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(54) **Improvements relating to the control of electric heating elements**

(57) An inlet connector for a cordless electrical water heating appliance is of a kind adapted to be mated with a complementary base connector throughout 360° of relative rotational orientation between the appliance and its base and is adapted to be secured centrally to the underside of the heating element of the appliance, preferably a thick film heating element. Two heating element overtemperature controls are integrated with the inlet connector by being received in pockets formed around the circumferential periphery of a moulded plastics body part of the inlet connector. In one embodiment each control consists of a bimetal supported in a spring metal carrier which has an integral part formed into a bistable, overcentre switch-operating mechanism. In another embodiment one control comprises a fusible component. Resetting of the or each bimetallic control is effected in response to lifting the appliance off its base and then reseating it on the base. The fusible component control holds the fusible component under spring tension so that when it melts in response to an overtemperature condition, the spring is released and causes rapid opening of a set of switch contacts. A steam sensor can be coupled directly to the connector.

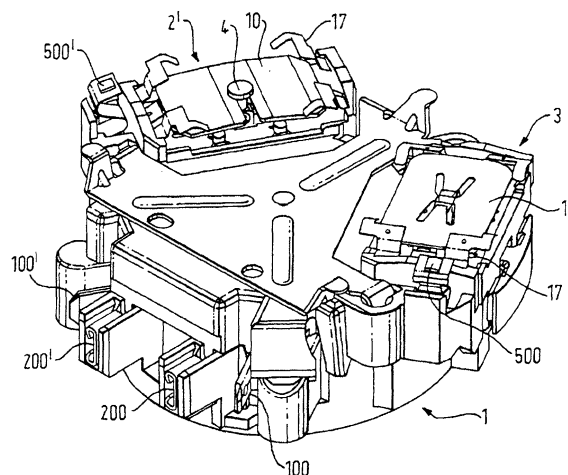


FIG. 21

Description

Field of the Invention:

[0001] This invention concerns improvements relating to the control of electric heating elements and, more particularly, is concerned with overtemperature controls for switching off the supply of electricity to an electric heating element in the event of the heating element temperature rising above a safe level, such controls commonly being referred to as element-protector controls.

Background of the Invention:

[0002] Element protector controls are commonly used in domestic water heating appliances, such as kettles and hot water jugs for example, but are also used widely in other domestic and industrial applications. In the following, the invention will be described with particular reference to the control of electric heating elements in domestic kettles and hot water jugs, but it is to be well understood that the invention has wider application.

[0003] Electric heating elements for domestic kettles and hot water jugs have conventionally been of the type comprising a resistance heating wire housed within an elongate tubular sheath packed with a mineral insulating material, and such sheathed heating elements were most commonly utilised in an immersion heating configuration where the heating element proper was affixed to a head plate enabling the heating element to be affixed in a vessel wall with the heating element proper immersed in the vessel contents. Planar or underfloor heating element configurations have also been known which comprised a plate, commonly of aluminium, having a sheathed heating element as aforementioned clamped or clenched to the undersurface thereof, and heating elements of this kind have been employed both as integral parts of water heating appliances and also as hot plates for use with separate water vessels, for example in coffee making machines.

[0004] More recently, so called thick film heating elements comprising an electrically insulating substrate having a resistance heating track or layer formed thereon have attracted the attention of manufacturers of domestic electric water heating appliances, inter alia on account of the increased power density of such heating elements as compared to the more conventional heating elements abovementioned which means that water can be heated much more quickly.

[0005] Bimetallic element-protector controls have commonly been utilized for the protection of conventional sheathed heating elements, both of the immersion heating type and of the planar or underfloor type, and bimetallic element-protector controls have also been proposed to be used with thick film heating elements. Such bimetallic element-protector controls have commonly comprised a bimetallic switch-actuating element arranged to be held in close heat transfer relationship

with the electric heating element and to operate a pair of switch contacts via a push rod. Proposals have been made to provide more than one bimetallic switch-actuating element in close heat transfer relationship with the electric heating element, the rationale for this being two fold, namely to provide primary and secondary (or back-up) levels of protection such that safety is assured even in the unlikely event of failure of the primary control to operate, and/or to provide thermal sensing at multiple locations of the heating element in an endeavour to ensure safety even if an appliance is operated on an inclined surface, a domestic draining board for example, so that if the appliance boils dry a specific part (the higher part) will boil dry and overheat whilst the remainder of the heating element surface is still covered with water and thus is at a normal operating temperature.

[0006] Other proposals for providing primary and secondary protection have utilized a bimetallic switch-actuating element for providing primary protection, and a fusible element with a melting temperature above that at which the primary bimetal would normally operate for providing secondary protection.

[0007] Reference may be made to our British Patents Nos. 2 176 055 and 2 194 099 for examples, respectively, of dual bimetal element protector controls and controls incorporating bimetallic primary protection in conjunction with fusible element secondary protection. Other such arrangements are disclosed in Strix Limited's British Patents Nos. 2 299 454 and 2 181 598.

[0008] Element-protection controls as described hereinbefore have been proposed to be used with both corded and cordless water heating appliances, corded appliances, as is well known, having an integral electricity supply cord or cable and cordless appliances comprising a base unit and an appliance proper, the base unit being corded and co-operating electrical connectors being provided on the appliance proper and on the base to enable a heating element in the appliance proper to be powered via the base when the appliance proper is appropriately seated with respect to the base. Cordless appliances and their co-operating electrical connectors were originally such that in order to effect proper connection, the appliance proper had to be set down onto its base in a predetermined relative orientation with respect to the base, but the disadvantages and inconveniences of this were appreciated and led to the development of 360° connector sets, that is to say cooperating base and appliance proper connectors which enabled the appliance proper to be set down on its base irrespective of its rotational orientation relative to the base.

[0009] Reference may be made to our British Patents Nos. 2 241 390 and 2 285 716 for examples, respectively, of cordless connection systems which required a particular orientation of the appliance proper with its base and 360° cordless connection systems. Other such arrangements are disclosed in Strix Limited's British Patent Application No. 2 263 364 and International Patent

Publication No. WO95/08204.

[0010] The Russell Hobbs Millenium™ kettle is an example of a recently launched and highly successful product which combines thick film heating element and 360° cordless technology with bimetallic heating element protection. We have made various proposals for integrating our CS4/CP7 360° cordless connector system as currently manufactured with our X2 series element protector control and examples of these proposals are described in our British Patent Application No. 2 306 801. As is well known, the X2 element protector control which is described in our British Patent Applications Nos. 2 315 366 and 2 248 724 utilizes a snap-acting bimetallic switch actuator for providing a primary level of protection and has the bimetal mounted in a collapsible thermoplastics carrier for providing a secondary or back-up level of protection operative in the event of failure of the primary protection.

[0011] The present invention results from further work that we have undertaken to integrate a 360° cordless connection system with an element protector control providing primary and secondary levels of protection, particularly for use with planar heating elements including both thick film heating elements and heating elements comprising a planar substrate having a sheathed heating element mounted in or on the underside thereof.

Objects and Summary of the Invention:

[0012] One of the objects of the present invention is to provide a 360° cordless connector having integrated heating element overtemperature protection which can be fitted to smaller sized heating elements for use with "mini" and "midi" sized appliances.

[0013] According to the present invention, in one of its aspects, a part of a 360° cordless connector system that is designed to be affixed to the underside of a planar heating element is formed with a moulded plastics material body part and the circumferential periphery of said body part has a plurality of circumferentially spaced-apart integrally moulded formations enabling the assembly of bimetallic heating element overtemperature controls to the connector part, each of said formations serving to locate the respective overtemperature control in close proximity with the connector part, preferably with a bimetallic switch actuating element of the control at least partially overlapping the connector part.

[0014] According to a preferred feature and further aspect of the present invention the bimetallic heating element overtemperature controls comprise a bimetallic switch-actuating element mounted in a spring metal carrier which, when the control is assembled with the 360° cordless connector part, presents the bimetallic switch-actuating element for making close thermal contact with a heating element to which the cordless connector part is affixed, the spring metal carrier furthermore being formed to form an integral part of a bistable, overcentre mechanism adapted to be operated in one sense by the

bimetallic switch-actuating element but to require a separate resetting operation.

[0015] The resetting of the overcentre mechanism is, in accordance with another aspect of the present invention, effected as a function of the normal operation of the 360° cordless connector system. Namely, the operation of removing the appliance proper from its base and then replacing it is arranged to effect a reset function upon the bimetallic controls or at least one of them.

[0016] As will be described hereinafter, in connection with exemplary embodiments of the invention, the combination of the abovementioned features provides a 360° cordless connector part having integrated primary and secondary heating element overtemperature controls which not only is capable of being manufactured to such small size as to enable it to be fitted to the smallest heating elements presently contemplated, but also exhibits other significant advantages.

[0017] According to a preferred feature of the present invention, a combined heating element protection control and 360° cordless connector part in accordance with the present invention has provision made for the direct connection thereto of a steam sensor control.

[0018] In our British Patent Application No. 9811400.2 filed 27 May 1998 there is described an improved steam sensor control which is marketed by us as the Z5 control. This control takes advantage of a generally E-shaped spring in which the central element of the E is formed as a C-spring and the outer (top and bottom) elements of the E carry switch contacts at their free ends. The C-spring central element is assembled with a pivotally mounted trip lever of the switch in an overcentre arrangement which is movable with a snap action between two opposite-of-centre stable positions. A thermally-responsive actuator, such as a bimetal or shape memory effect (SME) device for example, is arranged to determine the status of the overcentre arrangement. The movements of the outer elements of the E-shaped spring which accompany the movements of the overcentre arrangement effect substantial movements of the switch contacts at their free ends and advantages result as regards contact separation distances and reliability of switch operation when these contacts are utilized as moving contacts of the switch. As described hereinafter, the Z5 steam sensor control is an ideal candidate for integration with an element protector control according to the present invention to provide integrated control facilities in or for an electrically heated water boiling appliance.

[0019] In accordance with a further aspect of the present invention, one of the bimetallic actuators of the connector cum control aforementioned is replaced by a fusible component which is arranged to soften or melt when the heating element temperature rises to a predetermined level, the melting of the fusible component causing the heating element to be switched off.

[0020] It has long been known to protect an electric heating element against overheating by use of a fusible

material which is arranged to soften or melt when the heating element temperature rises to a predetermined level, the melting of the fusible material causing the heating element to be switched off. Early examples of such arrangements are described in GB-A-141820, GB-A-322851, GB-A-330100, GB-A-434553, GB-A-1 127212, GB-A-1 408 387 and GB-A-1 479 364 and more recent arrangements are described in GB-A-2 181 598, GB-A-2 194 099, GB-A-2 248 724, GB-A-2 025 995 and EP-A-0 014 102 where the fusible material is arranged to provide a back-up or secondary level of protection operable to ensure safety in a situation where a primary level of protection provided by a bimetallic device fails to operate.

[0021] A problem that can arise with the more recent control arrangements above described wherein the opening of switch contacts to disable the heating element is dependent upon the forced collapse of a fusible member spring biased towards the heating element, is that the switch contacts may open only relatively slowly. For heating elements having a relatively high thermal mass, such as sheathed heating elements of the immersion heating type or underfloor heating elements comprising a die cast metal mass incorporating a sheathed heating element or a metal plate having a sheathed heating element clamped or clenched to the underside thereof, this may not be a significant problem, but for the newly popular thick film heating elements which have only a relatively low thermal mass coupled with a high watts density (namely a high heat output per unit area) the problem of slow switch off can be significant.

[0022] According to yet another aspect of the present invention, therefore, it is proposed to make use of a fusible component in a quick break switching arrangement. For example, the control might comprise a fusible component, means holding said fusible component in a forward position for closely thermally contacting the heating element in use, and a spring urging said fusible component away from said holding means, the fusible component being arranged to release from its holding means in the event of the heating element overheating whereupon the spring is able to resile and open a set of switch contacts.

[0023] The fusible component might for example comprise a push-rod formed of synthetic plastics material having a well defined melting or softening temperature, the rod having a forward head portion engaged with a retaining member constituting said holding means and, more rearwardly along its length, having a formation engaged by a spring arranged, in the normal (cold) condition of the arrangement, to urge the push-rod rearwardly against the retention of its head portion. In use of the control, the head portion of the push-rod is held in close thermal contact with the heating element and softens or melts in the event of the heating element temperature rising above a predetermined level, whereupon the retaining member and the push-rod disengage, the push-rod is driven rearwardly by the spring and causes

a set of switch contacts to open. The switch contacts open rapidly once the heating element reaches the limit temperature at which the push-rod material softens or melts and furthermore will open to an extent which is independent of the melting of the fusible material of the push-rod and independent of the degree of overheating of the heating element.

[0024] Described hereinafter is an arrangement wherein the fusible component holding means is integral with the spring. According to this arrangement, the fusible component holds together two limbs of a spring metal component which otherwise would spring apart and when, in use, the fusible component is overheated and releases from one limb of the spring, constituting the holding means, the other limb is freed from constraint and can resile.

[0025] In a particularly advantageous arrangement according to the present invention, the fusible component holding means itself comprises a bimetallic switch actuator arranged to determine the condition of a set of switch contacts different from those whose condition is determined by the fusible component. In the abovementioned arrangement wherein the fusible component is a push-rod, for example, the retaining member which engages the head of the push-rod could thus comprise a snap-acting bimetal arranged to change its shape at a predetermined first heating element over-temperature and thereby cause the push-rod to open a first set of switch contacts. In the event of the heating element temperature continuing to rise, on account of failure of the first set of contacts to open for example because they have welded together or because the bimetal has failed, which is unlikely but not impossible, the melting of the head portion of the push-rod at a somewhat higher heating element temperature can ensure that the heating element is switched off. An arrangement is required to ensure that the operation of the secondary or back-up protection, afforded by the melting of the push-rod head portion and its separation from its bimetallic retaining member, is not prejudiced by movement of the bimetal and this can be achieved by use of appropriate contact spring arrangements and/or by spring mounting of the bimetal and/or by thermal conduction through the bimetal.

[0026] The present invention thus contemplates the provision of an integrated control cum 360° cordless connector component for a cordless water heating vessel. The 360° cordless connector component is adapted to be engageable with a complementary connector component in a base part of the appliance irrespective of the relative rotational orientation of the vessel and base parts of the appliance, the two components being available from us as the CS4/CP7 cordless connector set. The control can have first and second bimetallic switch actuators mounted adjacent to the CP7 vessel connector part of a CS4/CP7 cordless connector set for sensing the temperature of a thick film heating element arranged to be powered via the respective connector part. Each

bimetal is mounted in a respective spring metal carrier which is formed with a bistable part capable of moving overcentre with a snap action, and a push-rod is engaged with the bistable part. The bimetal is not affixed to the push-rod, but when the bimetal changes shape in response to overheating of the thick film heating element, it acts upon the push-rod which in turn causes the bistable part of the spring metal carrier to move overcentre, with the push-rod, which causes a set of switch contacts to be opened. The bimetal can be automatically resetting, so that they will return to their original state when the heating element cools and a camming arrangement can be provided in the connector part for resetting the switch contacts when the vessel part of the appliance is lifted off its base part and subsequently replaced thereon. The invention further contemplates that one of the bimetallic switch actuators of the control may be replaced by a fusible component which is held, in use, against the thick film heating element so as to be subject to the temperature thereof and is biased away from the heating element by means of a spring, the arrangement being such that on release of the fusible component at a predetermined heating element overtemperature, a set of switch contacts is opened. Such an arrangement could have the fusible component retained by a snap-acting bimetal as hereinbefore mentioned, in which case an additional level of protection would be afforded to the heating element. Yet a further level of protection could be achieved by substituting both of the bimetals of the control with such a fusible component arrangement.

[0027] The above and further features of the present invention are set forth in the appended claims and, together with the advantages thereof, will become clear from consideration of the following description given with reference to the accompanying drawings.

Description of the Drawings:

[0028]

Figures 1A to 1D illustrate a first embodiment of the invention, Figures 1A and 1B showing different perspective views of the embodiment, Figure 1C showing reduced scale side elevation and top plan views, and Figure 1D showing an exploded perspective view;

Figures 2A to 2D illustrate a second embodiment of the invention in views which are similar in each case to the corresponding views of Figures 1A to 1D; Figures 3A and 3B show enlarged perspective views, from opposite sides, of a spring metal carrier employed in the embodiments of Figures 1A to 1D and Figures 2A to 2D;

Figures 4A to 4D are schematic views illustrating a reset mechanism incorporated into the embodiments of Figures 1A to 1D and Figures 2A to 2D; Figure 5 is a perspective view illustrating an alter-

native means of mounting the embodiments to a thick film heating element;

Figure 6 is a perspective view of an exemplary combined heating element protection control and 360° cordless connector part incorporating means for the coupling thereto of a steam sensor control;

Figure 7 is a perspective view showing the device of Figure 6 from the opposite side and including a steam sensor control coupled thereto;

Figure 8 is a perspective view showing the arrangement of Figure 7 mounted to a heating element;

Figure 9 is a perspective view of the steam sensor control shown in Figure 7;

Figures 10A and 10B are perspective views of a modified steam sensor control incorporating an integral steam inlet;

Figure 11 is a schematic side elevation view of a fusible component thermally-responsive control which can replace one of the bimetallic controls of the preceding embodiments, the fusible control being shown in its normal low temperature condition; Figure 12 is a perspective view of the Figure 11 fusible control;

Figure 13 is a further perspective view of the Figure 11 fusible control;

Figure 14 is a perspective view similar to Figure 12 but showing the high temperature condition of the fusible control;

Figure 15 is a side elevation view similar to Figure 11 but showing the high temperature condition of the fusible control;

Figure 16 is a schematic side elevation view of yet another thermally-responsive fusible control shown in its normal low temperature condition;

Figure 17 is a schematic side elevation view of a slightly modified form of the fusible control of Figure 16;

Figure 18 is a perspective view of the Figure 17 control from one side;

Figure 19 is a perspective view of the Figure 17 control from the opposite side;

Figure 20 is a more detailed sectional side elevation view of the fusible control of Figures 17, 18 and 19; and

Figure 21 is a perspective view showing the combined heating element protection control and 360° connector part of Figure 6 modified by replacement of one of the bimetallic switches by a fusible component switch arrangement of the kind shown in Figures 17 to 20.

Detailed Description of the Embodiments:

[0029] The embodiments of the present invention that are described hereinafter are configured as modifications of the CP7 360° cordless plug (male) connector that we manufacture and sell for use with the CS4 360° socket (female) connector that we also manufacture and

sell. In a cordless water heating appliance the CP7 plug connector would normally be mounted in the bottom of the appliance part and the CS4 socket connector would be mounted on the upper surface of the base part. The CS4 and CP7 cordless connector parts are based upon the cordless connector parts described in our British Patent No. 2 285 716 with reference to Figures 7 to 11 of the drawings of the patent, and further information regarding the detailed construction of the CP7 connector part is to be found in our British Patent Application No. 2 306 801. In the following, for the sake of brevity, details of construction of the CP7 360° plug connector that are disclosed elsewhere will not be described in detail.

[0030] Referring first to Figures 1A to 1D, it can be seen from Figures 1A and 1B that the illustrated embodiment comprises a CP7 360° cordless plug (male) connector part 1 having integrated heating element over-temperature protection controls 2 and 3 circumferentially spaced apart from each other around the circumferential periphery of the CP7. As shown in Figures 1A and 1B, the CP7 is essentially an upturned cup-shaped moulded plastics body 4, and within the body 4 (though not visible in Figures 1A and 1B, but see Figure 5) there is an integrally moulded plastics material upstand 5 which is hollow in its centre. A central earth pin 6 is mounted within the hollow upstand 5, and the upstand itself is formed so as to accommodate first and second electrical terminal springs one of which faces inwardly of the upstand and the other of which faces outwardly. The CS4 socket (female) connector part (not shown) is shaped complementarily to the CP7 with a hollow central upstand of moulded plastics material within which there is provided a complementary spring terminal for electrically contacting the earth pin 6 of the CP7, and first and second ring-shaped terminals are provided, one on the outside of the central upstand of the CS4 and the other on the opposite, inwardly-facing surface of the moulded plastics CS4 body, for making electrical contact with the first and second terminal springs of the CP7.

[0031] The exploded view of Figure 1D shows how the first embodiment is constructed. The moulded plastics body 4 of the CP7 cordless connector part 1 is provided with first and second sets of integral formations 7 which are spaced apart from each other around the circumferential periphery of the moulded plastics body 4 as shown. These formations 7, together with formations 8 provided on a separate, moulded plastics capping part 9, define pockets 10 for accommodating the various parts of the bimetallic heating element overtemperature controls 2 and 3, the parts of the controls 2 and 3 being captured, as appropriate, in the pockets 10 when the capping part 9 is mounted onto the upturned base of the body part 4 of the CP7 cordless connector part.

[0032] The first and second spring terminals of the CP7 connector are designated 11 and 12 and each of these spring terminals has a first part, 11' and 12' re-

spectively, which extends down into the CP7 connector, a second part, 11" and 12" respectively, which extends across the base of the body part 4 and a third part, 11''' and 12''' respectively, which extends into respective ones of the pockets 10 and carries at its end an electrical contact 13 constituting the fixed contact of a set of switching contacts of the respective bimetallic overtemperature control.

[0033] A separate spring terminal 14 is provided for each of the controls 2, 3 and carries a contact 15 which constitutes the moving contact of the set of switching contacts of the control. This spring terminal 14 is captured between the formations 7 on the CP7 moulded plastics body 4 and the co-operating formations 8 on the capping part 9 when the capping part is fitted onto the CP7 body.

[0034] Each of the overtemperature controls 2, 3 has a bimetallic switch actuator 16 which is dished so as to be movable with a snap-action between oppositely dished configurations as the temperature to which it is subjected rises above a predetermined level. In the arrangements illustrated, the bimetal is upwardly-curved in its cold (normal) configuration and snaps into a downwardly-curved configuration as its temperature rises. The bimetals 16 are mounted in spring-metal carriers 17 which are shown to an enlarged scale in Figures 3A and 3B.

[0035] The spring-metal bimetal carriers 17 each comprise a base portion 18 and upwardly- and inwardly-turned end portions 19 which are formed into side portions 20 flanking a central portion 21, the side portions 20 and central portion 21 being formed to enable the ends of a generally-rectangular bimetal blade to be received therein with the portions 22 locating the blade against transverse movement, the portions 23 overlying the blade ends and the portions 24 underlying the blade ends. With the bimetals 16 thus supported, operational movement of the bimetals will be towards and away from the base portions 18 of the spring metal carriers 17 and will be greatest at the centres of the bimetals.

[0036] Two C-spring tongues 25 are released from opposite ends of the base portions 18 of the spring metal carriers 17, the tongues 25 extending towards each other as shown and having spaced-apart free ends, and push-rods 26 are designed to be received in the spacing between these free ends, the push rods being dimensioned so as to bias the free ends of the tongues 25 further apart from each other than in the free and unstressed state of the spring-metal bimetal carriers 17. This has the effect of forming bistable overcentre arrangements each capable of movement between a stable "cold" condition where the upper end of the push rod 26 is raised up towards the respective bimetal and closely underlies or abuts the bimetal and a stable "hot" condition where reversal of the bimetal curvative forces the push-rod 26 downwardly and moves the ends of the C-spring tongues 25 through an unstable central position so that they snap into the opposite stable condition.

[0037] The push-rods 26 have side formations 26' which coact with the leaf springs 14 which carry the moving contacts 15 of the heating element overtemperature controls so that a change in bimetal condition from "cold" to "hot" such as to cause the bimetal to snap into its oppositely dished configuration will result in opening of the set of switch contacts 13, 15 within the respective control.

[0038] For affixing the thus described arrangement to the underside of a planar heating element, a mounting bracket 27 is provided, the bracket 27 preferably being a metal pressing with feet 28 for attachment to the heating element. The bracket can be secured to the control by any convenient means, but in the example illustrated the earth pin 6 is employed as a securing means by virtue of being riveted to the mounting bracket 27. The mounting bracket 27 services also to shield the CP7 cordless connector part 1 from the heat of the heating element to which the arrangement is secured in use, and may be provided with a reflective or polished surface to enhance this effect.

[0039] The two bimetallic switch actuating elements 16 may be selected for operation nominally at the same temperature, or may be selected such that there is an operating temperature difference between them. In the former case both bimetals will normally respond to a heating element overtemperature condition, and in the latter case one of the bimetals will normally respond and will be responsible for effecting primary protection and the other, set to operate at a higher temperature, may not operate except in the case of failure of the primary protection or may operate only on temperature overshoot of the heating element after proper operation of the lower temperature bimetal. The bimetals furthermore can be set to operate at different temperatures according to the heat outputs of the different areas of the heating element to which they are juxtaposed.

[0040] The bimetals 16 can be arranged to reset automatically back to their "cold" conditions when the associated heating element cools down after being switched off by operation of one or other or both of the element overtemperature controls. However, since the bimetals are not attached to the push-rods 26, resetting of the bimetals 16 will not reset the switches within the controls. To reset the switches, a reset arrangement must be provided and an example of a particularly convenient reset arrangement will be described hereinafter with reference to Figures 4A to 4D. Alternatively, the bimetals 16 could be attached to the push-rods 26 so that the switches would automatically reset if the bimetals were of a kind such as to reset automatically; such an arrangement is, however, not preferred in view of the fact that it is considered to be strategically unwise to effect automatic reset of a switch designed to protect against an overtemperature condition, particularly a designated secondary protection switch. The preferred arrangement is that neither the bimetals nor the associated switches reset automatically and both have to be

manually reset.

[0041] The bimetallic switch actuators 16 in the above-described embodiment are generally rectangular with an X-shaped central cut-out such as to develop increased movement at the centre of the bimetal when it switches between its oppositely dished configurations. The X-shaped cut-out could however be omitted so long as sufficient movement remains to push the overcentre arrangement in the carrier springs 17 over centre, the switch-opening operation thereafter being dependent only upon the characteristics of the overcentre arrangement and being independent of the bimetal.

[0042] The side elevation views of Figure 1C show that when the assembled integrated 360° cordless connector and element protector controls are mounted to the underside of a planar heating element, the two bimetallic switch actuators 16 will be resiliently held by the spring carriers 17 in close thermal and physical contact with the heating element. Since the spring carriers 17 develop a spring force urging the bimetals 16 upwardly towards the heating element, any distortion of the heating element will not give rise to any detrimental effect on the responsiveness of the bimetal blades since the bimetals will be moved by the spring carriers so as to follow the distortion. Note furthermore in this connection that the feet 28 on the mounting bracket 27 are close to the bimetal blades 16 so as to limit the effect of heating element distortion upon the position of the bimetal blades relative to other components of the controls. The top plan view of Figure 1C shows this and additionally shows that the bimetals 16 partly overlap the footprint of the CP7 cordless connector part whereby the overall dimensions of the combined arrangement are much reduced as compared to prior proposals. The circle drawn around the arrangement as shown in plan view in Figure 1C has a diameter of only 65 mm. This same arrangement also ensures that the bimetals are located close to the centre of the heating element, assuming that the CP7 cordless plug connector is mounted centrally which would normally be the case, which is the best position for their location to be responsive to a boil dry condition while the appliance is on a sloping surface. Note also from the top plan view of Figure 1C that a third bimetallic switch actuator and associated control parts could if desired be added to the illustrated arrangement without increasing its overall dimensions.

[0043] In the described arrangement, the bimetals 16 are not electrically connected to each other, as neither are their spring metal carriers 17, and both the bimetals and their carriers are isolated from electrical parts of the arrangement. This has advantages, particularly when the arrangement is to be used with thick film heating elements where the different bimetals and their carriers might well be exposed to different electrical potentials if the bimetals are arranged to contact the heating element at locations whereat windows are opened in the upper electrically insulating layer of the heating element to ensure a rapid thermal response. In this connection,

the material of the spring metal carriers 17 can be selected to have an influence upon the thermal environment of the bimetals 16.

[0044] The abovedescribed embodiment is primarily intended for use with heating elements of a kind where electrical connection to the heating element is made by means of lead wires that are plugged into the element overtemperature protection controls 2 and 3 and mechanically connected to terminations provided on the heating element. Thus in the embodiment, the spring terminals 14 of the controls are formed with receptacles 29 for receiving spade terminations of the lead wires. The electrical path through the embodiment to an associated heating element is thus via the terminals 11 and 12 of the cordless connector part I and through the respective controls 2, 3 to the heating element terminations. Operation of either or both of the controls 2, 3 in an element overtemperature situation will thus serve to disconnect the heating element from its power supply. Resetting of the controls 2, 3 will be described hereinafter.

[0045] The embodiment of Figures 2A to 2D is in many respects identical to the embodiment of Figures 1A to 1D and therefore only the differences will be described. Whereas the embodiment of Figures 1A to 1D is designed to be connected to a heating element by use of separate lead wires as abovementioned, the embodiment of Figures 2A to 2D is particularly intended to be used with thick film heating elements where electrical connection to terminal pads provided on the heating element is by means of spring fingers. To this end, the spring terminals 14 that are provided in the controls 2, 3 are provided with spring terminations 30 which project upwardly out of the controls as shown so that when the embodiment is secured to a heating element the uppermost ends of the spring terminations 30 resiliently contact the terminal pads of the heating element. Another difference resides in the form of the spring terminal 60 of the Figures 2A to 2D embodiment, this corresponding to the spring terminal 11 of the Figures 1A to 1D embodiment, and the provision of a further terminal 65 which carries the fixed contact of the overtemperature control 2 (in the Figures 1A to 1D embodiment this was carried by the spring terminal 11). As shown in Figure 2D, the spring terminal 60 has a first spade terminal 60' and has no part corresponding to the part 11''' shown in Figure 1D. The terminal part 65 has a second spade terminal portion 65' and a contact carrying portion 65''. In use, the first and second spade terminals 60' and 65' serve for the connection of a steam sensor control, such as our J-series steam control as described in our British Patent No. 2 212 664 for example, in circuit with the element overtemperature controls, the steam control serving to switch off the heating element of an associated water boiling appliance when water boils in the appliance.

[0046] Figures 4A to 4D schematically illustrate a reset mechanism which advantageously can be associat-

ed with either or both of the element protector controls 2 and 3 in the individual controls. Thus, for example, if both controls were set to respond to an element overtemperature condition such as might be caused by switching on a water heating appliance without first filling it with water, it might be appropriate to arrange for easy resetting of both controls. On the other hand, if one of the controls was set to a higher temperature so that it would operate only if the other control failed, then it might be appropriate to provide a user operable reset facility for the lower temperature control, but to provide no such facility for the higher temperature control to ensure that a user could not reset the appliance into a potentially dangerous situation.

[0047] In Figure 4A, which shows the normal "cold" condition of the abovedescribed embodiments wherein the bimetal 16 is in its upwardly-curved condition and the overcentre arrangement of the spring-metal bimetal carrier (not shown) is in its up condition so that push-rod 26 is likewise in its up position and the formation 26' does not affect the position of leaf spring 14, the moulded plastics body 4 of the CP7 plug part of the cordless connector system is shown to be formed with a chamber 40 within which there is located a camming member 41 which is able to move freely within the confines of the chamber 40. An opening 42 through the outermost cylindrical wall of the moulded plastics body part is dimensioned to allow the camming member 41 to protrude into the annular passageway 43 that exists, within the CP7 plug part between its outer wall and its aforementioned central upstand, this annular passageway 43 being occupied by a complementary part of the CS4 socket part of the CS4/CP7 cordless connection system when the plug and socket parts are mated together. In Figure 4A, the respective part of the CS4 socket is designated 44. As shown in Figure 4A, a space exists between the lower end of push-rod 26 and the camming member 41.

[0048] Figure 4B shows what happens when the bimetal 16 snaps to its oppositely dished "hot" configuration, thereby causing push-rod 26 to be depressed by the overcentre mechanism of the bimetal carrier (not shown) so that leaf spring 14 is depressed by the formation 26'. The bottom end of the push-rod 26 moves closer to the camming member 41 but there remains a small spacing between the two parts.

[0049] In order to reset the overcentre mechanism of the bimetal carrier, which would remain in its downward condition in the absence of a resetting stimulus even if the bimetal reset automatically, the CS4 part has to be withdrawn from the CP7 part as represented by the arrow shown at the bottom of Figure 4C, this corresponding to lifting of the appliance off its base. This allows the camming member 41 to slide under its own weight (a driving spring could be provided) generally in the direction of the arrow shown to the left of the camming member 41 until an abutment on the cam abuts the edge of the opening 42. In this position, as shown, the camming member 41 sits in the opening 42 with a nose portion

45 of the camming member 41 projecting into the region 43 vacated by the CS4 socket part of the cordless connector set. When the appliance is subsequently replaced on its base, hopefully having been refilled in the meantime, the entering CS4 socket part 44 encounters the nose portion 45 of the camming member 41 as shown in Figure 4D and this causes the camming member to be driven generally in the direction indicated by the arrow shown to the left of the camming member in Figure 4D, namely upwardly and outwardly with respect to the CP7 plug part of the cordless connection system. Under this impetus, the opposite side 46 of the camming member 41 rides up an inclined surface 47 formed in the body moulding 4 and the cam engages the bottom end of the push-rod 26, drives it upwardly and thereby resets the overcentre mechanism and resets the bimetal 16. As the engaging movement of the CP7 plug part and the CS4 socket part continue, so the nose portion 45 of the camming member 41 eventually moves out of control with the forward end of the CS4 socket part whereby the camming member drops back to the position shown in Figure 4A.

[0050] The arrangement of the reset camming member 41 could advantageously be such that when the overcentre mechanism operates so as to depress the push-rod 26 and open the switch contacts, the end of the push-rod continues to exert a downwards pressure on the camming member 41 so that, when the two cordless connector parts are separated as the appliance is lifted off its base, the camming member is positively driven down and its nose portion 45, forced out through the opening 42. This would effectively avoid any tendency of the camming member 41 to stick in its upward position.

[0051] In use of the abovedescribed embodiments, the fixing bracket 27 can be secured to the heating element by any convenient means, such as by riveting, welding or by nut and screw connections for example, and may or may not be removable from the heating element for servicing or repair of either the heating element or the cordless connector/overtemperature controls combination. The bracket itself, however, is designed to be permanently affixed to the cordless connector/overtemperature controls combination. In the arrangement of Figure 5, an alternative form of fixing bracket 50 is provided which, as with the previously described bracket 27, has three feet 51 adapted to be secured to a heating element by laser welding for example and has three screw receptacles 52 enabling the cordless connector/overtemperature controls combination to be affixed to the bracket 50 in a removable manner by means of fixing screws 53. The use of a cordless connector/overtemperature controls combination which is removable from its fixing bracket is advantageous in that it enhances the reclaim of working components from a faulty assembly and provides supply opportunities that otherwise would not be available, for example the supply of brackets to heating element manufacturers and

controls (ie the cordless connector/overtemperature controls combination) to the final assembler of the heating elements and controls into appliances. Also the same bracket configurations can be supplied for use with different control configurations.

[0052] Referring to Figures 6 to 10, there will now be described a combined heating element protection control and 360° cordless connector part substantially as hereinbefore described which furthermore has provision made for the direct connection thereto of a Z5 steam sensor control in accordance with the invention of our British Patent Application No. 9811400.2 aforementioned.

[0053] Referring first to Figure 6, shown therein is a combined heating element protection control and 360° cordless connector part which is substantially as described hereinbefore with reference to Figures 1A to 1D. The embodiment comprises a CP7 360° cordless plug (male) connector part 1 having integrated heating element overtemperature protection controls 2 and 3 circumferentially spaced apart from each other around the circumferential periphery of the CP7. As shown in Figures 7 and 8, the CP7 is essentially an upturned cup-shaped moulded plastics body 4, and within the body 4 there is an integrally moulded plastics material upstand 5 which is hollow in its centre. A central earth pin 6 is mounted within the hollow upstand 5, and the upstand itself is formed so as to accommodate first and second electrical terminal springs 11 and 12 one of which faces inwardly of the upstand and the other of which faces outwardly. The CP7 connector is adapted for use with a CS4 socket (female) part (not shown) which is shaped complementarily to the CP7 with a hollow central upstand of moulded plastics material within which there is provided a complementary spring terminal for electrically contacting the earth pin 6 of the CP7, and first and second ring-shaped terminals are provided, one on the outside of the central upstand of the CS4 and the other on the opposite, inwardly-facing surface of the moulded plastics CS4 body, for making electrical contact with the first and second terminal springs 11, 12 of the CP7.

[0054] The construction and operation of the heating element overtemperature protection controls 2 and 3 is described hereinbefore. Each of the controls 2 and 3 has a bimetallic switch actuator 16 which is dished so as to be movable between oppositely dished configurations with a snap action as the temperature to which the bimetal is subjected rises above a predetermined level. The bimetals 16 are mounted in respective spring carriers 17 which are formed to constitute respective bistable overcentre arrangements with respective switch-actuating push-rods (not shown), the arrangement being such that, on movement of either of the bimetals 16 from its "cold" to its "hot" condition, the corresponding overcentre arrangement operates to open a set of switch contacts within the respective control 2, 3. The bimetals 16 are not themselves physically attached to the overcentre arrangements so that whilst the bimetals

can be arranged to reset automatically when their temperature cools, the overcentre arrangements and their associated switch contacts require to be actively reset. A resetting mechanism operates in response to the vessel part of a cordless appliance being lifted off its base and subsequently replaced. Other reset arrangements would, however, be possible.

[0055] As compared to the arrangement described hereinbefore, the arrangement shown in Figure 6 of the accompanying drawings has an additional pair of male spade terminals 100 and 100' and an additional pair of female receptacle terminals 200 and 200', the latter being partially enclosed by U-shaped shrouds 201 which are moulded integrally with the moulded plastics body 4 of the CP7 connector part 1. The terminals 100 and 200 are electrically commoned and connected to one of the terminal springs 11, 12, and the terminals 100' and 200' are electrically commoned and connect to one of the heating element overtemperature protection controls 2, 3 and thence, by way of a spade terminal 250 provided on the control, can be connected through the heating element to the other of the heating element over-temperature protection controls 3, 2, again by way of its spade terminal 250, the last-mentioned heating element overtemperature protection control 3, 2 then being connected to the other of the terminal springs 12, 11.

[0056] The terminals 200 and 200' are designed for the attachment to the arrangement shown in Figure 6 of a Z5 steam sensor control as described in British Patent Application No. 9811400.2 abovementioned. Figure 7 of the accompanying drawings shows such an arrangement, the steam sensor control being designated 300, and Figure 8 shows such an arrangement mounted onto an electric heating element of the kind comprising a metal plate 325 having a heating element 350 of the mineral-insulated, metal-sheathed, wire-wound type cast or clenched into its surface, the mounting of the combined steam and element protector control cum socket inlet connector 1, 2, 3, 300 to the heating element being effected by use of a mounting bracket 375 as described hereinbefore. It will be understood that in the arrangement of Figure 8 the terminals 250 of the heating element overtemperature protection controls 2, 3 will be connected to the terminal ends of the heating element 350 by means of connecting leads (not shown).

[0057] It will be understood that the arrangement of Figure 8 places the steam sensor control 300 in electrical series with the heating element 350 and the two heating element overtemperature protection controls 2, 3 between the terminals 11, 12 of the socket inlet connector part 1. This arrangement ensures that the heating element 350 will be disconnected from its electrical power supply in the event of one or both of the heating element overtemperature controls 2, 3 operating, or in the event of operation of the steam control 300.

[0058] The two additional terminals 100 and 100' provide for the connection of an indicator, a small neon lamp for example, across the steam sensor control 300. So

long as the control 300 is in closed circuit condition, namely not operated by exposure to steam, the control 300 acts as a short circuit across the terminals 100 and 100' so that the indicator does not operate. However, when the steam sensor control 300 goes open circuit in response to the sensing of steam, the short circuit across the indicator is removed and the indicator operates. The current passed by the indicator, which is arranged to have a high electrical resistance, is insufficient to have any significant heating effect upon the heating element 350.

[0059] Figure 9 shows the steam sensor control 300 inverted as compared to its showing in Figures 7 and 8 and it will be seen that the bimetal actuator 301 of the steam control faces downwardly and is shrouded by the moulded plastics material cover 302 of the control when the heating element 325 is fitted into the bottom of a water boiling vessel. In this connection, it is to be appreciated that the view of Figure 8 shows the arrangement inverted as compared to the way it would actually be when fitted into a vessel. By virtue of the bimetal actuator, 301 of the steam control 300 facing downwardly, and the internal switch components of the control 300 being contained within the cover 302 with only a push-rod (not shown) penetrating the cover for transmitting the operating movement of the bimetal actuator 301 to the internal switch components, it is ensured so far as is possible that the internal switch components of the control are not liable to be contaminated by debris or scale which travels down the vessel steam duct, namely the duct which transfers steam from a high level within the vessel to the location of the steam sensor control in the bottom of the vessel. A further advantage of arranging the bimetal actuator 301 so that it faces downwardly is that it is thus arranged further from the heating element 325 and from hot water contained in the associated vessel, which enhances the resetability of the bimetal actuator 301 after it has operated in response to the generation of steam; namely, the proximity of the bimetal actuator 301 to the heating element 325 and to the hot water in the vessel is not such as significantly to impede the cooling down of the bimetal actuator after the steam sensor control 300 switches off the heating element 325 so that hot steam ceases to be ducted onto the bimetal actuator 301.

[0060] Note additionally that the terminals 303, 303' of the steam sensor control 300 which mate with the terminals 200, 200' of the arrangement shown in Figure 6 are completely shrouded within the moulded plastics body 302 of the control 300. By virtue of this arrangement it is ensured that the mated terminals 303, 303' and 200, 200' are unlikely to suffer contamination from the steamy operating environment of the steam sensor control.

[0061] The steam sensor control 300 is intended to be used in a water boiling vessel formed with ducting, for example formed integrally with a moulded plastic body part of the vessel, for transporting steam from with-

in the vessel to the location of the steam sensor control in the vessel base. In the alternative arrangement shown in Figures 10A and 10B, the steam sensor control 300 is formed with a spigot 304 which is adapted to mate sealingly with features of the vessel body. Steam is directed to the bimetal actuator 301 by means of baffles (not shown) which are preferably part of the steam sensor control housing but could additionally or alternatively be part of the appliance.

[0062] Rather than being coupled directly to the combined inlet connector cum overtemperature protection controls as shown in Figures 7 and 8, the steam sensor control 300 could alternatively be coupled indirectly thereto by means of electrical leads connecting the terminals 200, 200' to the steam control terminals 303, 303'. In some appliances it is preferred that the steam control be mounted at a position in the appliance closely adjacent to the vent through which steam exits the appliance interior when water boils in the appliance. Such an arrangements is shown in GB 2 212 664 for example.

[0063] Some appliances may not require the provision of a steam control sensor and in such a case a suitable connector could be provided to connect the terminals 200, 200' together. Alternatively, the terminals 200, 200' could be arranged such that they are normally interconnected and their interconnection is broken when the steam sensor control 300 is attached. For example, spring terminals could be provided which normally interconnect the terminals 200, 200' and which are displaced when the steam sensor control is attached.

[0064] In the arrangement of Figures 7 and 8, the steam sensor control 300 extends horizontally. The arrangement could readily be modified so that the steam sensor control 300 extends vertically which could provide the overall arrangement with a smaller footprint enabling it to be used with even smaller appliances.

[0065] In the embodiments described hereinafter, one of the bimetallic switch actuators of the control described hereinbefore is replaced by a fusible component which is arranged to be held, in use, against the thick film heating element so as to be subject to the temperature thereof and is biased away from the heating element by means of a spring, the arrangement being such that on release of the fusible component at a predetermined heating element overtemperature, a set of switch contacts is opened.

[0066] The proposal is to replace one of the two bimetal actuators of the previously described embodiments with a thermal fuse adapted and arranged to allow as many common components as possible in the two switches. In the thermal fuse version, the melting component is formed by a variant of the push rod held captive at its outer end by a retaining component which is clipped into a groove close to the extremity of the rod. This retaining component replaces the bimetal of the previously described embodiments and holds the tip of the rod in thermal contact with the heating element that is to be protected. It may be resilient in itself, or it may

be resiliently mounted; it may be metal and similar in shape to the bimetal blade, or it may be of plastics material with a higher melting point than the rod. The rod is urged away from the heater by a variant of the over-centre spring mechanism of the previously described embodiments, which is no longer bistable, but is a simple spring (possibly a cantilever) which engages the rod at a suitable point along its length. The electrical contacts are similar to those of the previously described control. In action, when the surface of the heating element reaches a sufficient temperature, the tip of the rod melts and the rod becomes free of the metal part holding it in contact with the heating element. When the rod is freed, the spring which is urging the rod away from the heater is able to move the rod in a similar way to the push-rod of the previously described embodiments, to open the electrical contacts and switch off the heater. This proposed mechanism opens the contacts rapidly and will always open them fully, regardless of the degree of overshoot.

[0067] A metal plate could be used to replace the bimetal to retain the rod, but it would be preferable that the metal part which forms the spring would also form the retaining part, thus eliminating a component. The accompanying Figures 11 to 15 illustrate this version. Fig 11 shows a side view and Figs 12 and 13 isometric views of a replacement for the spring bimetal carrier of the previously described control. A spring metal retaining part 1 has a base part 2 which engages the tip 4 of the push-rod replacement 8 pushing it towards the heater (not shown). The arms 3 of the retaining part 1 are cantilever springs and engage arms 5 on the push-rod 8, tending to push the rod away from the heating element. The end 6 of the rod 8, remote from the heater, is positioned close to a spring contact arrangement 7. Figs 14 and 15 show the arrangement after operation of the fuse in response to a heating element overtemperature condition. The tip 4 of the rod has melted and has released from the retaining part 2. The arms 3 of the retaining part 1 have relaxed, moving the rod 8 away from the heater to engage the end of one of the contact springs 7 and open the contacts.

[0068] A variant of this thermal fuse could be a modification of our X3 control which is substantially as described in GB-A-2194099 with reference to Figure 3 thereof. The bimetal blade of the X3 control would form the retaining metal part, with the rod retained by the tips of the two longer centre legs of the X-shaped cut-out provided in the blade. These could be formed with a joggle to retain the substantially flat element interface presently provided by the X3, or the rod end could protrude beyond the bimetal into a depression formed in the heater, as was the case with our original X1 control. Under normal conditions, the X3 bimetal would open the primary set of contacts, via the rod, exactly as at present. However, a spring would be provided which urges the rod away from the heater, as described above. Normally the motion of the rod would be limited by the movement

of the bimetal as it reverses curvature. However if the heater temperature rises above normal levels, the tip of the rod would melt, releasing the rod. The spring would then be free to move the rod further away from the heater, and this additional movement would open a second set of contacts, providing a second level of protection.

[0069] The resilient mounting of the primary contacts, as in the present X3 design, would allow this further movement, even if they had become welded (this being the cause of the excess temperature). The changes to the present X3 to implement this would require the replacement of the thermoplastic bimetal carrier by a metal carrier as in the embodiments previously described herein, which would also provide the spring to move the rod away from the element. The secondary contacts which presently provide the force to collapse the carrier during secondary operation would be replaced by a simpler spring contact arrangement which would require lower forces and may only act on one pole of the supply. The neutral pin could for example be formed with a right angled bend on its inner end, like a walking stick, under which the secondary leaf spring would be trapped. The rod would act on the end of the leaf spring to push it away from the angled end of the pin. There is no reason, however, why the rod may not have a "T" shape, and operate on both poles of the supply. The existing contacts could be used, but would require a form of latch, normally holding the secondary springs against the terminal pins, which would be released by the movement of the rod.

[0070] The enclosed Figures 16 to 19 illustrate this proposal applied as a replacement for the present X3 plastics material bimetal carrier. Referring particularly to Fig 16, which shows a basic layout, the metal retaining part 9 and bimetal blade 10 are the same as in the present X4 product design. The rod 8 is identical to the rod in Figs 11 to 15 and is clipped to the bimetal blade 10 at its tip 4 in the same way that the original X1 push-rod was as described in GB-A-2194099. Not shown is a version of the bimetal blade with the tips of the centre legs engaged with the head of rod 8 set back to give a flush front face to the actuator, but this is just an adjustment of geometry. The spring arms 11 are shown as the "C" form of the previously described embodiment, but could be simple straight cantilevers as in the previous example. The other tip 6 of the rod is close to the primary contact set 12, while a projection 5 on the rod 8 is spaced a little way from the secondary contacts 13.

[0071] In operation, under normal dry boil, the bimetal reverses curvature and acts on the primary contacts 12 as is conventional, the movement of the rod being allowed by the resilience of the arms 11. Note that the force applied by the arms will have to be low enough to have only a minimal effect on the action of the bimetal. Typically the bimetal can exert 150 - 200 gms, so the arms 11 may exert 40 - 80 gms for example. When the bimetal cools, it returns the rod to its initial position and closes the contacts 12. On occurrence of a fault condi-

tion, for example if the contacts 12 weld, then the heater will overheat, melting the tip of the rod. The arms 11 will then urge the rod away from the heater, first engaging the contact set 12 at 6 and deflecting both springs (as a result of the weld) and then engaging the secondary contact set 13 with the arms 5 and opening it. The drawings do not show this version in an operated state, but this should be clear from comparison with Figs 14 and 15.

[0072] Figs 17, 18 and 19 show a more practical layout for such a modification of the X3 and show the neutral terminal pin 14 arranged with a right angle bend 15 at its inner end. This pin could for example be made from 1mm brass strip folded along its length to give a 2mm x 4mm pin, with the bend being formed in the 1mm section as more clearly seen in the isometric views of Figs 18 and 19. The leaf spring 13a is a modified neutral leaf spring which engages the bent end 15 of the terminal pin. A discrete contact 16 is shown attached to the leaf spring, but this may not be necessary and the arrangement may be as in the present X3 where silver plating is used. This contact pair is only called upon to operate once in anger. The action of this arrangement is the same as previously described. It should be noted that so long as the gap between the tip 6 and the primary contacts 12 is less than the gap between the arms 5 and the secondary contacts 13, then the circuit will always be broken by the primary contacts during normal use although the secondary contacts may part, and accordingly the secondary contact life will not be comprised by switching current. Only the neutral terminal arrangement is shown, but clearly a similar arrangement could be provided on the live side, worked by the second arm 5.

[0073] The metal retaining part 9 is intended to be secured to the outside of the X3 inner moulding (the pale cream one) by means of the four star shaped holes 17 visible in Fig 19. The whole of this metal assembly is outside the control, making the provision of electrical isolation simpler. There may be some advantage in retaining the form of overcentre spring shown in Figures 3A and 3B as compared to a simple cantilever in this embodiment. The overcentre spring has a non-linear force displacement curve and can be arranged to have a low force in the region of movement of the bimetal, but to exert a stronger force as the displacement increases. This would combine a lesser disturbance of the bimetal operating characteristics with a more positive action to open the second contacts. The tolerance that the X3 blade carrier gives to element distortion would be less necessary, since the metal blade carrier does not have to collapse and could be arranged to be a positive height stop within the control assembly to define the distance between the bimetal and the primary contacts, rather than using close control of the element pillar heights and flatness as is done at present.

[0074] Figure 20 is a sectional side elevation view showing the fusible component thermal control of Fig-

ures 17 to 19 in more detail, and Figure 21 shows a combined 360° appliance inlet connector and heating element overtemperature protection control similar to that shown in Figure 6 but with one of the thermally responsive bimetallic switches replaced by a fusible component thermal control as shown in Figures 17 to 20, the fusible component thermal control being designated 2' in Figure 21. In this arrangement, the member 10 retaining the uppermost end 4 of the fusible rod 8 is a stainless steel plate similar in size and shape to the bimetal 16 of the bimetallic switch 3 and formed with a slot for engagement with the necked upper end of fusible rod 8. The plate 10 is retained in the spring carrier 17, similarly to the bimetal 16, and the fusible rod 8 is held under tension by the spring parts 11 of the carrier 17. As will be well understood from the explanations previously provided, in the event of the fusible rod 8 being subjected in use of the device to a temperature such as to cause its head portion to soften or melt, the rod 8 will be released from its holding plate 10 and will be driven downwards (as shown in Figure 20) by the spring parts 11 so that the lug 5 causes the contacts 13 to open and thereby disrupt the supply of electricity to the associated heating element.

[0075] Another difference shown in Figure 21 is the provision of spring contacts 500 and 500' for contacting terminal portions of a thick film heating element.

[0076] The advantages of the above proposals of Figures 11 to 21 include the following:

- the provision of a fast contact opening independent of the rate or overshoot of the heater.
- making the mounting and alignment of the X3 bimetal independent of the secondary contacts.
- simplifying the form of the thermal fuse of the X3 so that it may be made from less amenable materials, such as Ryton, which have better thermal stability, but do not have the necessary resilience to assemble the X3 bimetal or to absorb shock without breaking.
- removing the effects of element tolerance from the bimetal to contacts distance, making the action of the control more consistent.
- the non linear force/displacement characteristic of the X4 spring form as shown in Figures 3A and 3B allows the thermal fuse to be combined with a bimetal actuator without substantial change to the bimetal actuator properties.

[0077] Having thus described the present invention by reference to preferred embodiments, it is to be well appreciated that the described embodiments are exemplary only and that modifications and variations are possible without departure from the spirit and scope of the invention as set forth in the appended claims. For example, whereas the invention has been described with particular reference to 360° cordless appliances, the invention is equally applicable to cordless appliances of

other kinds and could even be applied to corded appliances such as those incorporating conventional plug and socket type electrical connectors. Furthermore, while the embodiments described incorporate 360° cordless connectors, the invention could also be applied to the more conventional cordless connection systems which required the appliance to be set down onto its base in a particular orientation. The aspect of the invention whereby a bimetallic switch actuator is retained by a spring metal carrier formed to provide its own integral overcentre mechanism is particularly well adapted to wider application. Similarly, whilst the described embodiments have shown specific forms of heating element, other kinds of heating element could be used. Furthermore, the safety interlock that is the subject of our British Patent Application No. 9724799.3 filed 24 November 1997 could be employed in the practice of the present invention. The mechanism which switches off the steam sensor control can be mounted on the appliance inlet connector and, in the case of direct attachment of the steam sensor control, can act directly on the trip lever 305 of the steam sensor control. In the case where the steam sensor control is remotely mounted and connected electrically to the appliance inlet connector by means of electrical leads, the necessary actuating movement may be transmitted by a lever or, if the distance is excessive for a lever, by a Bowden cable or the like extending between the appliance inlet connector and the remotely mounted steam sensor control. Such a safety interlock mechanism could be applied to any kind of cordless connection system. Furthermore, a safety interlock of this kind could be applied to a corded appliance such that the steam sensor control is switched off (open circuit) when the appliance connector plug is inserted into the inlet socket.

Claims

1. A thermally responsive control for an electric heating element for disconnecting the heating element from its power supply in the event of the heating element overheating, said control comprising a set of switch contacts, a component formed of fusible material, means holding an end portion of said fusible component in a forward position for closely thermally contacting the heating element in use, and a spring held in compression by said fusible component, the end portion of the fusible component being arranged to melt and release from its holding means in the event of the heating element overheating whereupon the spring is released and resiles away from said forward position so as to cause the switch contacts to open.
2. A control as claimed in claim 1 wherein the spring is compressed between said end portion of the fusible component and an abutment on the fusible

component spaced from said end portion.

3. A control as claimed in claim 1 or 2 wherein the switch contacts are arranged to be opened by the fusible component serving as a switch actuator driven by said spring after it is released.
4. A control as claimed in any of the preceding claims wherein said spring comprises a spring metal element having a forward portion including means for holding said end portion of the fusible component and arms extending from spaced-apart locations of said forward portion rearwardly and inwardly into contact with said fusible component.
5. A control as claimed in claim 4 wherein said end portion of the fusible component is engaged with a retaining member and said spring metal element has its forward portion formed as a carrier for said retaining member.
6. A control as claimed in claim 5 wherein said retaining member comprises a metal plate and the forward portion of said spring metal element has spaced-apart formations engaged with said metal plate on opposite sides thereof.
7. A control as claimed in claim 6 wherein said metal plate is generally rectangular and said formations comprise, at opposite sides of said metal plate, spaced-apart spring metal fingers for locating opposite corners of said metal plate generally in the plane of the plate and other formations for locating the plate generally transversely to its plane.
8. A control as claimed in any of the preceding claims wherein said means holding an end portion of said fusible component has no thermally-responsive, switch-operating action.
9. A control as claimed in any of claims 1 to 7 wherein said means holding an end portion of said fusible component has a thermally-responsive, switch-operating action.
10. A control as claimed in claim 9 wherein the action of said spring when it is released is such as to open a first set of switch contacts of the control, and the thermally-responsive, switch-operating action of said means holding an end portion of said fusible component is such as to open a second set of switch contacts of the control.
11. A control as claimed in claim 10 as dependent upon claim 6 or 7 wherein said metal plate is bimetallic.
12. A control as claimed in claim 11 wherein said bimetallic plate is dished so as to move with a snap-ac-

tion between oppositely dished configurations at a predetermined temperature lower than the temperature at which said fusible material softens or melts.

13. A control as claimed in any of the preceding claims wherein a further thermally-responsive switch actuator and an associated further switch means are provided, said further thermally-responsive switch actuator being spaced apart from said fusible component such that when the control is juxtaposed with a heating element said fusible component and said further thermally-responsive switch actuator are responsive to the temperature of said heating element at spaced apart locations thereof.
14. A control as claimed in claim 13 wherein said further thermally-responsive switch actuator comprises a bimetallic element.
15. A control as claimed in claim 14 wherein said bimetallic element is dished so as to move with a snap action between oppositely dished configurations at a predetermined temperature.
16. A control as claimed in claim 15 as dependent upon claim 12 wherein the predetermined operating temperatures at which the two bimetallic switch actuators operate are substantially the same.
17. A control as claimed in any of claims 14 to 16 wherein the bimetallic element comprising said further thermally responsive switch actuator is arranged to operate its associated further switch means via an overcentre mechanism.
18. A control as claimed in claim 17 wherein said overcentre mechanism is formed as part of a spring metal carrier for the bimetallic element.
19. A control as claimed in claim 18 wherein said spring metal carrier comprises end portions spaced apart from each other and defining, at one level, locations for supporting a bimetallic blade therebetween and, at another level, spaced-apart spring elements adapted to receive a push-element therebetween so as to form an overcentre mechanism wherein the push-element is movable, in response to switch operating movement of the bimetal, between first and second stable positions on either side of a central unstable position.
20. A control as claimed in any of claims 17 to 19 including reset means associated with said overcentre mechanism.
21. A control as claimed in claim 20 including a moulded plastics body part formed with a connector socket for receiving a power supply connector plug and

wherein said reset means is operable in response to disconnection and subsequent reconnection of said plug and socket connectors.

22. A control as claimed in any of the preceding claims including means providing for the connection to the control of a separate steam sensor control.

23. A control as claimed in any of the preceding claims adapted for use with a planar heating element.

24. A control as claimed in claim 23 wherein spring terminals are provided on the control for engaging terminal portions of a thick film planar heating element.

25. A thermally responsive control for an electric heating element, said control comprising a bimetallic switch actuator mounted in a spring metal carrier so as in use of the control to be held by the carrier in close thermal contact with the heating element, a push-element coupling the thermally-responsive movement of the bimetallic actuator to a switch of the control for operating the same, and an overcentre mechanism associated with said push-element and formed integrally with said spring metal carrier.

26. A control as claimed in claim 25 wherein said bimetallic switch actuator comprises a dished bimetallic blade movable with a snap action between two oppositely-dished configurations.

27. A control as claimed in claim 26 wherein said spring metal carrier comprises, at a first level, spaced-apart portions defining therebetween a support location for said bimetallic blade and, at a second level, spaced-apart spring elements defining therebetween a support location for said push-element and serving as said overcentre mechanism.

28. A control as claimed in claim 27 wherein said spring metal carrier comprises a base part secured in said control, said spaced-apart spring elements being released from said base part, and, upstanding from opposite ends of said base part, a pair of arms facing each other and defining therebetween said support location for said bimetallic blade.

29. A control as claimed in claim 28 wherein said bimetallic blade is generally rectangular and said arms each have formations engaging respective opposite sides of said bimetallic blade.

30. A control as claimed in claim 29 wherein said formations comprise spaced-apart spring metal fingers for locating opposite corners of said bimetallic blade generally in the plane thereof, and other formations for locating the bimetallic blade generally transversely to its plane.

31. A control as claimed in any of claims 25 to 30 including reset means associated with said overcentre mechanism.

32. A control as claimed in claim 31 including a moulded plastics body part formed with a connector socket for receiving a power supply connector plug and wherein said reset means is operable in response to disconnection and subsequent reconnection of said plug and socket connectors.

33. A control as claimed in claim 32 wherein said connector socket provides for the connection thereto of a complementary power supply connector plug regardless of the relative rotational orientations of the plug and socket.

34. A control as claimed in claim 32 or 33 wherein said reset means includes cam means in said connector socket which is displaceable by disconnection and reconnection of the connector plug.

35. A control as claimed in claim 34 wherein said cam means comprises a camming member which is arranged to move, when said connectors are disconnected, into a position where it will be urged to reset the control upon reconnection of the connectors.

36. A control as claimed in claim 35 wherein said camming member is movable within a chamber formed in the control with an aperture in a wall of said chamber permitting the camming member to protrude into a plug-receiving passageway of the control, the aperture being closed by the plug so long as the plug is in the socket and, when the plug is removed, enabling the camming member to move so as to protrude into said passageway, the camming member and the chamber being formed such that subsequent insertion of the plug into said passageway drives the camming member so that it resets said overcentre mechanism.

37. A control as claimed in any of claims 25 to 36 comprising a further bimetallic switch actuator mounted so as in use of the control to be held in thermal contact with the heating element at a location spaced-apart from the location whereat the first-mentioned bimetallic switch actuator is in close thermal contact with the heating element.

38. A control as claimed in claim 37 wherein said further bimetallic switch actuator is mounted in a further spring metal carrier with a further push-element coupling it to a further switch of the control and with a further overcentre mechanism associated with said further push-element and formed integrally with said further spring metal carrier.

39. A control as claimed in claim 38 wherein the arrangement of said further bimetallic switch actuator, its spring metal carrier and its associated push-element and overcentre mechanism is generally the same as for the first-mentioned bimetallic switch actuator. 5
40. A control as claimed in any of claims 37 to 39 wherein the operating temperatures of said bimetallic switch actuators are substantially the same. 10
41. A control as claimed in any of claims 37 to 39 wherein the operating temperatures of said bimetallic switch actuators are different. 15
42. A control as claimed in any of claims 25 to 41 in combination with an electric heating element.
43. A combination as claimed in claim 42 wherein said electric heating element is a thick film heating element. 20
44. A combination as claimed in claim 43 wherein spring terminals of said control are engaged with terminations of said thick film heating element. 25
45. A liquid heating vessel incorporating a combination as claimed in any of claims 42 to 44.
46. A bimetallic switch actuator comprising a spring metal carrier for a bimetallic member and an integral overcentre mechanism. 30
47. A spring metal carrier for a bimetallic switch actuator, said carrier comprising a first portion adapted for the mounting of said bimetal and a second, integral part defining part at least of a bistable overcentre mechanism. 35
48. A carrier as claimed in claim 47 comprising a base part and turned up and over end parts at opposite ends of said base part, said end parts having formations for receiving the respective end of a bimetal and said base part having released therefrom first and second spring parts which extend towards each other, said first and second spring parts comprising said bistable overcentre mechanism. 40 45
49. A carrier as claimed in claim 48 wherein a member is disposed between the opposed ends of said first and second spring parts so as to bias them further apart. 50
50. A thermally-responsive control for an electric heating element, said control comprising a thermally-responsive actuator arranged to determine the condition of a bistable switch mechanism and means for resetting said bistable switch mechanism, a plastics material body part of said control being formed with a connector socket for receiving a power supply connector plug and said resetting means being operated by disconnecting and then reconnecting said plug and socket connectors, said body part of the control including a chamber within which there is contained a camming member and an opening in a wall of said chamber enabling said camming member to protrude into a passageway occupied by the connector plug when the plug and socket connectors are connected, removal of the connector plug from the connector socket causing the camming member to move within its chamber and protrude into said passageway whereupon reconnection of the plug and socket connectors causes the camming member to be driven by the connector plug as it is inserted into the connector socket, such movement of the camming member serving to reset the bistable switch mechanism if it is in condition to be reset.
51. A control as claimed in claim 50 wherein said thermally-responsive actuator comprises a bimetallic blade.
52. A control as claimed in claim 51 wherein said bimetallic blade is dished so as to be movable with a snap-action between oppositely-dished configurations.
53. A control as claimed in any of claims 50 to 52 wherein said bistable switch mechanism comprises an overcentre mechanism.
54. A control as claimed in any of claims 50 to 53 wherein the operation of said control is arranged to apply a spring force to the camming member within said chamber, such spring force urging the camming member to move so as to protrude through said opening and into said passageway when the plug and socket connectors are disconnected.
55. A control as claimed in any of claims 50 to 54 further comprising a second thermally-responsive actuator arranged to determine the condition of a second switch mechanism, said second thermally-responsive actuator being spaced-apart from the first-mentioned thermally-responsive actuator so that the two actuators are responsive in use to the temperature of the electric heating element at respective spaced-apart locations thereof.
56. A control as claimed in claim 55 wherein said second thermally-responsive actuator is arranged similarly to the first-mentioned thermally-responsive actuator to determine the condition of a bistable switch mechanism and with a resetting means comprising a said camming member operated by dis-

connecting and then reconnecting said plug and socket connectors.

57. A control as claimed in claim 56 wherein said first-mentioned and second thermally-responsive actuators are responsive at substantially the same temperature. 5
58. A control as claimed in claim 56 wherein said first-mentioned and second thermally-responsive actuators are responsive at different temperatures. 10
59. A control as claimed in claim 55 wherein said second thermally-responsive actuator comprises a fusible component. 15
60. A control as claimed in any of claims 50 to 59 wherein said connector socket is a 360° connector which can be mated with a complementary connector plug irrespective of the relative rotational orientation of the two connectors. 20
61. A control as claimed in any of claims 50 to 60 including means providing for the connection to the control of a separate steam sensor control. 25
62. A control as claimed in any of claims 50 to 61 adapted for use with a thick film planar heating element and wherein spring terminals are provided on the control for engaging terminal portions of a thick film planar heating element. 30
63. A control as claimed in any of claims 50 to 62 in combination with an electric heating element, said connector socket serving for the supply of electricity through the control and to the heating element in dependence upon the condition of said thermally-responsive actuator(s). 35
64. A water heating appliance provided with a control and an electric heating element as claimed in claim 63. 40
65. A plug or socket connector adapted to be mated with a complementary socket or plug connector and wherein an integral heating element overtemperature control of the first-mentioned connector is arranged to be reset by disconnecting and then reconnecting the two connectors. 45
66. A connector as claimed in claim 65 wherein a camming element is provided in the connector for resetting the control. 50
67. A connector as claimed in claim 66 wherein said camming element is provided in a chamber of said connector which has an opening into a void within the connector which is occupied by the complemen-

tary connector when the two connectors are mated together, a portion of said camming element being arranged to project out of said chamber and into said void via said opening when the two connectors are disconnected and to be urged back into said chamber by contact with the complementary connector when the two connectors are reconnected after being disconnected, the resulting movement of the camming member being utilized for resetting the control.

FIG. 1A

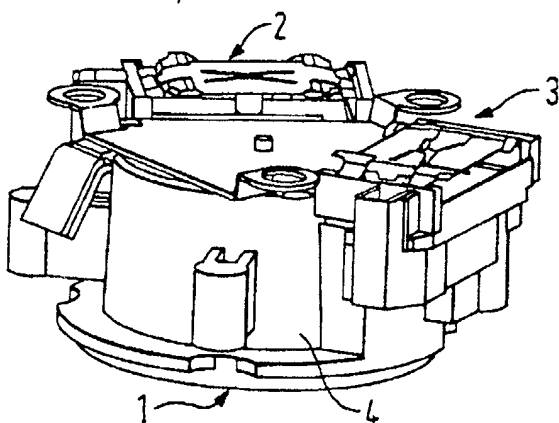
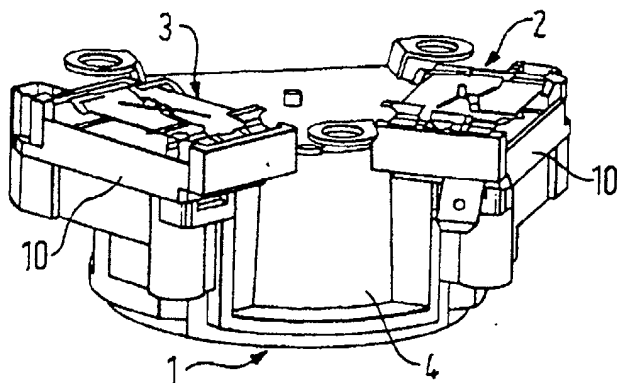


FIG. 1B

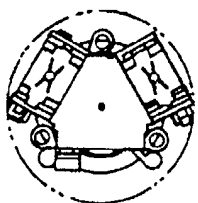


FIG. 1C

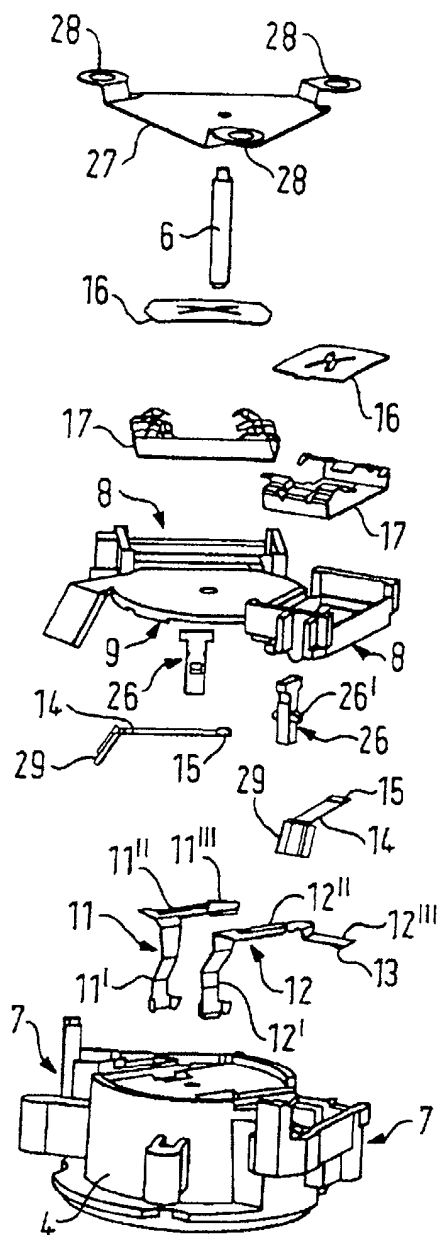


FIG. 1D

FIG. 2A

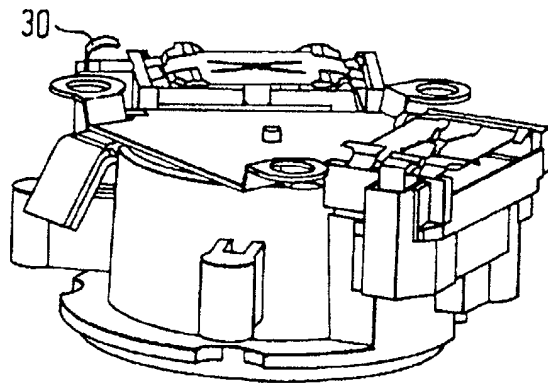
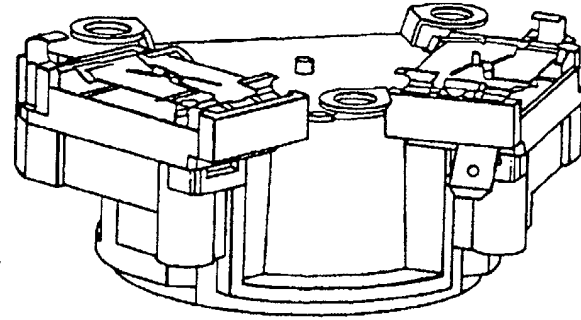


FIG. 2B

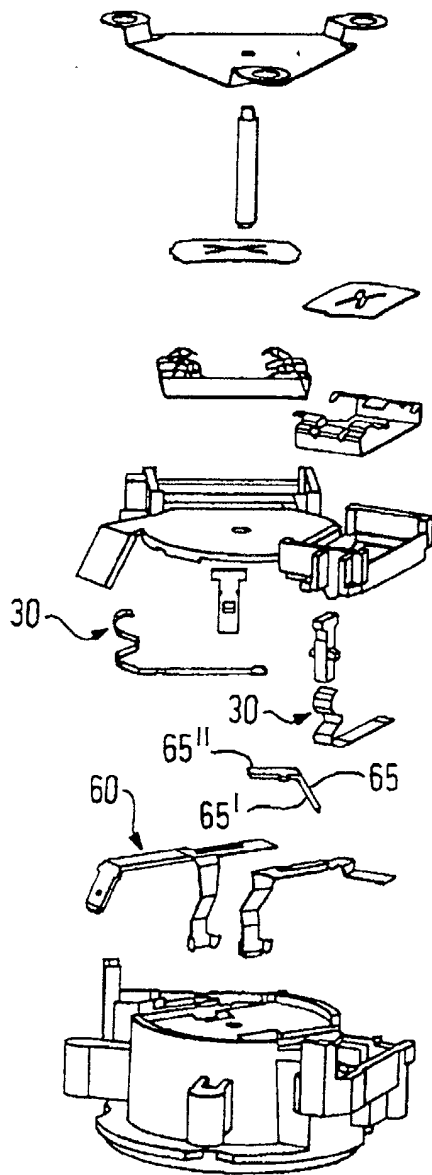


FIG. 2D

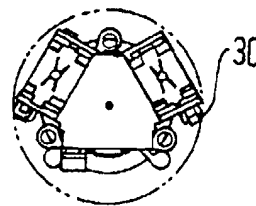
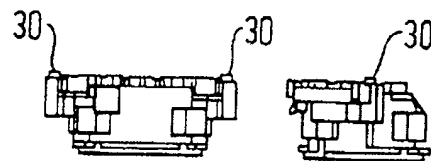
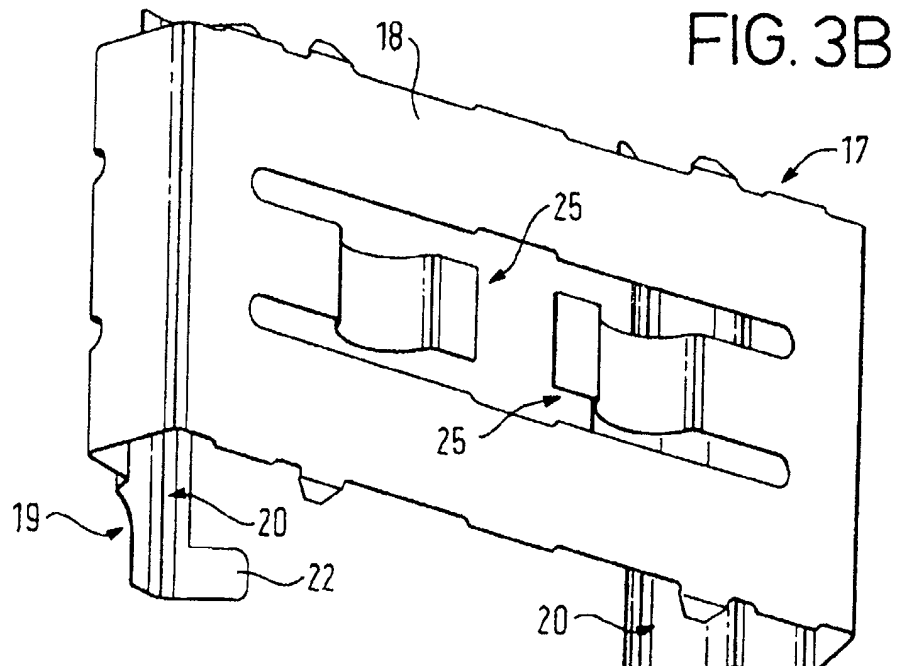
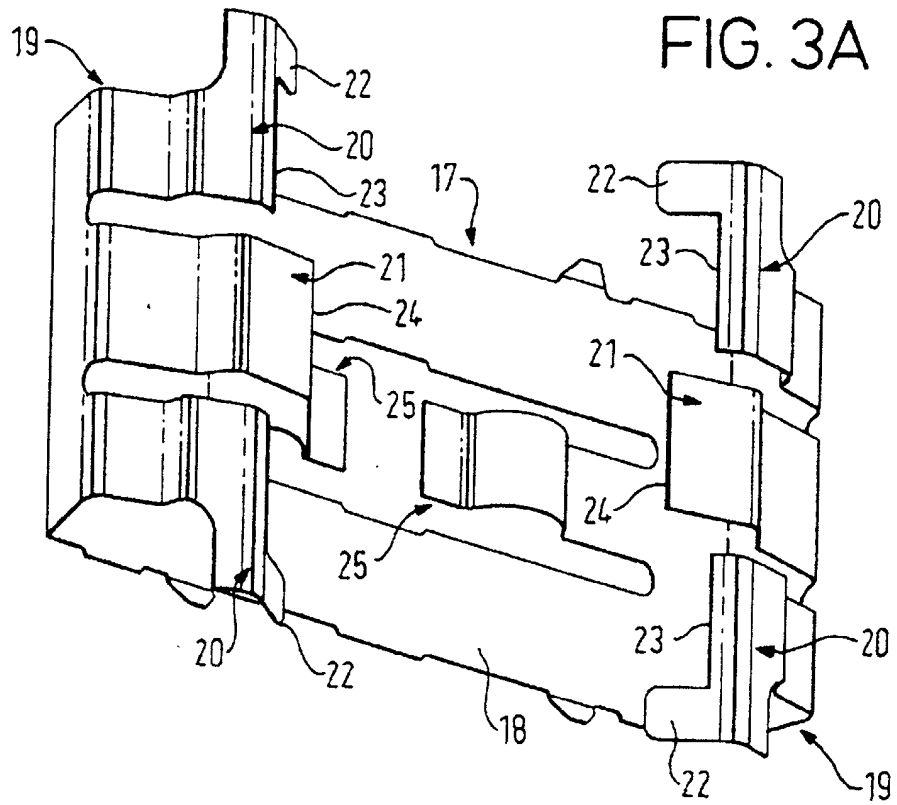


FIG. 2C



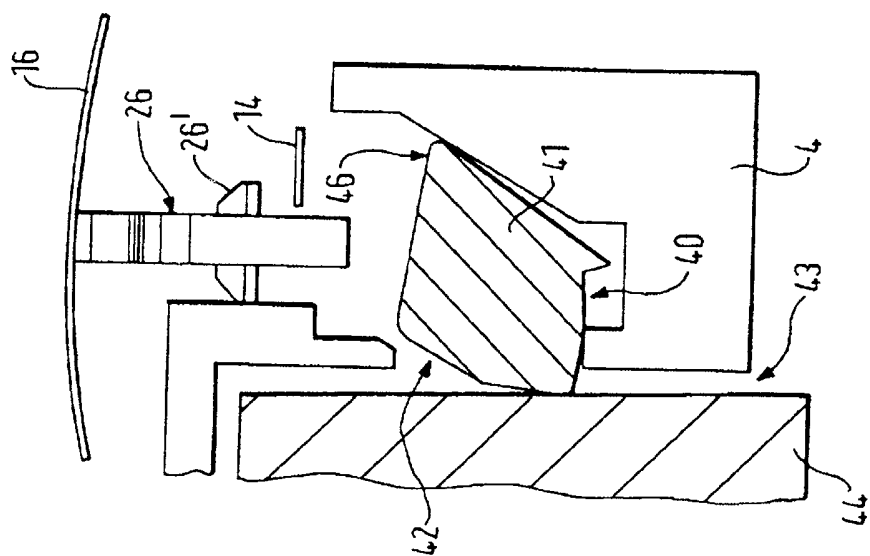


FIG. 4A

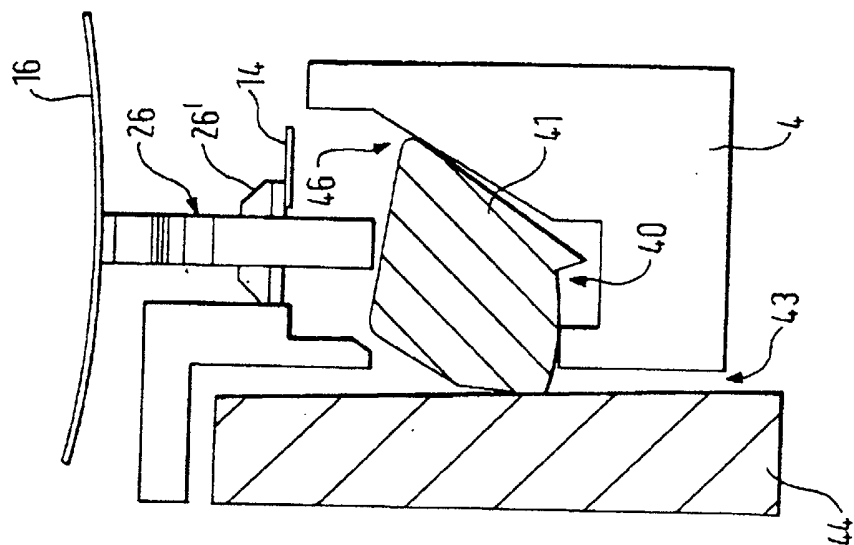
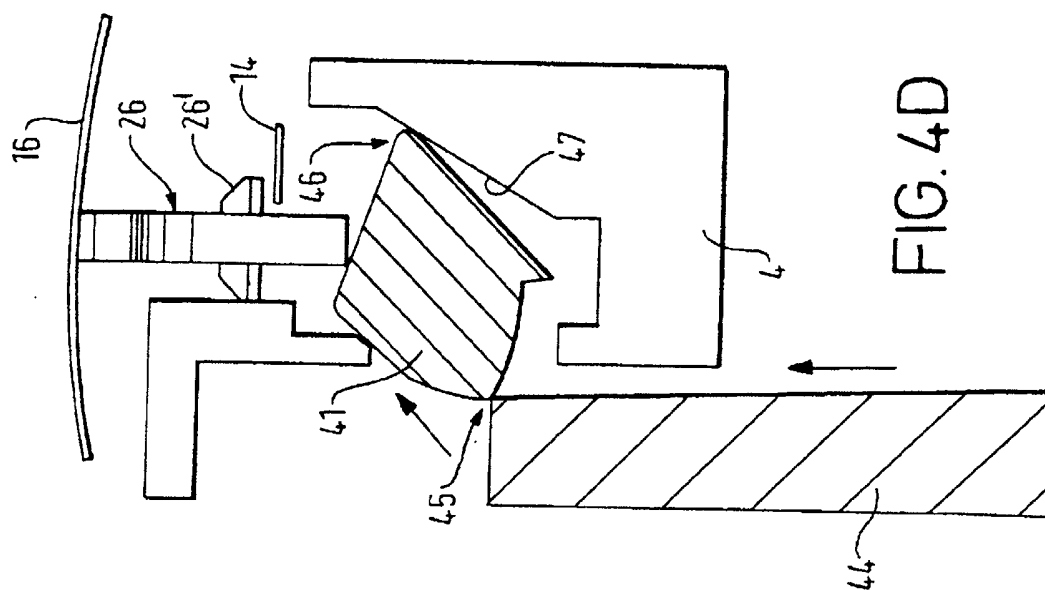
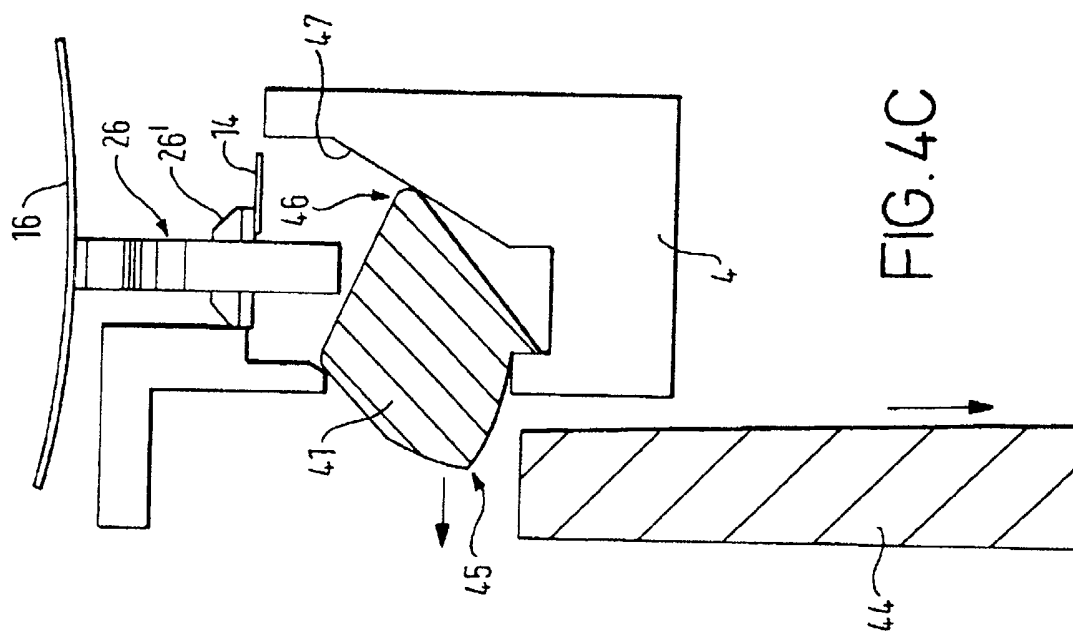


FIG. 4B



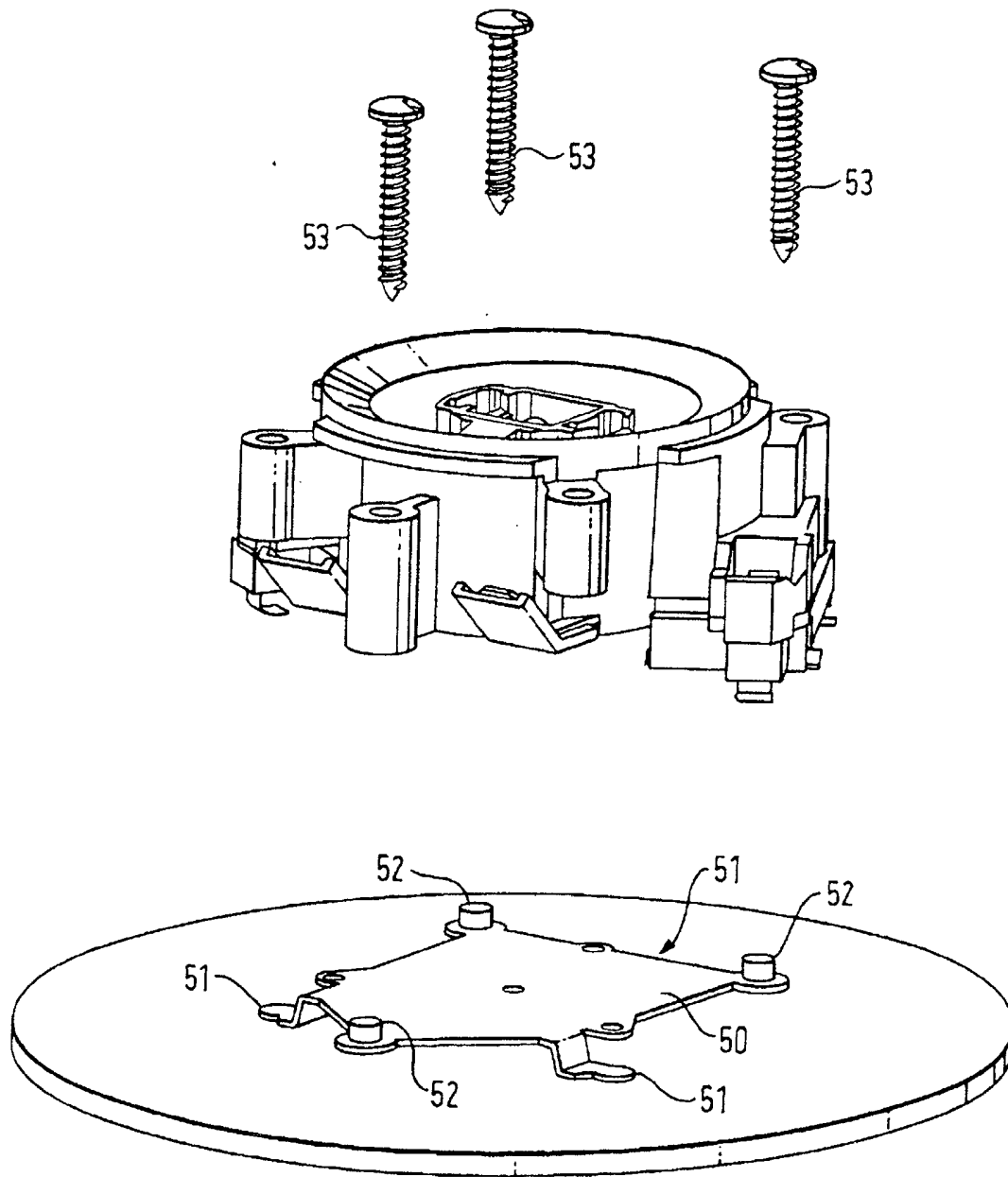
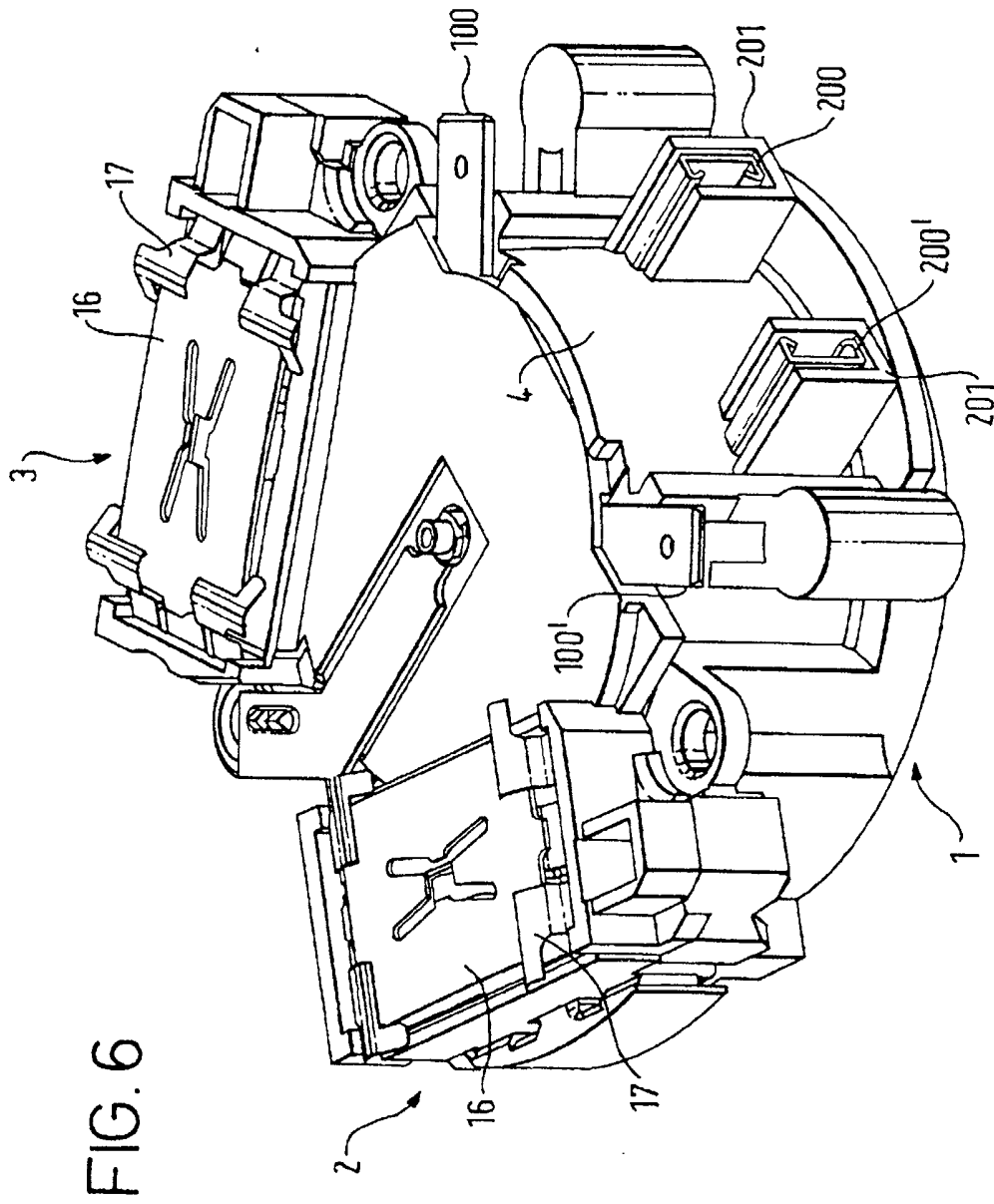


FIG. 5



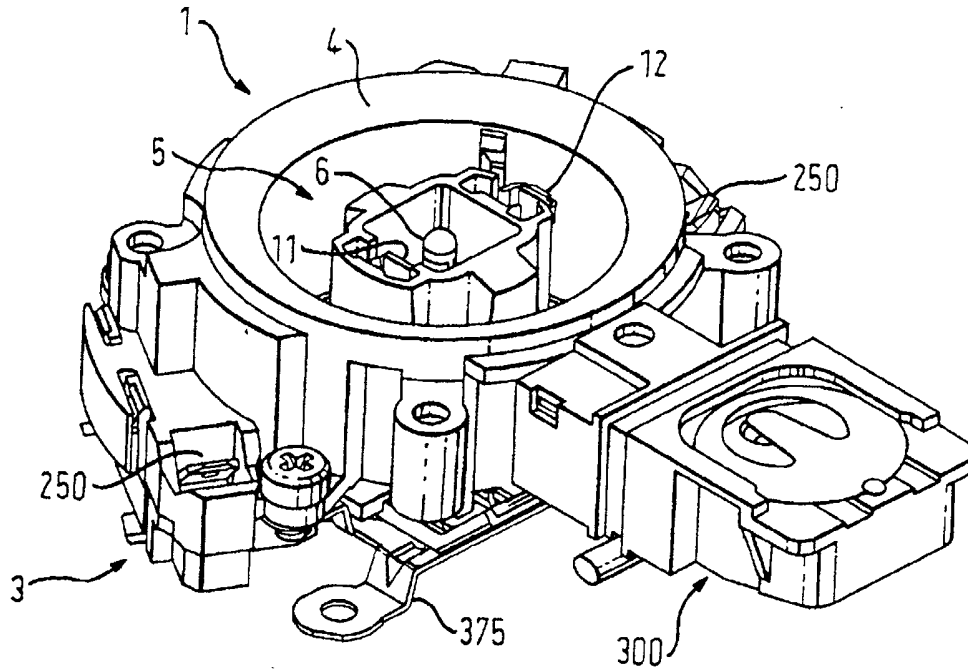


FIG. 7

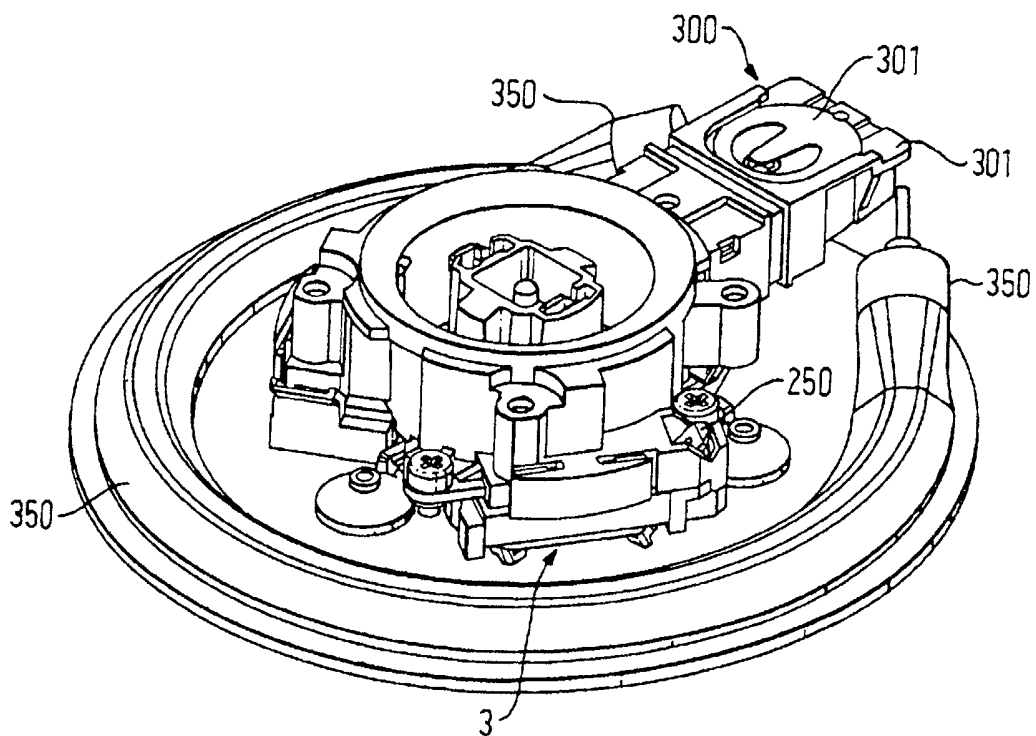


FIG. 8

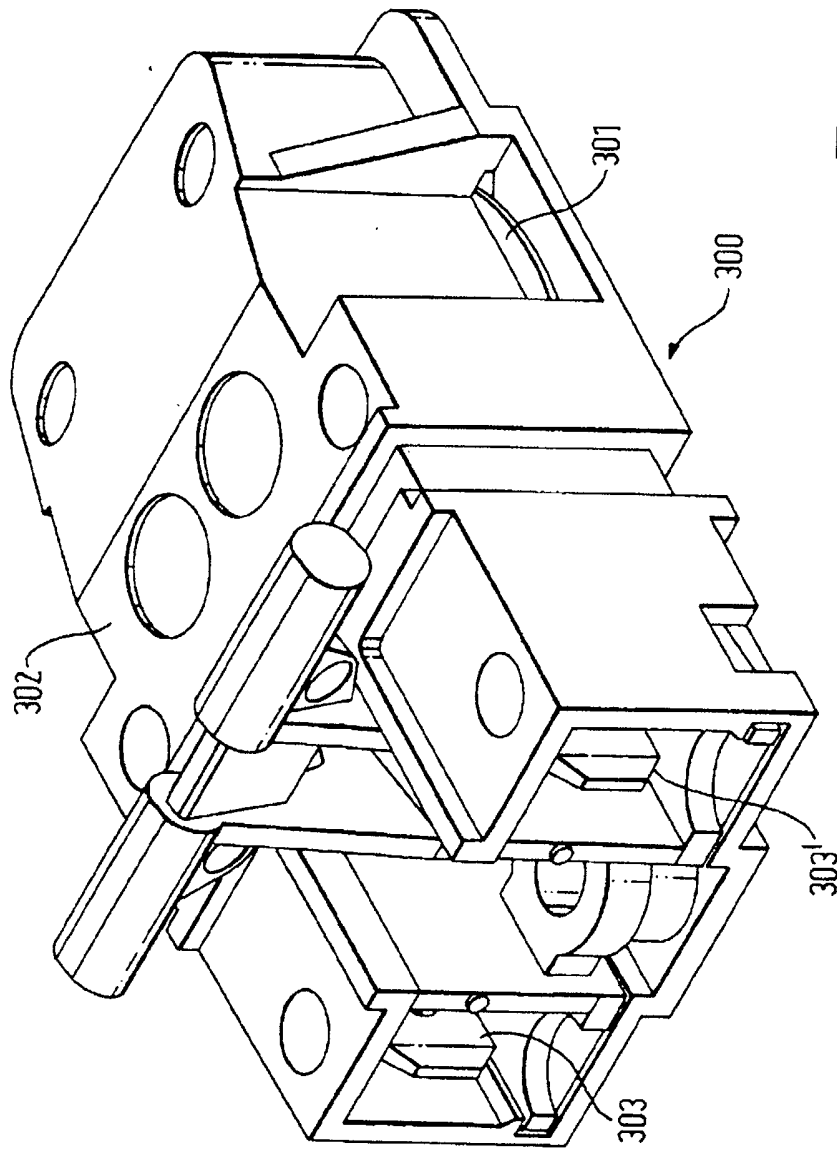


FIG. 9

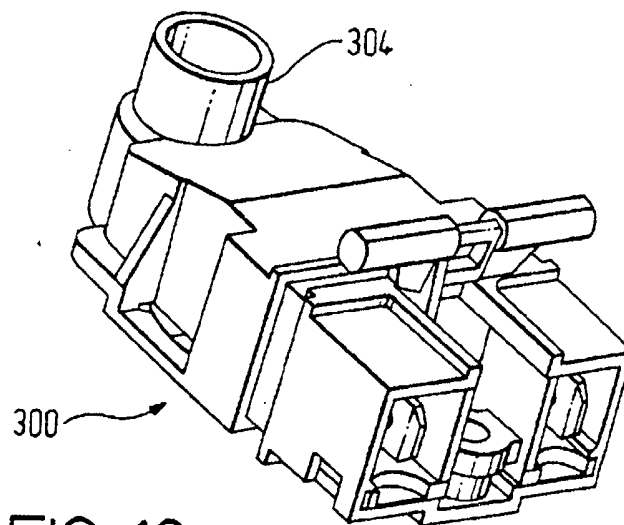


FIG. 10a

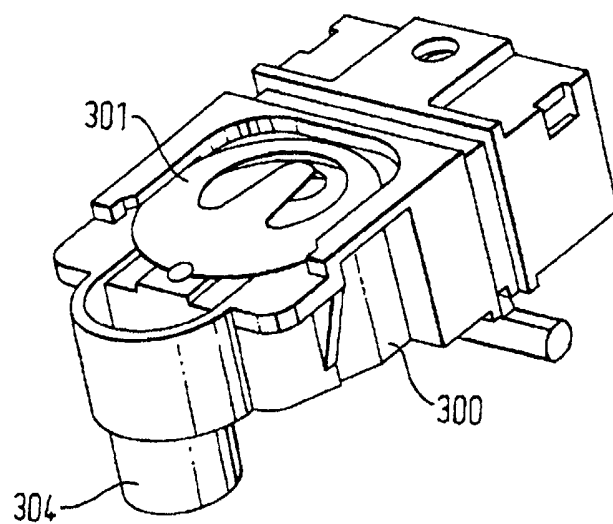


FIG. 10b

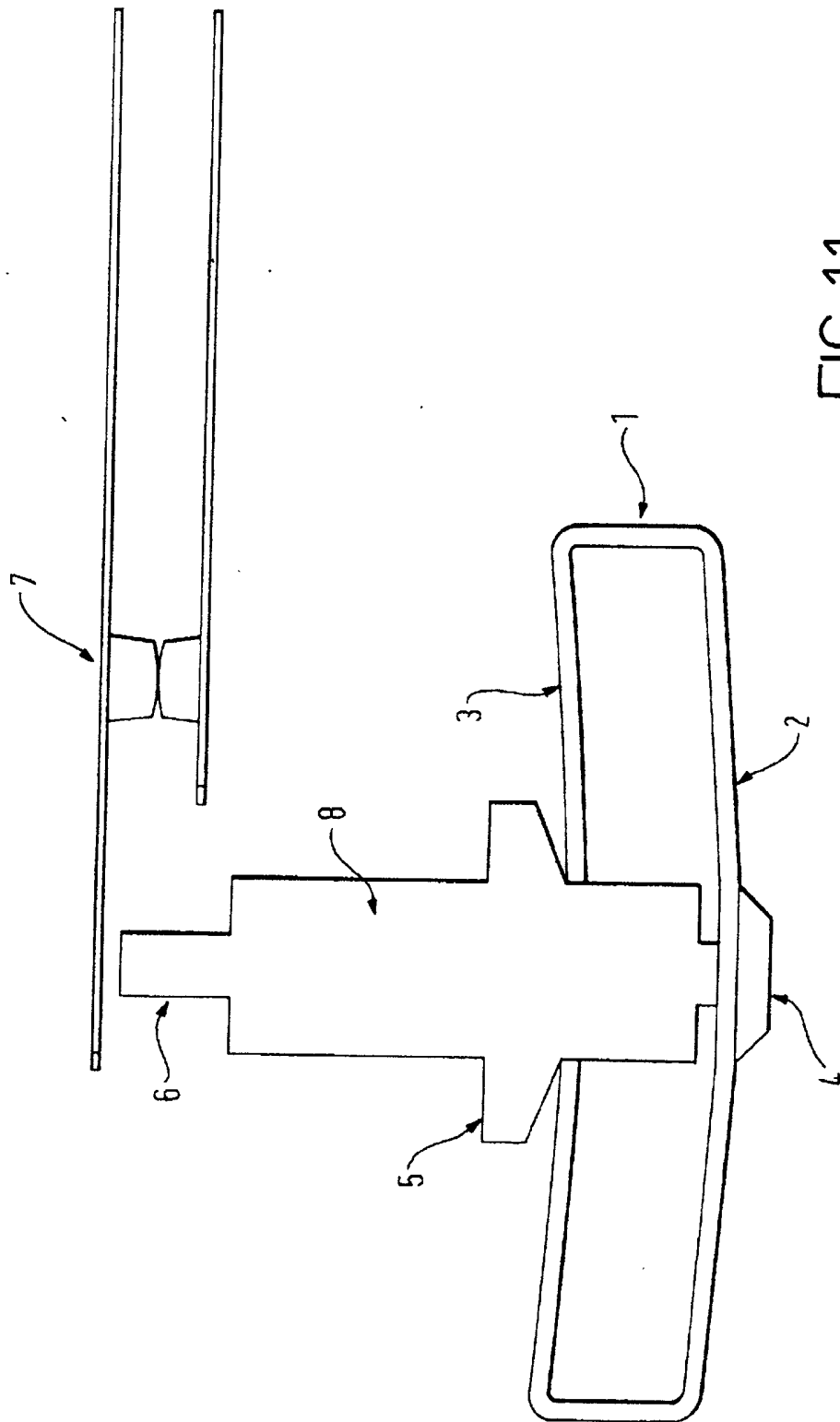
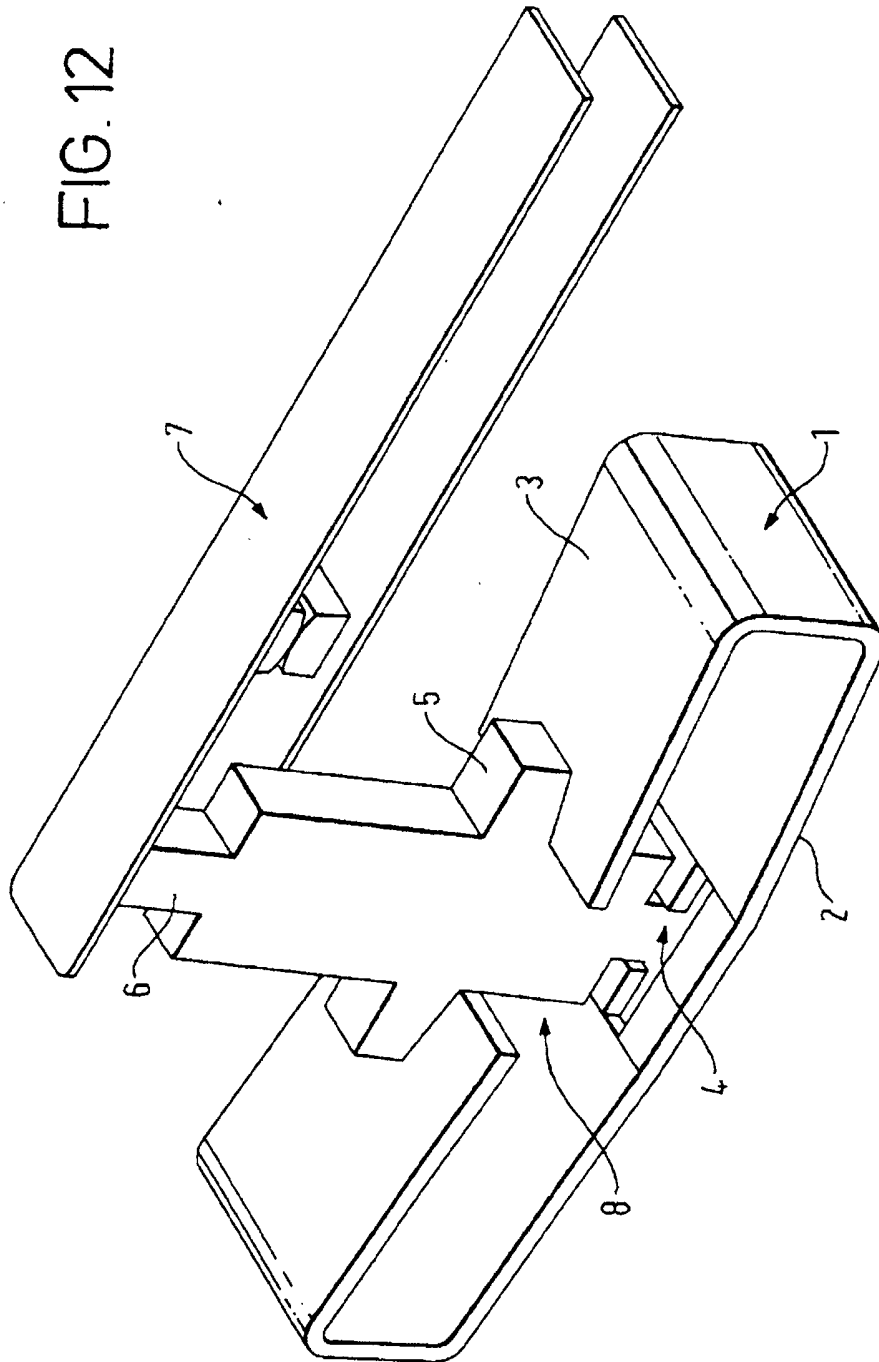


FIG. 11

FIG. 12



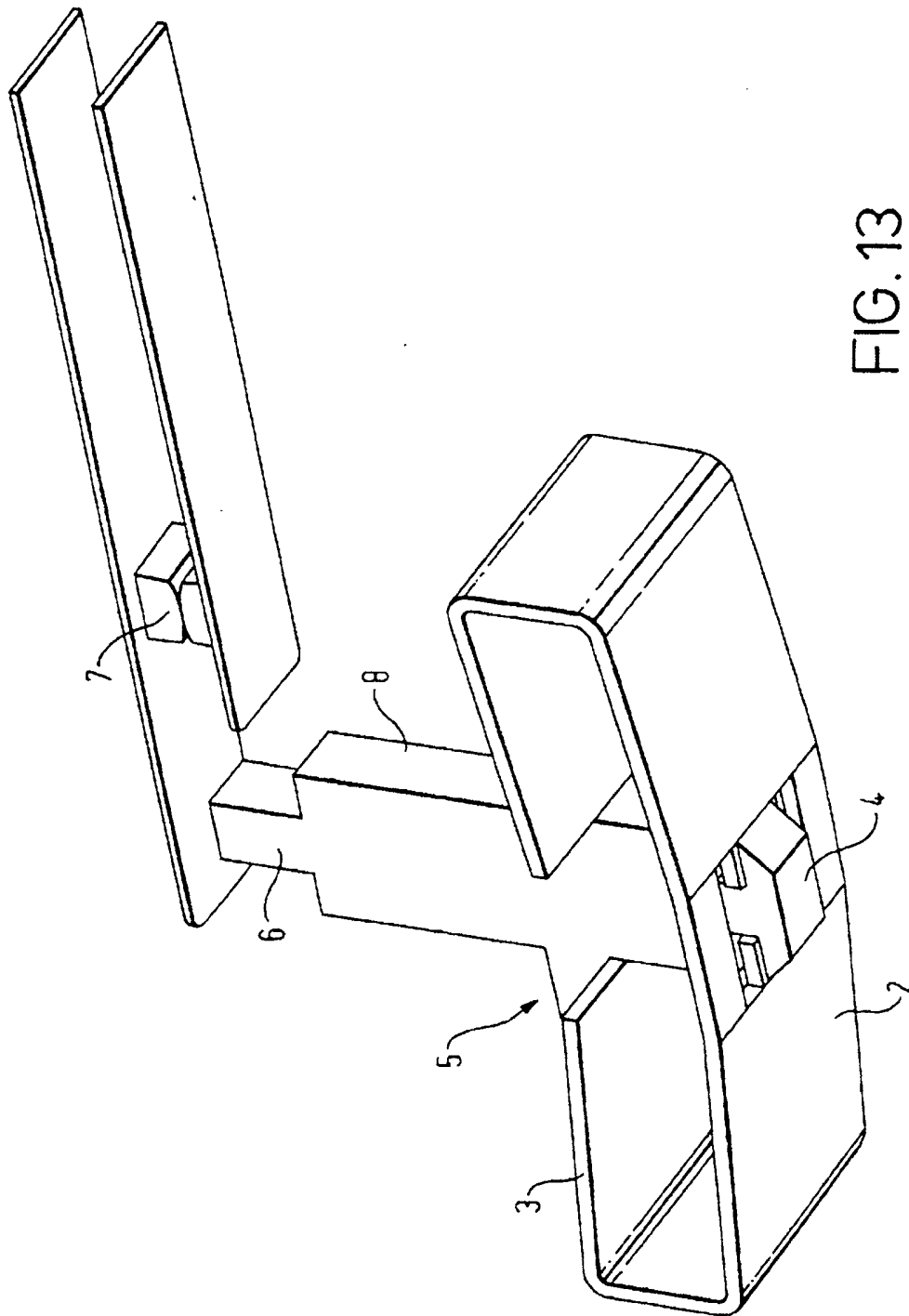


FIG. 13

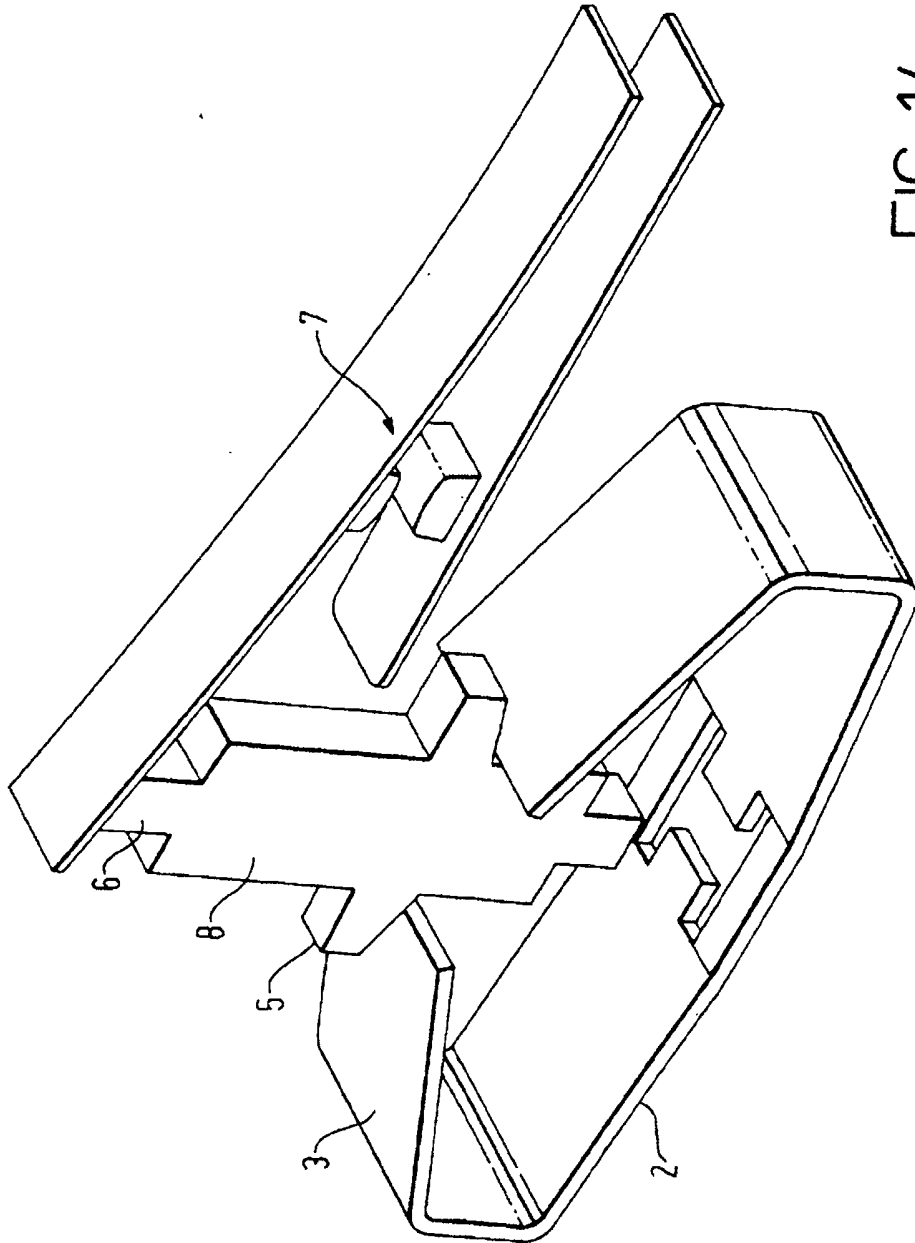
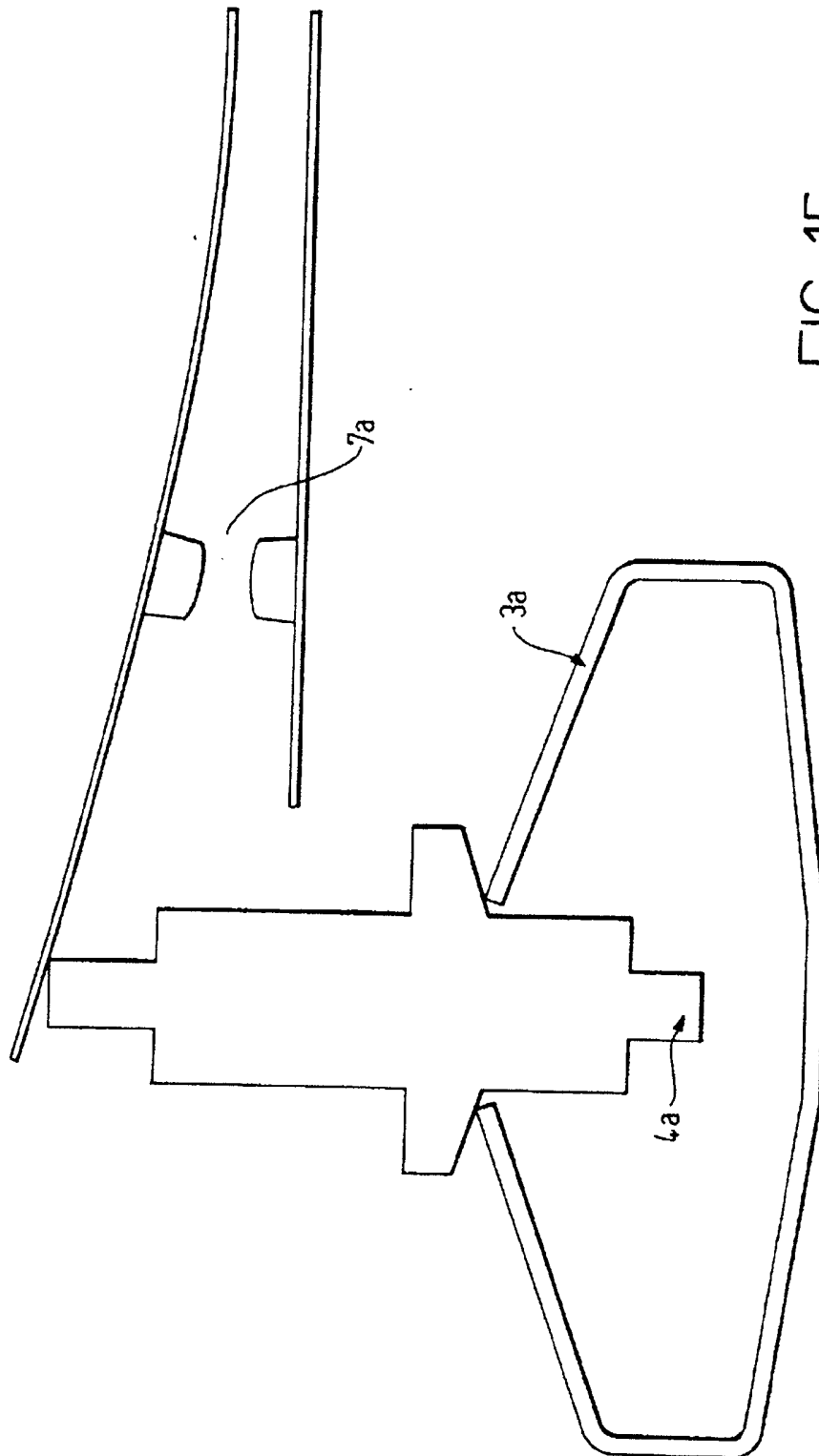


FIG. 14



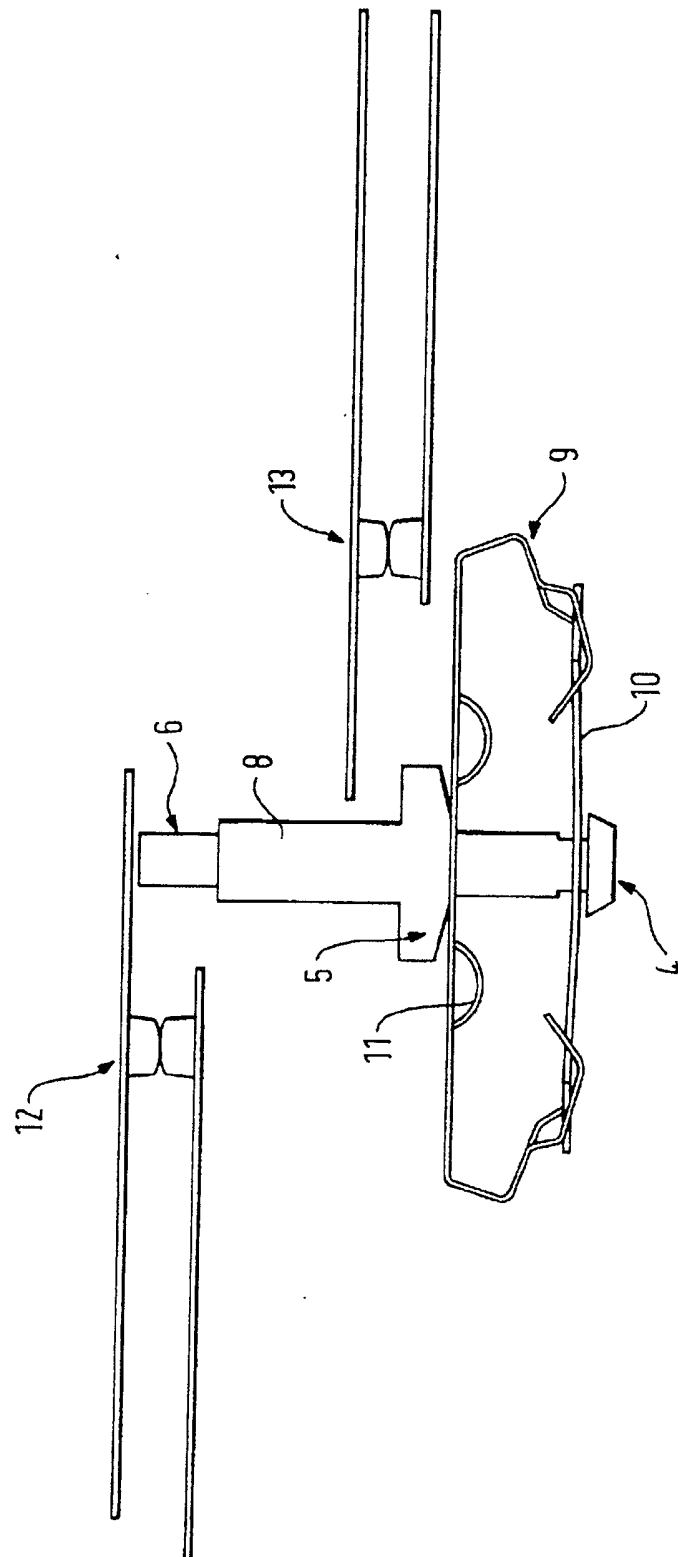


FIG. 16

FIG. 17

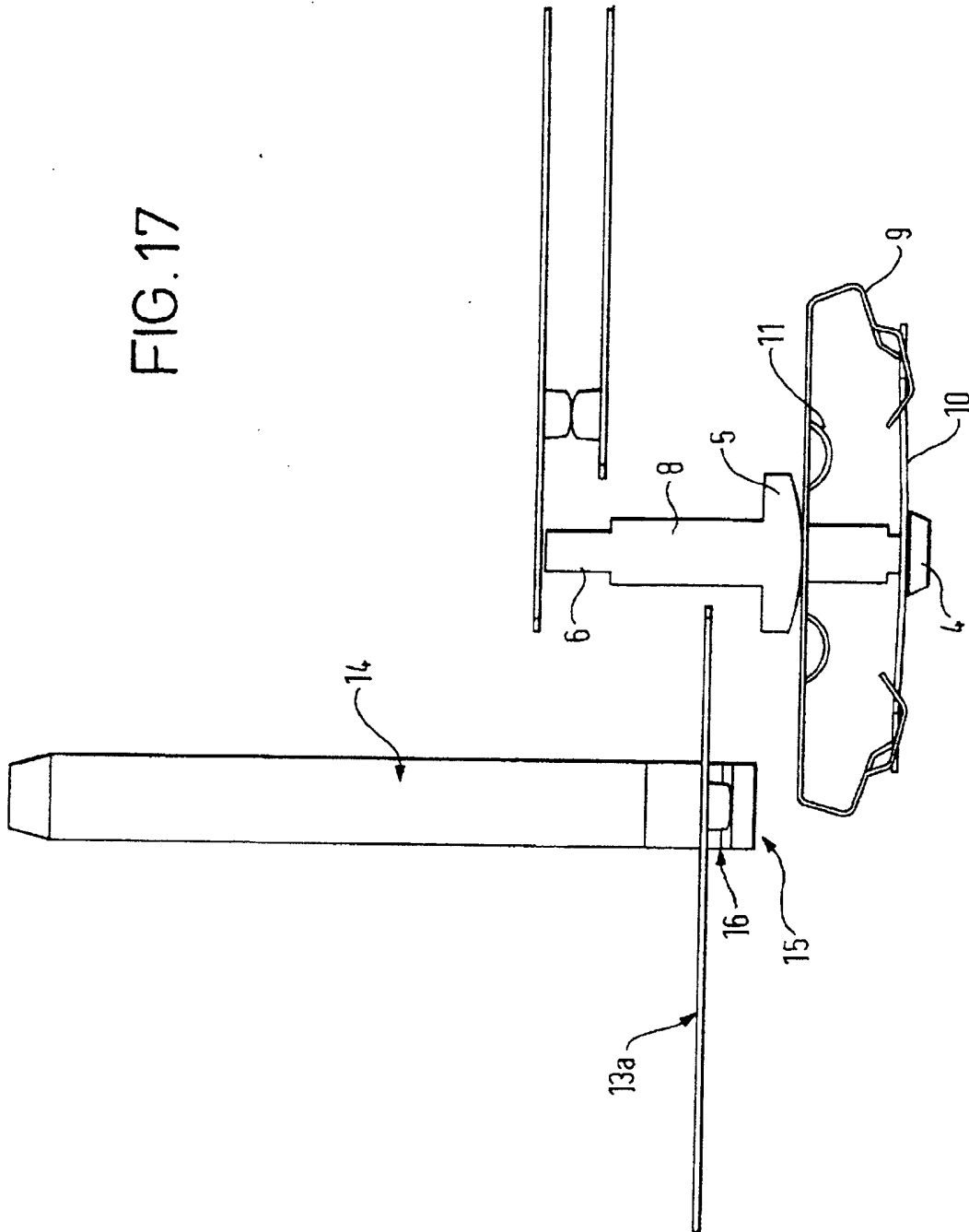


FIG. 18

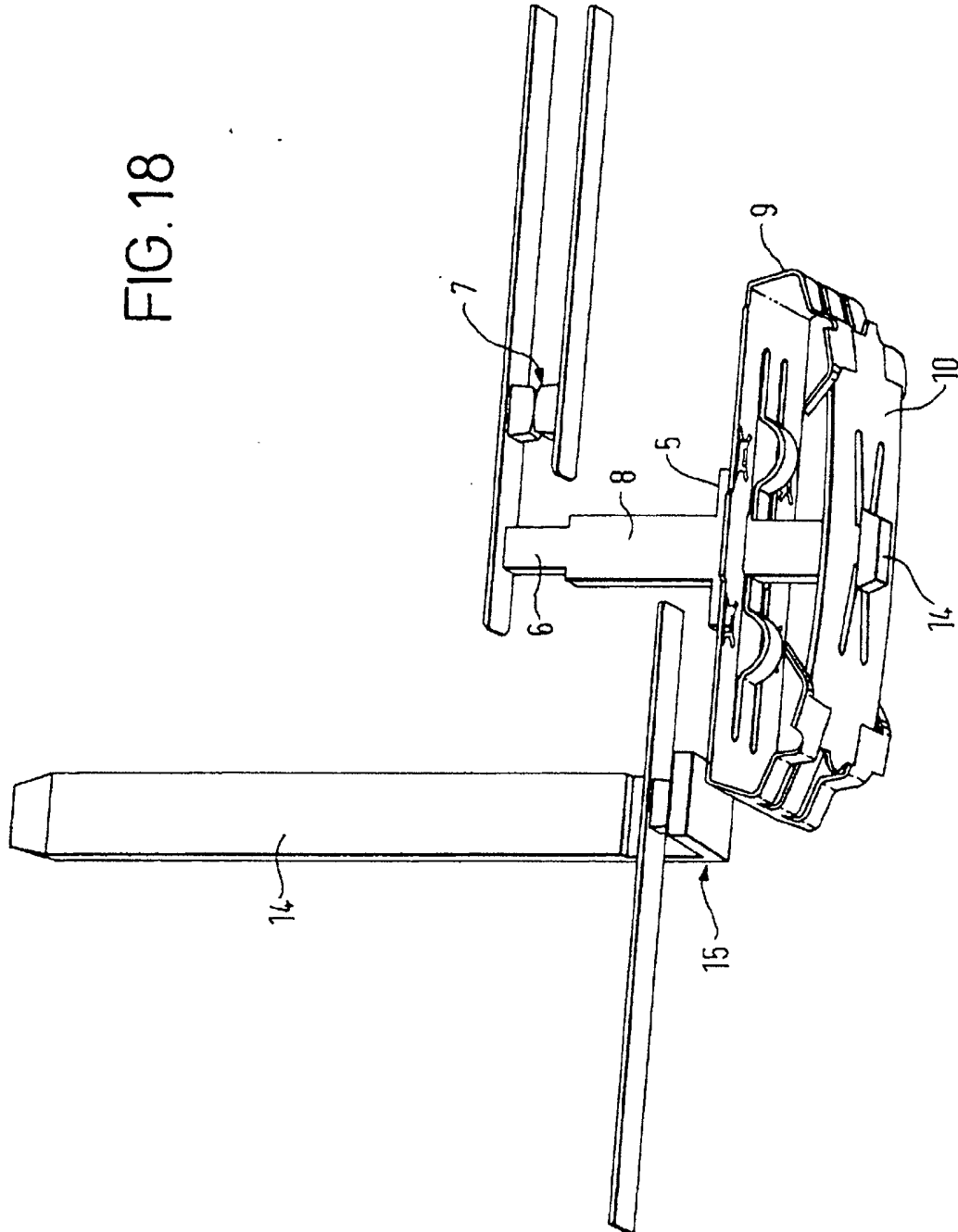
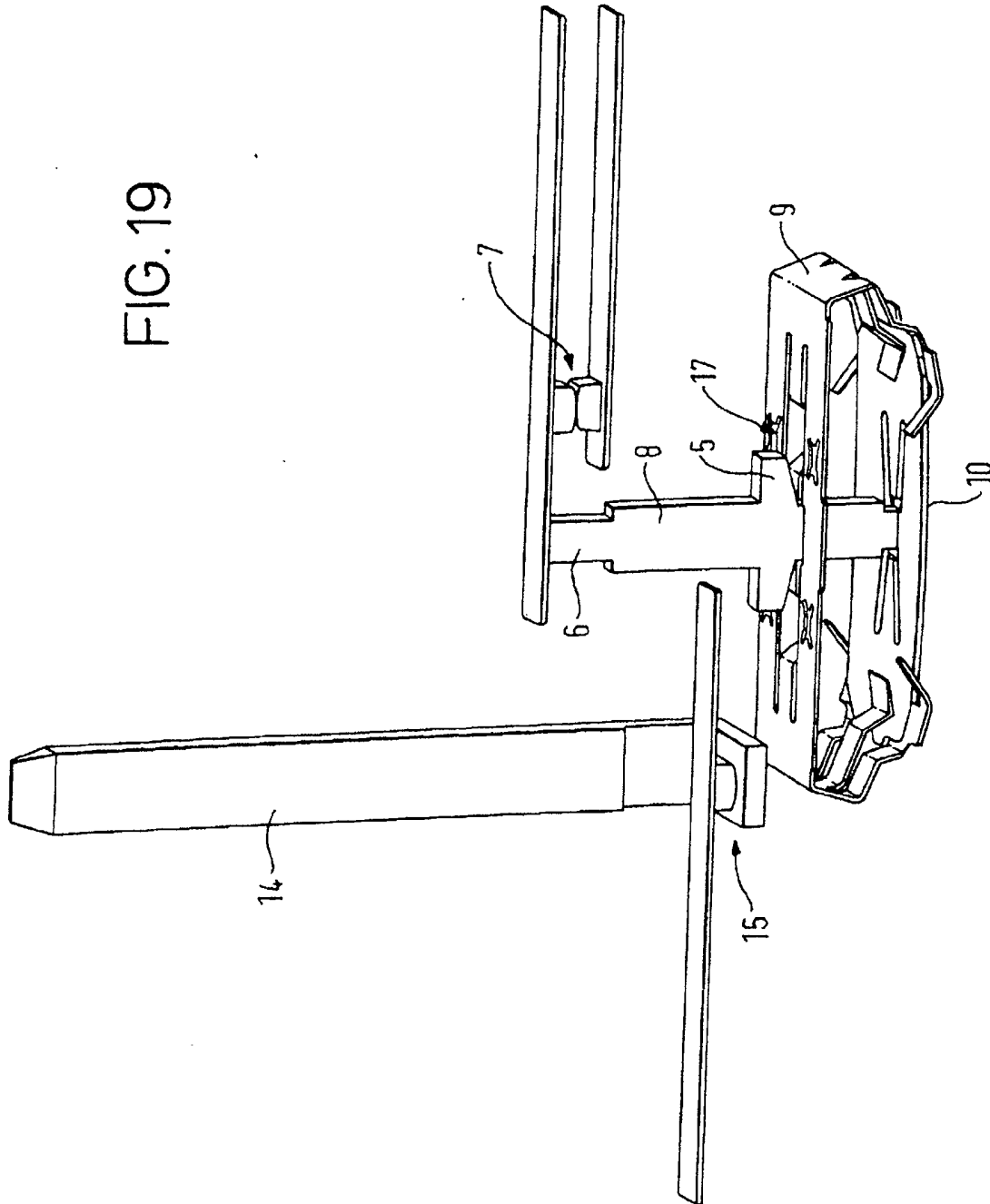


FIG. 19



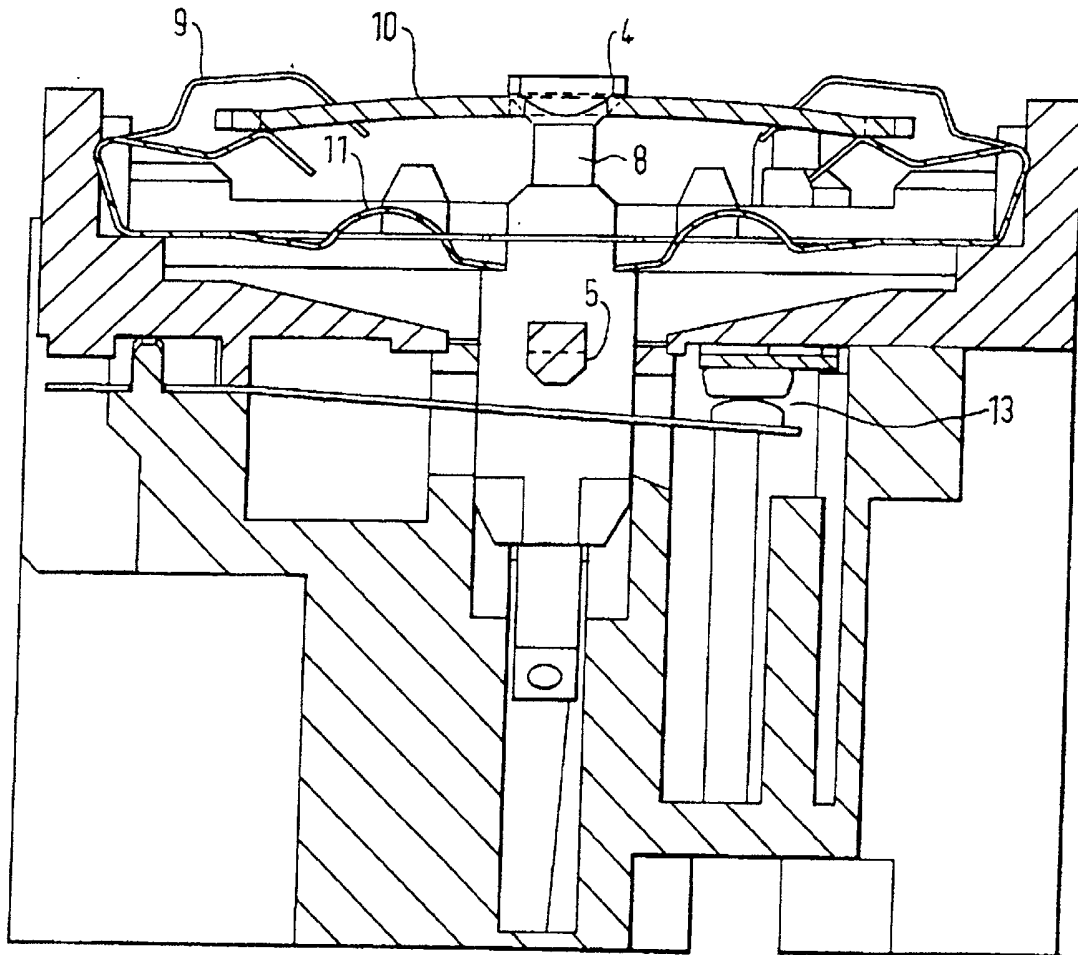


FIG. 20

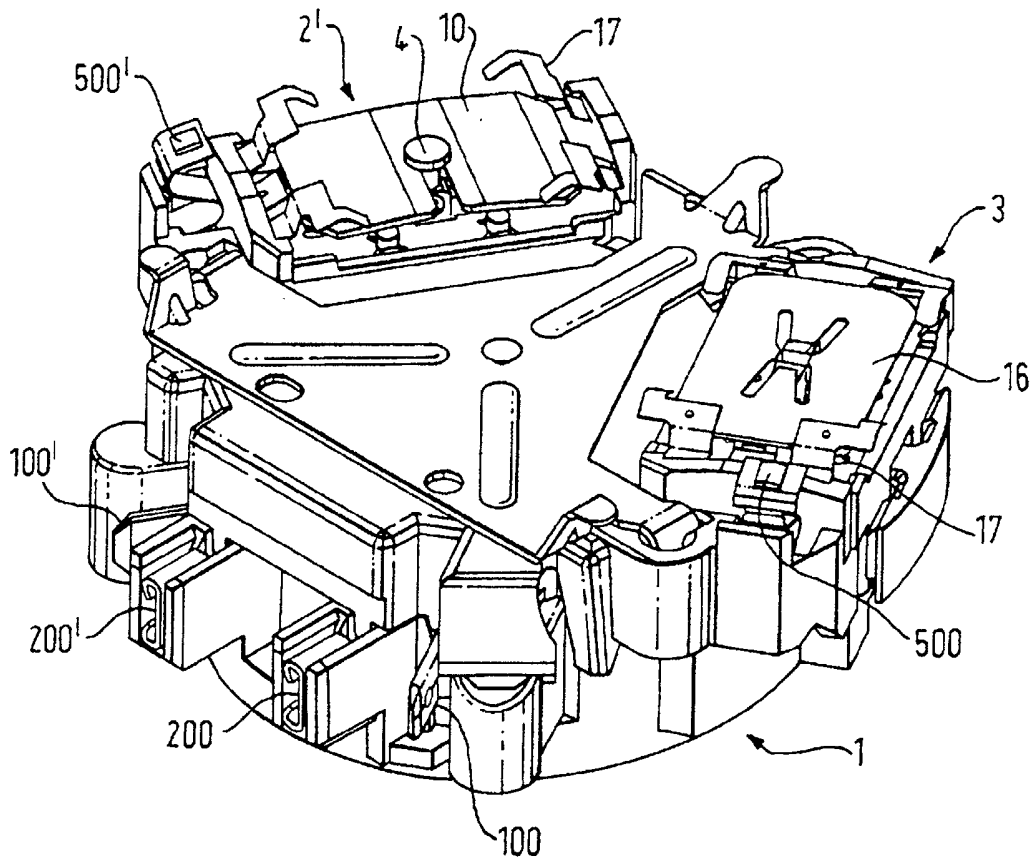


FIG. 21



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 07 7328

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y,D	GB 2 306 801 A (OTTER CONTROLS LTD) 7 May 1997 (1997-05-07) * page 9, line 22 - page 13, line 8; figures 1-8 * * page 9, line 22 - page 10, line 22; figure 4 *	1-67	H01H37/04 H01H37/00 H01R13/713
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			H01H H01R
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 19 August 2002	Examiner Criqui, J-J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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