United States Patent [19]

Busler et al.

[11] **3,785,035**

[45] **Jan. 15, 1974**

[54] **INSERTION OF LINERS INTO HOLES IN PRINTED CIRCUIT BOARDS**

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

[22] Filed: **Feb. 12, 1969**

[21] Appl. No.: **811,269**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 741,760, July 1, 1968, abandoned.

[52] **U.S. Cl.** ..... **29/203 B,** 29/625, 174/68.5

[51] **Int. Cl.** **H05k 3/00**

[58] **Field of Search** 29/423, 203, 522, 29/525, 625–627, 467, 465, 464, 466; 227/135, 136; 83/228, 637; 269/37

[56] **References Cited**

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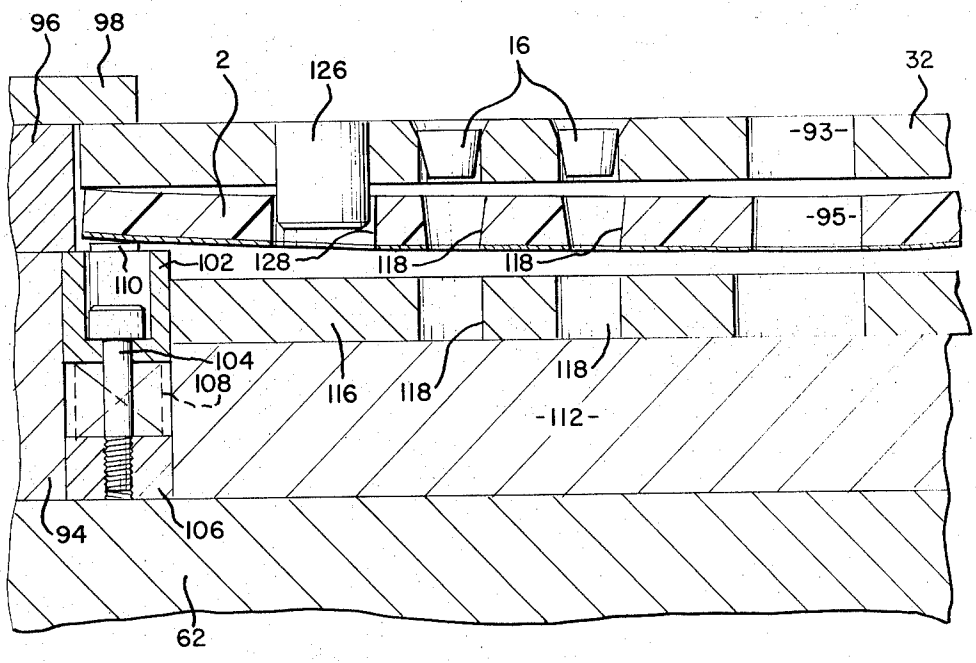
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Assistant Examiner—Joseph A. Walkowski
Attorney—William J. Keating, Frederick W. Raring and J. L. Seitchik

[57] **ABSTRACT**

Liners are inserted into holes in printed circuit boards by means of a templet having holes therein at locations corresponding to the holes in the printed circuit board. An excess of liners are placed on top of the templet and the templet is vibrated until one liner enters each hole in the templet. Thereafter, the templet is placed on top of the printed circuit board and the individual liners are punched from the templet holes into the printed circuit board holes.

4 Claims, 16 Drawing Figures



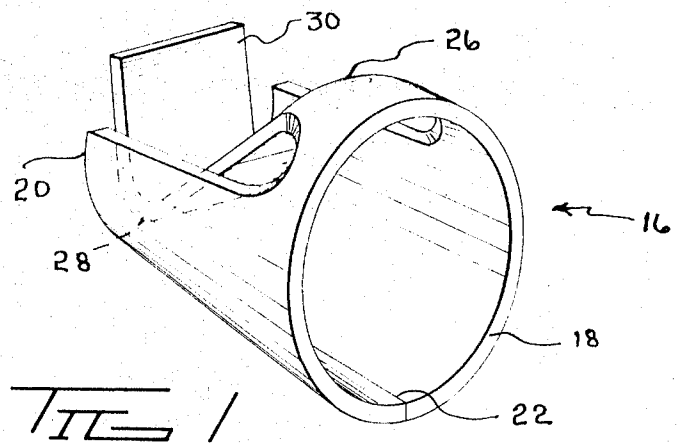


FIG 1

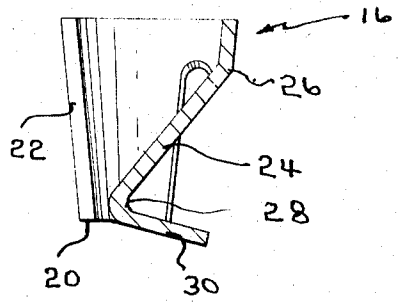


FIG 2

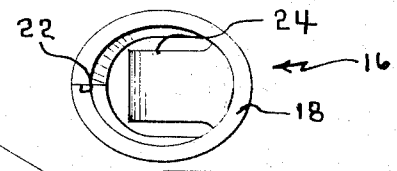


FIG 3

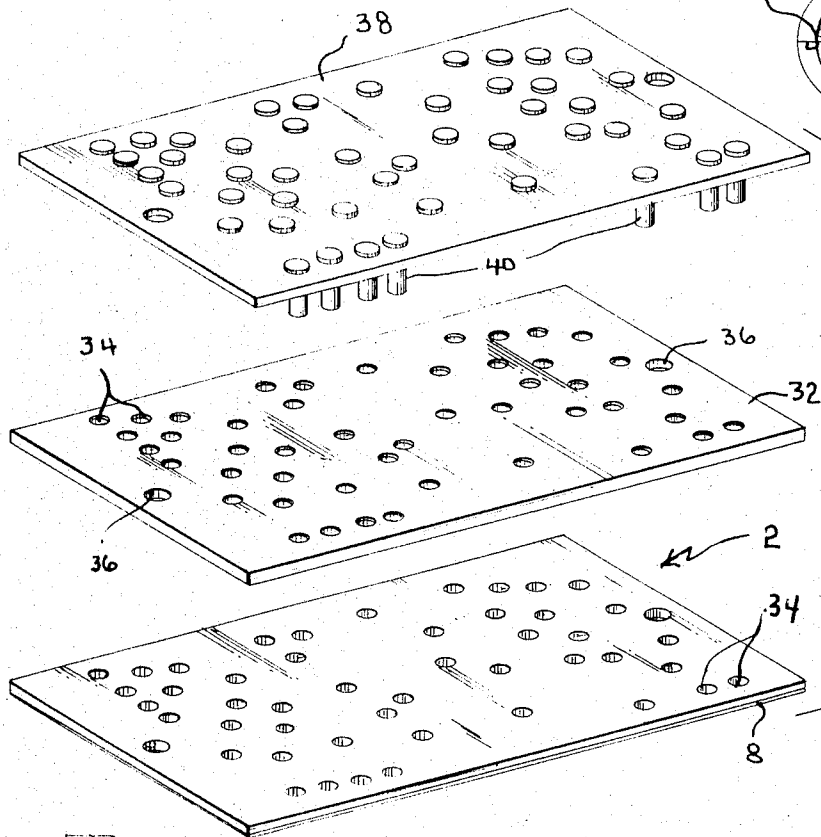


FIG 4

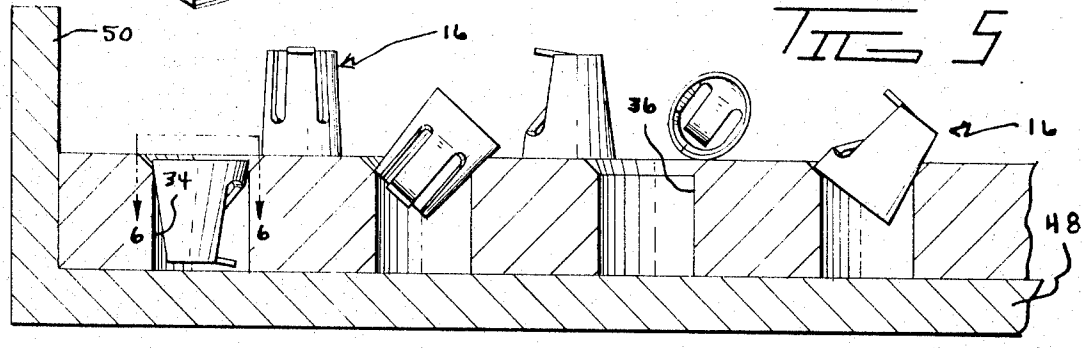


FIG 5

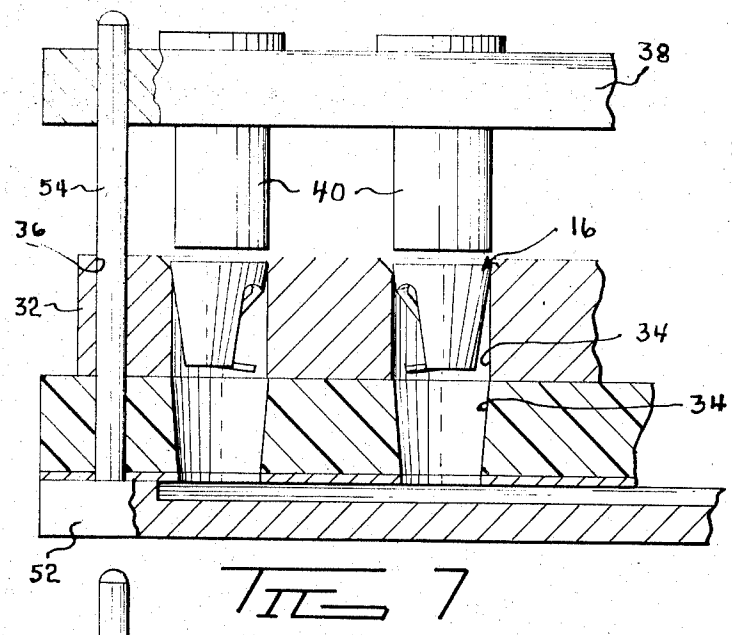


FIG 7

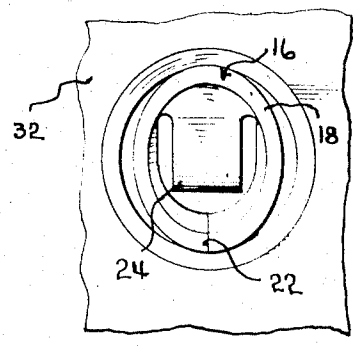


FIG 6

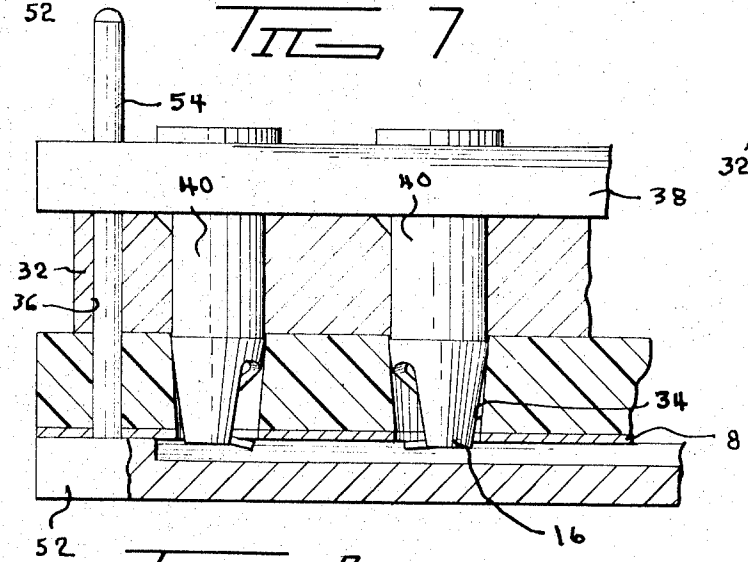


FIG 8

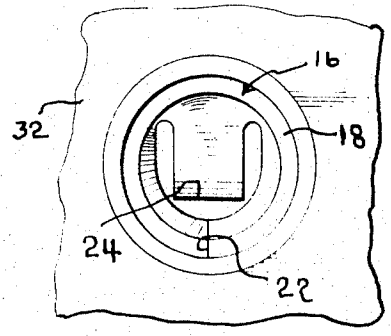


FIG 9

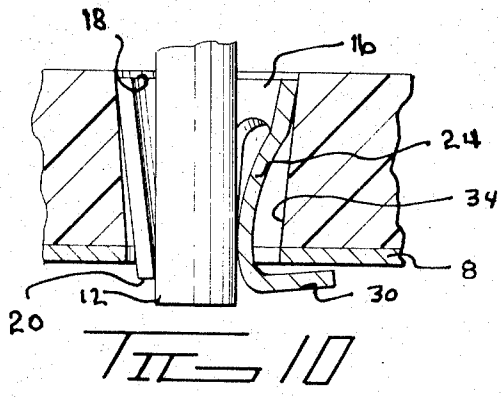


FIG 10

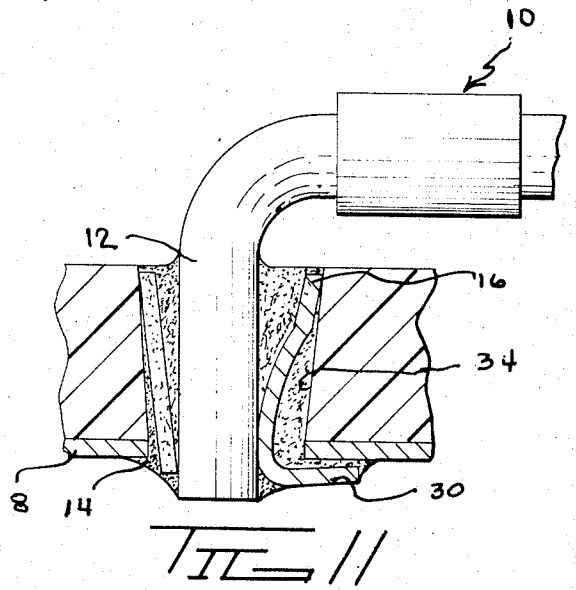


FIG 11

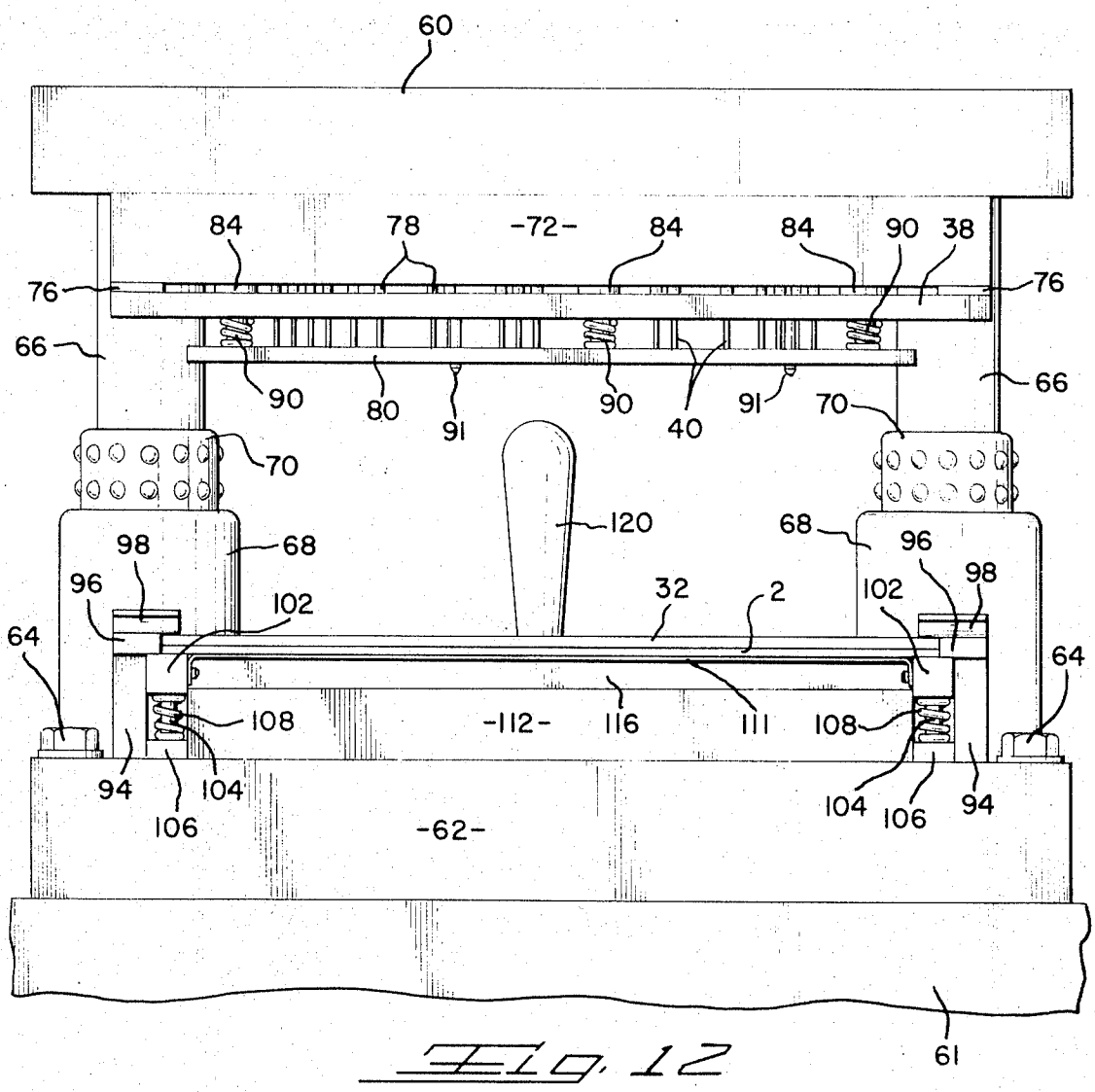
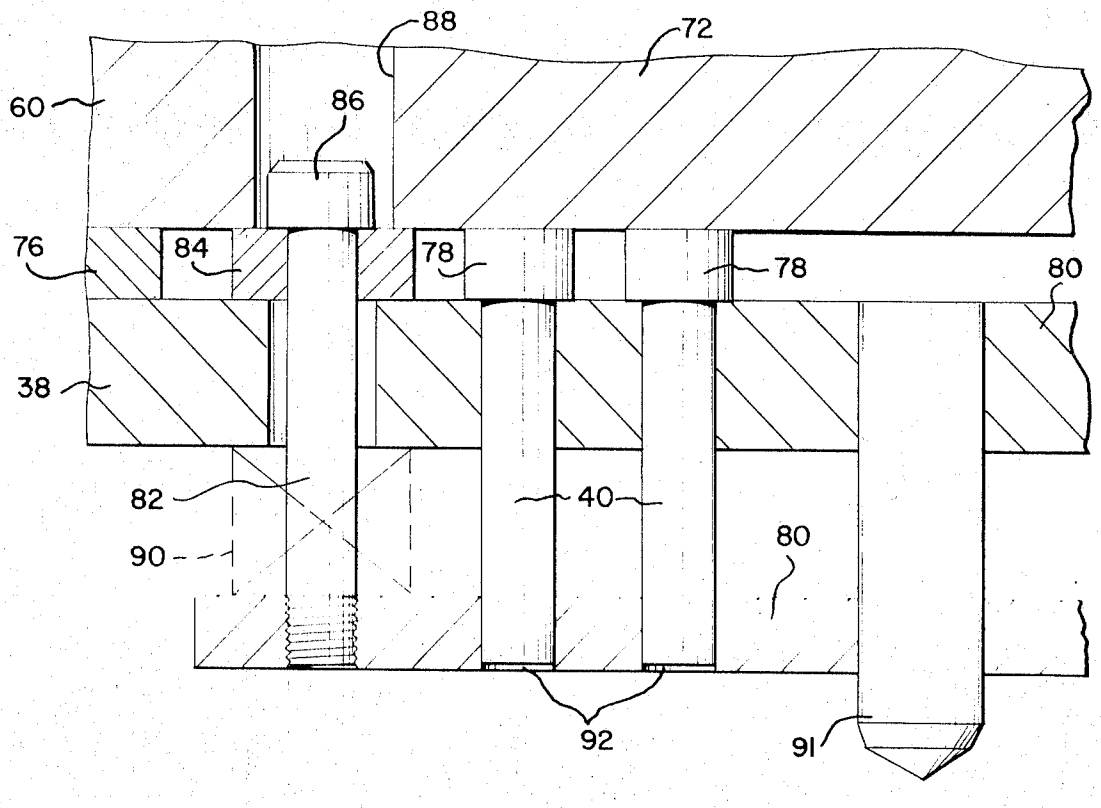

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FIG. 12


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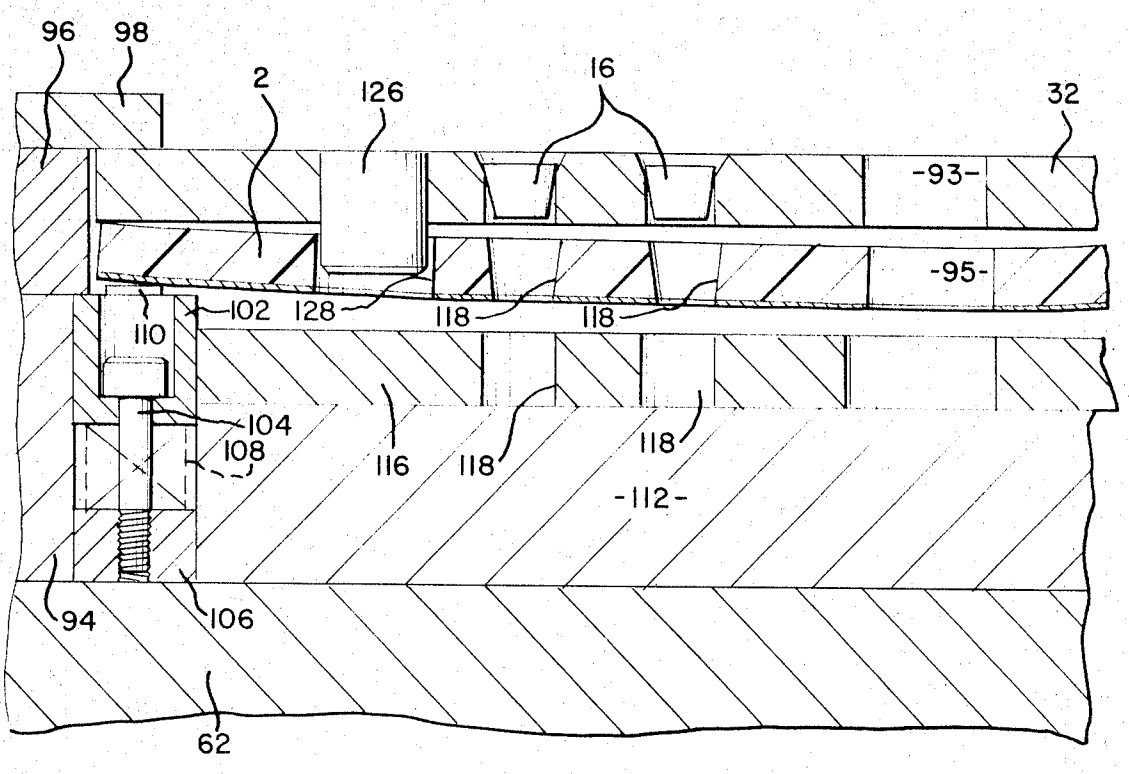

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Fig. 15

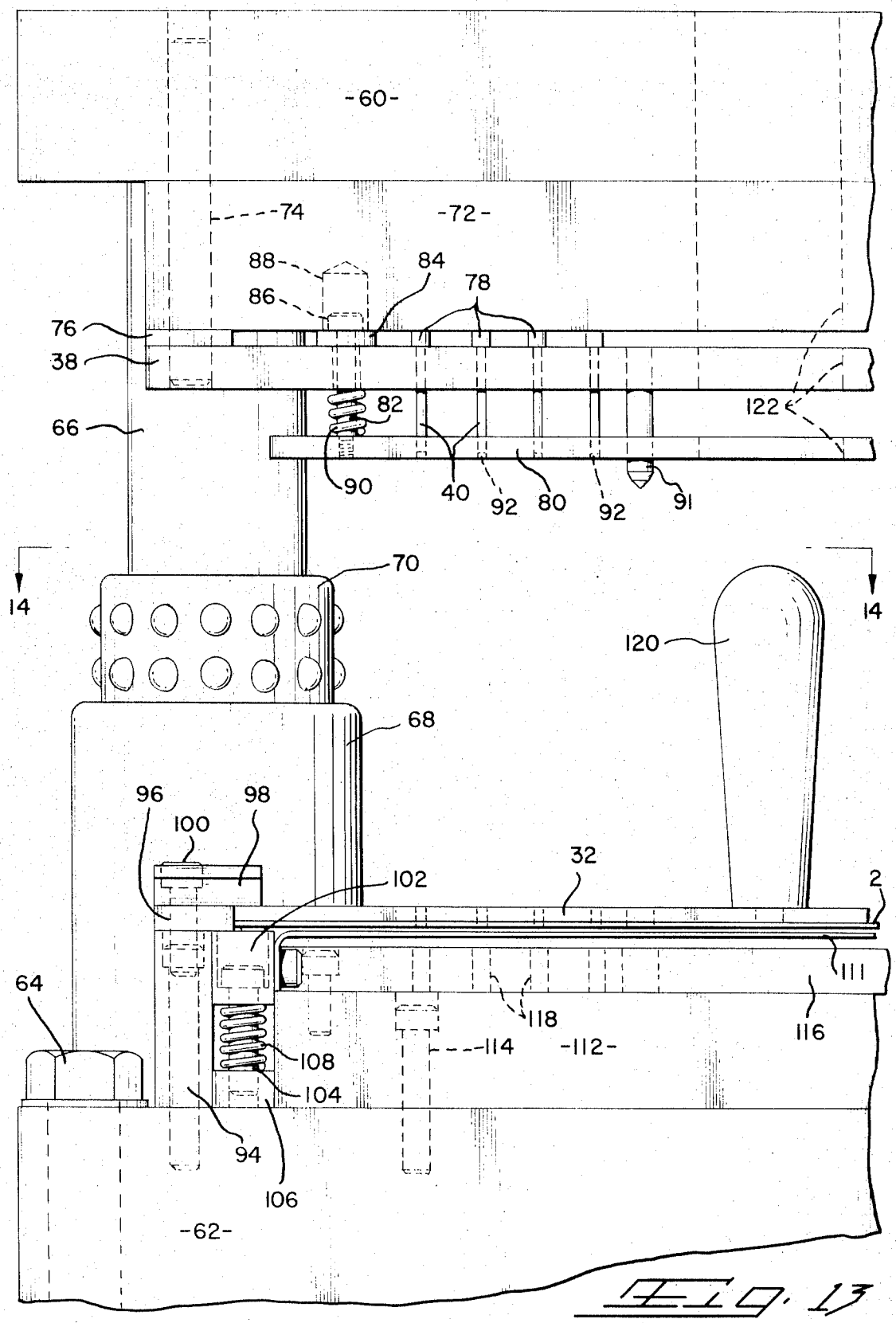

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Fig. 13

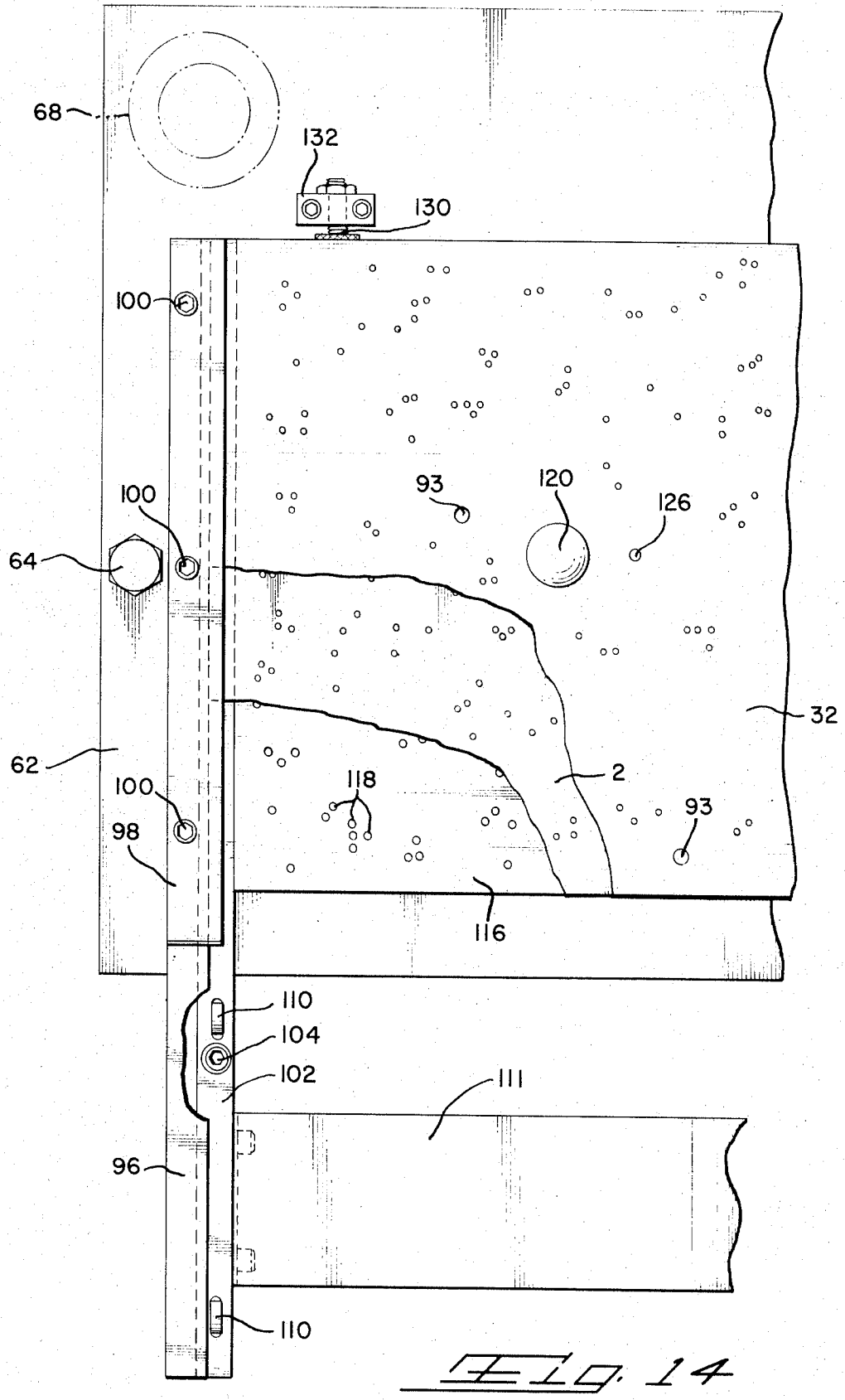

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FIG. 14

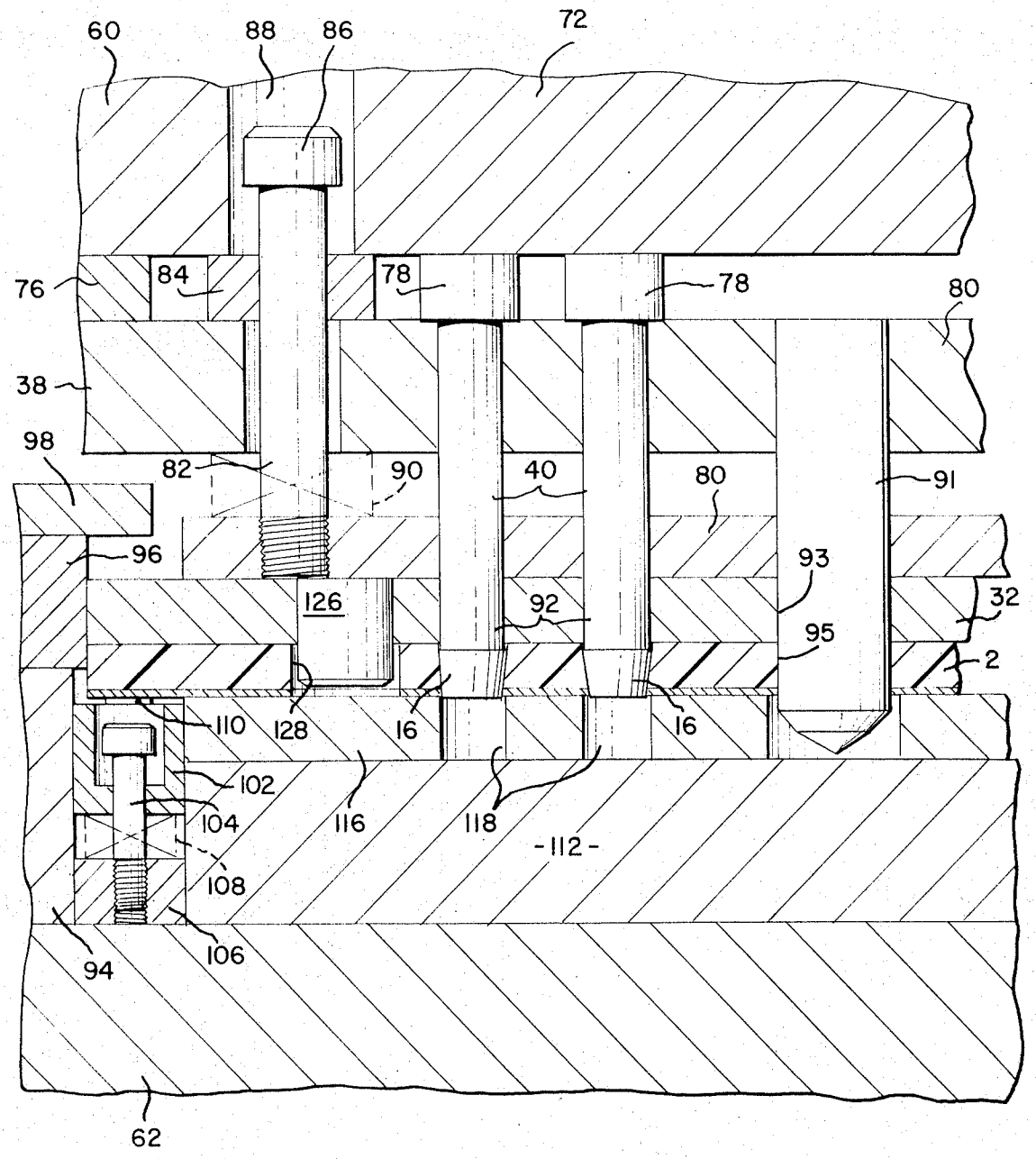

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Fig. 16

INSERTION OF LINERS INTO HOLES IN PRINTED CIRCUIT BOARDS

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of application Ser. No. 741,760, filed July 1, 1968, and now abandoned.

It is common practice in the art of manufacturing printed circuit boards to assemble the individual electrical components to the board by positioning a metallic liner in each hole in the board, inserting the wires extending from the components into the liners, and then dip soldering the entire board. The metallic liner usually has a relatively close fit in the printed circuit board hole to permit the solder to wick up from the solder bath by capillary action and effect permanent soldered connections of the leads from the electrical components to the conductors on the printed circuit board.

It has been common practice in the past to insert the liners into the board by conventional inserting devices similar to eyeletting machines but this method is relatively slow and time consuming, particularly where the printed circuit boards contain a large number of holes adapted to receive leads from electrical components. The instant invention is directed to the achievement of an improved inserting method for printed circuit board hole liners.

It is accordingly an object of the invention to provide an improved method of inserting liners into the holes of printed circuit boards. It is a further object to provide a method of inserting liners into printed circuit board holes by vibration. A still further object is to provide a method of inserting liners into printed circuit board holes which does not require a separate inserting operation for each hole in the board.

In accordance with a preferred embodiment of the invention, a templet is provided which has holes at the precise locations as the holes in the printed circuit board. This templet is mounted on a vibratory unit and an excess of hole liners, in loose piece form, is dumped onto the surface of the templet. The templet is then vibrated for a period of about 20 seconds or less during which the individual liners will be randomly bounced and move randomly over the surface of the board. During vibration, and as a result of this random movement and bouncing of the liners, a liner enters each of the holes in the templet. The dimensions and shape of the liners are such that the liners will be retained in the templet holes to permit handling of the templet for the subsequent steps of the process. The templet is then removed from the vibratory unit and placed above the printed circuit board and the liners are driven through the templet and into the holes in the board. This operation of driving the liners into the board is preferrably carried out by a punch plate having cylindrical punches thereon located to conform to the holes in the templet and the printed circuit board.

In the drawings:

FIG. 1 is a perspective view of a preferred form of printed circuit board hole liner adapted to be used in the practice of the invention.

FIG. 2 is a sectional side view of the liner shown in FIG. 1.

FIG. 3 is an end view of the liner shown in FIG. 1.

FIG. 4 is a perspective exploded view showing, in superimposed relationship, a printed circuit board, a templet, and a punch plate, the templet and punch plate being used to insert lines into the holes of the printed circuit board in accordance with the instant invention.

FIG. 5 is a sectional side view, on an enlarged scale, illustrating the manner in which the liners are positioned in the holes in the templet.

FIG. 6 is a view taken along the lines 6—6 of FIG. 5 and showing an end view of a templet hole having a printed circuit board hole liner contained therein.

FIG. 7 is a sectional side view showing the templet positioned on the upper surface of a printed circuit board and showing a punch plate above the templet, this view showing the positions of the parts immediately prior to punching of the hole liners from the templet into the holes in the printed circuit board.

FIG. 8 is a view similar to FIG. 7 but showing the positions of the parts after the liners have been inserted by punching into the holes in the printed circuit board.

FIG. 9 is a plan view on an enlarged scale showing a single hole in the printed circuit board having a liner positioned therein.

FIG. 10 is a sectional side view of a printed circuit board hole having a liner therein and having a component lead extending through the liner.

FIG. 11 is a view similar to FIG. 10 but showing the parts after the conductors on the underside of the printed circuit board have been soldered to the hole liners and the component leads.

Referring first to FIGS. 4, 10, and 11, a typical printed circuit board 2 of suitable plastic material such as an epoxy resin, is provided with a plurality of relatively small diameter holes 34 which are adapted to receive the leads 12 of components 10. The holes extend from the upper side of the board to the underside and communicate with the conductors 8 on the underside of the board so that when a lead wire is inserted through a hole and the lower surface of the board is floated on a solder bath, the lead wire will be soldered to the conductor as shown at 14. FIG. 11. When these holes are formed by a punching operation, as is commonly done, they are frequently not perfectly cylindrical but have a slightly greater diameter at their upper ends than at their lower ends because of the fact that some material is torn out by the punch on the side of the board which it initially enters. The nominal diameter referred to in this description is intended with reference to the diameter at the lower end of the hole.

In order to facilitate the soldering operation, and particularly to induce solder to wick-up from the solder bath by capillary action, it is common practice to provide a small sheet metal liner in the printed circuit board hole. It is desirable if these liners can be designed with the capability for performing the additional function of retaining a lead wire in the hole prior to the soldering operation so that the components can be assembled to the board and will remain in their intended positions until the lead wires from the components are firmly soldered to the conductors 8. It has been common practice in the past to insert the liners into the holes in printed circuit boards by more or less conventional inserting machines. The present invention is directed into a high speed inserting method which does not require inserting machines and is adaptable to the insertion of liners into boards having any possible hole pattern (i.e., having the holes randomly located in the board).

A preferred type of liner **16** adapted to be used in the practice of the instant invention comprises a thin walled sheet metal cylinder which tapers from an oval-shaped large end **18** to a generally circular small end **20**, the seam **22** extending along the liner and intersecting the major axis of the oval-shaped large end **18**. A retaining member **24** is struck from the sidewall of the liner and has a fixed end **26** adjacent to the end **18** of the liner. This retaining member extends obliquely inwardly as shown in FIG. **2** past the axis of the liner and is reversely bent as shown at **28** to define a radially outwardly extending retaining ear **30**. It will be apparent from FIG. **2** that the developed length of the retaining member **24** and the finger **30** is substantially greater than the length of the liner. As will be explained below, the length of the finger **30** is such that when the liner is mounted in a printed circuit board hole and the retaining member is moved outwardly from its position shown in FIG. **2**, the finger will project over the underside of the board to retain the liner in the hole. Liners of the type shown in FIG. **1** are more fully described and are claimed in application Ser. No. 748,694, filed July 29, 1968.

In accordance with the instant method, there is provided a templet **32** having the same general shape as the printed circuit board and having holes **34***a* extending therethrough at locations corresponding to the locations of the holes in the printed circuit board. The diameters of the holes are advantageously smaller than the maximum transverse dimension of the larger ends **18** of the liners so that the liners will move into the holes with their ends **20** facing downwardly. Preferably, the upper edges of the holes are beveled as shwon in FIG. **5** to facilitate entry of the liners into the holes during vibration as will be explained below. Aligning holes **36** are accurately located at opposite ends of the templet so that it can be aligned with corresponding aligning holes in the printed circuit board.

Referring to FIG. **5**, liners are positioned in each of the holes **34** of the templet by supporting the templet on a support plate **48** having vertical side-plates **50** extending therefrom which completely surround the templet. An excess of liners are placed on the upper surface of the templet and the entire assembly, the templet and the support plate, is vibrated at a frequency of about 60 CPS. The vibrations may be carried out by any of the commercially available vibration units which are commonly used for feeding operations. It has been found in practice that only about 20 seconds of vibration are necessary to fill all of the holes in the templet with liners.

The population densidty of the liners on the surface of the templet is advantageously maintained in the range of about 100 to 175 liners per square inch regardless of the number of holes, about 135 liners per square inch being the preferred density. If the number of liners is in excess of about 175 per square inch, the liners tend to damp each other random movements during vibration and incomplete filling of the holes results. If the population density is less than about 100 per square inch, the statistical possibility of incomplete hole filling increases because of decreased hole and liner propinquity. It should be added that these generalizations apply to the standard hole sizes for printed circuit boards as described below.

By virtue of the fact that the maximum transverse dimension of the large ends of the liners is slightly larger than the diameter of the templet holes **34***a*, the liners will enter the templet hole only with their small diameter ends **20** facing downwardly as shown in FIG. **5**. If an individual liner should attempt to enter the templet hole in the opposite direction, that is, with the big end facing downwardly, it would bridge the upper portion of the hole and during a subsequent vibration, it would be bounced out of the hole. It should also be noted that because of the laterally extending ears **30** on each of the liners, the liners do not become stacked or nested, one on top of the other, in the templet holes.

After all of the templet holes have been filed with liners, the templet is removed from the support plate and the printed circuit board is placed on the surface of an assembly jig support plate **52**. This support plate **52** has aligning pins **54** at its ends which are adapted to extend through the aligning holes **36, 37** in both the printed circuit board and the templet so that the holes of these two parts will be in precise alignment with each other. After the printed circuit board and the templet have been mounted on the jig **52**, a punch plate **38** is mounted on the aligning pins **54** and moved downwardly so that the individual punch members **40**, which are secured to plate **38** and which depend from the underside of the punch plate, enter the holes in the templet and push the individual liners downwardly from the templet holes into the printed circuit board holes. The diameters of the printed circuit board holes are such that when the liners are driven into the printed circuit board holes, they will be deformed to the extent that the large ends will become round as indicated in FIG. **9**. The tendency of the liners to return to their original oval shapes at their large ends has the effect of locking the upper ends of the liners in the printed circuit board holes so that the boards can be handled during subsequent component assembly operations which precede the soldering operation.

When the component leads are inserted through the liners in the printed circuit board holes, the retaining members **24** of the liners are bent or flexed outwardly so that the laterally extending ends **30** of these retaining members will project beyond the edges of the board holes. These retaining members **30** thus prevent relative upward movement of the liners in the holes and provide additional retention means to prevent the liners from falling out of the board. At the same time, the retaining members bear against the inserted component leads and press them against the internal surfaces of the liners thereby locking the leads in the liners while the board is being handled for the soldering operation. FIG. **10** illustrates the manner in which the retainers function to both retain the liners in the printed circuit board holes and retain the inserted leads in the liners prior to the soldering operations, while FIG. **11** shows the appearance of the parts after the solder-dipping operation has been carried out.

Some critical dimension should be maintained for best results in the practice of the invention. The maximum dimension of the smaller end of the liner should be less than the nominal diameter of the printed circuit board hole and less than the diameter of the templet holes. The maximum transverse dimension (the major axis) of the larger end of the liner should be greater than the diameter of the printed circuit board hole and should such that the external circumference of the liner is substantially equal to and very slightly greater than the circumference of the printed circuit board hole. As

previously noted, the templet holes have a nominal diameter which is slightly greater than the diameter of the printed circuit board holes. If these relationships are adhered to, the individual liners will have a close-fit in the templet holes and will have a force-fit in the printed circuit board holes. After the wires have been inserted into the printed circuit board holes, the retaining members will be swung outwardly and the liners will be firmly retained in the printed circuit board holes for the subsequent operations.

The invention can be successfully practiced with virtually any printed circuit board hole diameter and any of the commonly used lead wire diameters if the dimensions of the liner are selected accordingly. The following dimensions have been found to produce optimum results for one particular combination of printed circuit board hole diameter and wire diameter range.

Wire diameter range	0.015" – 0.035"
PC Board hole diameter	0.048" at bottom 0.057" at top
Templet hole diameter	0.058"
Diameter of bevel at upper end of templet hole	0.065"
Major axis dimension of large end of liner	0.062"
Minor axis of large end	0.052"
Diameter of small end of liner	0.048"
Stock thickness of liner	0.005"
Punch diameter	0.055"

It will be noted in the above table of dimensions that the punch diameter (0.55 inches) is slightly greater than the minor axis dimension (0.052 inch) of the liner. By virtue of the relationship, the punch is certain to engage the liner when its contained in the templet hole and is able to push the liner downwardly into the printed circuit board hole, the templet hole having a diameter of 0.058 inches and being capable of freely receiving the punch. The circumference of the large end of the liner is slightly greater than the circumference of the printed circuit board hole at its upper end so that a force-fit is obtained when the liner is pushed into the printed circuit board hole. At the same time, the liners are prevented from entering the relatively larger diameter templet holes with the large ends facing downwardly by virtue of the oval-shape of the large ends of the liners. The dimensions presented above can be departed from the printed circuit board holes which are larger or smaller than the nominal 0.055 inches for which the liner was designed. However, the relation ships between the dimensions should be maintained for optimum results. With relationships like these and with an amplitude of about 0.04 inches at a frequently of 60 CPS, it has been found that complete filling of the templet holes can be achieved in twenty seconds or less.

Under some circumstances, it will provide desirable to remove one or more of the punches **40** to preclude insertion of a liner into the corresponding printed circuit board hole. This technique, of removing selected punches, is particularly advantageous in manufacturing operations where a standard printed circuit board blank is used for many different specific circuit arrangements. Such standard board blanks are provided with holes in accordance with a predetermined grid system. For a specific circuit arrangement, liners are placed in only those holes which will receive a component lead wire and the remaining holes are not utilized. In accordance with the instant invention, the templet can be provided with holes arranged on the same grid pattern as the holes of the printed circuit board and the punch plate can be adapted to have punches mounted therein on the same grid system locations. The liners would be inserted into the templet holes as previously described, by vibration, and the punches would be mounted in the punch plate only at locations corresponding to the locations in the printed circuit board at which liners would be required. A distinct advantage of this manufacturing method would be that a standard templet and punch plate could be used for a wide variety of circuit arrangements.

FIGS. **12–16,** show a modified apparatus embodiment of the invention with the several parts thereof mounted in a conventional die set of the type shown, for example, in U.S. Pat. No. 2,846,278. It will be understood that this die set will be mounted on the platen **61** of a conventional press and that during operation, the upper or movable plate **60** of the die set will move towards and away from the lower or fixed plate **62,** the lower fixed plate of the die set being secured by fasteners **64** to the surface of the press platen **61.** The movable upper plate **60** is guided towards and away from the fixed plate by means of guide posts **66** secured to, and depending from, the movable plate and extending into bushings **68** on the fixed die plate, suitable ball-bearing retainers **70** being provided between the guide posts and bushings as shown.

A fixed back-up plate or spacer-plate **72** is secured to the lower surface of the movable die plate **60** by means of fasteners **74** and the punch plate **38** is mounted beneath, and spaced from, the lower surface of this back-up plate by means of the fasteners **74.** These fasteners extend through suitable spacers **76** (FIG. **13**), having a thickness which is equal to the height of the head portions **78** of the punches **40.** The punches are thus retained in the punch plate **38** by virtue of the fact that their head portions **78** completely fill the space between the punch plate and the back-up plate.

A stripper plate or clamping plate **80** is mounted beneath the lower surface of the punch plate **38** by means of screws **82** which have head portions **86** disposed in drilled openings **88** on the lower surface of the spacer plate **72.** The shank portions of these screws extend through central openings in spacers **84,** which are contained in the space between the stripper plate and the back-up plate, and through aligned openings in the punch plate **38,** the lower ends of these screws being threaded into the stripper plate **80** as shown. Springs **90,** surround the lower shank portions of these screws between the lower surface of the punch plate and the upper surface of the stripper plate, an arrangement which permits the stripper plate **80** to move relatively upwardly towards the lower surface of the punch plate during the liner inserting operation as illustrated in FIGS. **15** and **16** and as will be described below.

The stripper or clamping plate **80** is provided with openings **92** which are in alignment with the punches **40,** the spacing between the stripper plate and the punch plate being such that the lower ends of the punches are disposed in these openings **92** in the stripper plate when the parts are in the positions of FIGS. **13** and **15,** that is, prior to downward movement of the punch plate towards the template. It should also be noted, that in the modification of FIGS. **12–16,** several aligning pins **91** are mounted in the punch plate **38** and

extend downwardly through alinged openings in the stripper plate **80.** The lower ends of these aligning pins **91** normally project for substantial distance below the lower surface of the stripper plate **80** and have a conical shape for reasons which will be described below.

The template **32** and the printed circuit board **2,** are laterally contained above the surface of the lower die plate **62** by means of elongated guide blocks **94** which are mounted on each side of lower die plate **62.** Lower and upper guide strips **96, 98** are mounted on upper suffaces of the guide blocks **94** by means of suitable fasteners **100,** the lower guide strip **96** being relatively narrower than the upper guide strip **98,** as clearly shown in FIG. **13.** The lower guide strip, as viewed in FIG. **13,** extends rightwardly beyond the right hand side of the block **94** while the upper guide strip **98** extends rightwardly for a further distance beyond the lower strip **96.** Floating support rails **102,** are mounted against the inner surfaces of the guide blocks **94** and are resiliently biased upwardly by springs **108** so that they bear against the lower sides of the lower guide strips **96.** The mounting arrangement for the support rails **102** comprises screws **104** having head portions disposed in openings in the support rails and having their shank portions extending through reduced diameter sections of these openings. The lower ends of these screws are threaded into mounting rails **106** fixed to the upper surface of the lower die plate **62.** The springs **108** surround the intermediate shank portions of the screws **104** and bear against the lower surfaces of the support rails and the upper surfaces of the mounting rails, an arrangement which permits the mounting rails to move downwardly with concomitant compression of the springs **108.** It will be noted from FIGS. **13** and **15** that when the support rails **102** are in their normal positions, with their upper surfaces disposed against the undersides of the lower guide strips **96,** the spacing between the upper surfaces of these mounting rails and the lower surfaces of the upper guide strips **98** is slightly greater than the combined thicknesses of the printed circuit board **2** and the template **32,** an arrangement which defines keyways or grooves adapted to receive edge portions of the template and printed circuit board as shown.

Loading of the template **32** and the printed circuit board is facilitated by the fact that the lower guide strips **96** extend forwardly for a substantial distance beyond the front edge of the lower die plate, as shown in FIG. **14.** The upper guide strip **98** extends to a location adjacent to the forward end of the lower die plate but its leading end is upwardly turned slightly to provide a guide surface for the template-printed circuit board assembly during loading. Finally, it should be noted that a plurality of rollers **110** are mounted in suitable recesses in the support rails **102** to facilitate insertion of the assembly. A fixed support plate **111** extends between the projecting front end portions of the lower guide rails **96** and the support rails **102** and are secured to the opposed sides of the support rails, the upper surface of this support plate being adapted to support the printed circuit board and template while they are being loaded.

A fixed spacer plate **112,** is secured by means of fasteners **114,** to the upper surface of the lower die plate **62** between the mounting rails **106** and the support rails **102.** A back-up plate **116** is in turn secured to the upper surface of this spacer plate and has openings **118** in alignment with the openings in the printed circuit board and template and in alignment with the punches **40,** the openings **118** being substantially oversized relative to the diameters of the small ends of the liners and provide clearance for the lower ends of the liners.

The embodiment of FIGS. **12–16** is adapted for operation on relatively large printed circuit boards, for example, boards above twelve-inches square, and it is therefore desirable to provide a means for holding the template and board assembly when it is being loaded into the apparatus. To this end, a handle **120** is threaded into the upper surface of the template and aligned oversized openings **122** are provided in the stripper plate **80,** the punch plate **38,** the back-up plate **72,** and the upper die plate **60,** as shown in FIG. **13.** These openings provide clearance for the handle when the upper die plate moves downwardly.

It will be understood that the liners **16** are inserted into the openings **34** of the template in the manner described above, that is by a suitable vibration apparatus, and that after all of the template holes have been filled with liners, as described above, the printed circuit board **2** is placed against the underside of the template. Thereafter, the template-printed circuit board assembly is loaded into the apparatus shown in FIGS. **12–16.** It is desirable to provide a means for roughly aligning the printed circuit board **2** with the template **32** prior to the loading operation and to this end, there are provided a plurality of pins **126** in the template which are adapted to be received in oversized openings **128** in the printed circuit board. The alignment between the printed circuit board and the template achieved by means of the pins **126** and openings **128** is only relatively rough and a more precise alignment of the two parts is achieved immediately prior to the punching operation as will be described below.

The apparatus embodiment of FIGS. **12–16** is advantageously provided with a suitable stop **130** (FIG. **14**) mounted adjustably on a block **132** on the upper surface of the lower die plate **62.** This stop limits rearward movement of the template-printed circuit board assembly during the loading operation and roughly positions this assembly for the final aligning operation carried out by the aligning pins **91.**

The apparatus embodiment of FIGS. **12–16** contains structural features which permit its use with warped printed circuit boards. Printed circuit boards ideally should be perfectly flat but perfection, in this respect, is only rarely achieved because of the fact that the boards are extremely thin so that stresses set up during manufacture result in a slight curvature. In FIG. **15,** the warpage of the board **2** is somewhat exaggerated to illustrate the fact that the board should be flattened prior to the operation of punching the liner **16** from the templar holes into the printed circuit board holes. The manner in which the board is flattened against the upper surface of the back-up plate **116** will become apparent from the following description of the operation.

In operation, the template, after its holes have been filled with liners **16,** is positioned against the printed circuit board **2** with the pins **126** extending into the openings **128** to roughly align the template with the board. The board and template assembly is then loaded into the apparatus by resting it on the surface of the plate **111** between the guide strips **96, 98** and moving it inwardly, that is upwardly in FIG. **14,** over the rails **102** until the rearward edge of the assembly moves against the stop **130.** The press is then actuated to

move the upper die plate **60** downwardly until the punches drive the liners from the template holes into the printed circuit board holes. During such downward movement of the upper die plate **60** and the parts mounted thereon, the pilot portions of the aligning pins **91** first enter the pilot holes **93, 95** in the template and the printed circuit board to precisely align the printed circuit board with the template. Thereafter, the lower surface of the plate **80** moves against the upper surfaces of the template **32** and imposes a uniform downward clamping force on the template. The force imposed is transmitted to the printed circuit board and against the upper surfaces of the floating support rails **102,** so that, upon further downward movement of the upper die plate, these floating rails **102** move downwardly against the compression of the springs **108.** The printed circuit board **2** is thus flattened against the upper surface of the back-up plate **116** and the aligning pins **91** extend through the aligned openings **93, 95** in the template and the printed circuit board. At this stage then, the printed circuit board will be flattened and clamped against the surface of the back-up plate with the openings in the template in precise alignment with the openings in the printed circuit board. The stripper plate **80** is, at this time, disposed against the upper surface of the template and functions as a clamping means as will be apparent from FIG. **16.** Upon further downward movement of the upper die plate **60,** the springs **90,** which are interposed between the stripper plate **80** and the punch plate **38** are compressed and the punches moved downwardly from the position of FIG. **15** to the position of FIG. **16** thereby to push the liners from the template into the printed circuit board holes. Upon upward movement of the upper die plate **60,** the punches are withdrawn from the template and printed circuit board and the parts returned to their initial positions.

The embodiments of FIGS. **12–16** has several advantages which adapt it to production line processes where large number of boards must be processed in a short time. As noted immediately above, the board need not be perfectly flat since it is clamped and held in a flat condition by the clamping plate of the apparatus during the inserting operation. By virtue of this clamping arrangement, furthermore, relatively large boards can be processed since a given degree of warpage in a large board is more noticeable than the same amount of warpage in a small board and results in greater disparity between the hole locations in the template and the board than is the case in a small board.

The plate **80** also functions to hold the template down during initial upward movement of the upper die plate **60,** so that the punches will move cleanly out of the openings in the template **32** and will not tend to lift the template upwardly during such upward movement of the upper die plate. This plate serves an additional function in that it supports the lower ends of the punches **40** during the inserting operation and aligns the lower ends of the punches with the holes in the template **32.** As previously noted, the lower ends of the punches are normally disposed above the lower surface of the plate **80,** that is within the openings in the plate **80** as shown in FIG. **13.** It follows that the plate **80** will move against the template prior to movement of the punches into the template and the punches will thus be guided accurately into the template holes. It should be added that in order to achieve this affect it is desirable to drill the holes in the plate **80** and in the template **32** in the same operation, by clamping the two plates against each other and drilling the holes at the desired locations so that the holes will be in precise alignment with each other.

The depressible supporting rails **102** of the disclosed embodiment are provided for the purpose of permitting loading without sliding the underside of the printed circuit board over the surface of the plate **116.** Such sliding of the printed circuit board might result in damage to the conductors **8** on the underside of the board. It follows that a satisfactory alternative would be to make provision for removing the plate **116** at the time of loading so that the printed circuit board-templet assembly could be positioned against the plate **116** and the plate could then be positioned on the spacer plate **112.**

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only.

We claim:

1. Apparatus for inserting metallic liners into the holes of a printed circuit board comprising:

a templet having holes therein at the same locations as the holes of said printed circuit board, said templet holes having a diameter such that said liners will have a close fit therein,

punch plate having a plurality of punches on one side thereof, said punches being located at positions corresponding to the positions of said printed circuit board holes,

supporting means for supporting said printed circuit board and said templet against each other,

guide means for guiding said punch plate towards said templet and

aligning pin means in said punch plate extending parallel to, and beyond, said punches, said aligning pin means being movable through aligning openings in said templet and said printed circuit board whereby,

upon filling said templet holes with said liners and moving said punch plate towards said templet, said aligning pin means move through said alinging openings in said templet and said printed circuit board thereby to precisely align said printed circuit board holes with said templet holes and said liners are subsequently pushed from said templet holes into said printed circuit board holes.

2. Apparatus as set forth in laim **1** including clamping means for clamping said templet and said printed circuit board against said supported means thereby to flatten said printed circuit board against said supporting means.

3. Apparatus as set forth in claim **2** whereby said clamping means comprises a clamping plate between said punch plate and said supporting means, said clamping plate having holes therein at the same locations as said holes in said printed circuit board, said punches being movable relatively through said holes in said clamping plate during pushing of said liners from said templet into said printed circuit board.

4. Apparatus as set forth in claim **3** wherein said clamping plate has a lost motion connection to said punch plate and including resilient means interposed between said punch plate and said clamping plate, said resilient means being compressible during movement of said punches through said clamping plate and said templet.

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