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Piechocki, deceased et al.

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[54] **COMPENSATING BASE FOR LEAD-FRAME BONDING**

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[21] Appl. No.: **437,079**

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **3,729,810**
Issued: **May 1, 1973**
Appl. No.: **207,854**
Filed: **Dec. 14, 1971**

[52] **U.S. Cl.** **228/180;** 29/589; 29/592; 228/6; 228/44.1; 269/310; 228/233

[51] **Int. Cl.** **B23k 5/22**

[58] **Field of Search** 29/493, 589, 592; 228/3, 228/4, 5, 6, 44, 1; 269/37, 296, 310

[56] **References Cited**

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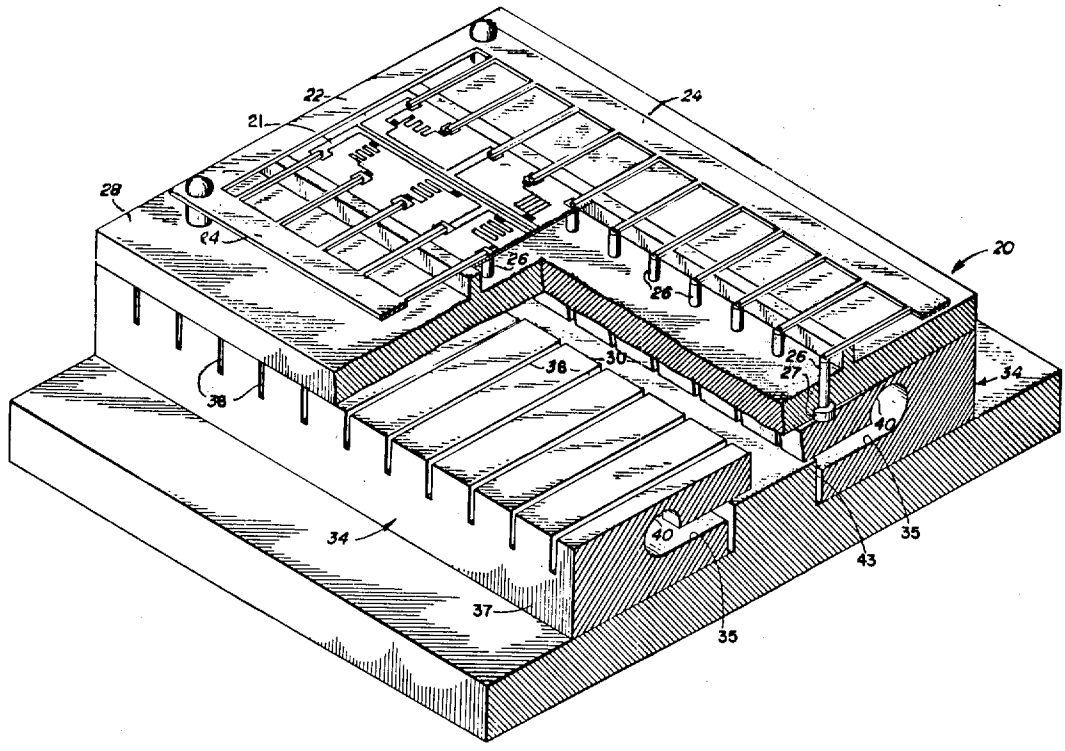
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Primary Examiner—Francis S. Husar
Assistant Examiner—Robert J. Craig
Attorney, Agent, or Firm—R. Y. Peters

[57] **ABSTRACT**

Bonding of lead frames to ceramic substrates is performed on a bonder with a compensating base. The compensating base includes a series of cantilever spring elements attached to a rigid support. The elements are reduced in cross-sectional area near the point of attachment to the rigid support. A free end of each of the spring elements is placed under each point of the substrate to which a lead is to be bonded. The elements accommodate to variations in thickness and waviness of the substrate so that it does not crack during the bonding operation.

4 Claims, 3 Drawing Figures



2 Sheets-Sheet 1

Fig. 1

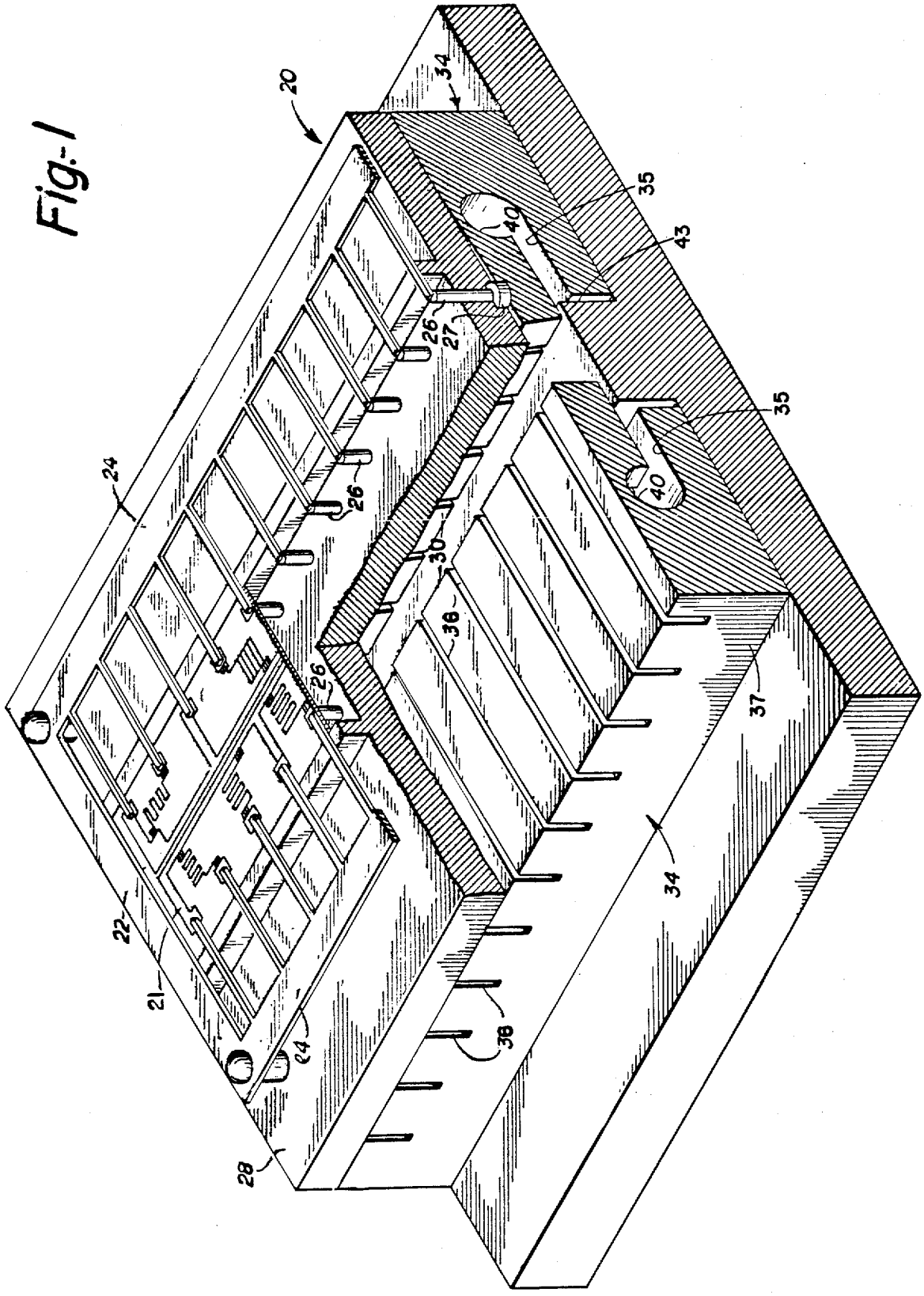


Fig.-2

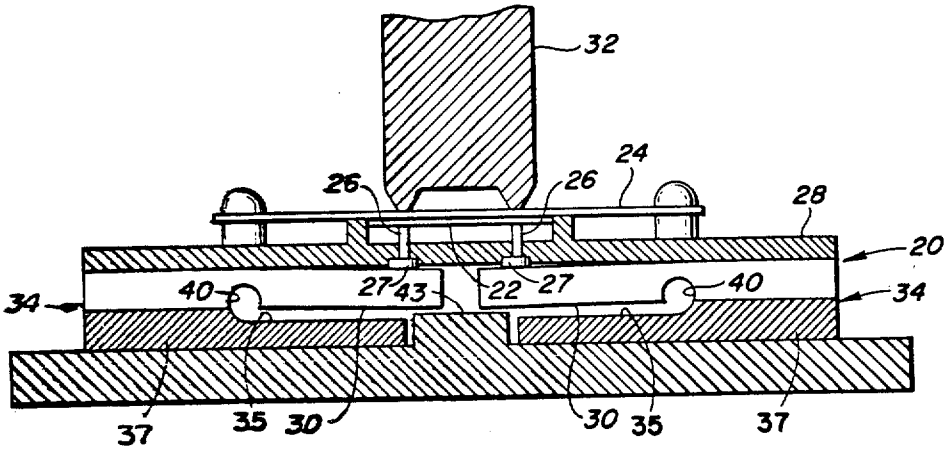
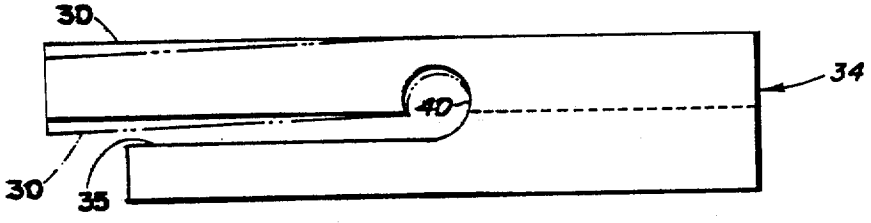

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Fig. 3


30
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40
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35

COMPENSATING BASE FOR LEAD-FRAME BONDING

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to thermocompression bonding of lead frames to brittle substrates such as thin-film circuits formed on ceramic substrates.

2. Description of the Prior Art

In the bonding of lead frames to thin-film circuits, it has long been recognized that a system of compensation is necessary. (See, for example, U.S. Pat. No. 3,608,809 issued to R. H. Cushman on Sept. 28, 1971.) Ceramic materials used as substrates for thin-film circuits are notoriously wavy and non-uniform in thickness. Thermocompression bonding of lead frames to the circuits on such ceramic substrates produces highly localized forces and stresses. The results of these stresses on the non-uniformly shaped substrates is a certain degree of irreparable cracking of the substrates with a consequent loss of entire thin-film circuits.

The difficulties of providing compensation are compounded by the fact that the thin-film circuits have very closely spaced leads. It is desirable to independently support each lead position during bonding. Such independent support is very difficult to achieve because the space available for spring elements or the like is extremely limited.

Various systems have been proposed and used for providing the desired compensation during bonding. While a number of the systems have appeared to be successful, no one of the systems has been totally successful in eliminating cracking of ceramic substrates during bonding.

At low volume production, a certain amount of cracking is economically tolerable. However, when production volume reaches high levels, a small percentage of breakage results in large absolute numbers of discarded thin-film circuits. The cost of such damage becomes significant and highly undesirable.

In addition to providing compensating arrangements to prevent cracking of substrates, attempts have been made to perform bonding operations at a slow speed. Also bonding has been performed by operating on only one lead at a time. These slow bonding processes, however, have the obvious disadvantage that high volume production can only be achieved by employing a great number of machines and a great number of employees to operate the machines. Clearly, such schemes for preventing cracking are economically unattractive.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide an improved compensating system for a thermocompression bonder which will substantially reduce the frequency of cracking of brittle substrates.

It is a further object of the invention to provide a compensating system for a bonder which will permit crack-free operation at high bonding speeds.

It is a still further object of the invention to provide a compensating system which will operate effectively in

circumstances where closely-spaced leads are being bonded.

These and other objectives are achieved by providing a bonder with a compensating base that includes a plurality of cantilever spring elements extending from a rigid support and corresponding in location to desired bonding points. The springs deflect to provide for stress relief during bonding.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and features of the present invention will be more readily understood from the following detailed description of specific embodiments thereof, when read in conjunction with the appended drawings in which:

FIG. **1** is a perspective view of an inventive compensating base for a bonding apparatus with various portions of the base and workpieces removed for purposes of clarity.

FIG. **2** is an end view of the inventive compensating base of FIG. **1** showing a bonding head engaged with a workpiece.

FIG. **3** is an end view of a spring element of the base of FIG. **1** with an exaggerated illustration of the mode of deflection of the spring element.

DETAILED DESCRIPTION

Referring now to FIGS. **1** and **2**, a compensating base, designated generally by the numeral **20**, is shown with a thin-film circuit **21** formed on a substrate **22** positioned for bonding. A lead frame **24** overlies the substrate **22**. The base **20** is provided with a plurality of movable pins **26** projecting through a platform member **28**. The pins **26** are positioned so that one pin underlies each lead of the lead frame **24**.

The pins **26** are free to move vertically within holes formed in the platform **28**. The bottom end of each of the pins **26** is provided with a head **27** which rests on a compensating spring element **30**. As shown in FIGS. **2** and **3**, when a bonding head or thermode **32** is pressed against the substrate **22** and the leads of the lead frame **24**, the pins **26** are pushed downwardly against the spring elements **30**. Each one of the pins **26** is free to move independently so that the proper vertical position is provided for a particular portion of the ceramic substrate **22**. Since the substrates **22** are not necessarily planar or uniform in thickness, each of the individual pins **26** may assume a vertical position which is different from that of the other pins.

A plurality of the spring elements **30** are illustratively shown as being integral with one of a pair of single-piece compensating units **34**. It can be seen that each of the units **34** have been produced by machining a slot **35** along a horizontal axis of the unit. The slot **35**, of course, does not extend through the entire depth of the unit **34**. The spring elements **30** are separated from one another by machining a series of parallel separating slots **36** along the length of each of the units **34**.

At the closed end of the slot **35** a hole **40** has been drilled along the entire length of the unit **34**. The resultant structure of the unit **34** is one in which the spring elements **30** can move independently of one another in a cantilever fashion but are attached to a rigid base **37**. In one advantageous arrangement shown in the drawings, the point of attachment of the spring elements **30** to the rigid portions of the unit **34** has a reduced cross-sectional area due to the presence of the hole **40**. Virtu-

ally all of the deflection of the spring elements **30** takes place in these reduced cross-section regions. The portions of the spring elements **30** having the larger cross-sectional areas are substantially rigid. This configuration and resultant deflection pattern is shown in FIG. **3.** The result of this type of shaping and deflection system is that the force needed to deflect the free ends of the spring elements **30** is linearly related to the amount of deflection which occurs. In other words, a constant force-to-deflection ration exists. The configuration of the spring elements **30** permits rapid bonding to take place without cracking of the circuits **22.**

As shown in FIG. **2,** each of the pins **26** is provided with a head **27.** When the units **34** are assembled with the platform member **28,** the spring elements **30** are deflected from their relaxed position by a distance equivalent to the projecting height of the heads **27.** The pins **26** and their heads **27** are ground after assembly to provide an accurately determined displacement. This displacement places the spring elements **30** in a pre-stressed state. The pre-stressed state is a desirable one, because the neutral or return position of the free ends of the pins **26** is always positively determined.

A stop member **43** is provided to limit the vertical travel of the free ends of the spring elements **30.** The member **43** has a thickness such that the distance between the lower side of the spring elements **30** and the upper side of the member **43** is limited. The distance is limited to the extent that when the spring elements **30** are driven into contact with the stop member **43,** the attachment regions of the spring elements to the unit **34** are still in a state of elastic deformation. In other words, the compensating unit **34** and stop member **43** are constructed so that the spring elements **30** cannot be over-stressed to the point of plastic deformation.

While the compensating units **34** have been described as being integral structures, it should be clear that compensating units can be easily constructed as a stacked arrangement (not shown) of members that have the general configuration of one end of the unit **34.** Spacers can be placed between the stacked members to provide separation between the spring elements.

The structure of the compensating base **20** is particularly advantageous where a great many leads are attached to a substrate with a close lead-to-lead spacing. It has been found entirely practical to bond leads onto substrates with a center-to-center spacing of the leads of only 0.075 inch. The spring elements **30** are made 0.055 inch thick and are spaced from each other by a distance of 0.020 inch.

By way of example, it has been determined that a spring element having a moment arm of 0.300 inch and a cross-sectional dimension of 0.055 inch×0.125 inch performs quite satisfactorily in high speed bonding of ceramic substrates formed of alumina having a thickness of 0.027 inch. The cross-sectional area of the spring element is reduced to 0.055 inch×0.080 inch at the point of connection with the rigid base member. A very desirable material for the spring element is Alloy 25-CA172,H Temper Beryllium Copper available from Brush Beryllium Co. of Cleveland Ohio.

Although certain embodiments of the invention have been shown in the drawings and described in the specification, it is to be understood that the invention is not limited thereto, is capable of modification and can be arranged without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of bonding a plurality of leads to a brittle planar article which comprises the steps of:

supporting the article with a plurality of cantilever spring elements *extending from a base with a space between the elements and the base*, each element being located below a point where a lead is desired and each element being movable independently of the others; and

compressively engaging all of the desired leads simultaneously against said brittle supported article to bond said leads to said article, whereby the spring elements are deflected independently of one another *into the space between the elements and the base* to reduce stresses introduced to said article during said compressive engagement thus preventing cracking of the article.

2. A method of bonding a plurality of leads to a brittle planar article which comprises the steps of:

supporting the article with a plurality of cantilever spring elements *extending and spaced from, and integral with, a common base*, each element being located below a point where a lead is desired and each element being movable independently of the others;

compressively engaging all of the desired leads simultaneously against said brittle supported articles to bond said leads to said article; and

compensating for irregularity of shape of the brittle article by deflecting the spring elements *into the space between the elements and the base*, during said compressive engagement to reduce stresses and prevent cracking of the article.

3. A method of bonding a plurality of leads to a brittle planar article which comprises the steps of:

supporting the article on a plurality of pins slidably extending through a platform, each pin having a free end located below a point where a lead is to be bonded and each pin having a head opposite its free end to prevent it from passing completely through the platform, each head being supported by a cantilever spring element so that each pin is movable through the platform independently of the others, each spring element extending from a base with a space between each element and the base;

compressively engaging all the leads to be bonded simultaneously against said supported article to bond said leads to said article; and

compensating for irregularity of shape of the brittle article by slidably moving the pins through the platform and deflecting the spring elements thereunder into the space between the elements and the base during said compressive engagement to reduce stress and to prevent cracking of the article.

4. The method of claim 3, wherein the spring elements are provided with an initial deflection by their heads being positioned between the platform and such elements so that the pins assume an initial predetermined neutral position.

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