

Description

This invention relates to connectors.

Power converters, for example, are sometimes connected to printed circuit boards by inserting their pins into round electrical connectors mounted on the boards. The connector may have internal tabs that grab the pin.

In general, in one aspect, the invention features a connector for a pin, including a support ring, and a contact ring of fingers that are (i) connected to and integrally formed with the support ring, (ii) held in a space within the support ring, (iii) define a channel within the contact ring for receiving the pin, and (iv) are resilient with respect to the support ring to apply radially inward forces on the pin.

Implementations of the invention may include one or more of the following. A resilient ring may be held in a space between the support ring and the contact ring. The ring may be made of a material that expands with rising temperature, e.g., silicone rubber. The ring may be molded to conform to the space between the support ring and the contact ring before the pin is inserted. The fingers may be contoured to retain the resilient ring in the space between the support ring and the contact ring. The channel may include a contact zone which is located along a longitudinal axis of the channel and is narrower than an outer circumference of the pin. Each of the fingers, when the pin is inserted within the connector, may touch the inside of the support ring at a point which is on the other end from where the finger is connected to the support ring. The support ring and the contact ring may be formed by cutting and bending. The support ring may be cylindrical, and may or may not be fully closed. The contact ring also may or may not be fully closed. The contact ring may be cylindrical and defined by fingers arranged at generally equal intervals around the contact ring. Each of the fingers may include a contact zone that is flat along the length of the finger, or that is convex with respect to the channel prior to insertion of the pin, and is flat after insertion of the pin. The support ring may have an outer wall, and the outer wall may include a stop, at one end, that extends outwardly from the outer wall. The connector may have a cap including a top surrounded by a rim, the rim being fitted between the support ring and the contact ring. An edge of the support ring may be rolled over the top of the cap. The fingers may include beryllium copper, and may be gold-plated. A housing may surround and further support the support ring. The pin and the connector may both be conductive.

According to an alternative aspect of the invention, we provide a connector for a pin characterised in comprising

a support ring,
a contact ring spaced apart from the support, for making contact with and applying a force to the pin, and

a resilient ring held in the space between the support ring and the contact ring,
the resilient ring expanding with increased temperature and configured so that as it expands it applies a force to the contact ring which enhances the force applied by the contact ring to the pin.

Advantages may include one or more of the following.

The connector makes a good, high current, low resistance electrical connection in a low profile assembly. The connector also makes a good mechanical connection. The connector may be fabricated as a one-piece drawn part and used without a housing, or formed and rolled from flat stock and used with a housing. The pins are not damaged (e.g., a tin plating is not scraped off) by insertion, which maintains the electrical contact. Decreasing contact resistance with rising temperature is provided by increased force due to the expansion of the rubber ring.

Other advantages and features will become apparent from the following description.

In the drawings:

Figs. 1a and 1b are cross-sections of a pin and a connector in two stages of insertion.

Fig. 2 is a sequence of views of the process of making a connector.

Fig. 3 is a bottom view of the connector.

Fig. 4 is a cross-sectional view of another connector.

Fig. 5a is a plan view of a cut blank.

Fig. 5b is a cross-sectional view of a finger.

Fig. 5c is a top view of the other connector.

Figs. 6a-6f are cross-sections of fingers.

Referring to Fig. 1a, a pin 11 of an electronic component (not shown) is grasped in a connector 10 (which is press-fit in a hole in a printed circuit board (PCB) 24). The connector includes a beryllium copper crown 12 that is deformed when the pin is inserted (arrow 20) from a position shown in Fig. 1b to the position shown in Fig. 1a. The crown has a double-backed configuration in which an outer cylinder 14 supports a concentric inner cylindrical framework of six fingers 18. This configuration aids the fingers in applying force to the pin when inserted. A high temperature silicone (rubber) ring 28 is molded to fit in the space between the outer cylinder and the framework of fingers. The ring is compressed by the insertion of the pin, and provides an additional even force along the finger, and, thus, against the pin, especially when increasing temperature causes expansion of the ring.

As seen in Fig. 1a, when the pin is in place in the connector, the deformation of each finger provides a contact zone 29 having a length L, and a central contact point 31 which is midway along the length L of the contact zone. To reduce the resistance, e.g., 160 μ ohms, of the contact, L is made long to increase the contact area. Conversely, for a short (low profile) connector, C should

be small to reduce the height H of the connector. The contour of the finger is chosen to meet these needs.

The fingers have curved surfaces 18a at their upper ends. When the fingers are deformed, the end 18b of each finger makes contact with the outer cylinder to provide a connection with even lower resistance and greater contact force. The fingers also retain the rubber ring.

In use, the current, e.g., 100-140 amps, through the connector causes the temperature of the fingers, and the ring, to rise. Because the ring has a certain stiffness (durometer of 54 shore A) the expansion of the ring as the temperature rises will apply additional force radially against the fingers and in turn between the fingers and the pin. Normally as temperature of the contact between the pin and the fingers rises, the resistance also rises (due to the properties of the pin and finger materials). The increased force applied by the expanding ring tends to offset the increased resistance by increasing the area of contact.

An extension 16 of each finger 18 links the finger to the outer cylinder, and is formed to provide a stop 17 which strikes the bottom of the PCB when the connector is press-fit. The outer cylinder is long enough to project to at least the top 25 of the PCB (and sometimes even beyond, as in the case of Fig. 1a). This permits easy soldering 27 of the connector to the PCB. Before soldering, a stainless steel cap 26 is press-fit into the inside of the outer cylinder to prevent solder from entering the inside of the connector when the connector is wave-soldered to the PCB. The cap fits in the space between the fingers and the outer cylinder. The edge 14a of the outer cylinder is rolled over the cap to provide further retention.

Referring to Fig. 2, to make the connector, disks 30 (one for each connector) are die cut from a strip 32 of beryllium copper. Each disk is drawn to form a cup 34. Next a central cylinder 36 is formed by drawing. A hole 38 is eventually formed at the upper end of the central cylinder. The stops 17 are then formed in the outer cylinder. Next the fingers are cut by punching and are given their final form. The connector is then heat treated to harden and impart spring-type properties to the beryllium copper, after which the ring is inserted by holding the fingers together.

Referring to Fig. 3, as a result of the process of drawing the fingers, they adopt a curved inner profile 40, which is structurally strong (and, thus, can apply a strong force to the pin) and similar in profile to the pin, to yield a larger contact area. Smaller gaps 42 between adjacent fingers yield greater contact area. A greater number of fingers also increases the contact area and lessens the chance that off-center pin insertion will damage the fingers.

In one example the connector has a first outer diameter OD_1 (Fig. 1b) of 0.270" (0.6858 cm) and a second outer diameter OD_2 of 0.262" (0.66548 cm), an inner diameter ID of 0.178" (0.45212 cm), a height H of 0.135" (0.3429 cm), and a gap 42 between fingers of

0.025" (0.0635 cm). L is 0.057" (0.14478 cm) and C is 0.051" (0.12954 cm). The fingers have a thickness of 0.008" (0.02032 cm). The thickness of the fingers affects their resilience and the dimensions of the connector. The interference fit between the fingers and the pins is 0.002-0.015" (0.00508-0.0381 cm), depending upon the application.

Other embodiments are feasible.

For example, as shown in Fig. 4, the connector may be held in a cylindrical copper housing 50 that has a rim 52 at the bottom with a hole 54 to receive the pin. The connector is soldered to the housing by a solder dipping process followed by a centrifuge operation that spins off excess solder and prevents the fingers from being soldered together. It is the housing, not the outer cylinder of the crown, that is soldered to the PCB.

The housing is capable of holding a connector that is drawn (not shown) or a connector that is formed by cutting and bending (along the dashed lines 61) a blank 60 of heat treated beryllium copper, as shown in Fig. 5a, to form fingers having the contour shown in Fig. 5b, and curling it in a circle as shown in Fig. 5c. The cross-sectional profile 62 of the finger is flat (unlike the curve 40 of Figure 3). Once curled, the crown is squeezed together and placed into the housing. The inside diameter of the housing is set to impart the desired diameter to the inserted crown. The crown material may be thinner when a housing is used.

Referring to Figs. 6a-6f, the fingers may also be shaped with a flat contact surface 18c to ensure a long contact length, or they may be shaped with a slight bow 18d, or convex surface, which is deformed to be flat during insertion and provides even greater contact force.

The crown need not have a stop.

The connector could be used to provide only mechanical support in some applications, rather than also making an electrical connection.

Some applications, for example, burn-in test chambers, require repetitive pin insertions and subject the connectors to higher than normal current flow. In such an application, the crown may be gold plated to provide continuously reliable electrical connections.

Claims

1. A connector for a pin characterised in comprising
 - a support ring, and
 - a contact ring of fingers that are connected to and integrally formed with the support ring, are held in a space within the support ring, and define a channel within the contact ring for receiving the pin,
 - the fingers being resilient with respect to the support ring to apply radially inward forces on the pin.

2. A connector according to Claim 1, characterised in further comprising
a resilient ring held in a space between the support ring and the contact ring.
3. A connector according to Claim 2, further characterised in that the resilient ring comprises a material that expands with rising temperature.
4. A connector according to any preceding Claim, further characterised in that
the channel includes a contact zone which is located along a longitudinal axis of the channel and is narrower than an outside circumference of the pin.
5. A connector according to any preceding Claim, further characterised in that each of the fingers, when the pin is inserted within the connector, touches the inside of the support ring at a point which is on the other end from where the finger is connected to the support ring.
6. A connector according to any preceding Claim, further characterised in that the support ring and the contact ring are formed by cutting and bending.
7. A connector according to any preceding Claim, further characterised in that the support ring is cylindrical.
8. A connector according to any of Claims 1 to 6, further characterised in that the support ring is not fully closed.
9. A connector according to any preceding Claim, further characterised in that the contact ring is not fully closed.
10. A connector according to any of Claims 1 to 8, further characterised in that the contact ring is cylindrical and defined by fingers arranged at generally equal intervals around the contact ring.
11. A connector according to any preceding Claim, further characterised in that each of the fingers includes a contact zone that is flat along the length of the finger.
12. A connector according to any of Claims 1 to 10, further characterised in that each of the fingers includes a contact zone that is convex with respect to the channel prior to insertion of the pin, and is flat after insertion of the pin.
13. A connector according to any preceding Claim, further characterised in that the support ring has an outer wall, and the outer wall includes a stop, at one end, that extends outwardly from the outer wall.
14. A connector according to any preceding Claim, characterised in further comprising
a cap including a top surrounded by a rim, the rim fitted between the support ring and the contact ring.
15. A connector according to Claim 14, further characterised in that an edge of the support ring is rolled over the top of the cap.
16. A connector according to any preceding Claim, further characterised in that the fingers comprise beryllium copper.
17. A connector according to any preceding Claim, further characterised in that the fingers are gold-plated.
18. A connector according to any preceding Claim, characterised in further comprising a housing ring which surrounds the support ring.
19. A connector according to any preceding Claim, further characterised in that the pin and the connector are both conductive.
20. A connector for a pin characterised in comprising
a support ring,
a contact ring spaced apart from the support, for making contact with and applying a force to the pin, and
a resilient ring held in the space between the support ring and the contact ring,
the resilient ring expanding with increased temperature and configured so that as it expands it applies a force to the contact ring which enhances the force applied by the contact ring to the pin.
21. A connector of Claim 20, further characterised in that the contact ring comprises contact fingers contoured to retain the resilient ring in the space between the support ring and the contact ring.
22. A connector according to Claim 20 or to Claim 2 or any Claim appendant to either such Claim, further characterised in that the resilient material comprises silicone rubber.
23. A connector according to Claim 20 or to Claim 2 or any Claim appendant to either such Claim, further characterised in that the resilient ring is moulded to conform to the space between the support ring and the contact ring before the pin is inserted.

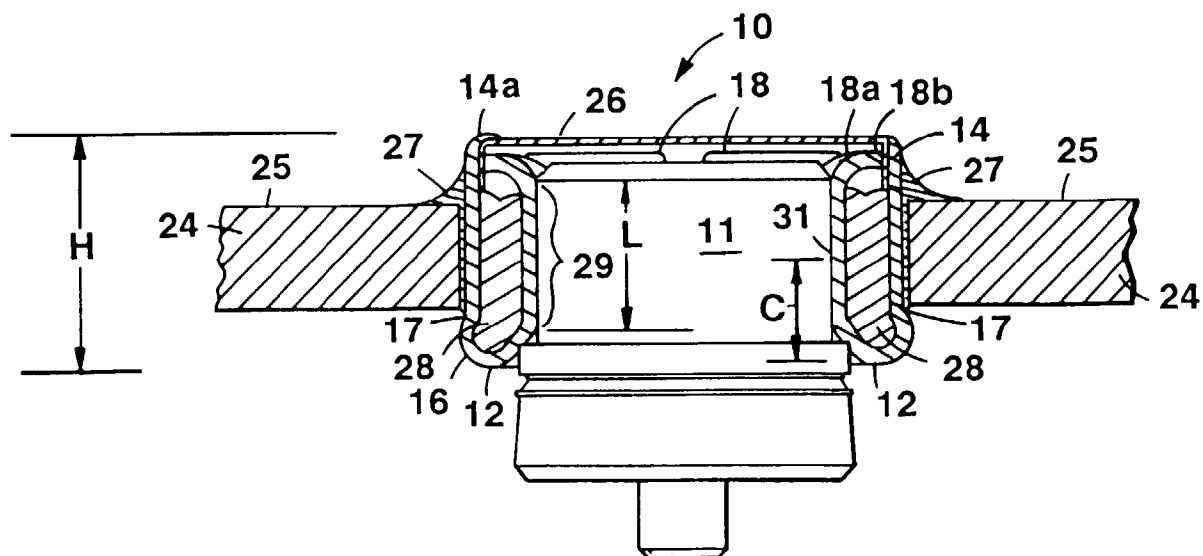


FIG. 1a

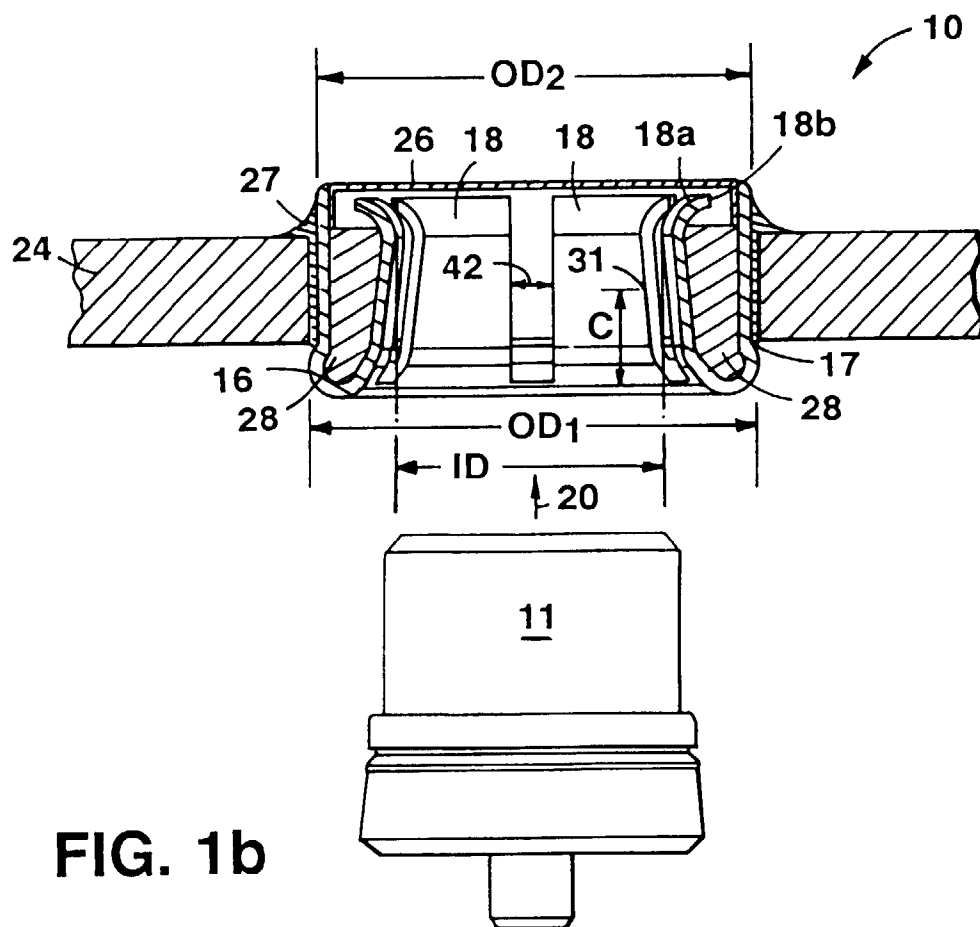


FIG. 1b

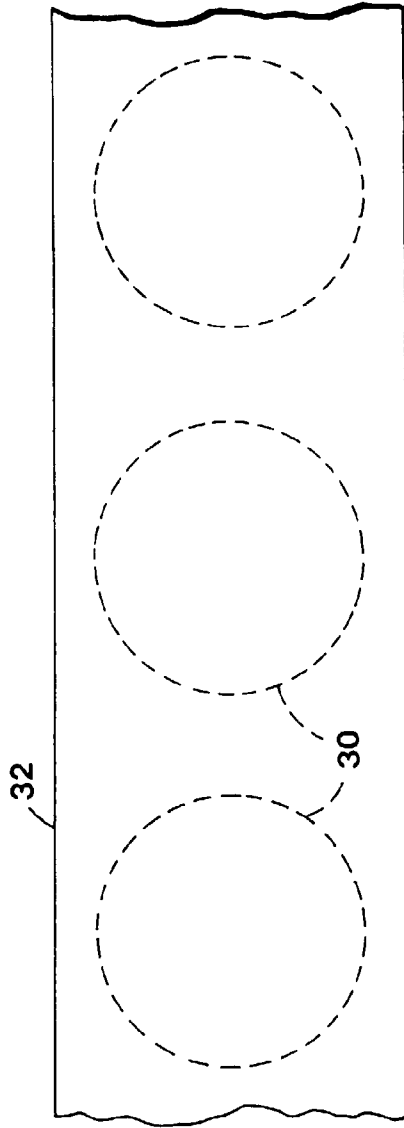


FIG. 2a

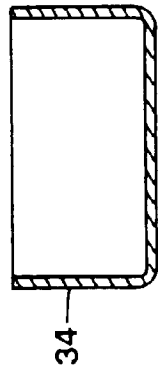


FIG. 2b

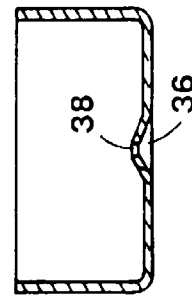


FIG. 2c

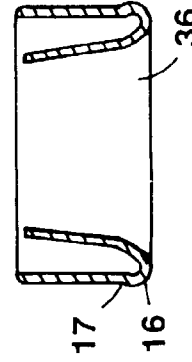


FIG. 2d

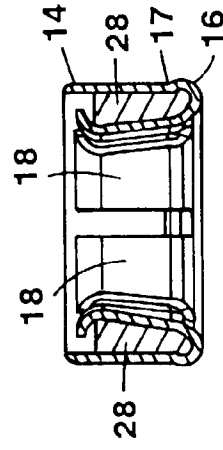
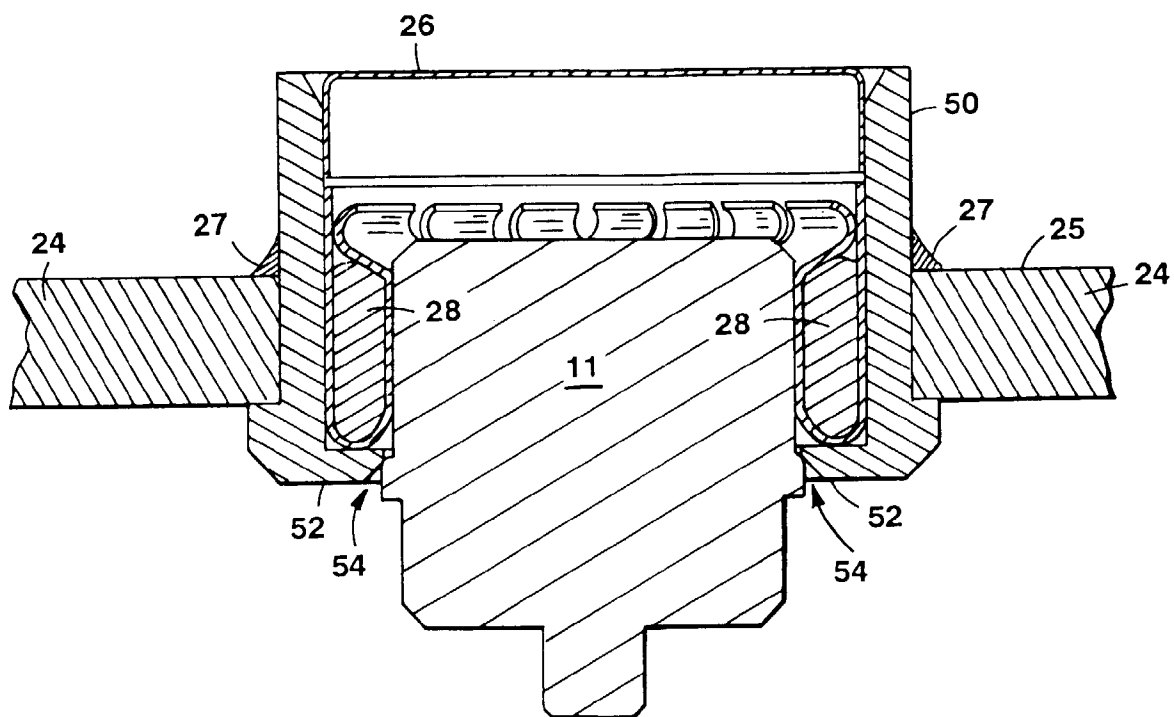
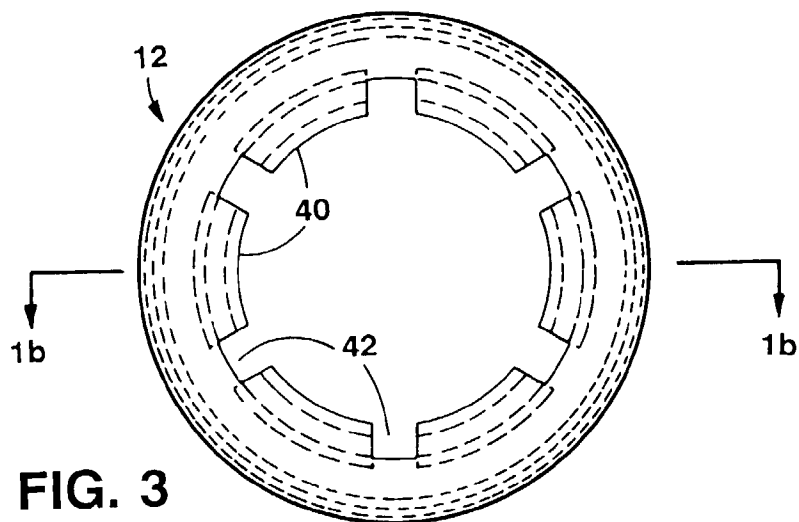


FIG. 2e



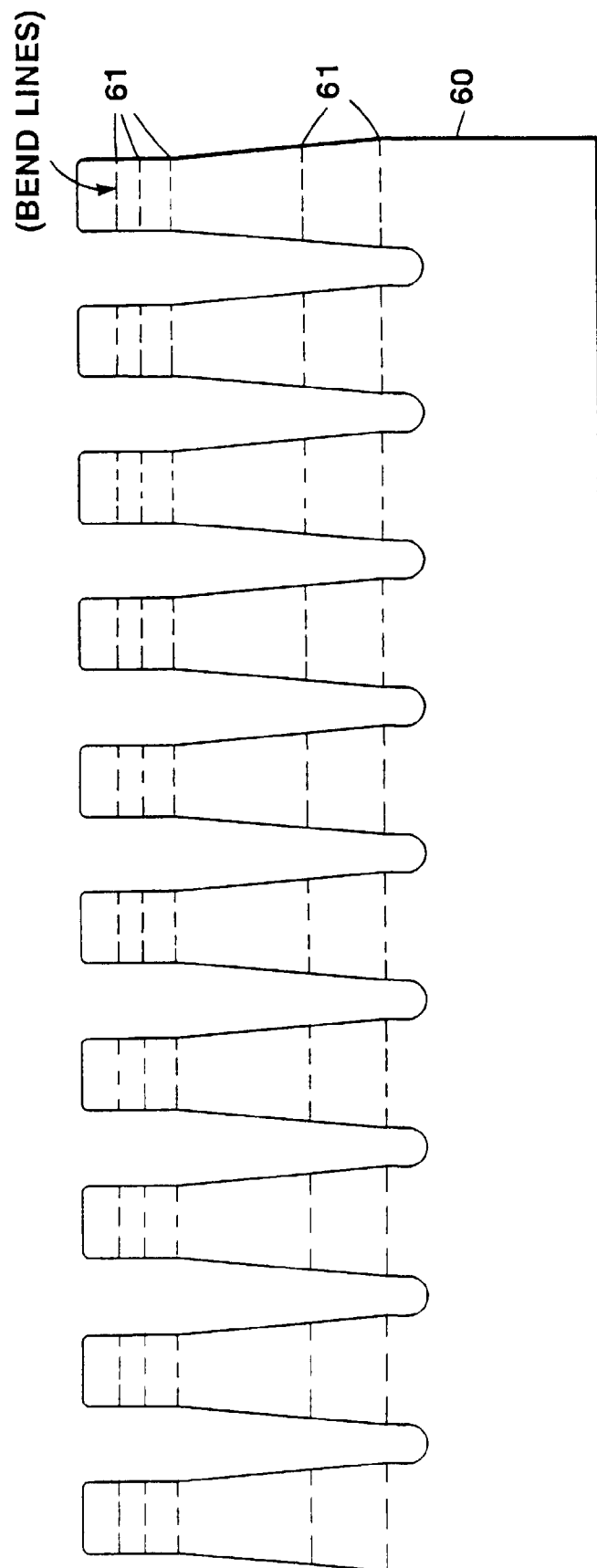


FIG. 5a

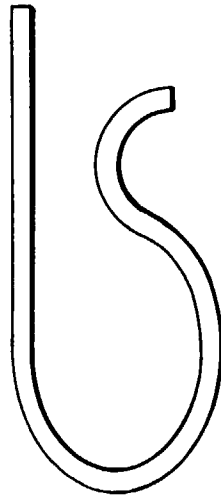


FIG. 5b

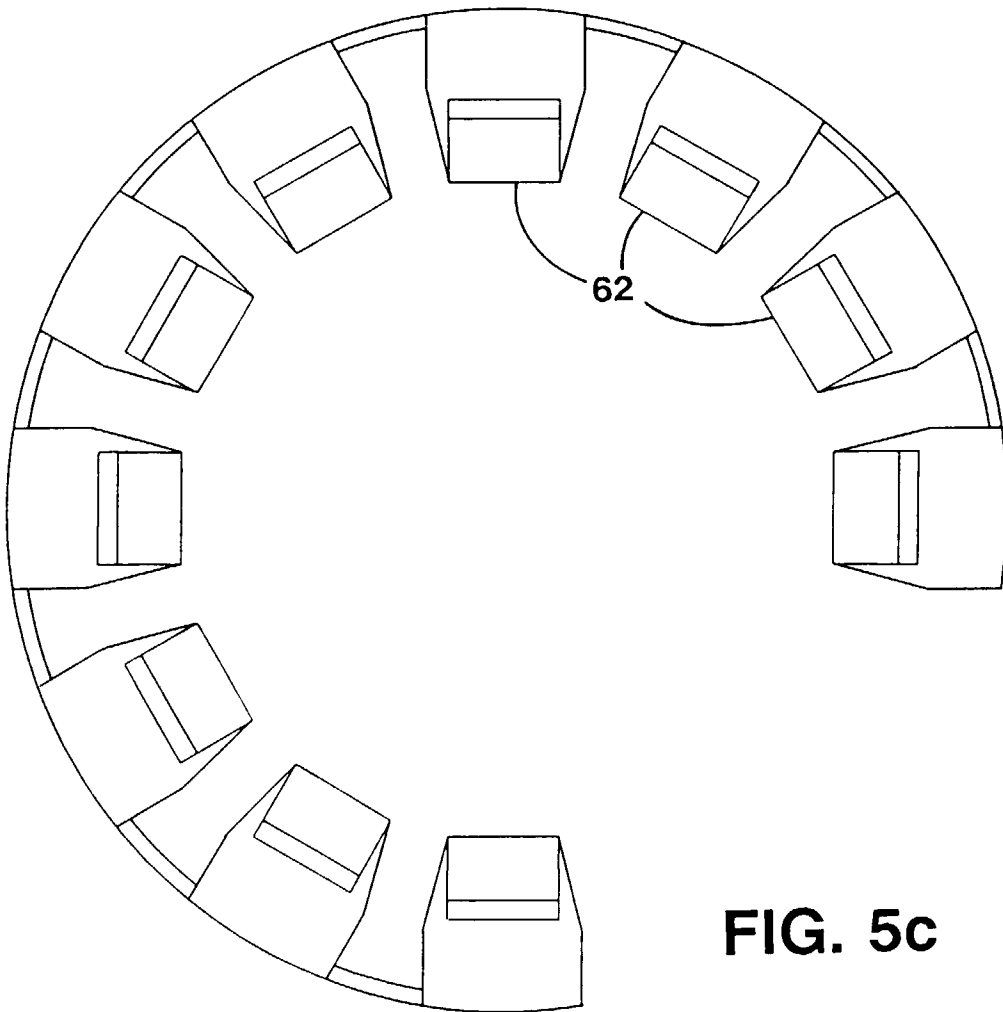


FIG. 5c

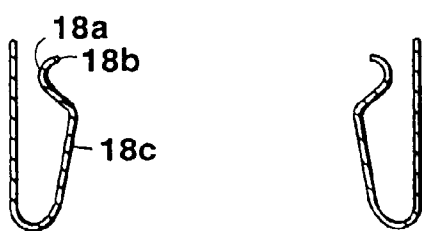


FIG. 6a

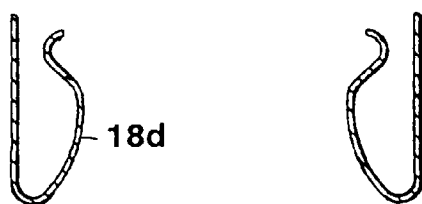


FIG. 6b

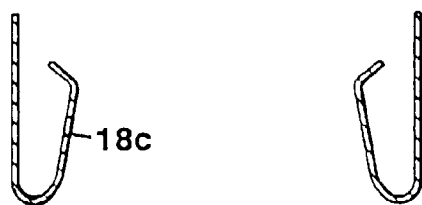


FIG. 6c

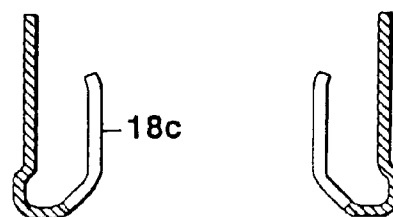


FIG. 6e

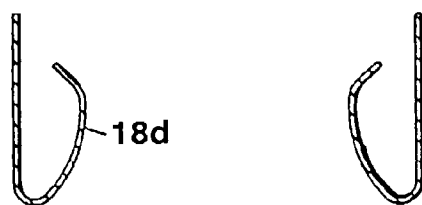


FIG. 6d

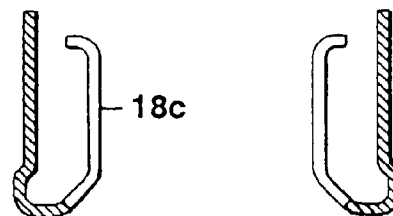


FIG. 6f