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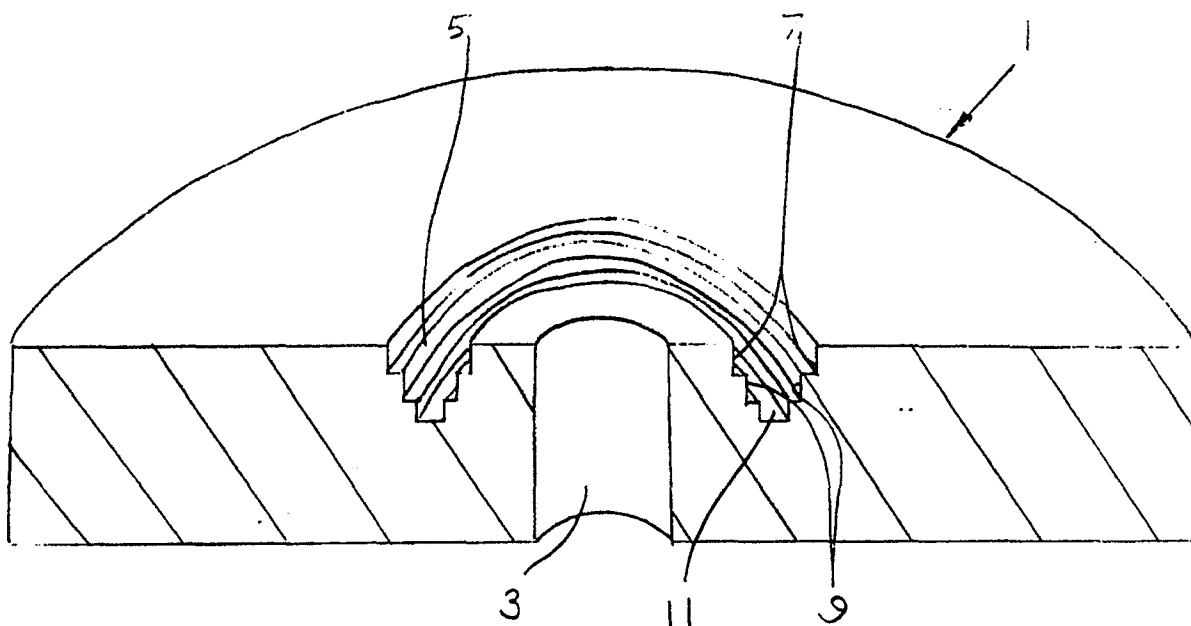
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Chelmsford, Essex, CM1 2QU(GB)(54) **Anode for a magnetron and method of manufacturing such an anode.**

(57) An anode for a magnetron comprises a cylinder (1) having a plurality of vanes (15) extending radially inwardly therefrom, the vanes having at least two slots (17) formed by substantially circular grooves (5,7,9) with groove centres at substantially the same

radius and at least two straps (19,23) located one in each of the slots (17).

The invention also includes a method of making such an anode.

**FIG. 1****EP 0 421 716 A2**

ANODE FOR A MAGNETRON AND METHOD OF MANUFACTURING SUCH AN ANODE

This invention relates to an anode for a magnetron and to a method of manufacturing such an anode.

In one known type of magnetron, an anode structure surrounds the cathode and comprises a plurality of radially extending vanes brazed to a surrounding cylinder. In order to control unwanted modes and to enable more power to be coupled from the magnetron, the vanes are often connected by straps in such a manner that every other vane is connected together. Thus two radially spaced straps are provided, one connecting even vanes and the other connecting the odd vanes.

With magnetrons, the lower the frequency, the larger is the magnetron itself. However, as magnetrons are designed to cope with higher and higher frequencies, they become, of necessity smaller and smaller. At frequencies above 20GHz, manufacturing difficulties become severe and, because of the small dimensions used and the high accuracy required, it is frequently difficult if not impossible to manufacture strapped anodes, particularly where mass production is involved.

The present invention seeks to provide a strapped anode for a high frequency magnetron which is reproducible on a mass production scale and to provide a method of producing such an anode.

According to a first aspect of the invention, there is provided an anode for a magnetron comprising a cylinder having a plurality of vanes extending radially inwardly therefrom, the vanes having at least two slots formed by substantially circular grooves with groove centres at substantially the same radius and at least two straps located one in each of the grooves.

The grooves may lie one within the other in a stepped formation or may lie on opposite sides of the vanes. Where the grooves are nested in a stepped configuration, there must be sufficient steps to ensure that one of the straps is in electrical contact with a vane and the other, or others, are electrically isolated therefrom. Thus, where two straps are employed there are effectively three grooves, one within the other, to ensure that one strap is properly spaced from the vane and the other strap. The straps may be provided with projections at a circumferential spacing equivalent to twice the circumferential spacing of the vanes, contact with the vanes being made through the projections.

In a preferred embodiment of the invention, at least one of the straps has projections extending inwardly and projections extending outwardly, giving a good thermal conduction path from the inte-

rior to the exterior of the magnetron. However, all the projections could be inwardly extensive or could be outwardly extensive.

According to a second aspect of the invention, there is provided a method of manufacturing an anode for a magnetron comprising the steps of producing an annular groove in one of the end faces of a cylindrical anode blank, forming vanes in the anode blank such that they lie extending radially inwardly from an annulus formed by the remainder of the blank and such that the groove is located towards the free ends of the vanes, and locating a strap in the groove so that it makes contact with a plurality of vanes.

Further according to this aspect of the invention, there is provided a method of manufacturing an anode for a magnetron comprising the steps of producing at least two annular grooves at substantially the same radius in one or both end faces of a cylindrical anode blank, forming vanes in the anode blank such that they lie extending radially inwardly from an annulus formed by the remainder of the blank and such that the grooves are located towards the free ends of the vanes, and locating at least two straps in the grooves so that they make contact with alternate vanes.

The grooves may be formed as a single stepped groove in which the outer portion forms a first groove and has a first strap therein while the inner portion forms a second groove with a second strap therein lying directly beneath the first strap and electrically isolated from it. Alternatively, the grooves may be formed in opposite end faces of the blank, one strap being located in each of the grooves. A combination of these arrangements may be provided in that the stepped groove may be provided at both ends allowing the provision of four straps or the stepped groove may be provided at one end while a single groove is provided at the other end, thus allowing the provision of three straps.

The grooves may be produced by machining, pressing or other suitable techniques while the vanes may be cut out from the blank by spark erosion methods.

The invention will now be described in greater detail, by way of example, with reference to the drawings in which :-

Figure 1 is a view, partially in section, of an anode blank having had a stepped groove cut into one face thereof;

Figure 2 is a perspective view of a portion of the anode blank shown in Figure 1 after vanes have been formed therein;

Figure 3 shows in partial plan view a form of

strap suitable for use in the stepped grooves cut into the vanes as shown in Figure 2;

Figure 4 is a partial perspective view of an anode constructed in accordance with the invention to show the arrangement of the straps.

Figure 5 is a sectional view taken on the line V-V of Figure 4.

Figure 6 is a sectional view taken on the line VI-VI of Figure 4;

Figure 7 is a sectional view similar to Figure 5 but showing the arrangement of an anode having a single strap at each face;

Figure 8 is a sectional view similar to Figure 5 but showing the arrangement of an anode having a two straps at each face;

Figure 9 is a sectional view similar to Figure 5 but showing the arrangement of an anode having a single strap at one face and two straps at the other face, and

Figure 10 is a plan view similar to Figure 3 but showing a different configuration of strap.

Referring first to Figure 1, the first step in making an anode in accordance with a first embodiment of the invention comprises taking a cylindrical copper blank 1 having a centre bore 3 therein and machining an annular multiple groove 5 therein. The groove 5 could be said to consist of three grooves 7, 9 and 11 nested together for a purpose to be described. As will be appreciated, the groove has a uniform profile throughout its length and is continuous.

The anode blank 1 is then further machined by means of a spark erosion technique so that it produces a number of radially inwardly extending vanes 15, as can be seen from Figure 2, by removing the material of the blank 1 between the vanes. Because of the groove 5 cut into the original blank, each vane 15 will have a slot 17 of identical shape, these slots being all that is left of the groove 5.

Two similar anode straps, one of which can be seen at 19 in Figure 3, are produced. Both straps comprise an annulus 20 with a number of radial projections 21 extending both inwardly and outwardly in pairs. Each pair is spaced angularly by an angle which is equal to twice the angle α between individual vanes 15. The projections one strap extend radially further than the projections on the other strap for a reason which will be described hereafter.

As shown in Figure 4, both straps 19 and 23 are placed in the slots 17 in the vanes, the strap 19 with the larger projections being placed on top of the strap 23 with the smaller projections. Each strap 19 or 23 connects together alternate vanes and for this purpose it is necessary for the projections 21 to be seated in the appropriate part of the slot 17. Figure 5 shows the upper strap 19 with its projections 21 taking up the top step 25 of the slot

17 while Figure 6 shows the lower strap 23 with its projections 21 taking up the second step 27 of the slot 17. Thus it will be appreciated that the projections 21 of one strap will be offset by the angle α from the projections 21 on the other strap. Each strap 19 and 23 is bonded to the walls of the slot 17 so as to provide a good thermal conduction across the strap.

In a modification of the method above described, the vanes could be produced first and, provided that the vanes were provided with sufficient support, the grooves could be then cut into the formed vanes.

The configuration of the straps on the anode vanes may be varied. Figure 7 shows, in section, a vane of an anode in which a single strap 19 is placed in a slot 29 in one edge of the vane 15 while the second strap 23, which in this case is identical to the first strap 19, is placed in a slot 31 at the other edge of the vane 15. Figure 8 shows an anode which has two straps in each of two slots 33 and 35. Thus the straps 19 and 23 are positioned in the upper slot 33 while the other two straps 37 and 39 are positioned in the lower slot 35. Yet another version is shown in Figure 9 which has a double strap slot 41 at one edge and a single strap slot 43 at the other edge. Here, three straps 19, 23 and 37 are used. With all these possible variations, it is possible to design anodes with significantly varying characteristics and, in particular, high values of strap capacity may be achieved.

Theoretically, more than two straps may be provided on both sides of the anode, but for practical purposes, three would normally be the limit. Equally, a single strap could be used on only one side of the anode.

Figure 10 shows a possible variation of the strap construction. In this figure, the strap 47 is configured to have a serpentine shape such that, when inserted into the slots 17 of the vanes it connects with one set of vanes and misses adjacent vanes.

In a further modification, the initial groove 5 could be machined with a non uniform profile along its length. Then, when the vanes are formed, alternate vanes will have parts of the groove with different profiles. This enables an anode strap to be used which has a uniform cross section throughout its entire length.

Claims

1. An anode for a magnetron comprising a cylinder having a plurality of vanes extending radially inwardly therefrom, the vanes having at least two slots formed by substantially circular grooves with groove centres at substantially the same radius and

at least two straps located one in each of the grooves.

2. An anode as claimed in claim 1, wherein the grooves lie one within the other in a stepped formation.

3. An anode as claimed in claim 1, wherein the grooves lie on opposite sides of the vanes.

4. An anode as claimed in claim 1, 2 or 3 wherein the straps are provided with projections at an angular spacing equivalent to twice the angular spacing of the vanes, contact with the vanes being made through the projections.

5. An anode as claimed in claim 4 wherein the projections are inwardly and outwardly extensive.

6. A magnetron comprising a cathode and an anode as claimed in any of claims 1 to 5.

7. A method of manufacturing an anode for a magnetron comprising the steps of producing an annular groove in one of the end faces of a cylindrical anode blank, forming vanes in the anode blank such that they lie extending radially inwardly from an annulus formed by the remainder of the blank and such that the groove is located towards the free ends of the vanes, and locating a strap in the groove so that it makes contact with a plurality of vanes.

8. A method of manufacturing an anode for a magnetron comprising the steps of producing at least two annular grooves at substantially the same radius in one or both end faces of a cylindrical anode blank, forming vanes in the anode blank such that they lie extending radially inwardly from an annulus formed by the remainder of the blank and such that the grooves are located towards the free ends of the vanes, and locating at least two straps in the grooves so that they make contact with alternate vanes.

9. A method as claimed in claim 8, wherein the grooves may be formed as a single stepped groove in which the outer portion forms a first groove and has a first strap therein while the inner portion forms a second groove with a second strap therein lying directly beneath the first strap.

10. A method as claimed in claim 8, wherein the grooves are formed in opposite end faces of the blank, one strap being located in each of the grooves.

11. A method as claimed in claim 8, wherein the grooves are formed as a stepped groove provided at both ends to allow the provision of four straps.

12. A method as claimed in claim 8, wherein the grooves are formed as a stepped groove provided at one end and a single groove provided at the other end, to allow the provision of three straps.

13. A method as claimed in any one of claims 8 to 12, wherein the grooves are produced by machining.

14. A method as claimed in any one of claims 8 to

12, wherein the grooves are produced by pressing.

15. A method as claimed in any one of claims 8 to 12, wherein the vanes are cut out from the blank by spark erosion methods.

16. An anode for a magnetron manufactured in accordance with any one of claims 7 to 15 and 17.

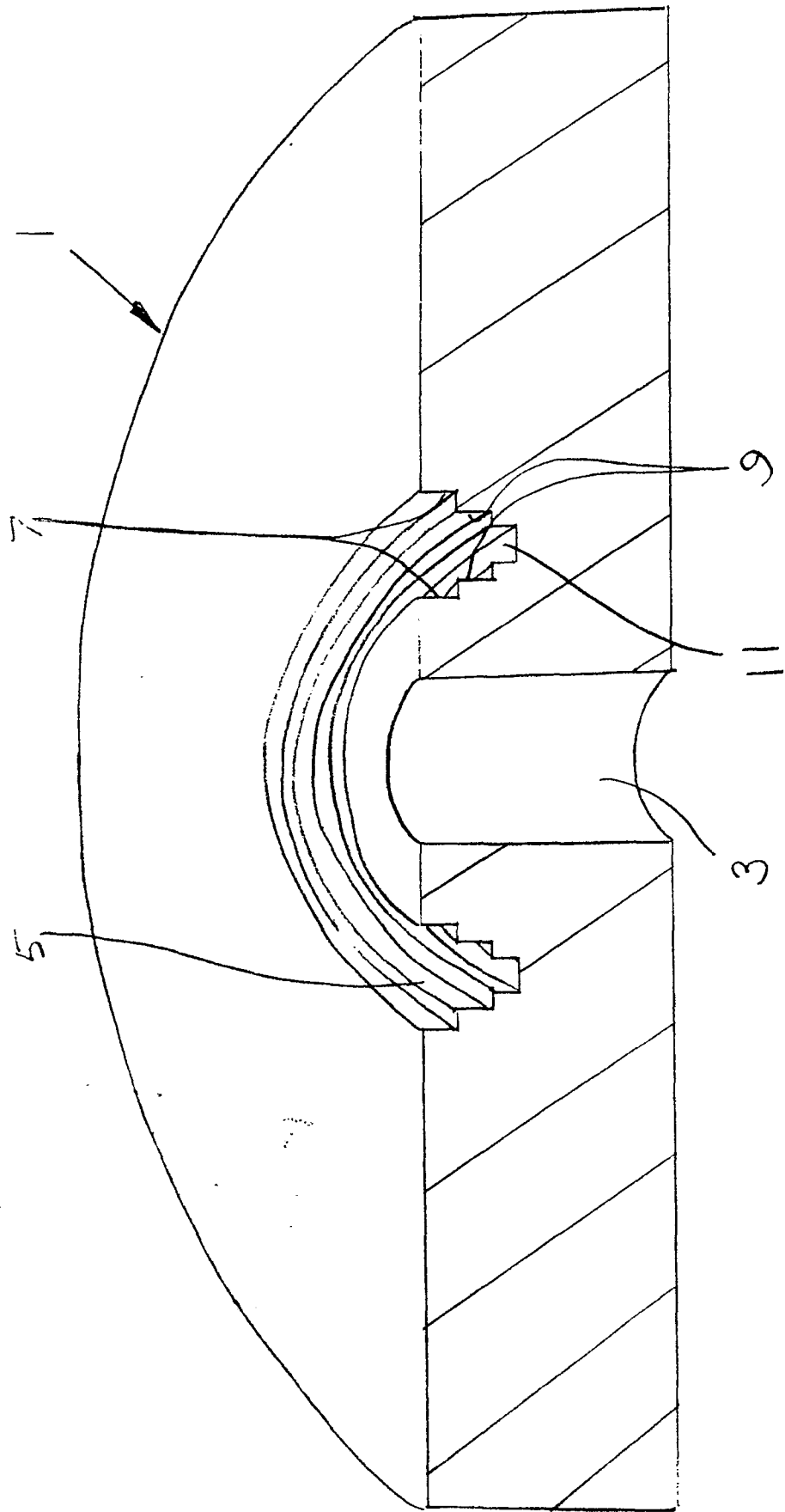
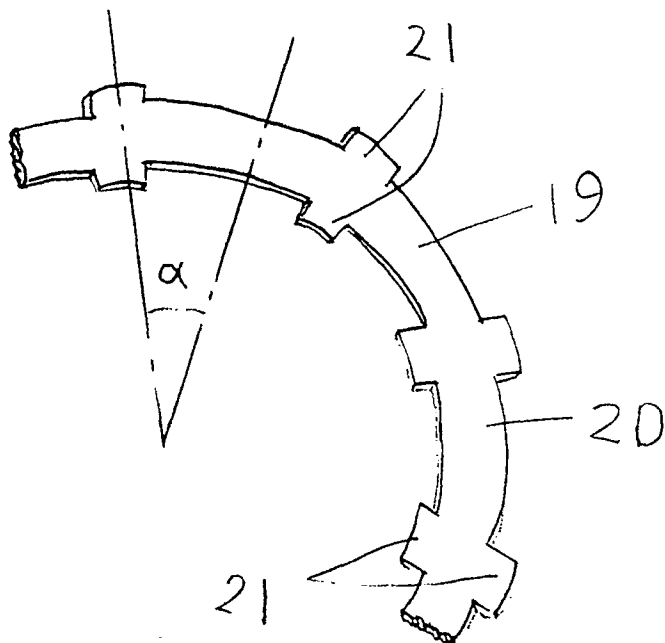
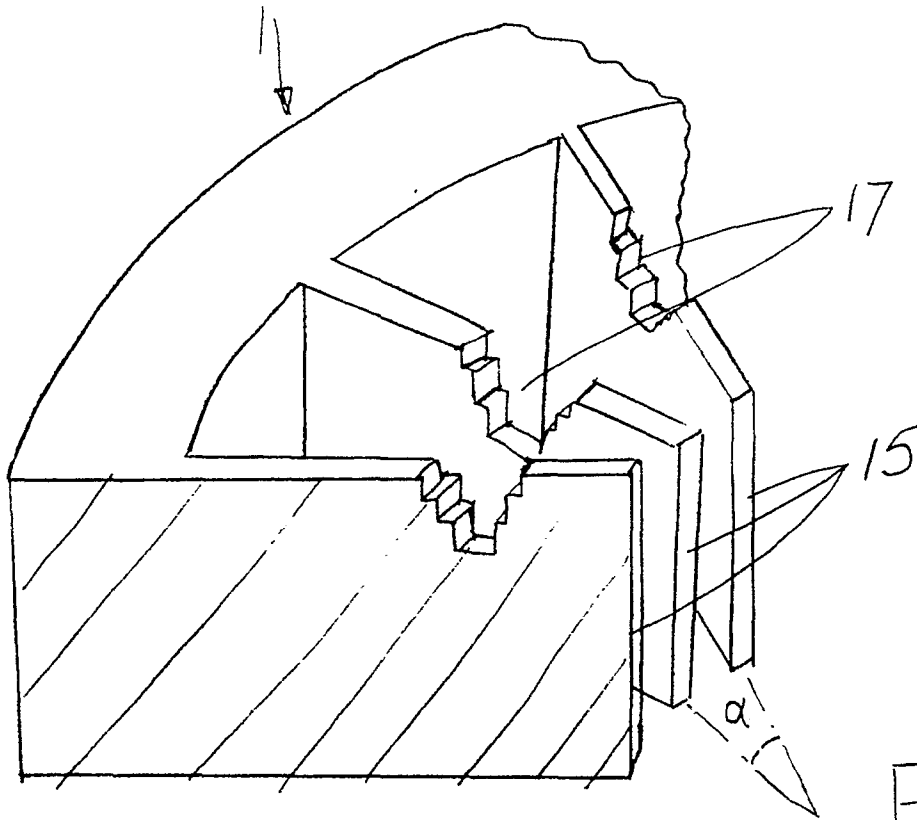


FIG. 1.



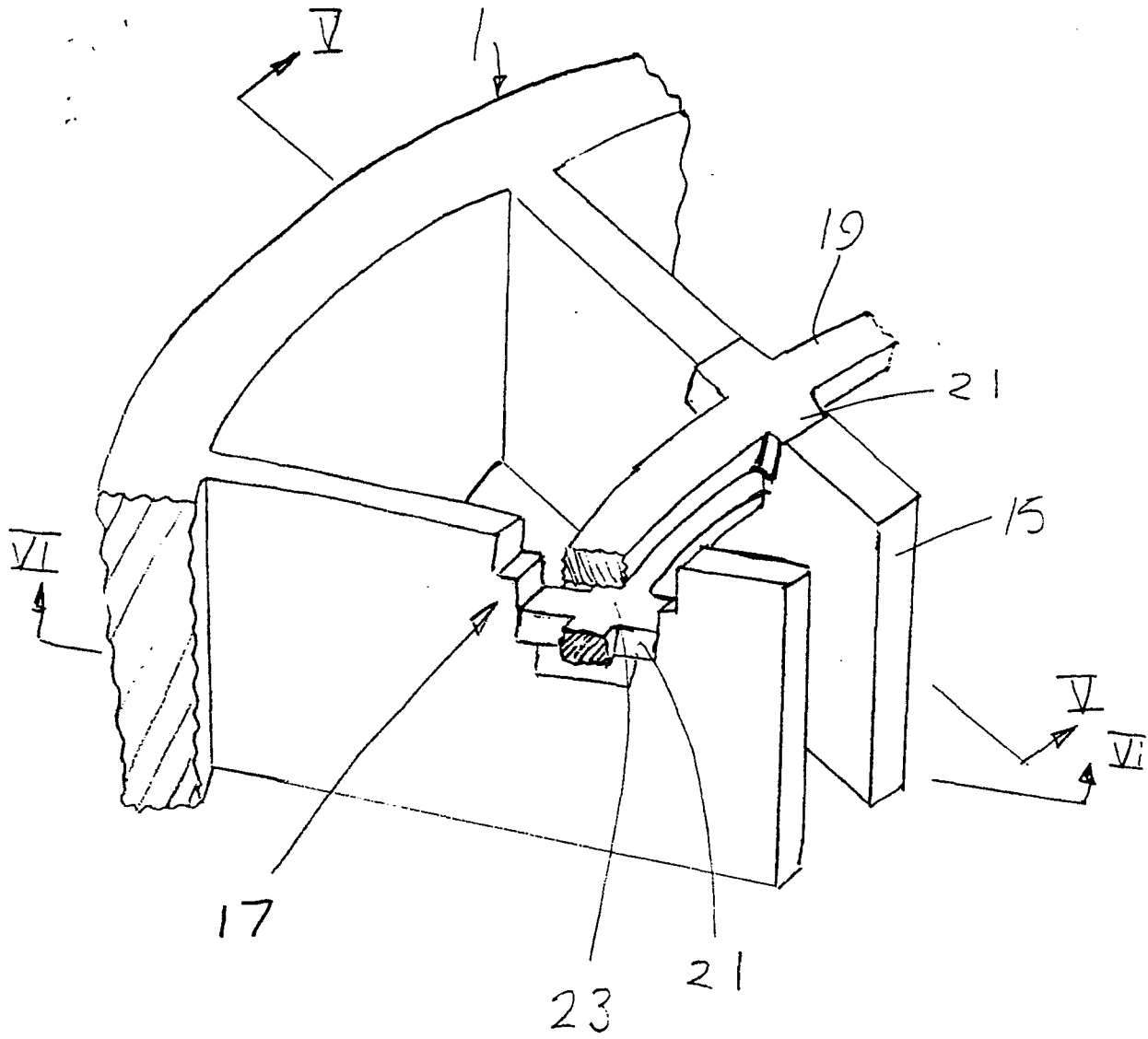


FIG 4

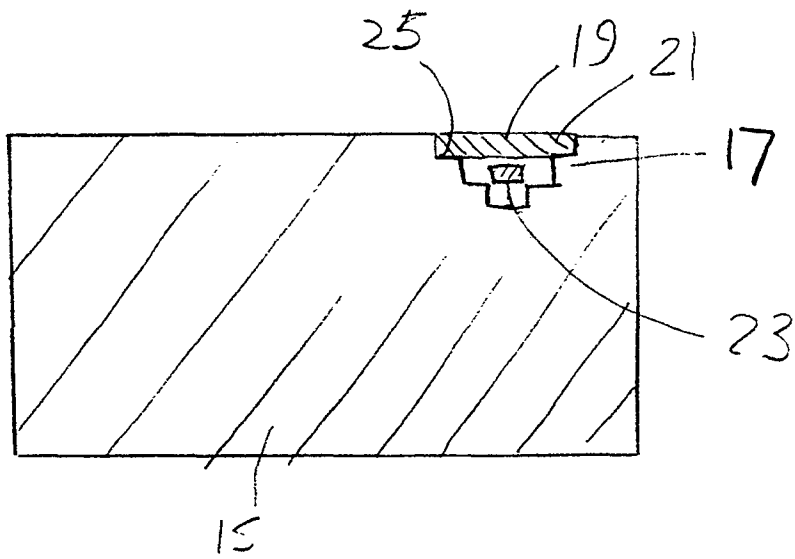


FIG 5

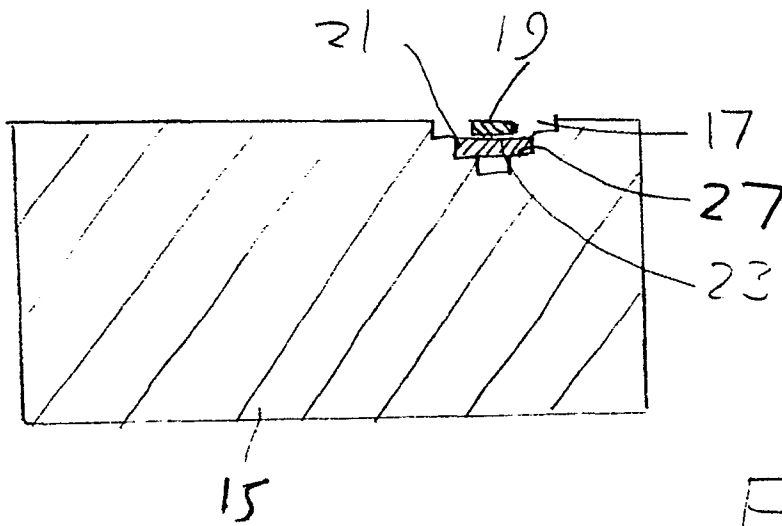


FIG 6

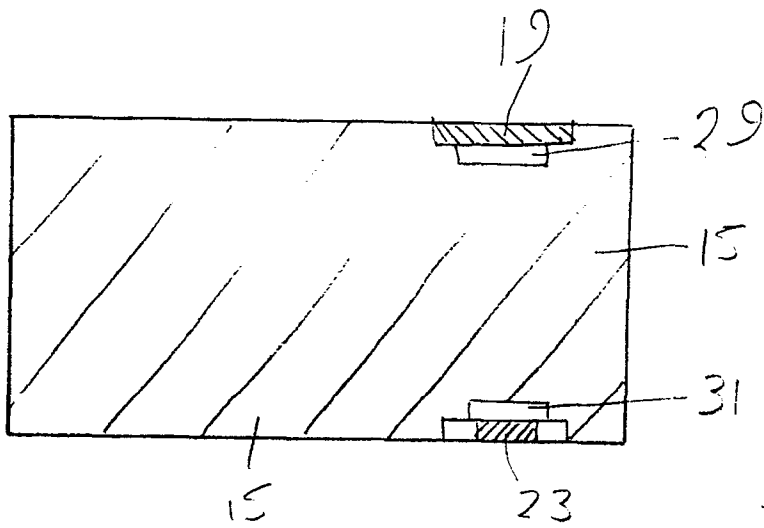


FIG 7

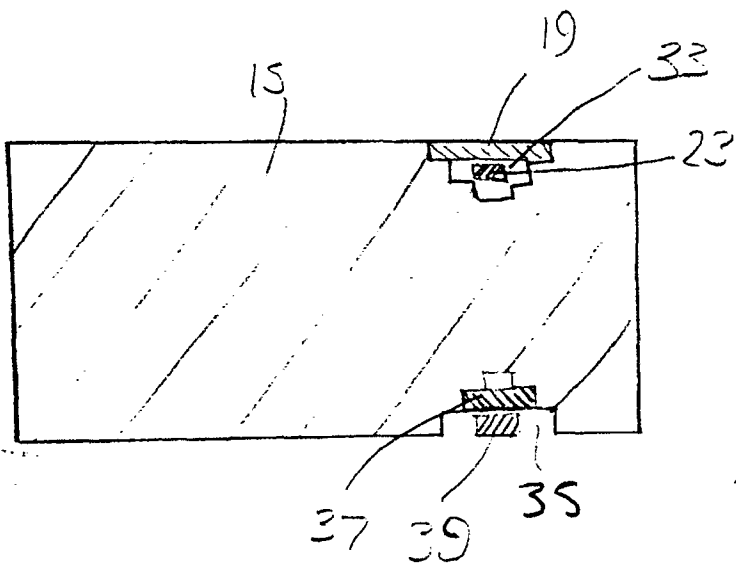


FIG 8

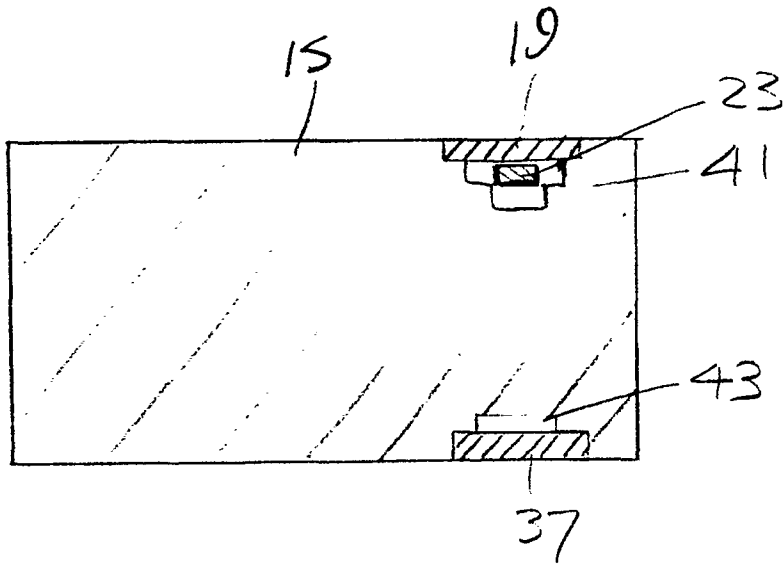


FIG. 9

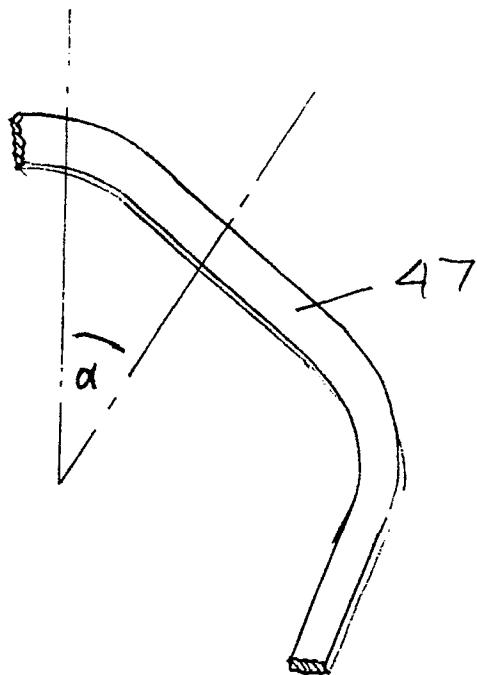


FIG. 10