United States Patent [19]

Sato

[11] **3,893,325**

[45] **July 8, 1975**

[54] **PROCESS FOR MANUFACTURING A BASE FOR A SEMICONDUCTOR DEVICE**

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[22] Filed: **July 5, 1974**

[21] Appl. No.: **486,083**

[30] **Foreign Application Priority Data**

July 10, 1973 Japan 48-77051
Nov. 22, 1973 Japan 48-130727

[52] **U.S. Cl.** **72/344;** 72/354; 72/356
[51] **Int. Cl.** **B21j 13/02**
[58] **Field of Search** 72/253, 344, 354, 356

[56] **References Cited**

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Primary Examiner—Lowell A. Larson
Attorney, Agent, or Firm—Woodling, Krost, Granger & Rust

[57] **ABSTRACT**

A process for manufacturing a base for a semiconductor device having a recess in the base on the upper surface to receive semiconductor means therein and a threaded stem extending from the bottom surface of the base, said process comprising the steps of preparing a blank of metal material; deforming by extrusion said blank with a shallower recess portion formed in said blank on the upper surface and with a shorter stem portion extending from the bottom of said blank while forming a projection on the bottom of said shallow recess portion in said blank; further deforming said blank so that said recess portion in said blank is deepened whereby said recess is formed in said base and so that said stem portion is lengthened whereby an unthreaded stem is formed; and threadedly rolling said stem on said blank.

9 Claims, 16 Drawing Figures

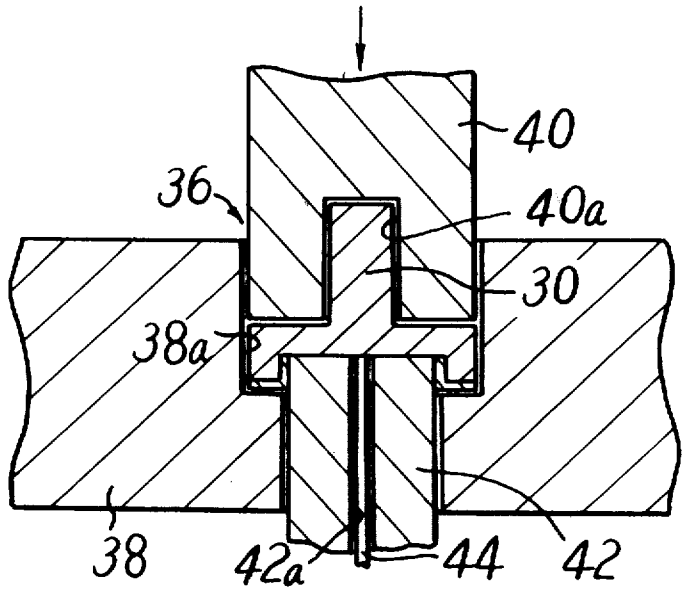


FIG. 1.

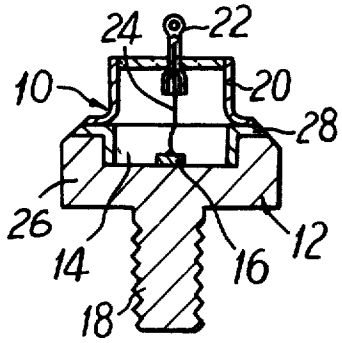


FIG. 2.

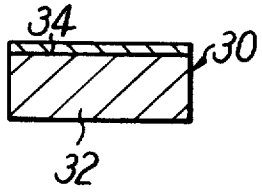


FIG. 3.

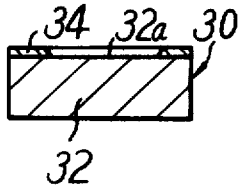


FIG. 4.

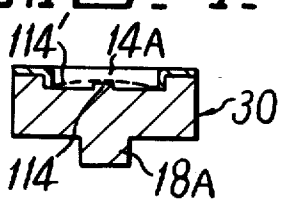


FIG. 5.

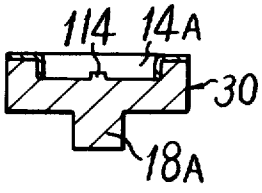


FIG. 6.

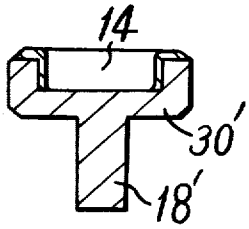


FIG. 7.

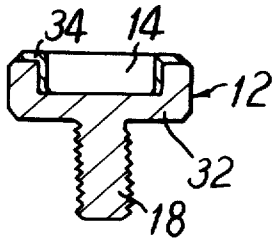


FIG. 8.

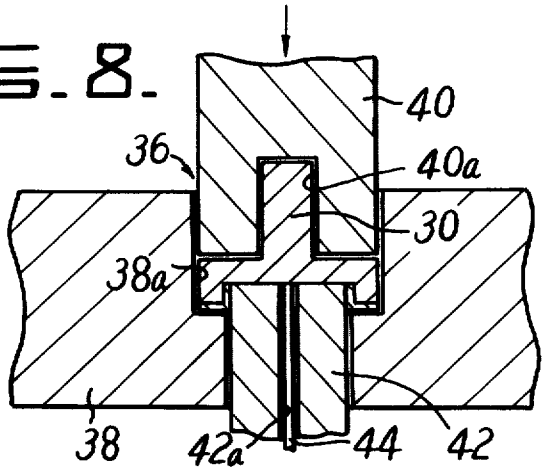


FIG. 9.

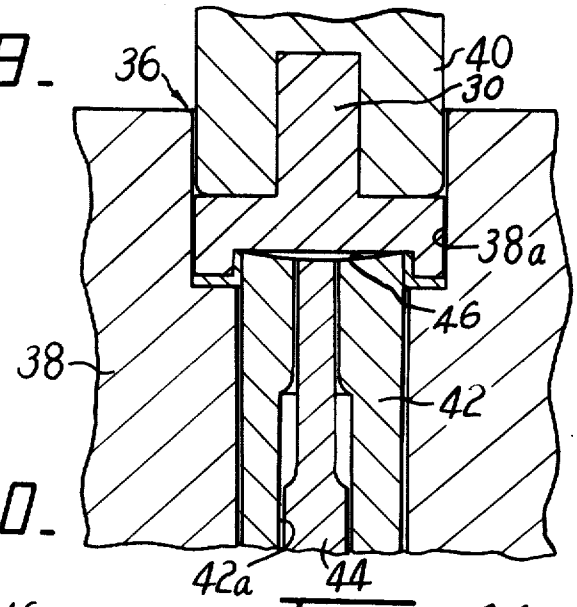


FIG. 10.

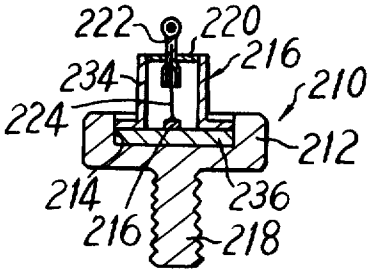


FIG. 11.

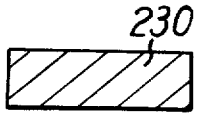


FIG. 12.

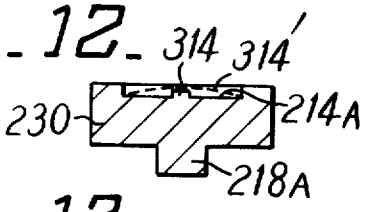


FIG. 13.

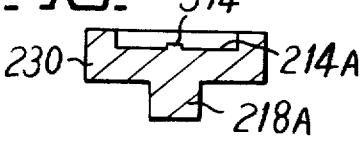


FIG. 14.

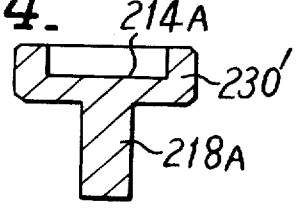


FIG. 15.

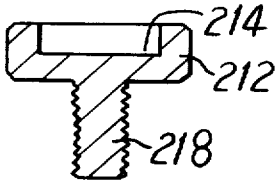
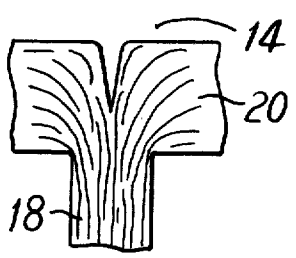


FIG. 16.



PROCESS FOR MANUFACTURING A BASE FOR A SEMICONDUCTOR DEVICE

FIELD OF THE INVENTION

This invention pertains generally to a process for manufacturing a base for a semiconductor device and more particularly to a process for manufacturing a base for a semiconductor device such as diode, thyristor and the like having a recess in the base on the upper surface to receive semiconductor means therein and a threaded stem extending from the bottom surface of the base and adapted to mount the base on a chassis of an electronic apparatus.

BACKGROUND OF THE INVENTION

In the prior arts, a base for a semiconductor device with a recess in the base on the upper surface to receive a semiconductor element or enclosure therein and with a threaded stem extending from the bottom surface of the base has been manufactured by deforming by extrusion a blank of metal material with a stem extending from the bottom of the blank, subsequently further deforming the blank with a recess formed in the blank on the upper surface to receive a semiconductor element or disclosure therein and shaping such deformed blank on the periphery thereof so that it has a hexagonal configuration. One of the disadvantages of the prior art is that there is formed a cavity or hole in the middle of the blank on the upper surface due to material stream flowing from the peripheral circumference towards the center of the blank as shown in FIG. **16** when the stem is formed by deforming the blank. As seen from FIG. **16,** such cavity is extremely deep and therefore, an acid agent, which is used to pickle the blank prior to the plating process, tends to be left in the cavity, resulting in the acid agent unpreferably blowing off on plating. Another disadvantage is that there are required two deforming steps for providing the base with the result in its costly manufacture. In the semiconductor device wherein the base serves also to enclose the semiconductor element or pellet together with a shell secured to the base, the base is generally formed of composite or clad metal including a lower or thermally and electrically conductive metal layer and an upper or weldable metal layer attached onto the lower metal layer. The upper metal layer at the center is generally removed after the recess to receive the pellet therein is formed in the blank of composite metal. Removal of the lower metal layer at the center has been effected by spot facing. However, such removal of the upper metal layer at the bottom of the recess is extremely troublesome because the operation must be done in the narrow space. In addition, the prior art is not adapted to manufacture various bases which have the recesses of different sizes therein.

OBJECT OF THE INVENTION

Accordingly, it is a principal object of the present invention to provide a process for manufacturing a base for a semiconductor device wherein the base can be manufactured without any cavity at the bottom of a recess to receive semiconductor means therein.

It is another object of the present invention to provide a process for manufacturing a base for a semiconductor device above-mentioned wherein a recess and a stem can be formed by a single step of deforming a base blank of metal material by extrusion.

It is further object of the present invention to provide a process for manufacturing a base for a semiconductor device above-mentioned wherein the base can be easily and inexpensively manufactured.

It is further object of the present invention to provide an extrusion die assembly adapted to practice the process for manufacturing the base for the semiconductor device in accordance with the present invention.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, there is provided a process for manufacturing a base for a semiconductor device having a recess in the base on the upper surface to receive semiconductor means therein and a threaded stem extending from the bottom surface of the base, said process comprising the steps of preparing a blank of metal material; deforming by extrusion said blank with a shallower recess portion formed in the said blank on the upper surface and with a shorter stem portion extending from the bottom of said blank while forming a projection on the bottom of said shallow recess portion in said blank; further deforming said blank so that said recess portion in said blank is deepened whereby said recess is formed in said base and so that said stem portion is lengthened whereby an unthreaded stem is formed; and threadedly rolling said stem on said blank.

In accordance with another aspect of the present invention, there is provided an extrusion die assembly for manufacturing a base for a semiconductor device having a recess in the base on the upper surface to receive semiconductor means therein and a threaded stem extending from the bottom of the base, said extrusion die assembly comprising a first die having a knockout with a knockout pin telescopically extending through said knockout, said first die having a cavity to receive said blank therein, a second die movable relative to said first die to strike against a blank in said cavity in said lower die, said knockout pin serving to form a projection in said recess portion by retraction of said knockout pin during the initial portion of the time when said second die moves into said first die.

In accordance with another aspect of the present invention, there is provided an extrusion die assembly for manufacturing a base for a semiconductor device having a recess in the base on the upper surface to receive semiconductor means therein and a threaded stem extending from the bottom of the base, said extrusion die assembly comprising a first die having a knockout with a knockout pin telescopically extending through said knockout, said first die having a cavity to receive a blank therein, and a second die movable relative to said first die to strike against said blank in said cavity in said first die, said knockout and said knockout pin at the heads thereof having a shallow concave allowing a projection to be formed at the bottom of the said recess in said blank.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and features of the present invention will be apparent from the teachings of the following description of preferred embodiments taken with reference to the accompanying drawings in which;

FIG. 1 is a vertical sectional view of a semiconductor device having a base manufactured in accordance with the present invention;

FIGS. 2 to 7 are vertically sectional views illustrating the sequential steps of processing material for manufacturing the base of FIG. 1 in accordance with the present invention;

FIG. 8 shows in vertical section an extrusion die assembly in a press in which material is deformed;

FIG. 9 shows in enlarged vertical section another extrusion die assembly in a press in which material is deformed;

FIG. 10 is a vertically sectional view of another semiconductor device having a base manufactured in accordance with the present invention;

FIGS. 11 to 15 are vertically sectional views illustrating the sequential steps of processing material for manufacturing the base of the semiconductor device of FIG. 10 in accordance with the present invention; and

FIG. 16 is an enlarged cross sectional view of a portion of a conventional base for a semiconductor device.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Referring now to FIG. 1, a semiconductor device is indicated generally at numeral 10 and has a base 12 obtained by a process in accordance with the present invention. The base 12 has a recess 14 in which a semiconductor element or pellet 16 is disposed and mounted at the bottom of the recess 14 and a threaded stem 18 extending downwardly from the lower surface of the base 12. As understood by those skilled in the art, the threaded stem 18 serves to secure the semiconductor device 10 to a chassis of an electronic apparatus by threadedly engaging the stem 18 with the chassis and to radiate heat from the semiconductor device through the chassis. A shell 20 at the flange is welded onto the base at the periphery and has a terminal 22 hermetically sealed and mounted in the shell 20 and connected by a lead 24 to the pellet 16. The base comprises a thermally and electrically conductive metal layer 26 and a weldable metal layer 28 affixed onto the metal layer 26. The shell 20 is welded on the weldable metal layer 28 of the base 12.

FIGS. 2 to 7 show the sequential steps for manufacturing the base 12 of the semiconductor device 10 shown in FIG. 1. FIG. 2 shows a circular blank 30 which is obtained by blanking or punching a clad or composite metal sheet (not shown) into a plurality of blanks each having a predetermined dimension. The clad metal sheet comprises a lower or thermally and electrically conductive metal layer such as copper layer having a relatively larger thickness and an upper or weldable metal layer such as cupronickel layere attached onto the lower metal layer and having a relatively smaller thickness. In FIG. 2 numerals 32 and 34 designate the lower and upper metal layers, respectively. The upper metal layer 34 in the middle is spot faced as shown in FIG. 3 so that the lower metal layer is partially exposed in the middle of the blank 30. Numeral 32*a* indicates the exposed surface of the lower metal layer 32.

Thereafter, the blank 30 with the lower metal layer exposed is introduced into an extrusion die assembly 36 in a press as shown in FIG. 8. The die assembly comprises a lower die 38 having a cavity 38*a* to receive the blank 30 therein and an upper die or punch 40 vertically movable by means of a ram of the press (not shown) and adapted to be received into the lower die for purpose of deforming the blank in the lower die. The cavity 38*a* in the lower die 38 is of hexagonal configuration according to that of the desired base. The lower die 38 has a knockout 42 extending through the lower die 38 in a coaxial relation to the cavity 38*a* to remove the deformed blank out of the lower die 38 and in addition serving as an auxiliary die to form a recess in the base as indicated at numeral 14 in FIG. 1. A knockout pin 44 telescopically extends through a center hole 42*a* in the knockout 42 for thrusting the deformed blank out of the lower die 38 and axially and upwardly urged by a spring not shown. The punch 40 at the bottom thereof has a cavity 40*a* which is adapted to form a stem on the blank which is in turn threadedly rolled later as indicated at numeral 18 in FIG. 1.

During downward movement of the punch 40, the blank 30 in the lower die 38 is deformed as shown in FIGS. 4 through 6. More particularly, the blank 30 is formed with a relatively shallower recess portion 14A in the blank 30 on one of the surfaces and with a relatively shorter stem portion 18A on the other surface of the blank during the initial portion of downward movement of the punch 40. It should be noted that at that time a fine projection 141 is formed on the shallow recess 14A at the center of the bottom because the knockout pin 42*a* is momentarily retracted relative to the knockout 42 by the pin's bouncing against the spring urging the pin 42*a*. During the further downward movement of the punch 40, the blank 30 is further deformed so that the recess portion 14A in the blank is increasingly deepened and also so that the stem portion 18A is increasingly lengthened. Meanwhile, the fine projection 141 becomes gradually smaller or penetrated into the bottom of the recess portion 14A. During the last downward movement of the punch 40, the blank 30 is further deformed in a similar manner until the recess has a predetermined depth and the stem 18' has a predetermined length as shown in FIG. 6. It will be noted from FIG. 6 that the fine projection 114 is completely penetrated into the bottom of the recess in the blank 30 so that the recess 14 has a flat surface. This means that the cavity, which otherwise tends to be formed in the recess bottom (FIG. 16), will be filled with the fine projection indicated at 114 in FIGS. 3 and 4 so that the possible cavity is eliminated. It will be also noted that the completely deformed blank 30' has a hexagonal periphery as shown in FIG. 6. Thereafter, the deformed blank 30' on the stem 18' thereof is threadedly rolled so that the threaded stem 18 is formed. Thus, the base 12 is completed as shown in FIG. 7.

FIG. 9 shows a modification of the extrusion die assembly wherein the same numerals indicate the same components. In this modification the die assembly 36 is substantially identical to that of FIG. 8 except that the knockout 42 and the knockout pin 44 at the heads thereof have a smooth shallow concave 46. The concave 46 in the knockout and the knockout pin causes the blank 30 to be deformed with a projection 114' indicated at dotted line shown in FIG. 4 and formed on the recess bottom of the blank 30 during the initial portion of movement of the punch 40. The projection 114' is penetrated into the recess bottom of the blank in the course of continued downward movement oof the punch until the recess bottom of the deformed blank has a flat surface. Thus, with the modification the base can be manufactured without any cavity in the recess

bottom of the base, which is substantially identical to that of FIG. 8 with this respect.

Referring now to FIG. 10, a semiconductor device is indicated generally by numeral 210, which comprises a base 212 including a recess 214 in the base on the upper surface to receive a semiconductor assembly 216 therein, and a threaded stem 218 extending from the bottom of the base. The semiconductor assembly 216 may comprise an enclosure 234 including a base plate 236 and a shell 220 at the flange welded to the edge of the base plate 236. A semiconductor element or pellet 216 is mounted on the base plate 236 within the enclosure 234 and a terminal 222 is hermetically sealed to the shell 220 and connected by a lead 224 to the pellet 216. The base is formed of thermally and electrically conductive metal such as copper. The enclosure 234, within which the pellet is mounted, is disposed within the recess 214 in the base 212 and attached thereto by any suitable means. Since the base plate may be formed of relatively thinner weldable metal such as steel iron, the current and heat from the pellet 216 can flow through the base plate 236 to the base 212 without any substantial resistance.

FIGS. 11 to 16 show the sequential steps for forming by extrusion the base 212 of the semiconductor device 210 shown in FIG. 10. Since the base is formed of a single metal layer rather than of composite or clad metal, the step of removal of the upper metal layer as shown in FIG. 3 is eliminated, but the other steps are substantially identical to those of FIGS. 2, 4, 5 and 6. More particularly, a blank 230 of copper as shown in FIG. 11 is prepared which is obtained by punching a metal sheet into a plurality of blanks. The blank 230 is then introduced into the extrusion die assembly as shown in FIG. 8 to be deformed in the manner as shown in FIGS. 12 to 15. In the first step, the blank 230 is deformed so that it has a relatively shallower recess portion 214A in the blank on the upper surface and also a relatively shorter stem portion 218A on the bottom of the blank, but at that time, it should be noted that the recess portion has a fine projection 314 at the center of the bottom of the recess portion. As shown in FIG. 14, the blank continues to be deformed so that the recess portion 214A becomes deeper and the stem portion 218A longer with the fine projection 314 penetrated into the bottom of the recess portion 214A at the center thereof. Thus, the blank is completely deformed until the recess portion 214A has a predetermined depth and the stem portion 218A has a predetermined length as shown in FIG. 14. It will be noted that the recess portion 214A has no cavity which otherwise tends to be formed at the center of the bottom of the recess portion. The deformed blank is then threadedly rolled at the stem portion 218A. FIG. 15 shows the base 212 thus provided with the recess 214 to receive the semiconductor assembly therein and the threaded stem 218 which is adapted to threadedly engage a chassis of an electronic apparatus. It will be understood that the blank 230 may be introduced into the extrusion die assembly shown in FIG. 9 for deformation of the blank. It will be also noted that in such case a projection 314' indicated at dotted line in FIG. 12 is formed and thereafter filled in the cavity which otherwise tends to be formed at the center of the recess portion 214A during deformation of the blank 230.

While some preferred embodiments of the present invention have been illustrated and described in connection with the accompanying drawings, it will be apparent to those skilled in the art that various modifications and changes might be made within the spirit and scope of the present invention, which is intended to be defined only to the appended claims.

What is claimed is:

1. A process for manufacturing a base for a semiconductor device having a recess in the base on the upper surface to receive semiconductor means therein and a threaded stem extending from the bottom of the base, said process comprising the steps of preparing a blank of metal material; deforming by extrusion said blank with a shallower recess portion formed in said blank on the upper surface and with a shorter stem portion extending from said blank at the bottom while forming a projection on the bottom of said shallower recess portion in said blank; further deforming said blank so that said recess portion in said blank is deepened whereby said recess is formed in said base and so that said stem portion is lengthened whereby an unthreaded stem is formed; and threadedly rolling said stem on said blank.

2. A process for manufacturing a base for a semiconductor device as set forth in claim 1, wherein said blank comprises a thermally and electrically conductive metal layer and a weldable metal layer clad on said thermally and electrically conductive metal layer.

3. A process for manufacturing a base for a semiconductor device as set forth in claim 1, wherein said blank comprises a single thermally and electrically conductive metal layer.

4. A process for manufacturing a base for a semiconductor device as set forth in claim 1, wherein said blank comprises a thermally and electrically conductive metal layer and a weldable metal layer clad on said thermally and electrically conductive metal layer, and said process further comprising the step of removing said weldable metal layer at the center thereof prior to deforming said blank by extrusion whereby said thermally and electrically conductive metal layer at the center is exposed in said recess of said base.

5. A process for manufacturing a base for a semiconductor device as set forth in claim 4, wherein said step of removing said weldable metal layer at the center is effected by spot facing said weldable metal layer.

6. A process for manufacturing a base for a semiconductor device as set forth in claim 1, wherein said steps of deforming said blank are effected by an extrusion die assembly comprising a first die having a knockout with a knockout pin telescopically extending through said knockout, said first die having a cavity to receive said blank therein, and a second die movable relative to said first die to strike against said blank in said cavity in said first die, said knockout pin serving to deform said projection in said recess portion by retraction of said knockout pin during the initial portion of the time when said second die moves into said first die.

7. A process for manufacturing a base for a semiconductor device as set forth in claim 1, wherein said steps of deforming said blank are effected by an extrusion die assembly comprising a first die having a knockout with a knockout pin telescopically extending through said knockout, said first die having a cavity to receive said blank therein, and a second die movable relative to said first die to strike against said blank in said cavity in said first die, said knockout and said knockout pin at the heads thereof having a shallow concave allowing said

projection to be formed at the bottom of said recess in said blank.

8. An extrusion die assembly for manufacturing a base for a semiconductor device having a recess on the upper surface of the base to receive semiconductor means therein and a threaded stem extending from the bottom of the base, said extrusion die assembly comprising a first die having a knockout with a knockout pin telescopically extending through said knockout, said first die having a cavity to receive a blank therein, and a second die movable relative to said first die to strike against said blank in said cavity in said first die, said knockout pin serving to form a projection in said recess portion by retraction of said knockout pin during the initial portion of the time when said second die moves into said first die.

9. An extrusion die assembly for manufacturing a base for a semiconductor device having a recess on the upper surface of the base to receive semiconductor means therein and a threaded stem extending from the bottom of the base, said extrusion die assembly comprising a first die having a knockout with a knockout pin telescopically extending through said knockout, said first die having a cavity to receive a blank therein, a second die movable relative to said first die to strike against said blank in said cavity in said first die, said knockout and said knockout pin at the heads thereof having a shallow concave allowing a projection to be formed at the bottom of said recess in said blank.

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