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(54) PCB-mounted switch

(57) A switch for mounting on a printed circuit board comprises a housing (20) having an opening (26) in one face and first and second contacts (12, 14) including portions (12a, 14a) for connection to the board. A moveable beam (18a) extends between the first and second contacts, the beam being biased into a position in which it connects together electrically the two contacts. A contact portion (19) is positioned at the opening (26) of the housing and comprises a projection which extends through the opening (26), arranged such that a pressure applied to the contact portion (19) at the opening moves the beam (18a) thereby to break the electrical contact between the first and second contacts. The projection may seal the opening (26) in the normal state of the switch.

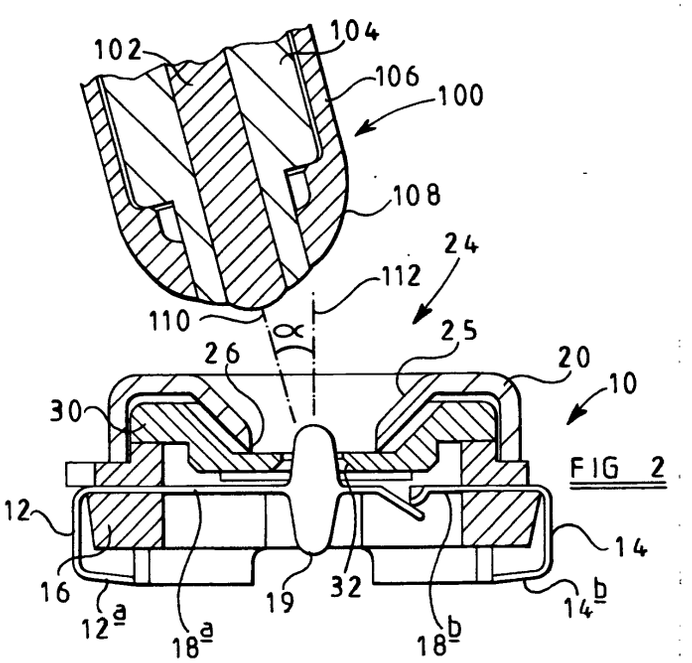

FIG 2

EP 1 039 588 A2

Description

[0001] This invention relates to switches for mounting on printed circuit boards, and more particularly, but not exclusively, to switches designed as coaxial connectors for radio frequency signals.

[0002] Coaxial connectors are well known for connecting coaxial cables to electrical equipment. For example, GB 2307113 describes a coaxial connector which enables an external aerial to be connected to a mobile telephone. The connector effectively comprises a switch having first and second contacts which include portions for connection to the printed circuit board. A moveable beam extends between the first and second contacts, the beam being biased into a position in which it connects together electrically the two contacts. One of the contacts is coupled to receiving and transmitting circuitry, and the other contact is connected to an internal aerial. The connector comprises a housing having an opening in one face which gives access to a contact portion of the beam. A pressure applied by a coaxial plug connector to the contact portion of the beam moves the beam so as to break the electrical contact between the transmitting and receiving circuitry and the internal aerial, and instead to couple an external aerial to the transmitting and receiving circuitry.

[0003] The coaxial connector plug, which is associated with the external aerial, has a projecting part to enter the opening of the housing and to make contact with the beam, so that the beam may be displaced by insertion of the coaxial plug connector.

[0004] A problem which arises in the known switch design is that dirt may enter the opening and reduce the quality of the electrical contact made by the beam. Furthermore, since the switch is PCB-mounted, it must be provided in a recess within the outer casing of the device (for example mobile telephone). Consequently, the coaxial plug connector must be formed with an extending plug part for insertion into the recess leading to the switch. This extending plug part has an inner projecting contact which is prone to damage, and which also may cause damage, for example to the clothing of an operator.

[0005] According to the present invention, there is provided a switch for mounting on a printed circuit board comprising:

a housing having an opening in one face;
first and second contacts including portions for connection to the board;
a moveable beam extending between the first and second contacts, the beam being biased into a position in which it connects together electrically the two contacts; and
a contact portion positioned at the opening of the housing and comprising a projection which extends through the opening, arranged such that a pressure applied to the contact portion at the opening moves the beam thereby to break the electrical contact between the first and second contacts.

[0006] In the switch design of the invention, a projection is provided which extends through the opening. In this way, the projection may partially seal the opening when the beam is in the position corresponding to the normal state of the switch (i.e. no external connector present). Preferably, the switch is for receiving a coaxial connector to apply the pressure to the contact portion.

[0007] A first terminal of the coaxial connector may be for connection to the contact portion, such that when the coaxial connector is received by the switch, the first contact is electrically connected to the first terminal through the beam and the first contact is disconnected from the second contact.

[0008] The contact portion may comprise a part of the beam, to reduce the number of components. Alternatively, the contact portion may comprise a contact member supported by a carrier which extends across the opening, the contact member being biased by the carrier towards a position in which it is spaced from the beam, pressure applied to the contact portion bringing the contact member into contact with the beam to break the electrical contact between the first and second contacts.

[0009] The latter arrangement enables the contact portion to be "cold", carrying no signal when the coaxial connector is removed. The reduces EMS problems.

[0010] The carrier preferably comprises a deformable web, pressure applied to the contact portion resulting in deformation of the web. The web can then perform a sealing operation for all positions of the contact portion.

[0011] The switch of the invention enables an internal component to be disconnected, and enables an external component having a coaxial connector to be connected to the circuitry on the printed circuit board.

[0012] The opening may be provided at the base of a tapered well. This acts as a guide surface for the introduction of the coaxial connector. Furthermore, the tapered well may have a conducting surface which acts as the contact face for a second terminal of the coaxial connector. The use of the tapered well surface as a contact for the coaxial connector enables some directional freedom to be provided for insertion of the coaxial connector.

[0013] The switch preferably comprises a unitary plastics body which defines the housing, portions of the body being coated with a conductive coating to define one or both of the first and second contacts. This enables the switch to be made with a minimum number of components. For example, the switch may comprise a single plastics component together with one metallic insert defining the beam.

[0014] Further portions of the body may be coated with a conductive coating for connection to a ground potential. For example, the outer surface of the housing may act as an electromagnetic shield.

[0015] The invention also provides a coaxial connec-

tor assembly comprising a switch of the invention and a coaxial connector for applying the pressure to the contact portion of the switch, and the coaxial connector preferably comprises a domed head having an inner core defining a first terminal, an outer surface defining a second terminal and an insulating portion between the first and second terminals. This domed head, the radially outer surface of which defines the second terminal, will make electrical contact with the conducting tapered well over a range of angles of insertion of the coaxial connector to the switch. Preferably, the domed head has a smooth outer surface so that the contacts of the coaxial connector are not prone to physical damage.

[0016] The invention also provides electrical equipment using a switch of the invention, with the switch provided in the path between an integral aerial of the equipment and a transmitter/receiver circuit, and being provided for disconnecting the integral aerial when a coaxial connector of a substitute aerial is introduced, thereby to connect the substitute aerial to the transmitter/receiver circuit. This equipment may comprise a mobile telephone.

[0017] The invention also provides electrical equipment having a coaxial connector assembly of the invention, the switch of the connector assembly being associated with the mobile telephone and the coaxial connector of the assembly being associated with a docking station having a substitute aerial. This docking station may comprise a cradle of a car phone which is linked to an external aerial.

[0018] The invention will now be described by way of example, with reference to and as shown in the accompanying drawings in which:

Figure 1 shows a first embodiment of coaxial connector assembly according to the invention;
Figure 2 shows a cross section of the components of the assembly of Figure 1;
Figure 3 shows in greater detail one component of the assembly of Figures 1 and 2;
Figure 4 shows the switch of a second embodiment of coaxial connector assembly;
Figure 5 shows an alternative view of the switch of Figure 4;
Figure 6 shows the switch of a third embodiment of coaxial connector assembly; and
Figure 7 shows a mobile telephone and docking station using a coaxial connector assembly of the invention.

[0019] Figure 1 shows a first embodiment of connector assembly of the invention. The assembly comprises a switch part 10 and a coaxial connector part 100 in the form of a connector plug. The switch part 10 is provided for coupling a first contact 12 to a second contact 14, not shown in Figure 1, on the opposite side of the switch 10. The contacts 12, 14 comprise a metal structure embedded in an insulating housing 16. A connecting beam 18 extends between the first and second contacts 12, 14. The contacts and the beam are mounted in an outer housing 20, one face 22 of which is provided with a receiving region 24 including an opening 26. The coaxial connector 100 is adapted to be received in the receiving region 24, in such a way as to displace the beam 18 (not shown in Figure 1) so as to break the connection between the first and second contacts 12, 14. In such a case, electrical contact is made between the first contact 12 and one of the terminals of the coaxial connector 100.

[0020] The switch part 10 is adapted to be mounted on a printed circuit board, and in particular the contacts 12, 14 are arranged to be connected to tracks on the printed circuit board.

[0021] The general operating principle of the coaxial connector assembly as described above is known in the art. This invention is concerned with the particular arrangement providing for movement of the beam 18, and the coaxial connection 100. Thus, as shown in Figure 1 a projection 19 is provided which extends through the opening 26. This projection 19 provides a point to which the mechanical forces required to displace the beam may be provided, and acts as an electric contact to the beam when the coaxial terminal is inserted.

[0022] The extension of the projection 19 through the opening 26 enables the projection 19 to seal the opening 26. Furthermore, this enables an improved design of the coaxial connector 100 as will be explained in the following.

[0023] Figure 2 shows in greater detail the components of the assembly described with reference to Figure 1, and the same reference numerals have been used. The beam 18 is shown in greater detail in Figure 2, which extends between the first and second contacts 12, 14. The beam effectively comprises two portions, a first portion 18a which defines the first contact 12 and a second portion 18b which defines the second contact 14. These portions are each held in position by inserting them in appropriate slots provided in the insulating housing 16, or else the housing 16 may be moulded around the metal beam portions. The shape of the two beam portions 18a, 18b is such that the first beam portion 18a is spring biased against the second portion 18b. In other words, stored energy in the first portion 18a tends to bias the projection 19 in the upward direction as represented in Figure 2 to close the switch.

[0024] The housing 20 may comprise a plastic body plated with a conducting coating. The receiving region 24 of the switch 10 comprises a recess having a conical side wall 25 which tapers inwardly towards the beam 18. This side wall 25 is defined as part of the housing 20 and thereby comprises a conducting surface. The opening 26 is defined at the base of the side wall 25, and a lateral spacing is provided between the projection 19 and the opening 26, which allows for some lateral misalignment of the connector 100. The switch 10 is provided with a further internal component 30 which also has a central opening 32 through which the projection

19 passes. The spacing between the projection 19 and the opening 32 is much smaller so that the projection 19 almost seals the opening 32 to prevent the passage of dirt into the interior of the housing 20. This protects the electrical contact area between the first and second beam portions 18a, 18b.

[0025] The coaxial connector 100 comprises a central inner conducting core 102, an insulating collar 104 concentric with the inner core and an outer conducting part 106. The inner core 102 and the outer part 106 define the two terminals of the coaxial connector. As a result of the projection 19, the inner core 102 of the coaxial connector 100 is not required to protrude from the end face of the connector as in prior art designs. Consequently, the coaxial connector 100 can be designed with a dome shaped end face 108. This reduces the likelihood of the two terminals being damaged in normal use. Furthermore, the engagement of the curved outer conducting part 106 with the side wall 25 to provide electrical contact can be achieved without the longitudinal axis 110 of the connector 100 being aligned perfectly with the preferred direction of entry 112. Thus, a range of angles α may be permitted within which correct contact between the outer conducting part 106 and the side wall 25 as well as between the inner core 102 and the projection 19 is possible.

[0026] In use of the device shown in Figures 1 and 2, the switch 10 is mounted on a printed circuit board, with the downward facing parts 12a, 14a of the first and second contacts 12, 14 being soldered to tracks of the printed circuit board. Alternatively, the switch 10 may be bonded to the printed circuit board using a conducting adhesive.

[0027] The conductive coating on the housing 20 is preferably also connected to ground potential lines on the printed circuit board. In this case, the side wall 25 comprises an earthed connection and the outer conducting part 106 of the coaxial connector 100 is also connected to earth. The signal information is carried by the inner core 102 to the first contact 12 through the first portion 18a of the beam.

[0028] A preferred use of the coaxial connector assembly is for introducing radio frequency signals to a printed circuit board carrying receiving and transmitting circuitry. Thus, the switch 10 may be mounted on the printed circuit board of a mobile telephone. In this case, the first contact 12 is coupled by the printed circuit board to receiving and transmitting circuitry, and the second contact 14 is coupled to an internal antenna of the mobile telephone. In the absence of the coaxial connector 100, the switch 10 couples these two components together. However, upon introduction of the connector 100, the internal aerial is disconnected from the receiving and transmitting circuitry, and instead an external aerial, which supplies signals to (or receives signals from) the connector 100, is connected to the receiving and transmitting circuitry.

[0029] The projection 19 may be formed by any suitable process. For example, it may be formed by deep-drawing part of the material of the beam. Alternatively, the beam portions 18a, 18b may comprise metal portions moulded into the desired shape. As a further alternative, the projection 19 may comprise a separate component which is introduced and fixed in an opening provided in the beam.

[0030] Figure 3 shows in greater detail the insulating housing 16 with the beam portions 18a, 18b in position. The first contact is formed as an integral part of the first beam portion 18a, and the second contact 14 is formed as an integral part of the second beam portion 18b.

[0031] A second embodiment of the invention will now be described with reference to Figures 4 and 5.

[0032] As shown in Figure 4, the switch again comprises a first contact 12 and a second contact 14 and these are connected through a beam having a projection 19. A receiving region 24 is again provided in the upper face 22 of the switch 10, and the receiving region 24 comprises a part-conical wall 25 at the base of which is defined an opening 26. These components of the switch 10 shown in Figure 4 function in exactly the same way as the switch of the first embodiment.

[0033] The switch 10 shown in Figure 4 additionally has a port 50 for receiving a fixed connector.

[0034] This will be described in greater detail with reference to Figure 5.

[0035] The housing 20 of the switch 10 shown in Figure 4 comprises a unitary plastics body, which is selectively plated to define conducting regions. In Figure 4, the hatched areas 52 represent regions of the housing 20 which are not plated with a conductive coating. Thus, the non-plated region 52a provides insulation between the first contact 12 and the bulk of the housing 20. The second non-conducting region 52b provides insulation between the second contact 14 and the bulk of the housing 20. The remainder of the housing 20 is plated with a conductive material, and this layer is again preferably connected to a ground line of the PCB so that the housing 20 acts as an electromagnetic shield and provides electromagnetic protection against cross-talk interference.

[0036] Figure 5 shows in greater detail the construction of the housing 20. In Figure 5, the plated areas have been represented as the hatched portions. These plated areas define the first contact 12 and the second contact 14 as well as the second portion 18b of the beam. Thus, the embodiment of Figures 5 and 6 requires only a single inserted metal component, the first portion 18a of the beam. This is mounted within the housing 20 to obtain the desired bias so that the end 18c of the first beam portion 18a contacts the plated area defining the second portion 18b of the beam.

[0037] The coatings provided on the surface of the housing 20 may be obtained by selective plating. This selective plating may be obtained by using a two part moulding process. A substructure is moulded from a first platable plastic which then has a superstructure mould-

ed around it, the plastic of the superstructure being resistant to plating. When the switch 10 is then plated, the exposed areas of the substructure accept the plating whilst those of the superstructure do not. This so-called moulded interconnected device (MID) technology is known in the art. Of course, various other techniques for providing conductive coatings or tracks on the surface of a plastic body can be employed, for example selective etching of a coating, or else masked deposition of coatings.

[0038] The embodiment of Figures 4 and 5 additionally comprises a further port 50 for connection of the internal aerial signal. This may be arranged to receive a conventional connector. As shown in Figure 5, the port 50 comprises a first contact 60 for the outer conducting part of a coaxial line. This contact 60 comprises an annular metallic ring which is clamped in respective grooves 62 of the housing 20, and thereby makes contact with the earthed plated material on the surface of the housing 20. A second metal component 64 provided inside the body of the switch 10 provides the electrical contact for the inner core of the coaxial line. This contact 64 comprises a sprung arrangement and which is retained by the housing 20 so as to be in contact with a further contact 66 of the switch (also shown in Figure 4). As shown in Figure 4, this further contact 66 is isolated from the main body of the housing 20 by the second non-conducting region 52b.

[0039] For connecting the first contact 12 (which leads to the transmitting and receiving circuitry) to the internal aerial, no external coaxial connector 100 is provided, and the beam 18 thereby connects the first contact 12 to the second contact 14. The internal aerial signal is provided to the port 50, and the internal aerial may be connected to the receiving and transmitting circuitry simply by providing a PCB track for connecting the contacts 14 and 66. However, it may be preferred to provide some additional circuitry between these two contacts.

[0040] In the same way as for the embodiment of Figures 1-3, if an external aerial is to be utilized, an appropriate coaxial connector 100 is introduced to the receiving region 24 to deflect the beam 18 thereby to break the electrical connection between the first and second contacts 12, 14. Instead, the first contact 12 is connected through the projection 19 to the central core of the coaxial connector 100. The coaxial connector for use with the switch of Figures 4 and 5 may have the same design as that shown in Figures 1 and 2.

[0041] A third embodiment of the invention will now be described with reference to Figure 6. In this embodiment the design of the projection 19 is different, and a different mechanism for sealing the opening 26 is provided. These differences may be imported into a design of the type represented in Figures 1 to 3, or into a design of the type shown in Figures 4 and 5. Thus, the specific design of the projection 19 represented in Figure 6 does not alter the possible ways in which the contacts to the PCB may be implemented.

[0042] In Figure 6, the same reference numerals have been used as in previous examples to denote the same components. The switch comprises a housing 20 which may again comprise a plastic body selectively plated with a conducting housing. In the particular example shown in Figure 6, a first plated region 70 defines a first contact area to the PCB, and a second plated area 72 defines a second contact area to the PCB. The housing 20 is shaped to define an interference fit recess 73 for the beam 18, so that one end of the beam makes contact with the first plated area 70. The bias of the beam 18 tends to urge the beam 18 against a contact area 72a which is part of the second plated area 72. In this embodiment, the beam 18 is not provided with the projection 19; it is instead provided as a separate contact member 19a. This contact member 19a is supported by a carrier 74 which extends across the opening 26. The carrier 74 is in the form of a deformable web, for example a rubber web, which is seated on shoulders 76 which form part of a housing 20. The web 74 is clamped between these shoulders 76 and a further press-fit retaining member 78. This retaining member 78 defines the side wall 25 which has a conducting coating, or else the member 78 may itself be formed from a conducting material. The conducting surface of the member 78 is in contact with a third plated area 80 which is again connected to ground potential lines on the printed circuit board, as described for previous embodiments.

[0043] The resiliency of the web 74 tends to urge it to a flat position, as shown in Figure 6. The components are sized such that in this position the contact member 19a is spaced from the beam 18, by the spacing 82 shown in Figure 6. Thus, when no coaxial connector is inserted into the switch, the contact member 19a is disconnected from any electrical signals and acts as a "cold" component. This reduces electromagnetic interference from the switch with other components on the PCB.

[0044] When the coaxial connector is inserted into the opening 26 of the switch, the central connector contacts the projection 19 and urges it downwardly against the bias of the web 74. The relative dimensions are selected such that the contact member 19a moves sufficiently to contact the beam 18 and deflects the beam 18 so as to break the electrical contact between the beam 18 and the second plated area 72. The movement of the contact member 19a is guided by the fitting of a cylindrical portion 84 of the contact member 19a in a bore 86 provided in the housing 20.

[0045] The membrane 74 acts as a seal between the inside and outside of the switch, for both positions of the contact member 19a.

[0046] Figure 7 shows schematically one application of the coaxial connector assembly of the invention. The switch 10 is provided on the printed circuit board of a mobile telephone 200 and a recessed opening 202 is provided for access to the switch 10. A docking station 210, acting as a cradle for the mobile phone 200, is pro-

vided with the coaxial connector 100. When the mobile phone 200 is detached from the cradle 210 the switch 10 serves to connect the internal aerial 204 to the receiving and transmitting circuitry, whereas when the mobile phone 200 is docked into the cradle 210 the receiving and transmitting circuitry is connected through the coaxial connector 100 to a substitute external aerial. Of course, additional connections may be provided for charging the battery of the mobile phone 200 or for transmitting other information to or from the mobile phone 200.

[0047] Although the construction described above is particularly suitable for the production of a switched RF connector, the coaxial connector assembly of the invention will be applicable for various other applications, as will be apparent to those skilled in the art.

Claims

1. A switch for mounting on a printed circuit board comprising:

a housing having an opening in one face;
first and second contacts including portions for connection to the board;
a moveable beam extending between the first and second contacts, the beam being biased into a position in which it connects together electrically the two contacts; and
a contact portion positioned at the opening of the housing and comprising a projection which extends through the opening, arranged such that a pressure applied to the contact portion at the opening moves the beam thereby to break the electrical contact between the first and second contacts.

2. A switch as claimed in claim 1 for receiving a coaxial connector to apply the pressure to the contact portion.

3. A switch as claimed in claim 2, wherein a first terminal of the coaxial connector is for connection to the contact portion, such that when the coaxial connector is received by the switch, the first contact is electrically connected to the first terminal through the beam and the first contact is disconnected from the second contact.

4. A switch as claimed in any preceding claim, wherein the contact portion comprises a part of the beam.

5. A switch as claimed in any one of claims 1 to 3, wherein the contact portion comprises a contact member supported by a carrier which extends across the opening, the contact member being biased by the carrier towards a position in which it is spaced from the beam, pressure applied to the contact portion bringing the contact member into contact with the beam to break the electrical contact between the first and second contacts.

6. A switch as claimed in claim 5, wherein the carrier comprises a deformable web, pressure applied to the contact portion resulting in deformation of the web.

7. A switch as claimed in claim 6, wherein the web provides a seal between the inside and outside of the switch.

8. A switch as claimed in any preceding claim, wherein the opening is provided at the base of tapered well.

9. A switch as claimed in claim 8, wherein the tapered well has a conducting surface.

10. A switch as claimed in claim 9, wherein a second terminal of the coaxial connector is for connection to the conducting surface.

11. A switch as claimed in any preceding claim, comprising a unitary plastics body which defines the housing, portions of the body being coated with a conductive coating to define one or both of the first and second contacts.

12. A switch as claimed in claim 11, wherein further portions of the body are coated with a conductive coating for connection to a ground potential.

13. A switch substantially as described herein with reference to and as shown in Figures 1 to 3, Figures 4 and 5, or Figure 6 of the accompanying drawings.

14. A coaxial connector assembly comprising a switch as claimed in any preceding claim and a coaxial connector for applying the pressure to the contact portion, wherein the coaxial connector comprises a domed head having an inner core defining a first terminal, an outer surface defining a second terminal and an insulating portion between the first and second terminals.

15. A connector assembly as claimed in claim 14, wherein the domed head has a smooth outer surface.

16. Electrical equipment having a switch as claimed in any one of claims 1 to 13, the switch being provided in the path between an integral aerial of the equipment and a transmitter/receiver circuit, and being provided for disconnecting the integral aerial when a coaxial connector of a substitute aerial is introduced and thereby to connect the substitute aerial

to the transmitter/receiver circuit.

17. Electrical equipment as claimed in claim 16, comprising a mobile telephone.

18. Electrical equipment having a coaxial connector assembly as claimed in claim 14 or 15, the switch being provided in the path between an integral aerial of the equipment and a transmitter/receiver circuit, the coaxial connector comprising a connector of a substitute aerial, the switch being provided for disconnecting the integral aerial when the coaxial connector of the substitute aerial is introduced and thereby to connect the substitute aerial to the transmitter/receiver circuit.

19. Electrical equipment as claimed in claim 18 comprising a mobile telephone provided with the switch and a docking station provided with the coaxial connector for a substitute aerial associated with the docking station.

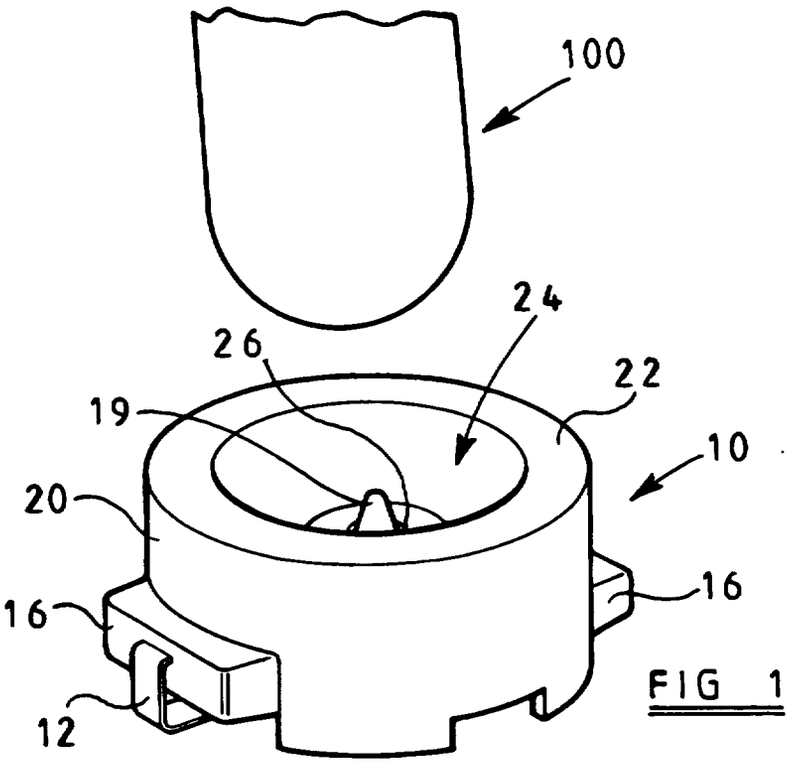
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FIG 1

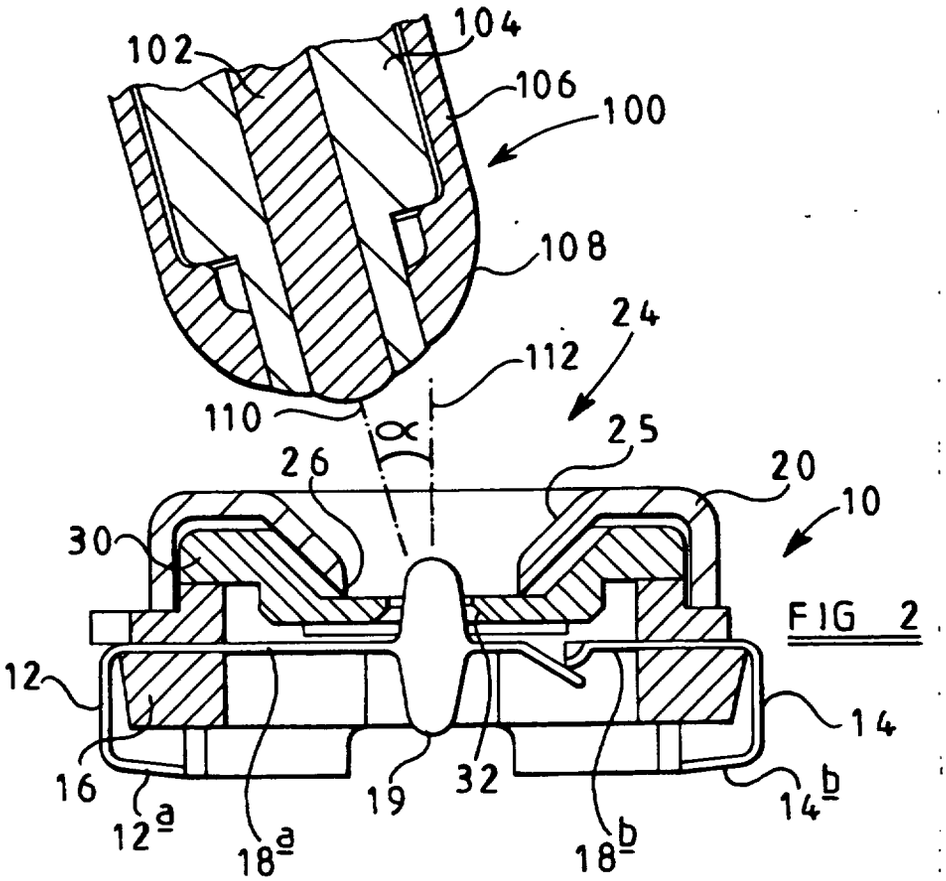
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FIG 2

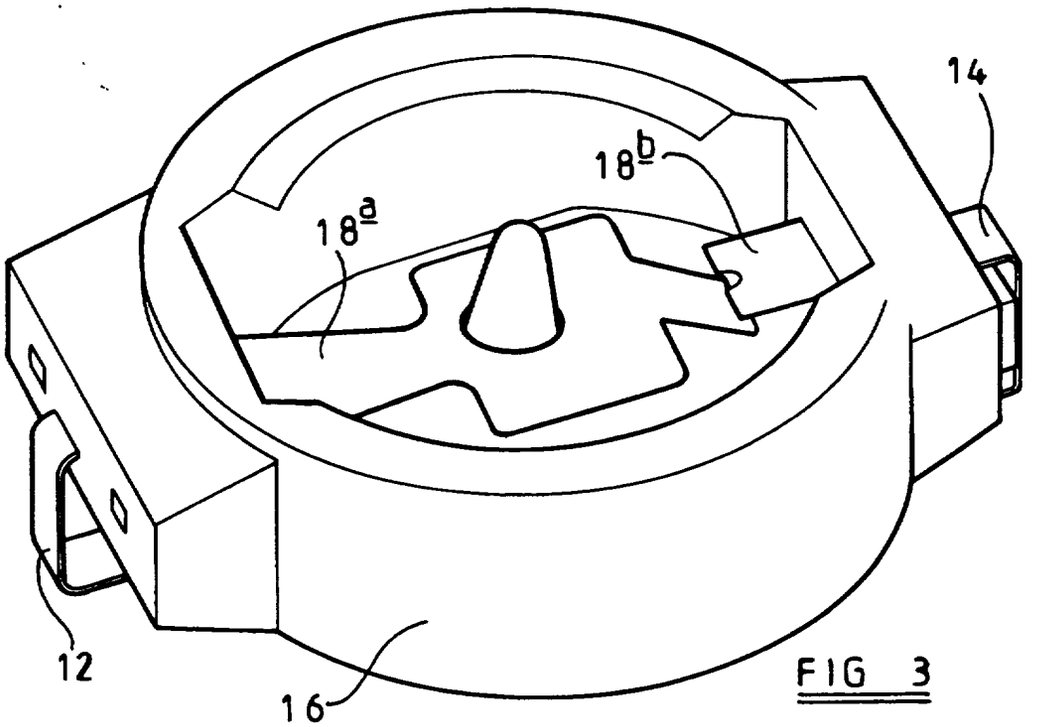

FIG 3

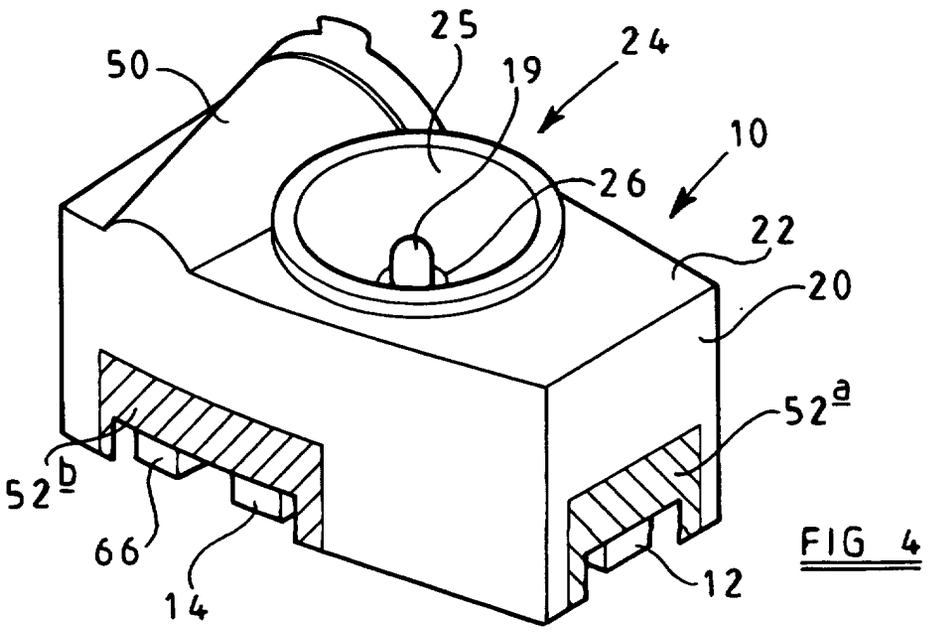

FIG 4

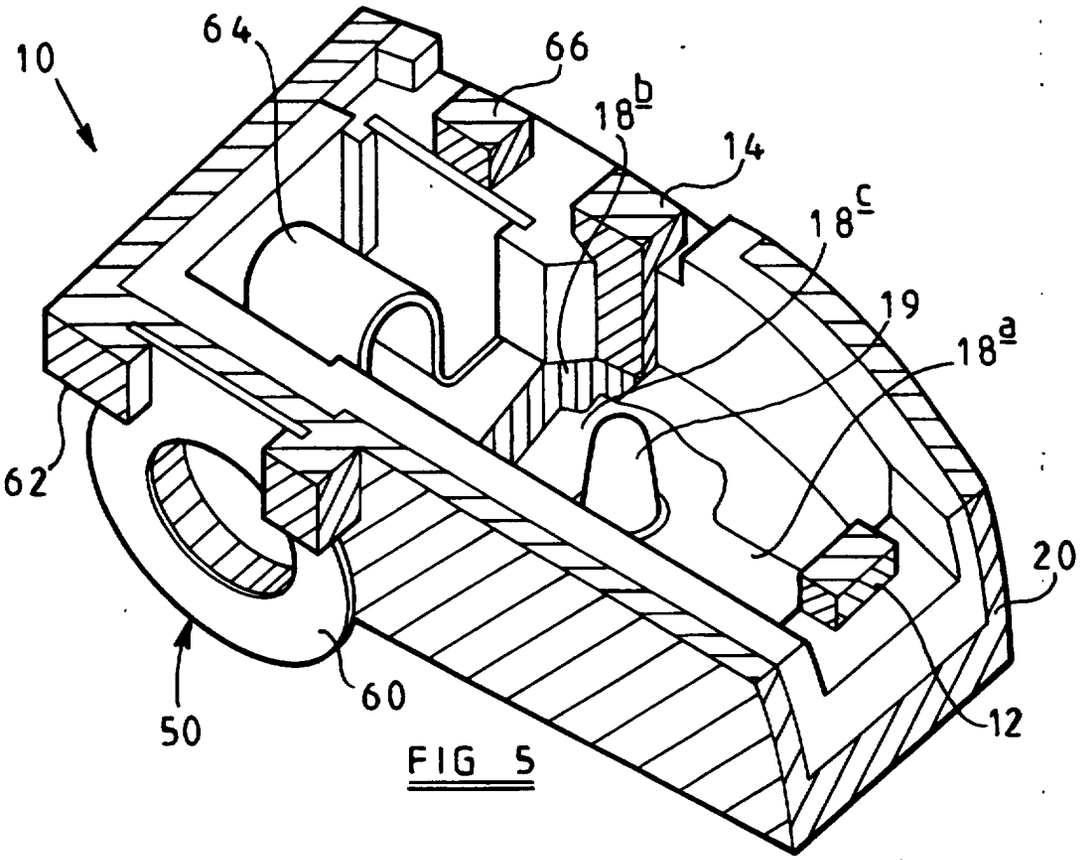

FIG 5

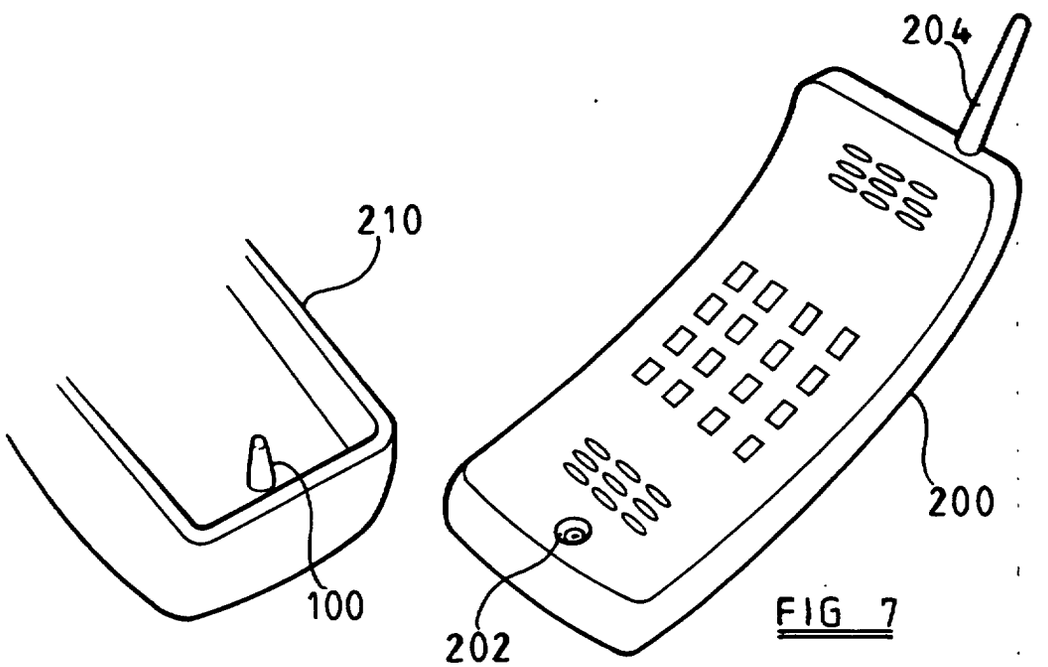

FIG 7

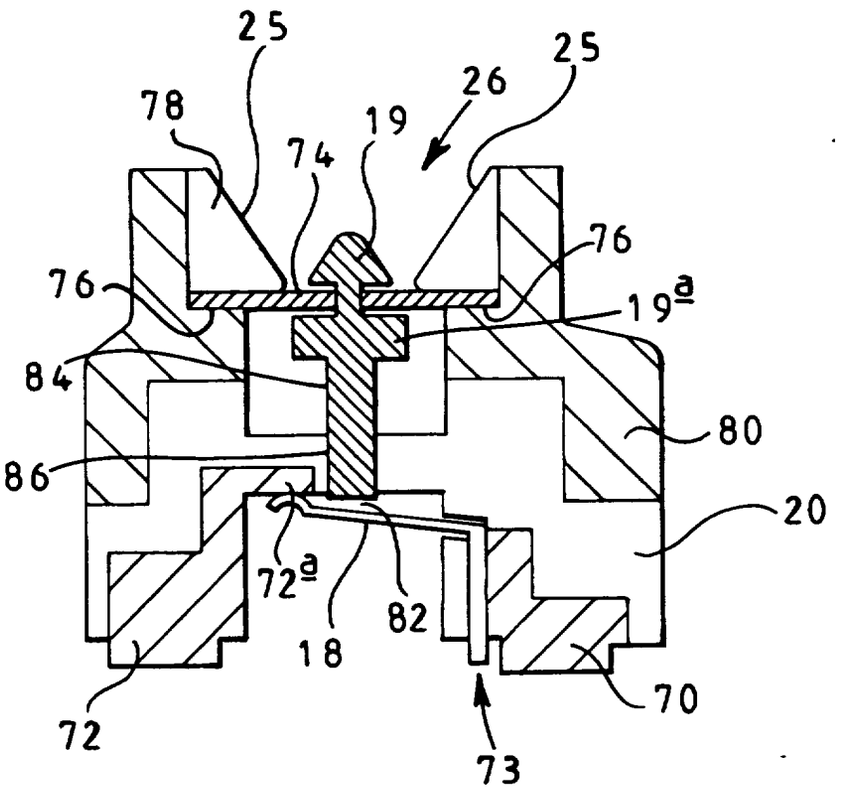

FIG 6