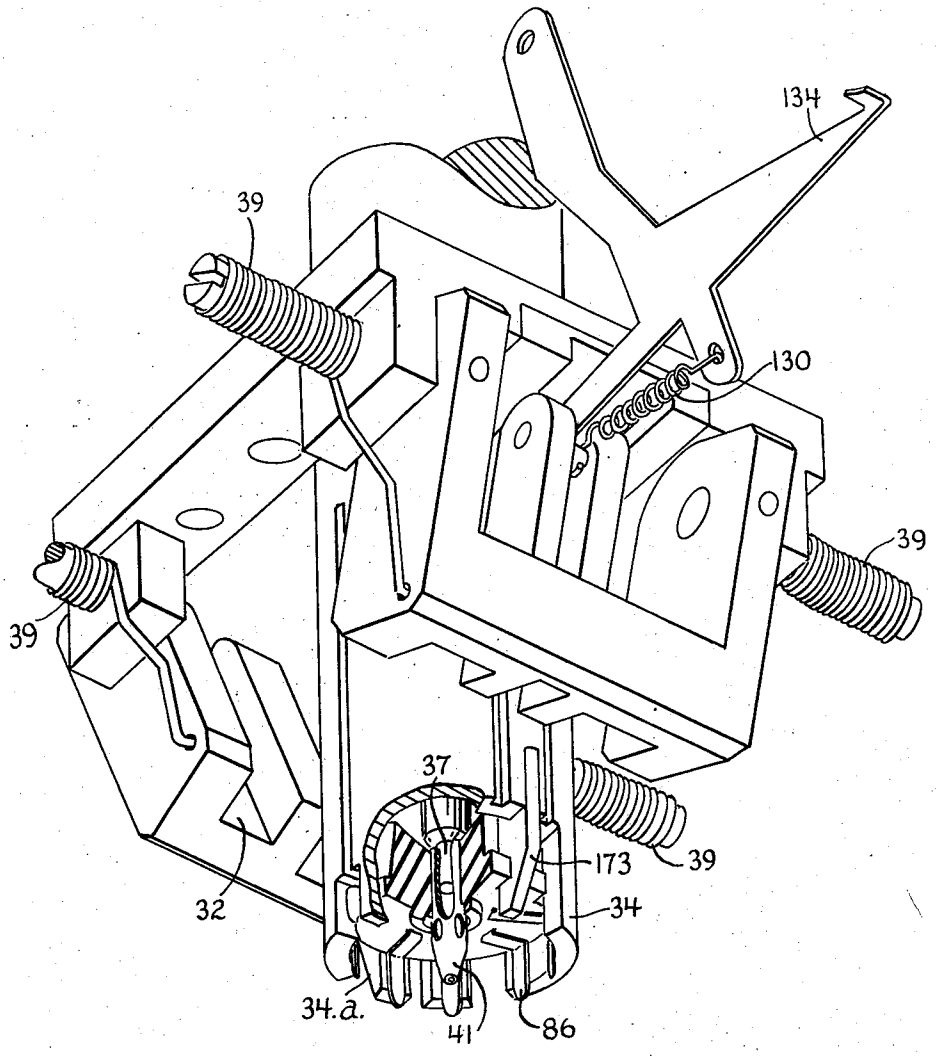

FIG. 8.

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United States Patent Office 2,928,165 Patented Mar. 15, 1960

2,928,165

COMPONENT ASSEMBLY MACHINE AND PROCESS

Carl F. Carlzen and Kenneth A. Kramer, Buffalo, and William L. Lehner, Snyder, N.Y., assignors, by mesne assignments, to Sylvania Electric Products Inc., Wilmington, Del., a corporation of Delaware

Application October 22, 1956, Serial No. 617,426

7 Claims. (Cl. 29—155.5)

This invention relates generally to machines and processes for assembling electrical components and more specifically to machines and processes for assembling or placing electrical components on a circuit base.

In the highly competitive field concerned with manufacture of electrical or electronic circuitry, it is desirable to assemble or place components on a circuit base, be it a conventional chassis or printed circuit board, by automatic devices which can be relied upon to provide a degree of uniformity as well as an assembly rate far beyond that attained to date by other means.

Little, if any prior art is available which teaches solutions to the various problems encountered in automatic assembly of circuits, especially those problems which arise in connection with the assembly of component sockets to a circuit base. Machines which have been previously suggested involve complicated socket orienting, pick up and placement processes and structures which require constant checking and rechecking in order to insure consistent operation.

Thus, it is an object of this invention to realize rapid continuous assembly of components to circuit bases with close space tolerances.

It is a further object of this invention to automatically place components on a circuit base in such a manner as to allow components to be positioned relatively close to previously placed components.

It is still a further object of this invention to accept sockets oriented relative to each other in stacked arrangement and place the sockets on a circuit base in oriented position relative to a circuit base dimension.

It is still another and further object of this invention to handle preoriented and stacked sockets in a feed arrangement which is capable of separating the sockets into side by side arrangement while maintaining orientation for insertion or assembly to a circuit base.

Another object of this invention is to adjustably orient socket placement around an insertion axis while using a preoriented stack of sockets.

For a better understanding of the invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following description and appended claims in connection with:

Fig. 1 which is a front view of an embodiment; and

Figs. 2A and B which show a side view of the Fig. 1 embodiment; and

Fig. 3 which is a detailed showing of the inserting assembly prior to pick up; and

Fig. 4 which shows the inserting assembly in inserting position; and

Fig. 5 which shows the top view of the socket separator; and

Figs. 6 and 7 which show cutaway portions of a socket feed structure; and

Fig. 8 which shows detailed structure of a trap and pick up collet; and

Figs. 9 and 10 which show a socket and socket loading strip.

Referring now to Figs. 1 and 2, 12 represents a machine frame, which may be fastened in adjustable manner, not shown, to a support table 14 in position to place components on circuit bases carried by conveyor 16, which as shown may be of the track type having circuit base supporting and advancing guide rails 18. Other types of conveyors may be used to hold the circuit bases beneath the machine during the insertion operation and for advancing the bases.

Sockets 22 are carried in stacked and preoriented formation in indexing turret 24 for supplying drop slide 26 with sockets, which, as best shown in Figs. 6 and 7, are extracted from drop slide 26 by means of a separator shown generally at 28. Separator 28 feeds the sockets 22, in side by side manner, oriented relative to each other, to trap 32 (Fig. 8) over a guide track 33. The socket 22 resting on trap 32, at any given instant, is in oriented position ready to be picked up and held by collet 34 and though collet 34, as shown, is of the friction hold type holding the socket body and applying a slight inward bending force to the socket solder lugs, other collets using vacuum, mechanical locking structures or any other holding means may be used.

Collet 34, which is mounted for sliding movement along driver rod 38 picks up the socket 22 from trap 32 and moves down to cam open the trap 32 against the force of biasing springs 39 and places the socket against a circuit base 20 which is shown to be of the printed circuit board type, though other types of circuit bases may be used. It can be seen that collet 34 is held from rotational movement relative to frame 12 by action of guide bar 34.*a*. which is slidably engaged with groove 35 in guide sleeve 36 attached to frame 12.

As the socket is positioned on circuit base 20, driver rod pin 37 forces the socket from collet 34 and holds it in position until anvil 40 strikes the bottom of the apertured socket center shield 41, spreading the portion below circuit base 20, to hold the socket in place. As can be seen, the walls of collet 34 are no thicker than strength demands require, making it possible to place sockets relatively close to other components already in position on the circuit base. Further, collet 34 and driver rod 38 may be made relatively long so that it is possible to position the unit high over the tracks 18 and apply sockets on bases already carrying components which extend beyond the top surface of circuit base 20 by many inches.

The embodiment shown may be powered by two cylinders, viz., indexing cylinder 42 and drive cylinder 44. Indexing cylinder 42, acting on information received from sensing means 46, indexes turret 24 as each turret slot is emptied of sockets, bringing a full turret slot into position over drop slide 26. As shown, sensing means 46 may comprise a light source and photocell pick up which plays a beam of light against the bottom of the turret slot in position over drop slide 26. When light is reflected back to the cell from metal surfaces normally behind the sockets, a signal is transmitted which actuates indexing cylinder 42 and a full turret slot is moved into position over drop slide 26. Other sensing means will occur to those skilled in the art. As to be more fully described hereinafter, drive cylinder 44 provides the power for inserting the sockets and also for actuating anvil 40.

To explain construction and operation of the inserting head structure in more detail, reference is made to Fig. 3 where driver rod 38 is shown slidably encased in a bearing sleeve 50 mounted in holder 52. Holder 52 is journaled for rotational adjustment in a clamp 54 which is mounted on frame 12 by means of bolts or screws 55. Clamp 54 is held in closed position by means of a screw or bolt 57.

The upper flanged portion 59 of collet 34 carries guide pins 58 which act to guide the springs 60 compressed during the insertion operation between flange 62, attached to driver rod 38, and the flange 59. Apertures 61 in flange 62 are formed to receive the ends of guide pins 58 when springs 60 are compressed.

Stop pin 64 inserted through collet 34 at the necked portion of driver rod 38 acts to limit the action of springs 60 in biasing the driver rod 38 and driver rod pin 37 in extended position relative to collet 34. This is best shown in Fig. 3.

The inserting head, per se, is operated by a floating drive cylinder 44, which may be of any desirable type. Assuming cylinder 44 is of the pneumatic type, when air is fed to the drive side of cylinder 44 from a source not shown, driver lever 70, which is coupled to the drive cylinder piston rod 71, is moved upward and at the same time, due to the floating connection of drive cylinder 44, a downward thrust is exerted against rocker arm 72 which is mounted for rotational movement around rocker shaft 73. Rocker arm 72 is initially held motionless by the action of delay spring or springs 75 mounted on a guide rod or rods 77. So long as the force required to overcome friction in the upper portion of the inserting head remains less than the force necessary to compress spring or springs 75, rocker arm 72 remains motionless against the thrust of drive cylinders 44 and driver lever 70 moves upwardly.

Drive lever 70 is connected by pin 79 to the upper rocker arm 81 which is mounted for rocking movement around rocker shaft 83. As the drive lever is moved upwardly, motion is imparted to upper rocker shaft 81 which in turn moves driver rod 38 through link 85. As driver rod 38 and collet 34 move downwardly, the socket then positioned on trap 32 is picked up, as shown in Fig. 8, before the trap 32 is cammed open by the lower surfaces of collet 34, against action of biasing springs 39.

Referring to Figs. 4 and 8, it can be seen that the socket 22 is carried by collet 34 to the circuit base 20, in oriented position so that the solder lugs 86 of the socket 22 are inserted through the circuit base apertures, not shown. Collet 34 is stopped at the circuit base surface when the lower surface of flange 59 strikes the upper surface of flange 87 of guide sleeve 36. Driver rod pin 37 continues its downward movement sliding socket 22 out of collet 34 onto the circuit base 20 until driver rod 38 is stopped by contact of flange 62 with the sleeve mounted above flange 59. In other words, driver rod pin 37 moves from an extended position relative to collet 34 prior and during pick up to a retracted position at the moment of insertion. When collet 34 and driver rod 38 are stopped, all of the force of cylinder 44 is applied to compress spring 75 and rocker arm 72 starts to move around rocker shaft 73 lifting anvil 40 from the rest position and the pair of links 89 which come into use on the downstroke of the anvil. Anvil 40 moves upward against socket shield 41 into the clinching position, compressing the shield between anvil 40 and driver rod pin 37. The lower portion of the center shield 41 is thus upset and spread along the bottom surface of the circuit base 20 over an area larger than the circuit base center shield receiving aperture. Thus socket 22 is firmly held in place.

Next, drive cylinder 44 receives a retracting pulse of air from a source not shown which allows delay springs 75 to lower anvil 40. After anvil 40 is lowered, drive lever 70 is lowered, raising drive rod 38 along with collet 34 through action of the rocker arm 81. Collet 34 remains adjacent the circuit base 20 until driver rod 38 moves upward sufficiently to allow springs 60 to bring stop pin 64 against the lower surface of the necked portion of driver rod 38. Driver rod pin 37 then is in its retracted position relative to collet 34, as shown in Fig. 3. Timing of the air impulses for operating cylinder 44, assuming it is of the pneumatic type, may be provided by either a master timer operating all machines in the line along conveyor 16, by a separate timing device or by a movement interlocked switch circuit.

As the collet 34 moves back through trap 32, bias springs 39 close the doors of trap 32 so as to bring the trap into socket receiving position. Sockets 22 are fed to trap 32 over guide track 33 from separator 28 when the trap is in the closed receiving position. Separator 28, best shown in Figs. 6 and 7, can be seen to comprise means for separating sockets from the stacked and oriented arrangement on drop slide 26 to a side by side oriented arrangement for feed over guide track 33.

Referring primarily to Figs. 2B, 3, 6 and 7, it can be seen that separator 28 is driven basically by drive cylinder 44 through driver rod 38 and cam rollers 91. When driver rod 38 is in the upward position, fingers 93 of oscillating slide aperture 95 are in position to provide support for the stack of sockets on drop slide 26 and as driver rod 38 moves downward toward the assembly position, carrying collet 34 into socket pick up position over trap 32, roller cams 91 are also moved downward. Roller cams 91 then strike linkage arms 97, as best shown in Figs. 4 and 5 to move oscillating slide aperture 95 through action of the spring loaded linkage rod 122. As a result, fingers 93 of oscillating slide aperture 95, are moved away from supporting engagement with the socket stack. Tongue 99, opposite fingers 93 on oscillating slide aperture 95, is positioned so as to cut between the top surface of the last socket and the bottom surface of the penultimate socket in the stack. Thus, tongue 99 is moved beneath the penultimate socket to hold the stack from further downward movement and to apply separating force on the bottom socket 22. The last socket, when separated from the stack, drops onto guide track 33 in side by side oriented arrangement relative to the other sockets 22 on the guide track.

Linkage arms 101, which are connected to linkage arms 97 through shaft 102, are also moved by action of roller cams 91 to rotate oscillating arms 104 around shaft 106. The lower portion of oscillating arms 104 include a bifurcated plate extension 107 to receive slide pins 108 which extend from the sides of pusher block 110. As can be seen, the downward movement of roller cams 91 moves pusher block 110 outwardly, away from the inserting head portion of the machine, along guide track 33, so as to allow the last socket in the stack, after being released from fingers 93, to drop in position on guide track 33 ahead of spring loaded pusher 112. When roller cam 91 moves upward along with driver rod 38, tension springs 114 return the linkage arms 97, 101 and 104 to the position shown in Fig. 3.

As seen in Fig. 7, this action of springs 114 moves oscillating slide aperture 95 toward the inserting head, retracting tongue 99 so as to allow the complete stack of sockets to drop for support on fingers 93. At the same time oscillating arm 104 also moves pusher block 110 along guide track 33 toward stop pin 118, forcing spring loaded pusher 112 against the socket last placed on the guide track 33. This slides the sockets 22 along the guide track 33 and the socket immediately adjacent trap 32 slides into position beneath collet 34 as soon as trap 32 is closed and in the socket receiving position. The force exerted by spring loaded pusher 112 may be adjusted by rotation of nut 120.

One of the basic requirements for inserting or assembling machines generally of the type involved in the concepts disclosed herein, is the need for operating without close supervision. Since components may or may not be manufactured uniformly and may or may not be damaged prior to placement in turret 24, it is desirable to provide sensing means such as a sensing finger 128 for ascertaining correct component placement on trap 32. Finger 128 extends over trap 32 so as to contact the socket positioned on trap 32 at any indexing point which

preferably is a point or area on the socket body or connecting terminal lugs which differs slightly from other points or areas around the socket.

Thus, when a socket moves onto the trap **32** the sensing finger is moved outwardly against the action of spring **130** and around pivot point or shaft **132**. As a result, switch contact arm **134** is raised slightly. If the actuating pin of a fairly sensitive snap action switch, shown generally at **136** in Fig. 2B, is arranged to operate in conjunction with switch contact arm **134**, it is possible to transmit information indicative of correct socket positioning on trap **32**. For example, if snap action switch **136** is not activated after a socket moves into position on trap **32**, assuming a normal open type of switch, the signal or lack thereof from snap action switch **136** can be used to block activating pressure from being fed to drive cylinder **44**. If it is desired to interlock all machines along conveyor **16**, this same signal can be used to stop the line. It can also be used to energize a trouble light or trouble indicator assigned to the machine. Such interlock circuitry is well known to those skilled in the art and it is not believed necessary to show or further describe it in further detail.

Circuit design requires socket component placement in any number of oriented positions relative to a given dimension of the circuit base **20**. Thus, one of the features of the disclosed embodiment resides in its adaptability to various circuit designs. It is clear that the frame **12** can be positioned so as to place the inserting area over a plurality of areas on circuit base **20** by shifting the frame on support table **14**. Further, clamp **54** may be loosened by releasing bolt or screw **57** and holder **52** rotated through approximately 180 degrees. The inserting assembly of trap **32**, guide track **33** and separator **28** is also rotated along with drop slide **26**. As can be seen, the upper portion of drop slide **26** is connected to a support disc **138** which is mounted on turret shaft **140** by means of a bearing race **142**. Support disc **138** is also supported relative to the indexing mechanism housing **144** by means of a bearing race shown generally at **146**. The complete turret is then mounted on a third bearing race shown generally at **148**. Drop slide **26** is also clamped at **149** to the lower flange **150** of indexing mechanism housing **144**.

Thus, when it is desired to rotate holder **52**, clamp **54** is loosened along with the drop slide clamp **149** on lower flange **150** and the whole inserting assembly rotates at the same time. Even if turret **24** is not adjustable between index points it should be clear that these two adjustments, i.e., adjustment of the frame on support table **14** and rotation of the inserting assembly makes it possible to preorient the sockets **22** and socket inserting assembly for placing a socket on any portion of circuit base **20** in almost any angular position relative to any given circuit base dimension.

The particular socket found desirable for use in the embodiment of the invention disclosed is shown generally in Figs. 9 and 10 and is better described in U.S. patent application, Carlzen et al., Serial Number 479,518 filed on January 3, 1955, now Patent No. 2,863,131, entitled "Tube Socket" which is to be considered as incorporated herein by reference. To consider the pocket shape briefly, it can be seen from Figs. 9 and 10 that the socket body **161** is tapered and that the solder lugs **86** are positioned beneath the socket body in such manner so as to allow for stacking. The lower two sockets in Fig. 10 have been shown without solder lugs in order to clarify socket body detail.

Socket body **161** is formed to provide an indexing slot **163** along the outer periphery, and the flat surfaces **165** bordering the indexing slot may be used for sensing position of the socket on trap **32** by means of sensing finger **128**. The two nubs **167** are used to maintain orientation when the sockets are held in turret **24**. Flexible strip **169** represents a packaging strip having a cross section such

that the sockets may be slid along its length from the socket assembly machine at the place of socket manufacture thereby holding the sockets in preoriented position and in stacked arrangement from time of manufacture. The stacked arrangement protects the individual solder lugs and keeps them from being bent both while in transit and while being inserted in turret **24**. The small raised portions **171** on the bottom of the socket body keep the socket bodies separate whereby tongue **99** of oscillating slide aperture **95**, as previously explained, may separate the bottom socket from the penultimate socket in a given stack.

The turret slots are loaded by taking a loaded flexible strip **169** including a bottom stop, not shown, which may comprise merely a deformed portion of strip **169**, and placing it in the particular turret slot to be loaded. Then the sockets are held in place and the flexible strip **169** extracted.

As best shown in Fig. 8, the indexing slot **163** in the socket body also acts in conjunction with the knife shaped finger **173** of collet **34** to provide means for holding the socket in preoriented position as the socket is picked up from trap **32** and moved toward the circuit base **20**. Other sockets may be used so long as they are formed to provide means for holding orientation while in turret **24**, along drop slide **26** and guide track **33** and while held by collet **34**. It can be seen that the specific shape of collet **34** will be governed by the particular indexing socket body form utilized.

Thus, it can be seen that the concepts involved herein allow sockets to be accepted in preoriented and stacked arrangement relative to each other and placed on a circuit base in adjustable oriented position relative to a circuit base dimension. Further, the concepts disclosed herein allow the stacked sockets to be separated into a side by side feed without disruption of preorientation.

While there has been shown and described what is at present considered a preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the appended claims.

Having thus described the invention, we claim:

1. In a machine for mounting electrical components on a circuit base, the combination comprising a support frame, a frame supported trap yieldably biased in closed position for supporting an electrical component in fixed orientation prior to pick up, a frame mounted inserting assembly including a driver rod for pressing the electrical component onto the circuit base and a pick up collet slidably mounted on said driver rod, said pickup collet being formed to receive and hold the body of an electrical component as oriented on said trap from component pick up to component mounting positions, means for moving said driver rod and said collet through said trap to the mounting position, means limiting the sliding movement of the pick up collet with respect to the driver rod and permitting relative movement therebetween from an extended relationship through pick up and hold positions to a retracted relationship at the mounting position.

2. In a machine for placing electrical sockets on a circuit base the combination comprising a frame, a holder mounted on said frame for adjustable movement around its longitudinal axis, a guide track mounted on said holder and formed to slidably support sockets in predetermined oriented position for movement toward said holder axis, a trap yieldably biased in closed position and mounted on said holder centrally and transverse said holder axis, a friction collet mounted for reciprocating movement along said holder axis through the general plane of said trap to the work position support level of a circuit base onto which sockets are to be placed, a driver rod slidably mounted internal said collet for reciprocating movement along said holder axis, means yieldably biasing said collet in extending position relative

to said driver for movement of said collet along with said driver, stop means for limiting travel of said collet adjacent the work position support level of the circuit base, means for moving said driver means and said collet along said holder axis from above said trap through the general plane of said trap, and for continuing movement of said driver after said collet reaches said collet stop, whereby the collet is cleared of any collet carried socket at the work position.

3. In the assembly of sockets to a circuit base the method comprising the steps of dispensing sockets, each having a socket body and downward depending solder lugs from the bottom of a stack of oriented sockets into an oriented side by side arrangement, grasping the first of the sockets in side by side arrangement from above and around the outer periphery of the socket with a collet to align the downward depending solder lugs and to rotationally align the socket body, moving the collet and grasped socket downward to a circuit base having apertures aligned with said collet, sliding the grasped socket from said collet to insert the solder lugs in the circuit base apertures.

4. In a machine for assembling sockets to a socket base the combination comprising an inserting assembly having a given operational axis, means for holding a stack of sockets in pre-oriented position, means for extracting the last socket from said socket stack, means for supporting and advancing extracted sockets in side by side oriented relationship to the inserted assembly axis, means for operating said extracting means and said advancing means from said inserting assembly, and frame means for supporting the inserting assembly, the holding means, the extracting means and said support and advancing means for rotational adjustment around the inserting assembly operational axis.

5. In a machine for assembling sockets to a socket base in oriented position relative to given circuit base dimensions, the combination comprising a frame, a pick-up and inserting assembly mounted on said frame, means coupled to said inserting assembly for placing an oriented socket in circuit assembly position for pick-up and insertion by said inserting assembly, frame supported anvil means mounted beneath the socket assembly position for reciprocating movement between an upper clinching position and a lower rest position, a single power means coupled to float between said inserting assembly and said anvil means, a delay spring coupled to said anvil means for biasing said anvil means against movement until after said inserting assembly has substantially reached the pick-up and insertion position.

6. In a machine for assembling sockets to a circuit base the combination comprising a frame, a rocker arm actuated inserting assembly mounted on said frame, means coupled to said inserting assembly for placing an oriented socket in circuit assembly position for pick-up and insertion by said inserting assembly, and frame supported rocker arm actuated anvil means mounted beneath the circuit assembly position for reciprocating movement between an upper clinching position and a lower rest position, power means coupled to float and apply a thrust between said inserting assembly actuating rocker arm and the anvil actuating rocker arm, a delay spring coupled to oppose movement of said anvil means from the rest position, said delay spring requiring a greater distorting force before allowing movement of said anvil than the force required to move said inserting assembly.

7. In the method of assembling sockets to a circuit base the steps comprising, supporting a circuit base having solder lugs receiving apertures in socket receiving position, supporting a socket in spaced relationship with the circuit base with the socket body in oriented position relative to a given circuit base dimension and with the socket solder lugs in radially expanded position relative to the circuit base solder lug receiving apertures, grasping the socket to apply inward bending force to the socket lugs sufficient to align the lower tip of each solder lug with an associated receiving aperture in the circuit base, reducing the spaced relationship between the socket and the circuit base to insert the solder lugs in the circuit base solder lug receiving apertures.

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