United States Patent [19]

Coller

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[45] **Apr. 17, 1973**

[54] **METHOD AND MACHINE FOR FORMING AND INSERTING WORKPIECES IN AN APERTURED WORKPIECE HOLDER**

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[73] Assignee: **AMP Incorporated,** Harrisburg, Pa.

[22] Filed: **Mar. 20, 1972**

[21] Appl. No.: **236,515**

Related U.S. Application Data

[63] Continuation of Ser. No. 90,593, Nov. 18, 1970, abandoned.

[52] **U.S. Cl.**.....**29/429,** 29/203 D, 29/626

[51] **Int. Cl.**....**B23p 19/00,** H01r 43/00, H05k 13/04

[58] **Field of Search**.....29/203 D, 203 R, 29/626, 429, 208 D, 211 R

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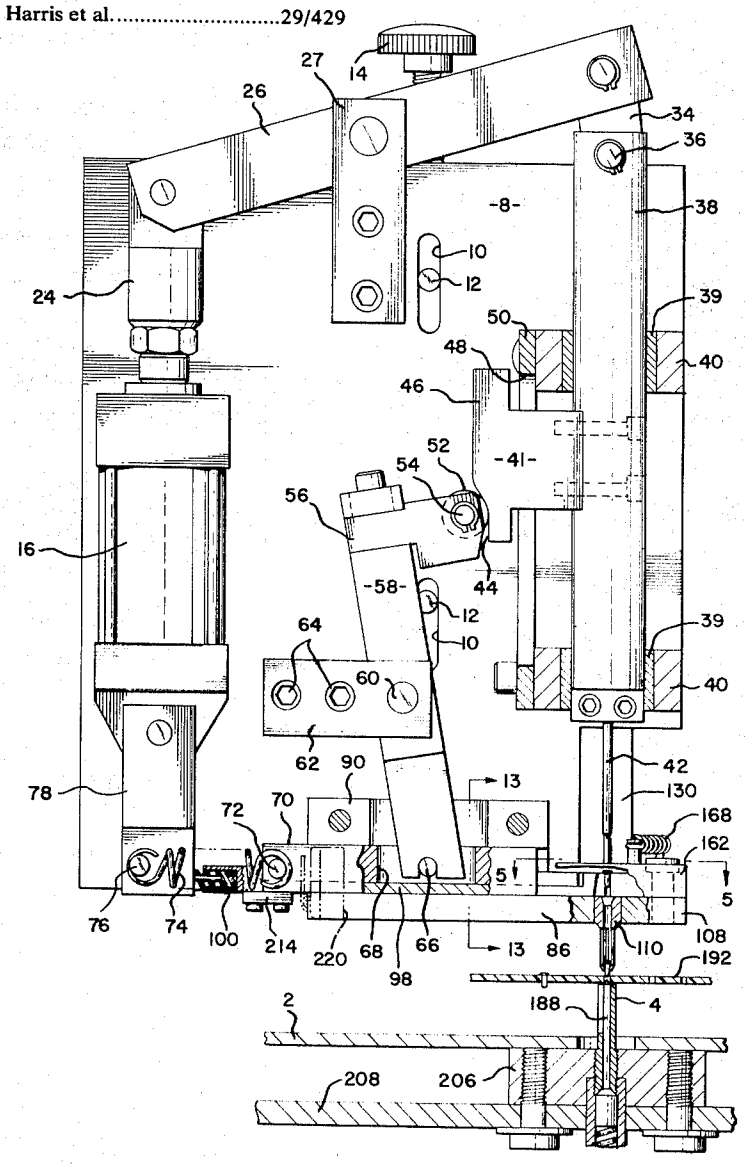
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Attorney—William J. Keating

[57] **ABSTRACT**

A method and machine is provided to serially supply a plurality of workpieces to a work station where each workpiece is individually subjected to a forming operation that conditions the workpiece for an interference fit when inserted within an aperture of a workpiece holder such as a card or printed circuit board. Each workpiece is individually and sequentially subjected to the forming operation, then segregated from the remaining workpieces and precisely positioned for automatic insertion into the apertured card or board by a transfering mechanism. The occurence of a malfunction in the automatic insertion operation will automatically shut off the machine enabling correction of the malfunction.

10 Claims, 13 Drawing Figures



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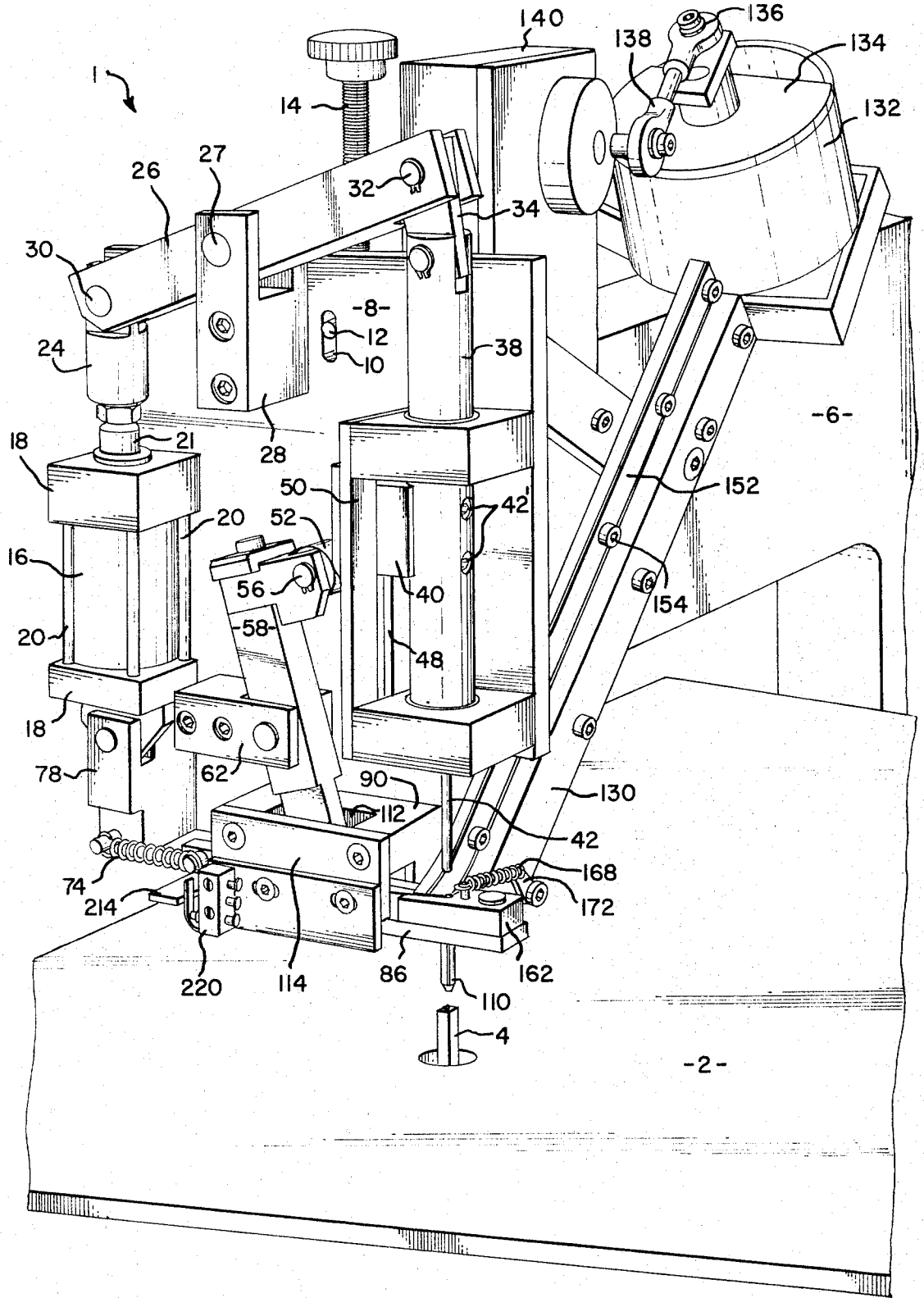


Fig. 1

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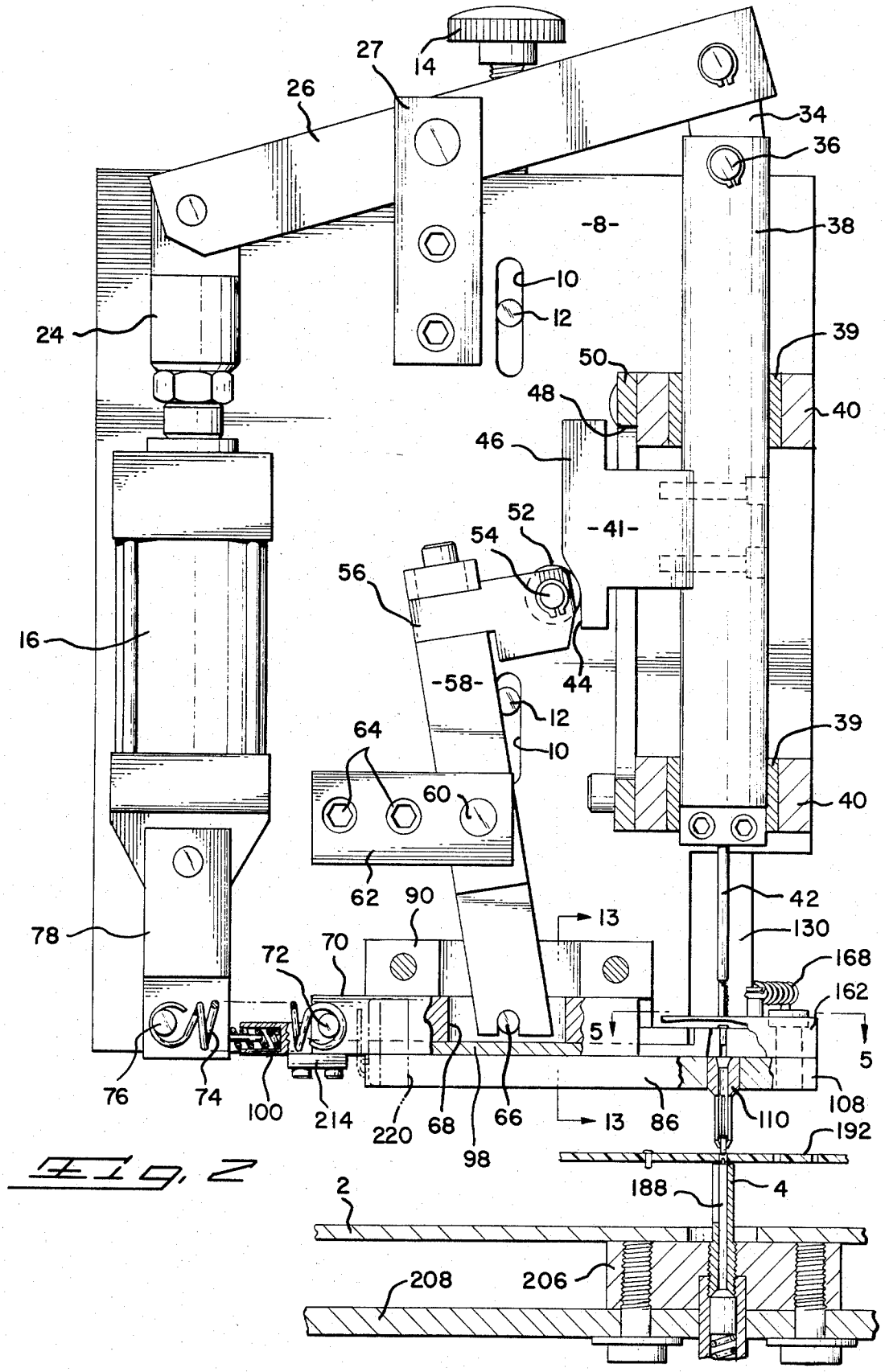

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162
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Fig. 2

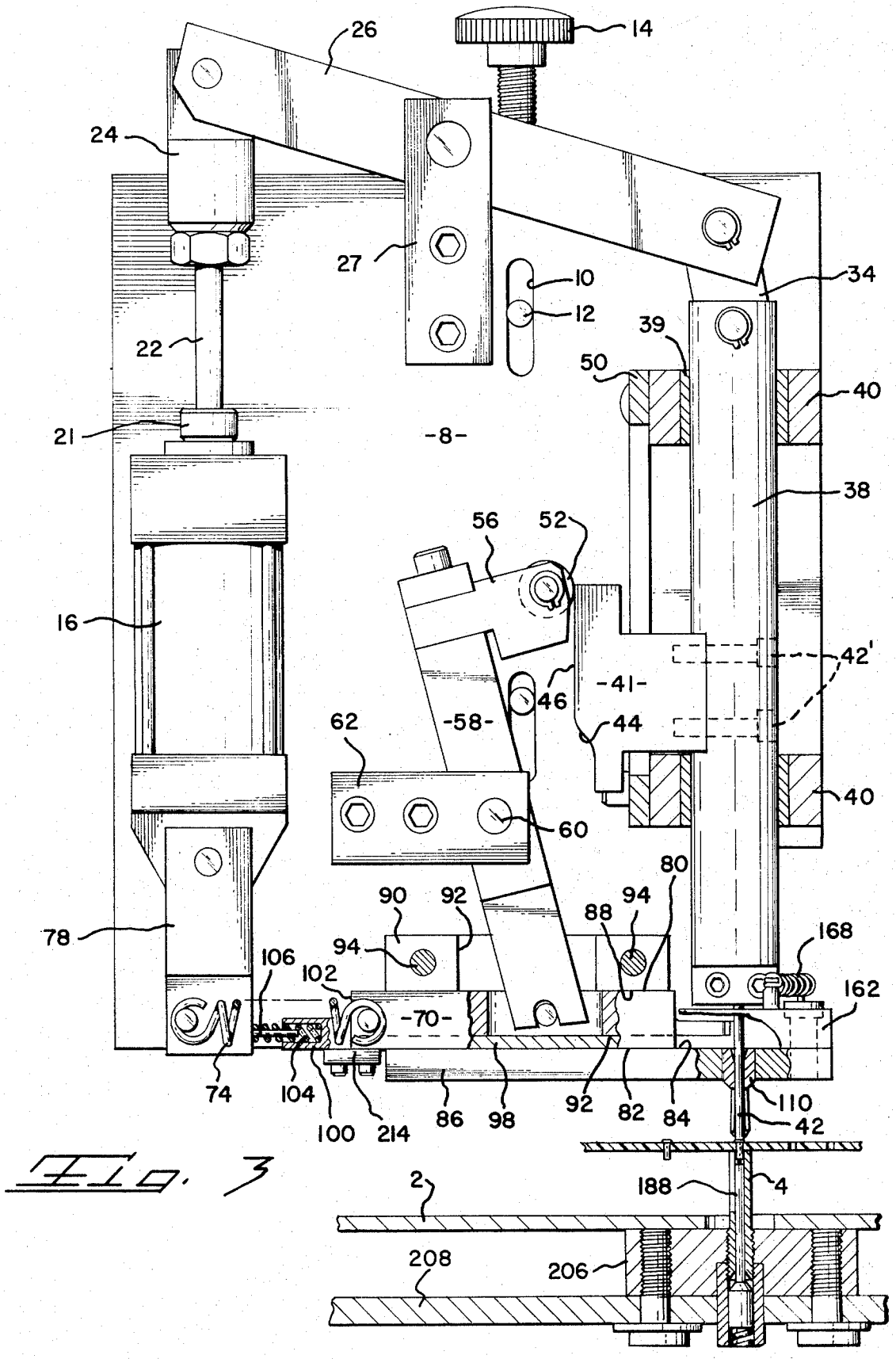
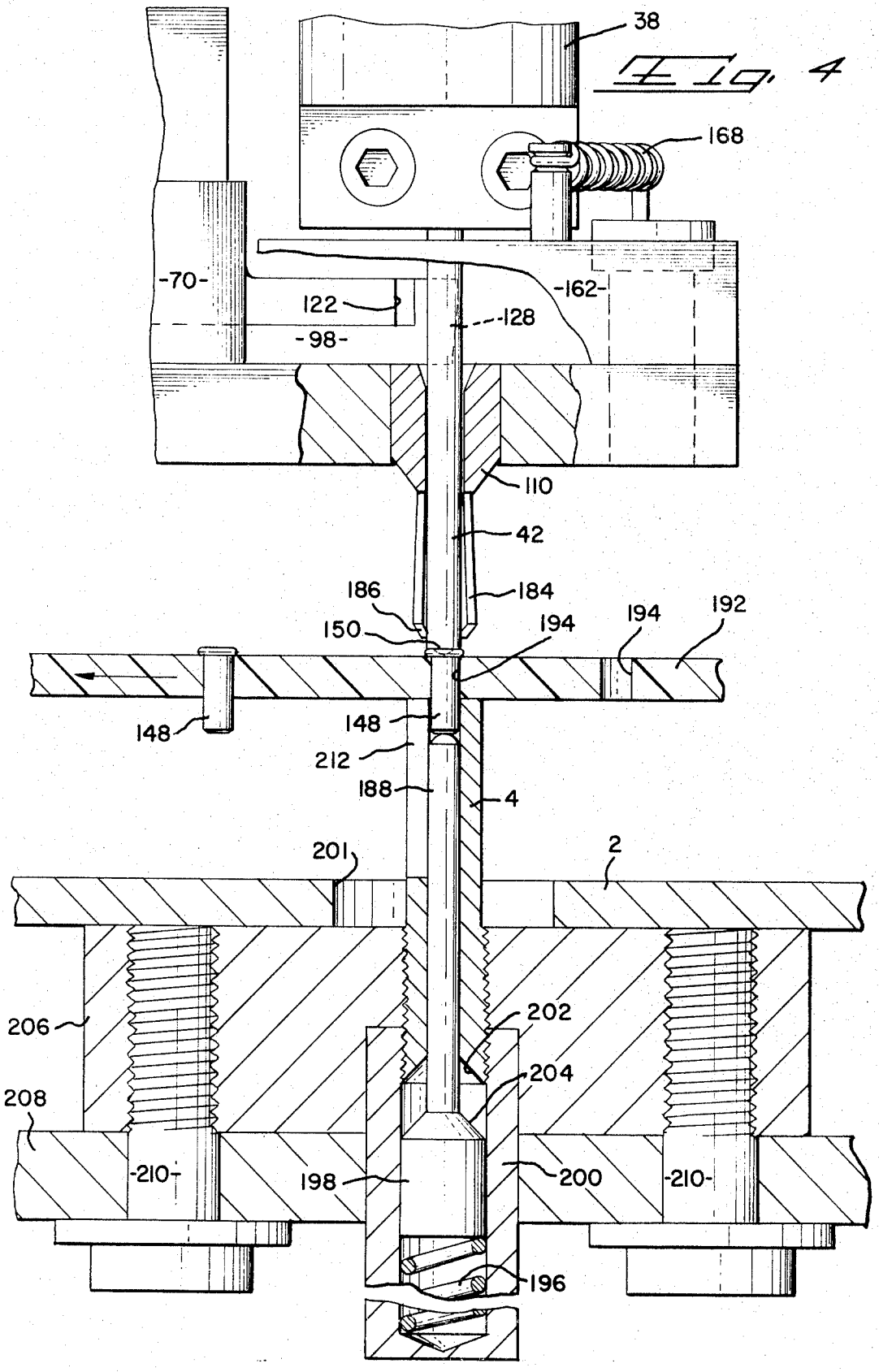

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-70-
74
104
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86
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42
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Fig. 3

Fig. 4


38
168
-70-
122
-98-
-128
-162-
110
42
186
184
150
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192
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148
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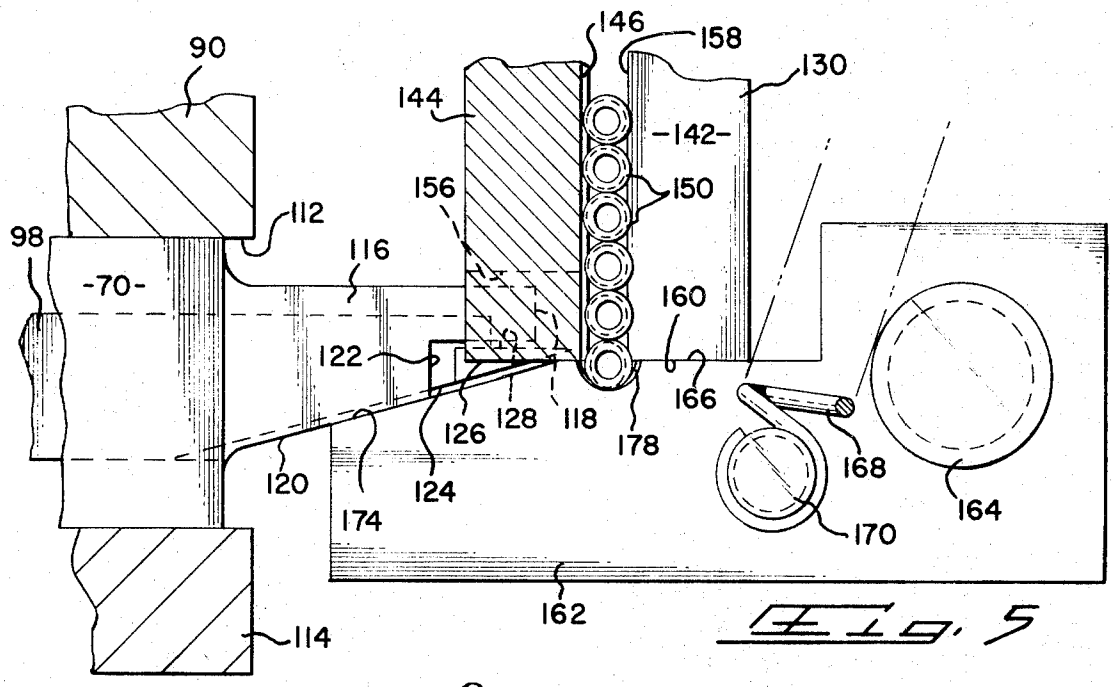


Fig. 5

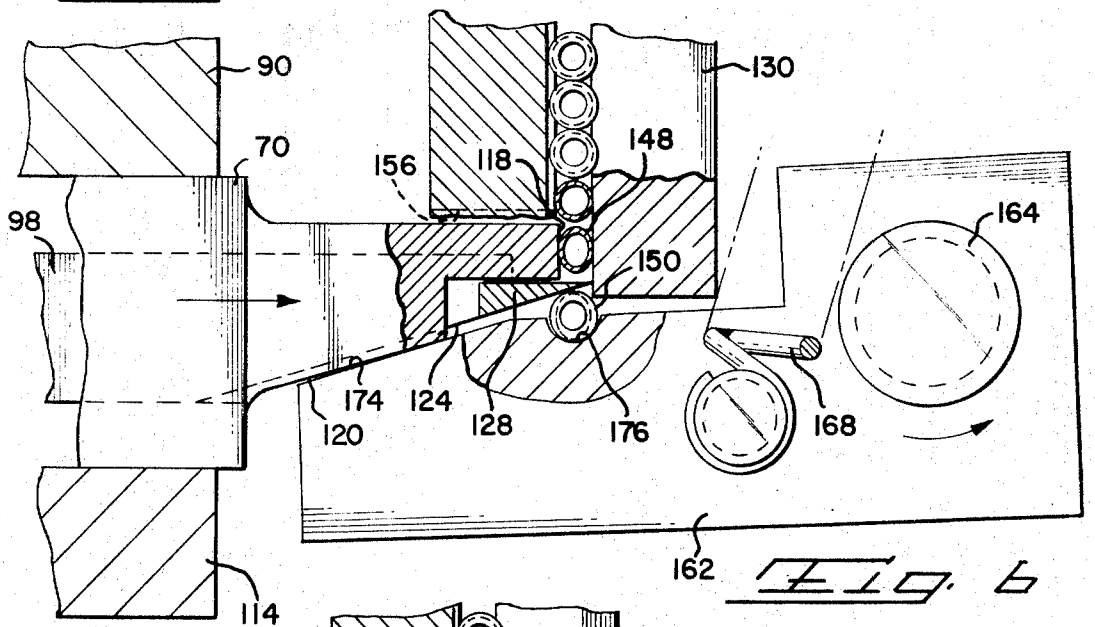


Fig. 6

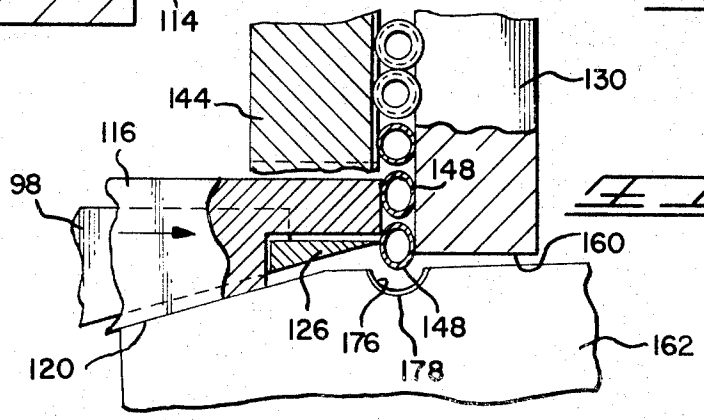


Fig. 7

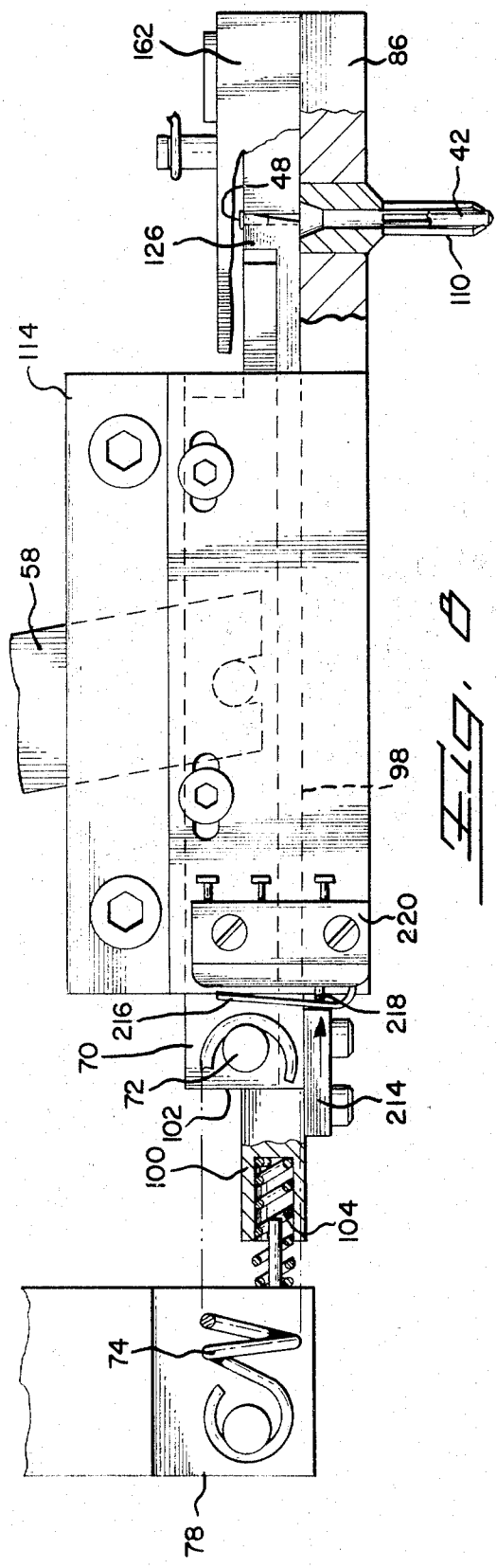

162
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FIG. 8

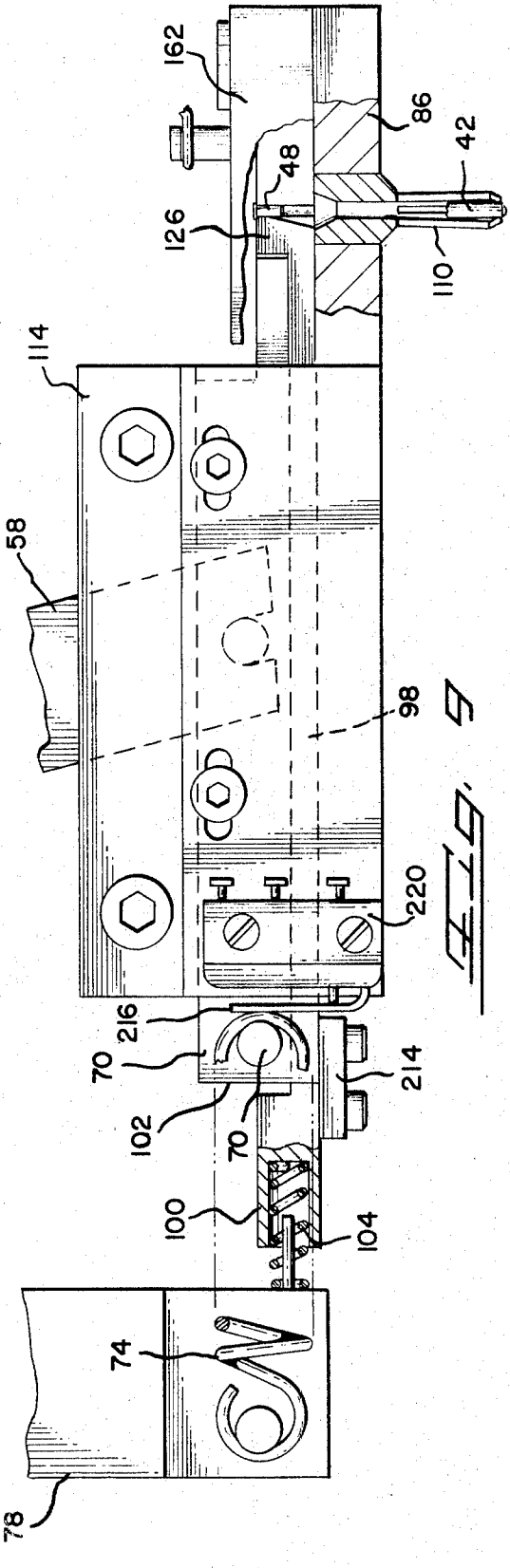

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FIG. 9

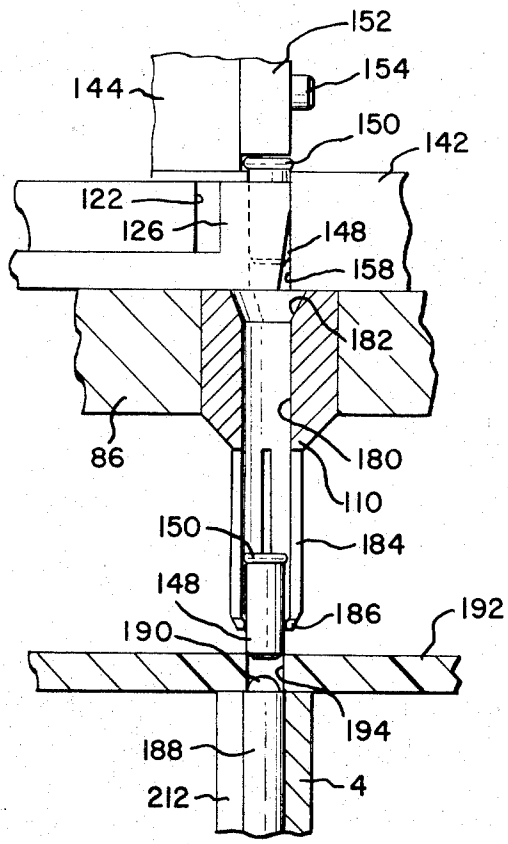


Fig. 10

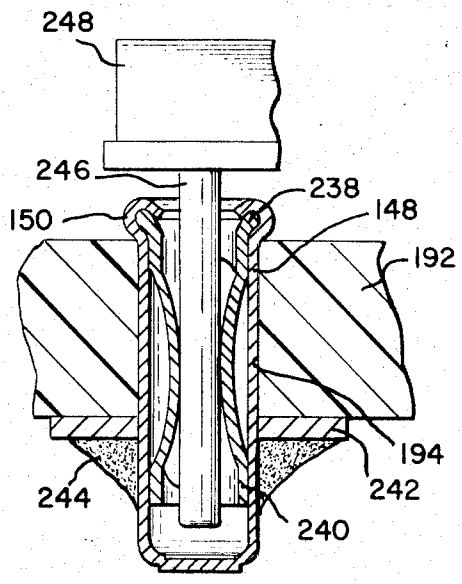


Fig. 12

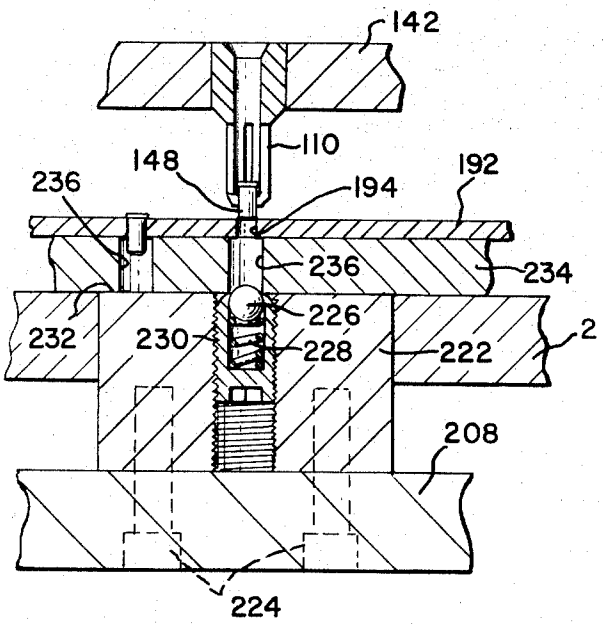


Fig. 11

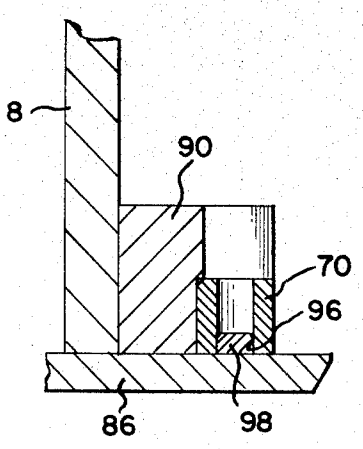


Fig. 13

METHOD AND MACHINE FOR FORMING AND INSERTING WORKPIECES IN AN APERTURED WORKPIECE HOLDER

This is a continuation of application Ser. No. 90,593, filed Nov. 18, 1970, now abandoned.

The present invention generally relates to a method and apparatus for automatically inserting serially supplied workpieces into the apertures of a workpiece holder properly indexed into position.

According to a preferred embodiment of the machine and in performance of the method according to the present invention, a plurality of workpieces are serially supplied to a work station which includes a stationary anvil cooperating with a reciprocating hammer to form and condition each workpiece to a slightly elliptical configuration. An escapement blade is slidably actuated together with the hammer for segregating an individual conditioned workpiece from the remaining serially supplied workpieces. The segregated workpiece is positively dissociated from the work station upon actuation of the escapement blade and is received within a surrounding collet. A transfering mechanism in the form of a ram is slidably actuated within the collet to transfer the workpieces to an apertured workpiece holder, for example, a card or printed circuit board, or other stiff or flexible material, properly indexed into position adjacent the collet. In the event that a workpiece is not positively dissociated from the work station and positioned properly within the collet for insertion, the machine will shut off automatically to prevent continued cycling of the machine subsequent to an improper insertion cycle.

The machine conditions each workpiece for an interference fit prior to insertion, thereby eliminating inadvertant removal of the workpieces after insertion. All of the operations are performed on the exterior of each individual workpiece in order to eliminate damage to the workpiece interior structure. Since the machine automatically shuts off during an improper insertion cycle, the invention automatically and immediately detects an omitted workpiece insertion, which advantageously eliminates the need for subsequent inspection of the card or printed circuit board apertures for an inadvertant workpiece omission. Additionally, the forming and conditioning of each workpiece for an interference fit within the card or printed circuit board prevents inadvertant removal therefrom.

It is therefore an object of the present invention to provide a method and machine for automatically forming and conditioning a plurality of workpieces and individually segregating and inserting the workpieces into an apertured workpiece holder without damaging the interior structure of the workpieces.

Another object of the present invention is to provide a method and machine for automatically inserting workpieces sequentially into an apertured workpiece holder, and for automatically detecting the inadvertant omission of an inserted workpiece.

Still another object of the present invention is to provide a method and machine for automatically inserting a plurality of workpieces sequentially in corresponding apertures of a workpiece holder, and for forming and conditioning the exterior configuration of the workpieces for an interference fit within the apertures.

A further object of the present invention is to provide a method and machine for automatically inserting a plurality of workpieces sequentially within corresponding apertures of a workpiece holder, and for eliminating the need for subsequent inspection of the workpiece holder for an inadvertant omission of a workpiece.

Other objects and many attendant advantages of the present invention will become apparent upon perusal of the following detailed description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a fragmentary perspective of a preferred embodiment of a forming and inserting machine according to the present invention;

FIG. 2 is a fragmentary front elevation with parts partially broken away and with parts in section illustrating the preferred embodiment shown in FIG. 1 in readiness for an inserting operation;

FIG. 3 is a fragmentary front elevation of the preferred embodiment shown in FIG. 1 with parts partially broken away and with parts in section to illustrate the preferred embodiment shown in FIG. 1 upon completion of an insertion operation;

FIG. 4 is an enlarged fragmentary elevation of a portion of the embodiment shown in FIG. 3 with parts partially broken away and with parts in section in order to illustrate further in detail the relative positions of certain machine parts and workpieces upon completion of an insertion operation;

FIG. 5 is an enlarged fragmentary section taken along the line 5—5 of FIG. 2 illustrating the relative positions of certain parts of the machine shown in FIG. 2 in readiness for an insertion operation, and further illustrating a workpiece in registration against a release door and in position for insertion, with a serially adjacent workpiece located at a work station anvil of the machine and adjacent to a forming hammer and an escapement blade;

FIG. 6 is an enlarged fragmentary section of a portion of the preferred embodiment as shown in FIG. 5, and further illustrating the relative positions of the machine parts shown in FIG. 5 upon completion of an insertion operation, with the release door pivoted away from a workpiece, the workpiece located within a collet in readiness for striking by an inserting ram, with the serially adjacent workpiece being formed into an elliptical configuration between the hammer and the anvil, and further with the escapement blade inserted in front of the serially adjacent workpiece preventing the same to drop into the collet;

FIG. 7 is an enlarged fragmentary section similar to FIG. 6 and illustrating the escapement blade undesirably in registration against an improperly positioned workpiece, and with the escapement blade in displaced relationship with respect to the forming hammer to illustrate a shut-off feature according to the present invention;

FIG. 8 is an enlarged fragmentary front elevation of a portion of the device shown in FIG. 3 illustrating the triggering of a reset switch upon completion of an inserting operation;

FIG. 9 is an enlarged fragmentary front elevation of a portion of the device shown in FIG. 3 illustrating the detection of a workpiece improperly positioned for insertion and the resultant shutoff of the machine upon a failure to actuate the reset switch;

FIG. 10 is an enlarged fragmentary elevation partially in section of a portion of the device shown in FIG. 2, further illustrating a formed and conditioned workpiece positioned within a surrounding collet in readiness for insertion within an aperture of a workpiece holder properly indexed into position adjacent to the collet;

FIG. 11 is an enlarged fragmentary elevation with parts in section illustrating an alternative structure for properly indexing an apertured workpiece holder into position adjacent to the collet shown in FIG. 10;

FIG. 12 is an enlarged fragmentary elevation partially in section particularly illustrating the details of a preferred workpiece, inserted according to the practices of the present invention and the intended use of the workpiece in receiving an electrical lead of a printed circuit board component; and

FIG. 13 is an enlarged detail section taken along the line 13—13 of FIG. 2.

With more particular reference to FIG. 1 of the drawings, there is shown generally at 1, a preferred embodiment of a machine according to the present invention including a generally planar work table 2 including an upstanding post 4. The work table additionally includes a mounting arm 6 carrying a plate 8 in spaced relationship from the planar surface of the work table 2.

OVERALL MACHINE STRUCTURE

As shown in FIGS. 1 and 2, the plate 8 includes a pair of elongated generally vertical slots 10 slidably received over a pair of corresponding dowels 12 projecting from the mounting arm 6. A manually operated adjustment screw 14 is threadably received in the plate 8 and engages against the arm 6 such that rotation of the screw 14 will vertically adjust the position of the plate 8 with respect to the fixed dowels 12 and with respect to the planar surface of the table 2.

As shown in FIG. 1, the machine includes a double-acting pneumatic power cylinder 16, manufacturer's model TC, manufactured by Tiny Tim Compressed Air Service Company of Dayton, Ohio mounted to the plate 8 by a pair of spaced pillow blocks 18 braced together by rods 20 extending therebetween. As shown in FIG. 3, an output fitting 21 of the power cylinder surrounds a reciprocating piston rod 22 having an enlarged cylindrical flanged fitting 24. A lever 26 is pivotally mounted by a pin 27 to a yoke 28 in turn mounted by cap screws to the plate 8. One end of the lever 26 is bifurcated and pivotally secured by a pin 30 to the flanged end of the fitting 24. The other end of the lever 26 is bifurcated and pivotally secured by a pin 32 to one end of a link 34. As shown in FIG. 2, the other end of the link 34 is pivotally secured by pin 36 within the bifurcated end of a sliding ram 38. The ram 38 is slidably received in a pair of sleeve bearings 39 carried by spaced bearing blocks 40. The ram 38 includes a reduced diameter elongated cylindrical end portion 42 for a purpose to be hereinafter described in detail.

As shown in FIG. 3, the ram 38 includes a laterally extending cam 41 mounted thereon by machine screws 42'. The cam 41 includes a recessed arcuate surface 44 adjacent to an elongated planar cam surface 46. The cam is vertically slidable within a slot 48 formed in an elongated plate 50 connecting the two bearing blocks 40. As shown in FIG. 2, a cam follower in the form of a roller 52 is rotatably secured by a pin 54 to an arm 56 projecting laterally from one end of an arm 58. The arm 58 is pivotally secured by pin 60 to a second yoke 62 secured by cap screws 64 to the plate 8. The remaining end of the lever arm 58 is provided with a notch receiving a pin 66 mounted within a recess 68 of an elongated, generally rectangular forming hammer 70. A pin 72 is located at one end of the forming hammer and receives a hook end of a coil spring 74. The other hook end of the coil spring 74 is received over a pin 76 carried at one end of a flanged mounting post 78, which may advantageously house the input fitting for the compressed air supply to the power cylinder 16. As shown more particularly in FIG. 3, the forming hammer 70 is of elongated rectangular configuration and is defined by a planar bearing surface 80 and an opposed inverted planar bearing surface 82. The bearing surface 82 is in slidable registration on a planar surface 84 of a work station table 86 and the planar surface 80 of the hammer 70 is in slidable registration on an inverted planar surface 88 of a mounting block 90 which is apertured at 92 in order to provide clearance for the notched end of the lever arm 58 engaged on the pin 66 of the hammer 70. The block 90 is secured by machine screws 94 to the plate 8. Thus, the forming hammer 70 is constrained for lateral sliding motion interposed between the work station table 86 and the block 90. The inverted surface 82 of the forming hammer 70 is provided with an inverted groove 96 extending longitudinally of the forming hammer 70. Received in the groove is an elongated escapement blade 98 in the form of a thin plate terminating in an enlarged end portion 100 which protrudes from the terminal end 102 of the forming hammer 70. A recess is provided in the end of the enlarged end portion 100 and receives therein one end of a coil spring 104. A projecting pin 106 extends from the flange 78 and receives thereover the other end of the coil spring 104. In practice, the coil spring 104 is maintained in compression against the flange 78 and the bottom of the recess provided in the enlarged end portion 100 of the escapement blade 98. This serves to bias the enlarged end portion of the escapement blade in abuttment against the terminal end 102 of the forming hammer 70 and in opposition to the resilient action of the relatively enlarged coil spring 74.

With more particular reference to FIG. 2, the work station table 86 has an extended portion 108 interposed between the post 4 and the ram end portion 42. Mounted in the extended end portion of the work station table is a depending collet 110 which is longitudinally aligned with the post 4 and the ram end portion 42, for a purpose to be hereinafter described in detail.

FORMING HAMMER AND ESCAPEMENT BLADE

With more particular reference to FIG. 5, considered in conjunction with FIG. 1, the particular details of the machine will be further described. FIG. 5 is a fragmentary enlarged plan view of portions of the forming hammer and portions of the escapement blade structure adjacent to the ram end portion 42. Thus in FIG. 5, the rectangular forming hammer 70 is constrained to slidably reciprocate between a vertical inner wall 112 of the block 90 and a vertically extending cover plate 114 secured to the block 90 by screws as shown in FIG. 1. Thus the forming hammer 70 is encircled by the

block 90 and the cover plate 114, and is constrained for sliding motion in a direction laterally of the longitudinal axis of the ram end portion 42.

With more particular reference to FIG. 5, the end portion of the forming hammer 70 terminates in a reduced rectangular end portion 116 having a planar terminal end 118 serving as a hammer face. The hammer end portion 116 further includes a tapered sidewall 120, serving as a camming surface, and a generally L-shaped notch 122 adjacent to the hammer face 118. As further shown in FIG. 5, the escapement blade 98 has a tapered sidewall 124 which is parallel to, but laterally recessed within, the confines of the sidewall camming surface 120 of the hammer. The escapement blade as before described is of thin plate material and is slidably received within the inverted channel 96 of the hammer 70. The escapement blade has a terminal end portion 126 which projects vertically into the L-shaped notch 122 of the hammer 70, as shown more particularly in FIG. 10. The tip of the terminal end portion is tapered and is bounded by a planar sidewall 128 disposed immediately adjacent to and perpendicular to the planar hammer face 118.

FEED TRACK

With reference being made to FIG. 5, taken in conjunction with FIG. 1, a generally vertically inclined workpiece feed track 130 communicates with the interior of a generally cylindrical hopper 132. The hopper cover plate 134 carries a shaft 136 of a commercially available wiper brush (not shown) and a linkage 138 operatively connects the shaft 136 to the output shaft of an electrical motor 140 mounted on the arm 6.

As shown in FIG. 5, taken in conjunction with FIG. 10, the feed track 130 includes two spaced rails 142 and 144. The rail 144 is provided with a vertically recessed longitudinal ledge portion 146, adjacent to and parallel with the surface of the other rail 142. A longitudinal space between the ledge 146 and the rail 142 provides a conveyor track for a plurality of workpieces each having a configuration, for example, like that shown in FIG. 10. With reference to FIG. 10, each workpiece is characterized by a relatively reduced diameter elongated cylindrical portion 148 having at one end thereof an enlarged annular lip 150. A plurality of such workpieces are serially supplied from the hopper 132 of FIG. 1 and are conveyed serially along the feed track with the enlarged rim 150 of each workpiece in slidable registration with the surface of the ledge 146 and the rail 142, and with the cylindrical portion of each workpiece 148 being suspended vertically in the conveyor space between the rails 144 and 142. Further the rail 144 is provided with a covering rail 152, overlying and in spaced relationship from the rim 150 of each individual workpiece being conveyed between the rails 144 and 142. For example, the covering rail 152 is secured by cap screws 154 to the rail 144.

As more particularly shown in FIG. 5, taken in conjunction with FIG. 10, the rail 144 includes a notch portion 156 which partially receives laterally therein the hammer striking face 118 and the tip 128 of the escapement blade 98. The hammer face 118 and the escapement blade tip 128 are thus in opposed relationship with respect to a planar sidewall 158 of the rail 142, which sidewall 158 serves as an anvil for the forming hammer face 118 as described hereinafter. The rail 142 terminates in a generally vertical end wall 160 as shown in FIG. 5.

RELEASE DOOR

With more particular reference to FIGS. 5 and 1, a workpiece release door 162 is mounted on the surface of the table 86 by a pivot pin 164. A longitudinal sidewall 166 of the release door is biased into engagement against the end portion 160 of the rail 142 by the action of a coil spring 168 secured to a post 170 provided on the release door 162. As shown in FIG. 1, the other end of the spring 168 is connected to a stationary arm 172 provided on the feed track 130.

With reference again to FIG. 5, the release door 162 includes a tapered sidewall 174 immediately adjacent to the tapered sidewall 120 of the forming hammer. As shown in FIGS. 5 and 6 taken together, the release door 162 is further provided with a vertically extending arcuate recess portion 176 having an adjacent vertically recessed ledge 178. As shown in FIG. 5, a first supplied workpiece is supplied by the action of gravity down the feed track and initially is shown with its enlarged rim 150 in registration on the ledge 178 of the release door 162 and in partial registration also on the rail 142 and also on the ledge 146 of the feed track 130. The enlarged rim 150 of a second supplied workpiece immediately behind the first workpiece engages the rim 150 of the first supplied workpiece with the reduced diameter cylindrical portion in position against the anvil in opposed relationship from the hammer face 118. The tip 128 of the escapement blade is opposite the space between the reduced diameter cylindrical portions 148 of the first and second supplied workpieces.

COLLET

With more particular reference to FIGS. 10 and 2, a collet 110 is mounted in the table 86 at a location adjacent to but below the terminal end of the feed track. The collet is further provided therethrough with a vertically extending cylindrical bore 180 of sufficient diameter to receive therein the enlarged rim 150 of a workpiece 148. The bore 180 communicates with an outwardly flared counterbore 182 adjacent to the surface of the table 86 and immediately adjacent to the terminal end of the feed track 130. The collet 110 terminates in a plurality of integral circumferentially spaced resilient fingers 184, the ends of which project radially inwardly at 186 thereby reducing the effective diameter of the bore 180 and preventing inadvertant passage therethrough of the enlarged rim 150 of a workpiece 148. The post 4 which projects from the surface of the work table 2 is in the form of a sleeve containing a vertically mounted plunger 188 which, as shown in FIG. 10, terminates in a semi-spherical tip 190.

MACHINE OPERATION

With reference yet to FIG. 10 and 2, the operation of the machine preferred embodiment will be described in detail. Thus as more particularly shown in FIG. 10, an operator first indexes an aperture 194 provided in a

workpiece holder **192** into position over the post **4** until the tip **190** of the plunger **188** is partially received in the aperture **194**. Such procedure properly indexes the aperture **194** into a position adjacent to and below the collet fingers **184** to receive therein a workpiece **148**. Insertion of a workpiece is accomplished by an operator in a fashion similar to that of indexing a sound reproducing record over the spindle of a turntable.

As shown in FIG. **2**, the workpiece holder **192** is thus properly indexed to position for receiving an inserted workpiece **148**. With reference to FIGS. **2** and **3**, the machine is then actuated by a foot treadle switch, or any other well known actuating switch, operatively connected to the power cylinder according to the manufacturer instructions. The actuated power cylinder slidably actuates the piston rod **22**. The lever **26** will then be pivoted clockwise about the pin **27** from its position shown in FIG. **2** to its position shown in FIG. **3**. The ram **38** together with its associated cam **41** will vertically translate from their positions shown in FIG. **2** to their positions shown in FIG. **3**. As the cam **41** vertically translates, the roller **52** will be forced to traverse initially over the recessed arcuate surface **44** of the cam, which causes the arm **58** to pivot clockwise on the pin **60**. Such action will immediately slidably actuate the forming hammer **70** and the associated escapement blade **98** horizontally from their positions shown in FIG. **2** to their positions shown in FIG. **3**. Such action will elongate the coil spring **74** producing stored energy therein. Also, the compressed coil spring **104** will elongate and release its stored energy to insure positive sliding actuation of the escapement blade.

To more particularly describe the sliding actuation of the hammer and associated escapement blade, reference will be made to FIGS. **5** and **6**, considered together with FIGS. **1** and **2**. FIG. **5** shows the initial positions of the hammer and escapement blade in relation to the serially supplied workpieces **148** in readiness for an insertion operation. As the machine is actuated as above described, the hammer and the escapement blade will be slidably actuated from their positions shown in FIG. **5** to their positions shown in FIG. **6**. With more particular reference to FIG. **6**, the escapement blade **128** will become slidably interposed between the reduced diameter cylindrical portions **148** of the first and the second serially supplied workpieces. Simultaneously, the hammer **70** will slidably actuate causing the face **118** thereof to strike the cylindrical portion **148** of the second workpiece against the anvil **158**. Such action forms the cylindrical portion **148** to a desired slightly elliptical configuration as shown in FIG. **6** thereby conditioning the workpiece for an interference fit as explained in detail hereinafter. As shown in FIG. **6**, as the escapement blade tip is slidably actuated, the tapered sidewall **124** of the escapement blade progressively impels the first workpiece to disengage from the terminal end of the feed track **130**. The planar surface **128** of the escapement blade is interposed in front of the second workpiece which prevents the second workpiece from traveling by the action of gravity past the terminal end of the feed track. As shown in FIG. **6**, as the hammer **70** slidably actuates, the tapered sidewall **120** of the hammer will wedgingly engaged the adjacent tapered surface **174** of the release door **162**. Such action will force the release door to pivot generally counterclockwise about its pivot pin **164** in opposition to the resilient action of the coil spring **168**. Such action further disengages the release door **162** from the terminal end **160** of the feed track **130** allowing the first workpiece to become disengaged from the feed track as described and slidably traverse by the action of gravity through the vertical recess **176** of the release door **162**.

With reference to FIGS. **6** and **10**, the first workpiece is further received in the collet **110**, and by the action of gravity, traverses through the bore **180** of the collet **110** until received in registration against the tips **186** of the collet fingers which grip the first workpiece and position the same adjacent to and vertically in alignment with the corresponding aperture **194** of the card or printed circuit board **192**.

To further explain the operation of the preferred embodiment, reference will be made to FIG. **4**, considered together with FIGS. **3** and **10**. As shown in FIG. **3**, as the ram **38** slidably actuates, the roller **52** immediately traverses the arcuate surface **44** of the cam **41** with the result that the first workpiece enters the collet **110** as described. Upon the continued sliding actuation of the ram **38**, the roller **52** will traverse along the projecting vertical surface **46** of the cam **41**, thereby retaining the hammer **70** and the escapement blade **98** in their positions shown in FIG. **6**. Such action retains the hammer in engagement against the second workpiece and the escapement blade tip in front of the second workpiece to prevent the same from entering the collet **110**, as the ram **38** continues in its sliding motion.

As more particularly shown in FIGS. **3** and **4**, the reduced cylindrical end portion **42** of the ram **38** will be forced longitudinally of the bore **180** of the collet **110** as the hammer and escapement blade are retained in their positions shown in FIG. **6**. The ram will thus forcibly engage the workpiece within the collet and forcibly transfer it from the collet into the aperture **194** of the card or printed circuit board **192**. As shown in FIG. **4**, the fingers **184** of the collet are resiliently biased radially outward upon passage therebetween of the ram end portion **42**. This allows the enlarged rim **150** of the workpiece **148** to be forced past the tips **186** of the fingers and inserted in the corresponding aperture **194**.

As the workpiece engages the semi-spherical tip of the plunger **188**, the plunger is forcibly retracted within the post **4** against the action of a compressed coil spring **196**. The plunger **188** terminates in an enlarged diameter end portion **198** which is slidably mounted within a chamber block **200** together with the coil spring **196**. The chamber block **200** is threadably secured to the end of the post **4** which has a tapered recess **202** acting as a stop for a frusto-conical portion **204** of the plunger **188**. The post **4** is additionally threadably secured in a mounting block **206** which forms a part of the table **2**. The chamber block **200** is secured in any well known manner to a plate **208**, in turn threadably secured to the mounting block **206** by cap screws **210**. The post **4** extends upwardly through an aperture **201** provided in the table **2**. After insertion of the workpiece **148** by the ram **42**, the machine must be positively actuated in a manner to be explained hereinafter in order to retract the ram end portion **42** from the collet and return actuate the machine to its starting position shown in FIG. **2**.

This allows another workpiece to be supplied in registration against said release door. The board carrying the inserted workpiece may then be indexed to remove the inserted workpiece **148** from the post **4** and to index another aperture **194** over the plunger **188** whereupon the insertion operation may be repeated. To permit removal of the workpiece **148** from the post **4**, the post is provided with a longitudinal slot **212** which obviates the need for lifting the board or card to remove the inserted workpiece from the post **4**. Upon such removal of the workpiece as described, the compressed resilient spring **196** will reciprocate the plunger **188** so that the spherical tip thereof projects above the post **4** enabling the operator to register another aperture of the card or board thereon.

MACHINE RESETTING AND SHUT-OFF FEATURE

With reference to FIGS. **8** and **1**, a positive resetting and shut-off feature of the machine will be explained. The escapement blade **98** has mounted thereto a laterally extending finger **214** which engages a leaf spring **216** when the escapement blade slidably actuates to its position shown in FIG. **6**. The leaf spring resiliently bends in cantilever fashion to depress a plunger **218** of an electrical switch shown generally at **220**. The switch **220** then supplies an electrical signal to the double-acting power cylinder **16** for initiating the reset action of the machine. The particular switch **220** as well as its circuitry and interface with the power cylinder **16** is eliminated for clarity, since such requirements are well known and may be made according to specifications prescribed by the manufacturer of the power cylinder. Thus, the switch **220** supplies an electrical signal to the power cylinder **16** which positively resets the machine upon completion of an insertion operation as described. The machine will thus return from its position shown in FIG. **3** to its positions shown in FIG. **2** in readiness for a repeated insertion operation.

With reference to FIGS. **7** and **9**, a shut-off feature of the present invention will be described in detail. As shown in FIG. **7** it may occur that a workpiece **148** is not properly urged by the action of gravity down the feed track and become in registration with and positioned against the ledge **178** of the release door **162**. If this occurs the workpiece will not disengage from the end **160** of the feed track and enter the collet **110** as heretofore described in conjunction with FIG. **10** of the drawings. This occurance is usually prevented since the feed track **130** is vertically inclined, and since the terminal end **160** is the lower most point of the feed track enabling the workpieces to be properly positioned against the ledge **178** by the action of gravity. However, should a workpiece **148** for some reason not disengage from the terminal end **160** of the feed track, the slidably actuated escapement blade tip **126** will impinge against the workpiece as shown in FIGS. **7** and **9**. This results in only partial displacement of the blade as compared to its normally complete displacement shown in FIG. **6**. Thus, as shown in FIG. **8**, the end portion **100** of the blade will separate from the end **102** of the forming hammer which slidably actuates in its normal manner in order to form and condition a workpiece **148**, as shown in FIG. **7**. Thus, the finger **214** secured to the escapement blade near the enlarged terminal end **100** thereof is prematurely terminated short of engagement against the leaf spring **216** to initiate a reset signal from the electrical switch **220**. Since the double-acting cylinder **16** must be positively activated to reset the machine, the machine will shut-off at the completion of its insertion operation. This indicates to an operator of the machine that a workpiece failed to be inserted during the insertion operation. Such action further serves to eliminate the need for a subsequent inspection of the card or printed circuit board **192** for possible omission of inserted workpieces during repeated insertion operations performed by the machine.

MODIFIED POST

With reference to FIG. **11**, a modification will be described in detail. The post **4** may be replaced by a mounting block post **222** secured on the surface of the plate **208** by cap screws **224**. The plunger **188** may be replaced by a spherical ball **226** engaging a resilient spring **228** mounted in a chamber block **230**, in turn mounted within the block **222**. The ball **226** projects through a top planar bearing surface of the table **2**. The apertured card or printed circuit board **192** is shown mounted over a template **234**, having enlarged apertures **236** corresponding in position to the apertures **194** of the card or printed circuit board. As shown in FIG. **11**, the template apertures **236** are larger in diameter than the apertures of the card or printed circuit board and are thus more readily registrable upon the ball **226** in readiness for an insertion operation by the machine **1**. After completion of an insertion operation, the template **234** may be slidably indexed in order to position another aperture of the card or printed circuit board for a repeated insertion operation. The ball is positively retracted into the chamber block by the slidably indexed template without a need for lifting the template from the planar surface **232**. Thus, the template is well suited for indexing by an automatic indexing mechanism, not shown for purposes of clarity.

WORKPIECE

With reference to FIG. **12**, a preferred embodiment of the workpiece **148** will be described in detail. Each workpiece **148** mounted in the card or printed circuit board **192** is characterized by the enlarged rim **150** in the form of a lip receiving the end **238** of a generally cylindrical slotted spring sleeve **240** similar in structure to the spring shown in each of U. S. Pat. Nos. 3,222,632 and 3,286,671. The aperture **194** of the card or printed circuit board **192** is provided through an electrical circuit path **242** mounted on the card or printed circuit board **192**. A quantity of solder **244** adheres to the circuit path **242** and the workpiece **148** to provide mechanical and electrical contact therebetween. In a typical use of the workpiece **148** an electrical lead **246** of an electrical component **248**, such as a transistor or an integrated circuit component, is resiliently received in mechanical engagement within the spring **240** thereby establishing electrical contact from the lead **246** to the circuit path **242**.

Many alternative types of workpieces may be inserted by the machine described. Examples of such fasteners are, aperture lining sleeves, grommets, shafts, pivots, rivets, pop rivets, blind rivets and other

fasteners. Thus what has been shown is a method and machine for inserting workpieces within a workpiece holder. The machine includes a reciprocating escapement blade which positively segregates a workpiece from a plurality of workpieces and positively dissociates the workpiece from a feed track and an anvil. The escapement blade further positively urges a segregated workpiece into a collet and provides a barrier preventing the remainder of the workpieces to also enter the collet. A transfer mechanism forcibly transfers the workpiece within the collet to a workpiece holder such as a card or printed circuit board.

A workpiece is urged by the action of gravity to initially register against a release door, with the remainder of the workpieces being serially supplied and positioned individually against an anvil cooperating with a reciprocating hammer which forms and conditions the workpieces which are normally too small to be formed and conditioned by a hand operation. The hammer additionally actuates the release door as the escapement blade positively urges a segregated workpiece into the collet. The hammer further remains impinged against a workpiece to prevent additional workpieces from entering the collet during completion of the insertion operation.

Other modifications and embodiments of the present invention will be covered without departure from the spirit and scope of the invention as defined by the appended claims, wherein:

What is claimed is:

1. A machine for inserting workpieces and a workpiece holder, comprising;

means for serially feeding a plurality of workpieces to a work station, an anvil, a hammer cooperating with said anvil for individually forming and conditioning each workpiece, segregating means for segregating a first conditioned workpiece from the remainder of said workpieces, a release door initially receiving said first segregated workpiece in registration thereagainst, actuating means for displacing said release door and for disengaging said first segregated workpiece from said door, a collet adjacent to said door and receiving said first segregated workpiece upon disengagement thereof from said door, a workpiece holder means indexed to a position adjacent to said collet, transfer means for transfering said first segregated workpiece from said collet to said workpiece holder means, and resetting means for returning said transfering means and said hammer and said escapement blade to their initial positions permitting another formed and conditioned workpiece to register against said release door.

2. The structure as recited in claim **1**, wherein said resetting means includes switch means for initiating a reset signal upon engagement of said switch means by a portion of said segregating means.

3. The structure as recited in claim **2**, and further including means for prematurely terminating displacement of said segregating means short of engagement with said switch means should a conditioned workpiece fail to register against said release door.

4. The structure as recited in claim **1**, wherein, said segregating means positively dissociates a segregated workpiece from said anvil and transfers said segregated workpiece into said collet.

5. The structure as recited in claim **1**, and further including: indexing means for indexing said workpiece holder means into position adjacent said collet for receiving insertion of a workpiece.

6. A method for inserting workpieces in a workpiece holder, comprising the steps of:

supplying workpieces serially along a feed track to an anvil, forming and conditioning said workpieces against said anvil, individually segregating a formed and conditioned workpiece from the remainder of said workpieces, and inserting said segregated workpiece with an interference fit within a workpiece holder.

7. The method as recited in claim **6**, and further including the steps of: positively urging said segregated workpiece into a collet, using said collet to position said segregated workpiece adjacent to said workpiece holder, and said step of inserting further includes the step of transfering said segregated workpiece from said collet to said workpiece holder.

8. A method for inserting workpieces having substantially cylindrical-shaped body portions in a workpiece holder, comprising the steps of:

supplying said workpieces serially along a feed track to a work station,

forming and conditioning said workpieces by applying a radially directed force successively against said cylindrical body portions of each of said workpieces to cause the same to become elliptically configured,

individually segregating a formed and conditioned workpiece from the remainder of said workpieces,

transferring each of said segregated workpieces from said work station to said workpiece holder, and

inserting each of said segregated workpieces with an interference fit within said workpiece holder.

9. The method as recited in claim **8**, wherein said step of forming and conditioning said workpieces by applying a radially-directed force thereagainst includes:

compressing said cylindrical body portion of each of said workpieces between an anvil and a diametrically opposed relatively movable force applying member.

10. The method as recited in claim **8**, further including the step of:

positively urging each of said segregated workpieces successively into a collet movable between said work station and said workpiece holder

and wherein said step of inserting includes the step of transferring said segregated workpiece from said collet to said workpiece holder.

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