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(54) Title: LOW PROFILE AUTOMOTIVE FUSE

(57) Abstract: An automotive blade-type fuse and method of manufacturing same are provided. The fuse includes a pair of metallic terminals separated by and in electrical communication with a fuse element. An insulative housing is provided that covers at least a portion of the of an inner edge of each of the terminals and exposes the outer edges of the terminals and at least a portion of the upper edges of the terminals. The upper edges of the terminals are bent inward to crimp the housing between an intermediate portion of the terminals and the bent upper end edges.

SPECIFICATION

TITLE OF THE INVENTION

LOW PROFILE AUTOMOTIVE FUSE

PRIORITY CLAIM

5 This application claims priority to and the benefit of U.S. Provisional Patent Application "LOW PROFILE AUTOMOTIVE FUSE," Serial No. 60/550,682, Filed March 5, 2004.

BACKGROUND OF THE INVENTION

10 The present invention relates to fuses and more particularly to automotive fuses.

 Automotive fuses, such as blade type fuses are known in the art. Modern electrical blade fuses have been manufactured by Littelfuse, Inc., the assignee of the present invention. Blade fuses protect electrical automotive circuits from current overloads. The protection results from the creation of an opening of a fuse element of
15 the fuse, and therefore in the circuit protected by the fuse. Upon a current overload of a certain magnitude and over a predetermined length of time the fuse element or link breaks or opens.

 Blade fuses are used extensively in automobiles. Automobile manufacturers are constantly looking for ways to reduce costs as much as possible. Manufacturers
20 strive to reduce costs, such as material and manufacturing costs, as much as possible. Automobile manufacturers on the other hand are constantly adding more electrical devices and accessories to automobiles. Consequently, automobile circuits having increasingly higher operating voltages, e.g., 60 volts, are being contemplated and implemented. Higher ratings require more robust conductive elements and more
25 insulation. The trend towards lower cost therefore competes against the trend towards higher capacity.

 Known blade fuses employ: (i) an insulative housing; (ii) conductive male terminals that fit into female terminals extending from the automobile's fuse block; and (iii) a fuse element connecting the male terminals. The male terminals have
30 typically extended below the insulative housing. When installed in the fuse block, the

housing of the fuse sits above the female terminals. The housing in such configuration and placement provides a convenient apparatus or place of the fuse to be grasped and pulled or pushed to remove or replace the fuse, respectively.

In known blade-type fuses, the upper portions of the male terminals, which
5 reside within the housing, provide suitable places to which to secure the insulative housing to the terminals or metal portions of the fuse. Because the upper parts of the terminals sit above the fuse block, the upper parts can be used to define holes, for example, through which the housing is anchored. One common process for attaching the insulative housing to the metal terminals is called a "staking" process. In a heat
10 staking process, heat is applied to the housing at points overlapping or aligned with the holes in the terminals. The applied heat melts or deforms the insulative housing so that the insulative material flows into the holes, hardens and thereafter holds the housing and the terminals together. Another staking method is commonly called a "cold stake", in which the material is deformed by mechanical force alone. No heat is
15 used.

Recently, attempts have been made to reduce the amount of metal in blade-type fuses by eliminating the upper parts of the male terminals so that the resulting fuse fits primarily in between the female terminals of the fuse block and not significantly above the female terminals. One such "low profile" blade fuse is disclosed in U.S. Patent
20 No. 6,359,543. The fuse disclosed therein includes a housing that covers the top of the terminals but enables the outer sides of the terminals to be exposed. The exposed surfaces of the terminals are mated with the female terminals of the fuse block.

One concern facing all blade-type fuses arises when the fuse element opens. The opening of the fuse element coincides with a release of energy, including sound
25 and heat. The air within the housing expands, placing stress on the housing and the attachment mechanisms holding the housing to the terminals. In certain instances if the housing is not properly attached to the terminals, the housing upon a short circuit can come free from the terminals or otherwise become difficult to remove from the fuse block.

30 The "low profile" fuse, while reducing the amount of metal and insulating material for a given rating, makes insertion and removal more cumbersome because there is less material exposed to grasp. Further, the reduced metal and insulative

material reduces the area of overlap between the metal and the insulative material, making the staking or attachment process more difficult and less effective. The housings of known “low profile” fuses may therefore be more susceptible to dislodgement upon opening, creating a situation in which it is difficult to remove the male terminals of the fuse, which are friction fitted to the female terminals of the fuse block. This is especially true in the case of the “low profile” fuse because the male terminals do not extend significantly above the female terminals of the fuse block.

A need therefore exists for a “low profile” type fuse having a housing more securely attached to the terminal portions of the fuse to reduce the likelihood that the housing will become dislodged from the terminals when the fuse element opens.

A further need exists for a “low profile” type fuse that is readily removeable from the fuse block after an overcurrent condition occurs and the element opens.

SUMMARY OF THE INVENTION

The present invention includes an improved fuse and method of manufacturing same. In one embodiment, the fuse is a blade-type fuse, which can be used in automobiles. The fuse includes a pair of “low profile” terminals that can be male or female terminals. The fuse also includes an insulative housing that covers a portion but not all of the terminals. The housing is fixedly attached to the terminals so that the housing will not become dislodged from the terminals when the fuse element of the fuse opens due to an overcurrent condition.

In particular, the housing covers an inner portion of the terminals but exposes the outer edges and a portion of the top edge of the terminals. The housing is thereby able to be made using less material compared with known fuses. The terminals are also shortened with respect to known blade-fuse terminals. The “low profile” nature of the terminals is possible because the terminals do not have to extend beneath the housing, as present in typical blade fuses, to be capable of mating with female fuse block terminals.

The fuse of the present invention overcomes the potential problem of the housing becoming dislodged from the conductive portion of the fuse upon opening. The problem is solved by the present apparatus and method for more rigidly fastening the terminals to the housing. As illustrated below, a metal terminal portion of the fuse is provided. In the flat, the metal or conductive portion includes a pair of arms that

each extend upwardly from the outer edge of either one of the terminals. After the housing is inserted over the metal portion of the fuse, the arms are bent inward, clamping or crimping the housing between the bent arms, which now form the upper edges of the terminals, and intermediate edges of the conductive terminals housed
5 within the insulative housing.

The bent upper edges provide a portion of the fastening function. The bent upper edges also provide probe points, which enable the user to test the integrity of the fuse. The housing in one embodiment is notched to receive the bent upper edges. The notch includes side walls that extend vertically above a portion of the bent upper end
10 edges of the terminals to help mitigate the risk of an accidental arcing across the terminals.

The terminals and the housing can be made of a variety of materials as discussed herein. Further, the fuse link or fuse element connected electrically between the terminals can be of the same or different material as the terminals and can be sized
15 for any suitable current rating.

The housing is ribbed or flanged to provide rigidity. The flanges contacting the terminals in one embodiment are staked to provide additional support and stability. In one embodiment, the terminals define apertures or indentations for enabling the hot or cold staked housing material to project into the terminals to further mechanically
20 attach the housing to the conductive portion of the fuse.

A pair of holes and corresponding stakes is provided for each terminal in one embodiment. The holes and stakes are spaced apart vertically along the terminals. This configuration helps so that the weaker element does not bend inadvertently, enabling the terminals to pivot within the housing.

25 In another embodiment, the terminals are each vertically grooved. The housing provides corresponding elongated vertical ribs or projections that fit into the grooves to prevent the element from bending and the terminals from inadvertently pivoting about a horizontal axis through the fuse housing. This groove/rib configuration cooperates with or replaces the staking in one embodiment. The grooves in one
30 embodiment are located on opposite sides of the terminals. This configuration also helps prevent the terminal portion of the fuse from pivoting about a vertical axis

through the body. The grooves/projections also help to prevent translational movement of the terminal portion within the fuse housing in multiple directions.

It should be appreciated however that the bent upper edges provide a more secure attachment mechanism than known staking processes and staking is not
5 required in the fuse of the present invention to properly fix the housing to the terminal portion of the fuse.

The terminal portion of the fuse in one embodiment is centered between the flat sides of the insulative housing. The centering mitigates the possibility that the housing will distort or melt upon opening of the fuse.

10 To the above described ends, in one embodiment, an automotive blade-type fuse is provided. The fuse includes a pair of metallic terminals separated by and in electrical communication with a fuse element. An insulative housing is provided that covers at least a portion of an inner edge of each of the terminals and exposes the outer edges of the terminals and at least a portion of the upper edges of the terminals. The
15 upper edges of the terminals are bent inward to crimp the housing between an intermediate portion of the terminals and the bent upper end edges.

In one embodiment, the terminals each define an aperture and the housing is staked at portions covering the apertures in the terminals. The bent upper edges can be located so as to provide probe points from which the integrity of the fuse element can
20 be tested.

The housing includes a top. The top defines notches that receive the bent upper edges. The top can extend outward from front and back faces of the housing to increase rigidity of the housing. Viewing the terminals and housing from the front, the top can also extend above the bent upper edges so as to provide protection against an
25 inadvertent electrical connection across the bent upper edges. At least one of the front and back faces of the housing includes a projection that increases the rigidity of the housing.

In another primary embodiment of the present invention, an automotive blade-type fuse manufacturing method is provided and includes: (i) forming a pair of
30 metallic terminals separated by and in electrical communication with a fuse element; (ii) covering at least a portion of the of an inner edge of each of the terminals with an insulative housing and exposing the outer edges of the terminals and at least a portion

of the upper edges of the terminals; and (iii) bending the upper edges of the terminals inward and crimping the housing between a body portion of the terminals and the bent upper end edges.

In one embodiment, the housing is staked to at least one the terminals. The bent upper edges provide probe points from which the integrity of the fuse element can be tested. The housing can be notched at locations receiving the bent upper edges and/or extended above the bent upper edges to provide protection against an inadvertent electrical connection across the bent upper edges.

It is therefore an advantage of the present invention to provide an improved fuse.

It is another advantage of the present invention to provide an improved method of making a fuse.

Moreover, it is an advantage of the present invention to provide a "low profile" type of fuse, in which the insulative housing is securely fastened to the metal portion without requiring staking.

It is a further advantage of the present invention to eliminate additional insulative material with respect to known "low profile" fuses.

Furthermore, it is an advantage of the present invention to provide an apparatus that secures the terminal portion of the fuse within the insulative housing in multiple translational directions and about multiple axes of rotation.

Still further, it is an advantage of the present invention to secure the terminal portion of the fuse within the insulative housing so that the terminal portion is at least substantially centered within the housing.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and the figures.

BRIEF DESCRIPTION OF THE FIGURES

Figs. 1 to 4 are perspective, top, front and side views, respectively, illustrating one embodiment of the conductive portion of the fuse of the present invention in an unbent condition.

Figs. 5 to 8 are perspective, top, front and side views, respectively, illustrating one embodiment of the insulative housing of the fuse of the present invention.

Figs. 9 to 12 are perspective, top, front and side views, respectively, illustrating an assembled fuse using the apparatuses of Figs. 1 to 8 of the present invention, wherein the legs of the terminal portion are now bent to provide a secure attachment.

Figs. 13 to 17 are front, top, bottom, side and perspective views, respectively, illustrating various views of another embodiment of the conductive portion, insulative housing and associated assembly of the fuse of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to Figs. 1 to 12, one embodiment of a fuse 10 of the present invention is illustrated. Fuse 10 includes a conductive or metal portion 20 and an insulative housing 50. Conductive or metal portion 20 can be made of any suitable conductive material, such as metal. In various embodiments, conductive portion 20 is made of copper, aluminum, zinc, nickel, tin, gold, silver and any alloys or combinations thereof. In alternative embodiments, the conductive portion 20 or sections thereof can be plated with one or more metal or conductive plating.

Insulative housing 50 is made of any suitable plastic or non-conductive material. For example, housing 50 can be made of any of the following materials: polycarbonate, polyester, polyethylene, polypropylene, polystyrene, polyvinylchloride, polyvinylidene chloride, acrylic, nylon, phenolic, polysulfone and any combination or derivative thereof. In one embodiment, conductive portion 20 is stamped, wire electrical discharge machining ("EDM") cut, laser cut or otherwise formed by any suitable metal forming process. Housing 50 in one embodiment is injection molded or extrusion molded.

Metal portion 20 includes a pair of terminals 22 and 24. Terminals 22 and 24 are sized and shaped appropriately to be mated to a pair of female terminals (not illustrated) that extend from a fuse block, for example, a fuse block of an automobile. While fuse 10 is illustrated as a male-type blade fuse, the teachings of the present invention are not limited to: (i) a male fuse or (ii) a blade-type fuse. The present invention instead applies to any fuse for which an insulative housing, such as housing 50, is coupled or fastened to a conductive portion, such as portion 20.

Terminal 22 includes an inner edge 26a, an outer edge 28a, an upper edge 30a (Figs. 9 to 12) and a lower edge 32a. Likewise, terminal 24 includes an inner edge

26b, outer edge 28b, an upper edge 30b (Figs. 9 to 12) and a lower edge 32b. As seen, upper edge members 30a and 30b are bent over housing 50 and remain exposed and uncovered. Upper edges 30a and 30b double as fastening devices and probe points for a user to detect the integrity of a fuse element 40 linking terminals 22 and 24
5 electrically.

Terminal 22 defines an upper aperture 34a and a lower aperture 36a. Terminal 24 defines an upper aperture 34b and a lower aperture 36b. Apertures 34a and 34b and 36a and 36b are provided near the inner edges 26a and 26b of terminals 22 and 24, respectively, for purposes discussed below. As illustrated below in connection with
10 Figs. 13 to 19, the terminals can define a myriad of different types of apertures, notches or grooves for various functional purposes.

Figs. 1 to 4 illustrate that metal portion 20 when in the flat defines or includes straight legs 38a and 38b. Those legs are bent over portions of housing 50 after housing 50 has been inserted onto metal portion 20. That bending or crimping process
15 secures conductive or terminal portion 20 to insulative housing 50.

As discussed above, conductive portion 20 includes a fuse element or fuse link 40 that connects terminals 22 and 24 electrically. Fuse element or link 40 is illustrated as having an inverted "U" shaped portion 42, in which the ends of the "U" are connected respectively to terminals 22 and 24 via conductive interfaces 44a and 44b.
20 Portion 42 of fuse link 40 alternatively has any desirable and functionally suitable shape, such as a "V"-shape, "M"-shape, "N"-shape, as well as others. As illustrated, link 40 can be thinned or contoured as needed to produce a fuse having desired electrical characteristics. In the illustrated embodiment, link 40 is coined, milled or otherwise machined on one surface or side, so that link 40 and conductive portion 20
25 are asymmetrical as seen best in Fig. 2. As discussed below, link 40 in an alternative embodiment is symmetrical with respect to the conductive portion, which may also be symmetrical.

Fuse element 40 can be made of the same or different type of material as terminals 22 and 24. Fuse element 40 and thus fuse 10 can be rated for any desirable
30 amperage. For automotive uses, for example, element 40 and fuse 10 can be rated for 1 amp to 80 amps. For uses other than automotive uses, fuse 10 and element 40 can have different amperage ratings as desired.

Insulative housing 50 includes a top 52 and a body 54. As illustrated, top 52 defines notches 56 and 58 that receive bent upper end edges 30a and 30b, respectively, of terminal portion 20. Legs edges 38a and 38b of Figs. 1 to 4 are crimped down on the surface of notches 56 and 58, trapping those surfaces and housing 50 between
5 upper end edges 30a and 30b and intermediate edges 46a and 46b of terminals 22 and 24. That mechanical crimping provides a very secure attachment between the metal portion 20 and the housing 50. The crimped attachment should eliminate problems with housing 50 becoming dislodged from conductive portion 20 when fuse link 40 opens due to an overcurrent condition. Further, the process of bending legs 38a and
10 38b over notches 56 and 58 is a relatively simple process that can be performed with standard equipment. The surfaces defining notches 56 and 58 can be radiussed as illustrated to facilitate the bending process.

In one preferred embodiment, the surface of top 52 extends vertically above the top of a portion of upper edges 30a and 30b. That configuration aids in preventing a
15 person from inadvertently creating an electrical path across upper edges 30a and 30b, for example, by laying a conductive instrument on top of fuse 10 or by pressing down on fuse 10 with one's finger. It should be appreciated however that upper end edges 30a and 30b remain exposed so that the edges can be used additionally as probes for determining the integrity of fuse 10.

20 While housing 50 covers at least a portion of the front and back surfaces of terminals 22 and 24 along inner edges 26a and 26b, housing 50 does not cover the front and rear surfaces of terminals 22 and 24 along the outer edges 28a and 28b and portions of the front and rear surfaces of terminals 22 and 24 at upper edges 30a and 30b. Because the housing 50 is securely attached to conductive portion 20 via upper
25 edges 30a and 30b, the amount of dielectric material used for covering the element 40 and securing housing 50 to portion 20 is reduced. A majority of the surface area of terminals 22 and 24 is exposed in the illustrated embodiment, including the outer edges thereof, enabling the fuse to be inserted primarily between mating terminals of the fuse block as opposed to above the mating terminals.

30 Terminals 22 and 24 extend slightly below housing 50 as illustrated. In alternative embodiments, terminals 22 and 24 may be flush with the bottom of housing 50 or reside slightly above the housing.

Body 54 (on both sides) includes or defines outwardly extending projections 60. Each projection 60 extends outwardly on one side of housing 50 from insulative flange sections 62a and 62b. Flange section 62a covers the front and rear faces of terminal 22 along the inner edge 26a of terminal 22. Likewise, flange 62b covers the inner portions of the front and rear faces of terminal 24.

Flanges 62a and 62b include staking areas 64a and 66a and 64b and 66b, respectively. Those staking areas are provided on both sides of housing 50 in one embodiment. The areas are cold staked or otherwise heated to a temperature sufficient to melt or deform the insulative or plastic material of housing 50. Insulative material (cold staked or heated) extends into apertures 34a, 36a, 34b and 36b of terminals 22 and 24, respectively. The cold or hot staked material or solidifies, cools and/or hardens and provides further mechanical attachment between terminal portion 20 and housing 50.

It should be appreciated that staking is not required and that bent upper end edges 30a and 30b sufficiently hold housing 50 and conductive portion 20 together. However, for further support and to prevent pivoting of housing at the lower portion of terminals 22 and 24, staking can be done in one or more places. The staking tends to prevent element 40, which is thinner and weaker than the terminals, from bending inadvertently. This prevents terminals 22 and 24 from shifting translationally and from pivoting inwardly or outwardly about axes extending perpendicularly from the broad side of terminal portion 20. The staking also helps to stabilize conductive portion 20 laterally (front to back) within housing 50 and about an axis extending through the top of the fuse.

Although not illustrated, housing 50 can include or define a tab at its bottom that extends across the opening shown defined by housing 50. That tab helps to collect any residue from the opening of fuse element 40 upon an overcurrent condition.

Referring now to Figs. 13 to 17, one preferred conductive portion 120 and associated housing 150 form fuse 100 of the present invention. Fuse 100 is similar in many respects to fuse 10. In particular, metal portion 120 includes a pair of terminals 122 and 124. Terminals 122 and 124 are sized and shaped appropriately to be mated to a pair of female terminals (not illustrated) that extend from a fuse block, for example, a fuse block of an automobile. While fuse 100 is illustrated as a male-type

blade fuse, the teachings of the present invention are not limited to: (i) a male fuse or (ii) a blade-type fuse. The present invention instead applies to any fuse for which an insulative housing, such as housing 150, is coupled or fastened to a conductive portion, such as portion 120.

5 Terminal 122 includes an inner edge 126a, an outer edge 128a, an upper edge 130a (Figs. 13 to 16) and a lower edge 132a. Likewise, terminal 124 includes an inner edge 126b, outer edge 128b, an upper edge 130b (Figs. 13 to 16) and a lower edge 132b. As seen, upper edge members 130a and 130b are bent over housing 150 and remain exposed and uncovered. Upper edges 130a and 130b double as fastening
10 devices and probe points for a user to detect the integrity of a fuse element 140 linking terminals 122 and 124 electrically.

Terminal 122 defines slot 134a. Terminal 124 defines slot 134b. Slots 134a and 134b are provided for staking purposes discussed below. The terminals can define a myriad of different types of apertures, notches or grooves for various functional
15 purposes.

Figs. 13 to 16 illustrate that metal portion 120 when in the flat defines or includes straight legs 138a and 138b. Those legs are bent over portions of housing 150 after housing 150 has been inserted onto metal portion 120. That bending or crimping process secures conductive or terminal portion 120 to insulative housing 150.

20 As discussed above, conductive portion 120 includes a fuse element or fuse link 140 that connects terminals 122 and 124 electrically. Fuse element or link 140 is illustrated as having an inverted "U"-shaped portion 142, in which the ends of the "U" are connected respectively to terminals 122 and 124 via conductive interfaces 144a and 144b. Portion 142 of fuse link 140 alternatively has any desirable and functionally
25 suitable shape, such as a "V"-shape, "M"-shape, "N"-shape, as well as others. As illustrated, link 140 can be thinned or contoured as needed to produce a fuse having desired electrical characteristics. In the illustrated embodiment, link 140 is coined, milled or otherwise machined on two surfaces or sides, so that link 140 and conductive portion 120 are symmetrical as seen best in Figs. 14 and 15. As discussed above, link
30 40 of fuse 10 in an alternative embodiment is asymmetrical with respect to conductive portion 20 (see Fig. 12).

Fuse element 140 can be made of the same or different type of material as terminals 122 and 124. Fuse element 140 and thus fuse 100 can be rated for any desirable amperage. For automotive uses, for example, element 140 and fuse 100 can be rated for 1 amp to 80 amps. For uses other than automotive uses, fuse 100 and
5 element 140 can have different amperage ratings as desired.

Insulative housing 150 includes a top 152 and a body 154. As illustrated, top 152 defines notches 156 and 158 that receive bent upper end edges 130a and 130b, respectively, of terminal portion 120. Legs 138a and 138b of Figs. 1 to 4 are crimped down on the surface of notches 156 and 158, trapping those surfaces and housing 150
10 between upper end edges 130a and 130b and intermediate edges 146a and 146b of terminals 122 and 124. That mechanical crimping provides a very secure attachment between the metal portion 120 and the housing 150. The crimped attachment should eliminate problems with housing 150 becoming dislodged from conductive portion 120 when fuse link 140 opens due to an overcurrent condition. Further, the process of
15 bending legs 138a and 138b over notches 156 and 158 is a relatively simple process that can be performed with standard equipment. The surfaces defining notches 156 and 158 can be radiussed as illustrated to facilitate the bending process.

In one preferred embodiment, the surface of top 152 extends vertically above the top of a portion of upper edges 130a and 130b. That configuration aids in
20 preventing a person from inadvertently creating an electrical path across upper edges 130a and 130b, for example, by laying a conductive instrument on top of fuse 100 or by pressing down on fuse 100 with one's finger. It should be appreciated however that upper end edges 130a and 130b remain exposed (front, back and top thereof) so that the edges can be used additionally as probes for determining the integrity of fuse 100.

25 While housing 150 covers at least a portion of the front and back surfaces of terminals 122 and 124 along inner edges 126a and 126b, housing 150 does not cover the front and rear surfaces of terminals 122 and 124 along the outer edges 128a and 128b and portions of the front and rear surfaces of terminals 122 and 124 at upper
30 edges 130a and 130b. Because the housing 150 is securely attached to conductive portion 120 via upper edges 130a and 130b, the amount of dielectric material used for covering element 140 and securing housing 150 to portion 120 is reduced. A majority of the surface area of terminals 122 and 124 is exposed in the illustrated embodiment,

including the outer edges thereof, enabling the fuse to be inserted primarily between mating terminals of the fuse block as opposed to being inserted above the mating terminals.

Terminals 122 and 124 extend slightly below housing 150 as illustrated. In
5 alternative embodiments, terminals 122 and 124 may be flush with the bottom of housing 150 or reside slightly above the housing.

Body 154 (on both sides) includes or defines outwardly extending projections 160. Projections 160 extend outward on both sides of housing 150 from insulative flange sections 162a and 162b. Flange section 162a covers the front and rear faces of
10 terminal 122 along the inner edge 126a of terminal 122. Likewise, flange 162b covers the inner portions of the front and rear faces of terminal 124.

Flanges 162a and 162b include staking areas 164a and 164b, respectively. Those staking areas are provided on both sides of housing 150 in one embodiment. The areas are cold staked or otherwise heated to a temperature sufficient to melt or
15 deform the insulative or plastic material of housing 150. Insulative material (cold staked or heated) extends into slots 134a, 134b of terminals 122 and 124, respectively. The cold or hot staked material solidifies, cools and/or hardens and provides further mechanical attachment between terminal portion 120 and housing 150.

It should be appreciated that staking is not required and that bent upper end
20 edges 130a and 130b sufficiently hold housing 150 and conductive portion 120 together. However, for further support and to prevent pivoting of housing at the lower portion of terminals 122 and 124, staking can be done in one or more places. The staking tends to prevent element 140, which is thinner and weaker than the terminals, from bending inadvertently. This prevents terminals 122 and 124 from pivoting
25 inwardly and outwardly about axes extending perpendicularly from the broad side of terminal portion 120. The staking also helps to stabilize conductive portion 120 laterally (front to back) within housing 150.

In the illustrated embodiment, terminals 122 and 124 of terminal portion 120 include or define grooves 136a and 136b, respectively. Grooves 136a and 136b can
30 extend, e.g., half way into terminals. Grooves 136a and 136b in the illustrated embodiment are provided on opposing sides of terminal portion 120. Grooves 136a

and 136b may be milled, stamped or otherwise formed into terminals 122 and 124 via any suitable method.

Housing 150 includes or defines mating inward projections or ribs 166a and 166b (projection 166a not seen in the perspective view of Fig. 17 but is formed in flange section 162a on back side of fuse 100). Projections 166a and 166b extend into grooves 136a and 136b. The interlocking relationship prevents terminal portion 120 from rotating within housing 150 along an axis through the front and back of fuse 100. Locating the interlocking projections/grooves on either side of fuse 100 also prevents terminal portion 120 from rotating within housing 150 along an axis through the top and bottom of fuse 100. In addition to rotational restraint, the grooves and projections constrain movement of the terminals within the housing translationally back-and-forth and side-to-side. The interlocking relationship of the projections/grooves is believed to provide a robust fuse 100. Terminals 122 and 124 will tend not to pivot and thus element 140 will tend not to bend.

Grooves 136a, 136b and projections 166a, 166b are at least substantially rectangular as illustrated, rounded, U-shaped, V-shaped, T-shaped, slotted or otherwise have any suitable interlocking shape. The interface between grooves and slots may be a press-fit interface or slightly less than press-fit as desired. A series of smaller grooves (e.g., rectangular or ovular) and smaller mating projections (e.g., rectangular or ovular) may be provided instead of one longer groove/projection interface. The grooves and projections can be provided on opposing sides of terminal portion 120 as illustrated, the same side of terminal portion 120 or on both sides of all terminals. In one preferred embodiment, at least two groove/projection interfaces are provided although a single interface would still be beneficial.

While grooves 136a, 136b and projections 166a, 166b are preferred in one embodiment, it is also possible that terminals 122 and 124 are provided with projections and housing 150 includes outwardly facing mating projections. For example, a portion of the inner edges 126a and 126b of terminals 122 and 124 could be bent one direction or the other at least substantially perpendicularly from terminals 122 and 124. Projections 160 extending outwardly from body 154 would then fit over and, e.g., provide an interference fit with the bent tabs.

Although staking is not needed, slots 134a and 134b coupled with stakes 164a and 164b provide further rigidity and robustness. Terminal portion 120 is centered within body 150. Element 140 is centered between terminals 122 and 124. This configuration evens the clearance between element 140 and housing 150, which
5 reduces the possibility that element 140 will deform or melt either side of body portion 154 of housing 150 upon opening. Outwardly extending projections 160 also help in this regard.

Although not illustrated, housing 150 can include or define a tab at its bottom that extends across the opening shown defined by housing 150. That tab helps to
10 collect any residue from the opening of fuse element 140 upon an overcurrent condition.

The present invention as described herein includes apparatuses 10, 100 as well as a method of manufacturing apparatuses 10, 100. As described, the method includes forming the individual pieces 20, 120 and 50, 150 and sliding housing 50, 150 over
15 conductive portion 20, 120. The method then includes bending upper edges 30a, 130a and 30b, 130b inward to clamp the surface of notches 56, 156 and 58, 158 between upper edges 30a, 130a and 30b, 130b and intermediate surfaces 46a, 146a and 46b, 146b. The method can further include staking housing 150 at certain places coinciding with apertures or deformations formed in terminals 122 and 124.

20 Further, the method can include structuring housing 50, 150 so that the surface of top 52, 152 extends above bent upper end edges 30a, 130a and 30b, 130b to mitigate the risk of inadvertent arcing between terminals 22, 122 and 24, 124. Moreover, the method includes locating and exposing bent upper edges 30a, 130a and 30b, 130b so that the edges double as probe points for testing the integrity of the fuse.

25 It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present invention and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended
30 claims.

CLAIMS

The invention is claimed as follows:

1. An automotive blade-type fuse comprising:
5 a plurality of metallic terminals separated by and in electrical communication with a fuse element;
an insulative housing covering at least a portion of the of an inner edge of each of the terminals and exposing the outer edges of the terminals and at least a portion of the upper edges of the terminals; and
10 wherein the upper edges of the terminals are bent inward to crimp the housing between a body portion of the terminals and the bent upper end edges.
2. The automotive blade-type fuse of Claim 1, wherein at least one of the terminals defines at least one aperture and the housing is staked at a portion covering
15 the at least one aperture.
3. The automotive blade-type fuse of Claim 1, wherein the bent upper edges are located so as to provide probe points from which the integrity of the fuse element can be tested.
20
4. The automotive blade-type fuse of Claim 1, wherein the housing includes a top, and wherein the top defines notches to receive the bent upper edges.
5. The automotive blade-type fuse of Claim 4, wherein the top extends outward
25 from front and back faces of the housing to increase rigidity of the housing.
6. The automotive blade-type fuse of Claim 4, wherein viewing the terminals and housing from the front, the top extends above the bent upper edges so as to provide protection against an inadvertent electrical connection across the bent upper edges.
30
7. The automotive blade-type fuse of Claim 1, wherein at least one of the front and back faces of the housing includes a projection to increase rigidity of the housing.

8. An automotive blade-type fuse comprising:
a plurality of metallic terminals separated by and in electrical communication with a fuse element, the terminals each having a groove;
- 5 an insulative housing covering at least a portion of the of an inner edge of each of the terminals and exposing the outer edges of the terminals, the housing defining projections that extend into the grooves of the terminals; and
wherein the upper edges of the terminals are bent inward to crimp the housing between a body portion of the terminals and the bent upper end edges.
- 10
9. The automotive blade-type fuse of Claim 8, wherein the insulative housing exposes at least a portion of the upper edges of the terminals.
10. The automotive blade-type fuse of Claim 8, wherein one of the terminals
15 defines its groove on a first side of the terminals and another one of the terminals defines its groove on an opposing second side of the terminals.
11. The automotive blade-type fuse of Claim 10, wherein the housing defines a
20 first projection extending into the groove on the first side of the terminals and a second projection extending into the groove on the second side of the terminals.
12. The automotive blade-type fuse of Claim 8, wherein the grooves and
projections are at least one of: (i) at least substantially rectangular; (ii) at least
25 substantially rounded; (iii) at least substantially U-shaped; (iv) least substantially V-shaped; (v) at least substantially T-shaped; (vi) slotted; (vii) press-fit together; (viii) provided on each side of each terminal; and (ix) provided on the same side of two terminals.
13. The automotive blade-type fuse of Claim 8, wherein at least one of the
30 terminals includes a series of elongated slots and the housing includes a series of elongated mating projections.

14. The automotive blade-type fuse of Claim 8, wherein at least one of the terminals defines an aperture and the housing is staked at a portion covering the at least one aperture.
- 5 15. The automotive blade-type fuse of Claim 8, wherein the grooves and projections constrain movement of the terminals within the housing (i) rotationally about at least one axis and (ii) translationally in at least one direction.
16. An automotive blade-type fuse manufacturing method comprising the steps of:
10 forming a pair of metallic terminals separated by and in electrical communication with a fuse element;
covering at least a portion of the of an inner edge of each of the terminals with an insulative housing and exposing the outer edges of the terminals and at least a portion of the upper edges of the terminals; and
15 bending the upper edges of the terminals inward and crimping the housing between a body portion of the terminals and the bent upper end edges.
17. The automotive blade-type fuse manufacturing method of Claim 16, which includes the step of staking the housing to at least one the terminals.
20
18. The automotive blade-type fuse manufacturing method of Claim 16, which includes bending the upper edges so as to provide probe points from which the integrity of the fuse element can be tested.
- 25 19. The automotive blade-type fuse manufacturing method of Claim 16, which includes notching the housing at locations receiving the bent upper edges.
20. The automotive blade-type fuse manufacturing method of Claim 16, which includes extending the housing above the bent upper edges to provide protection
30 against an inadvertent electrical connection across the bent upper edges

FIG. 1

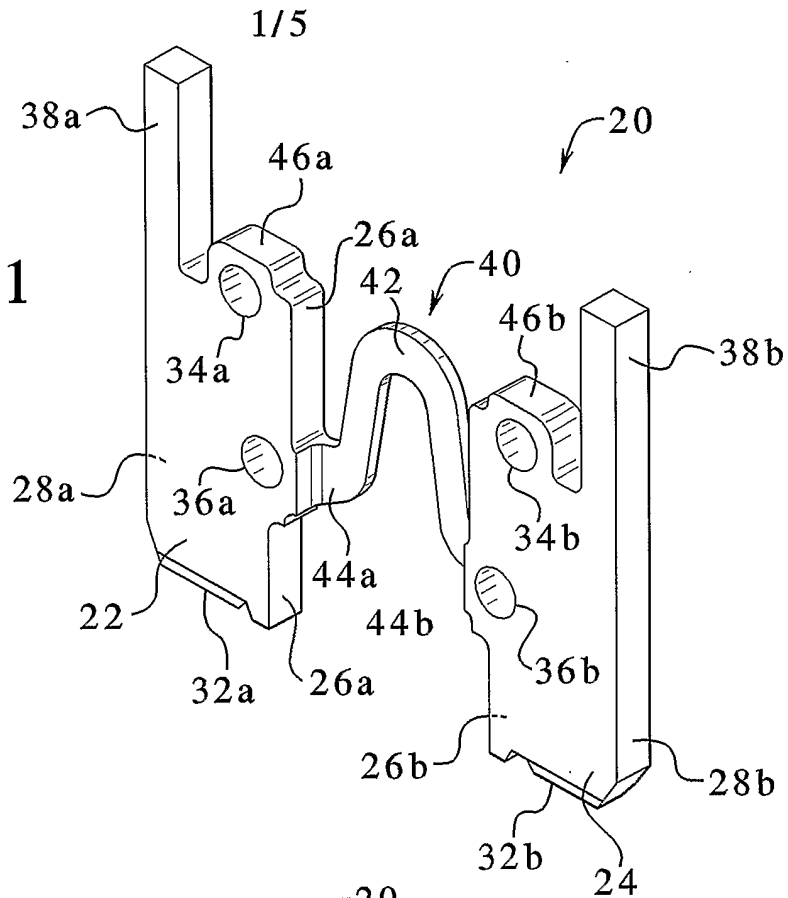


FIG. 2

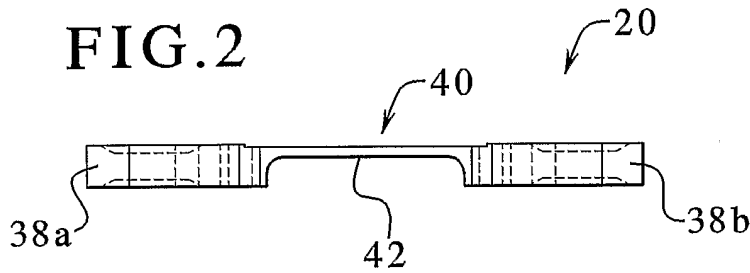


FIG. 3

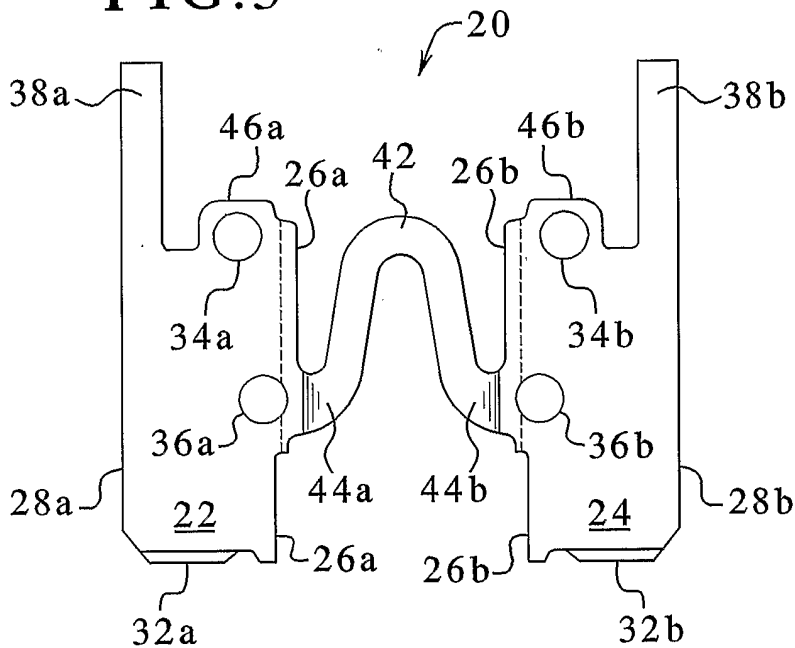


FIG. 4

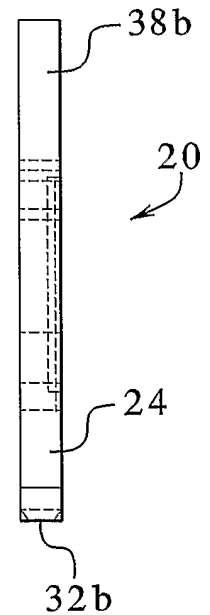


FIG. 5

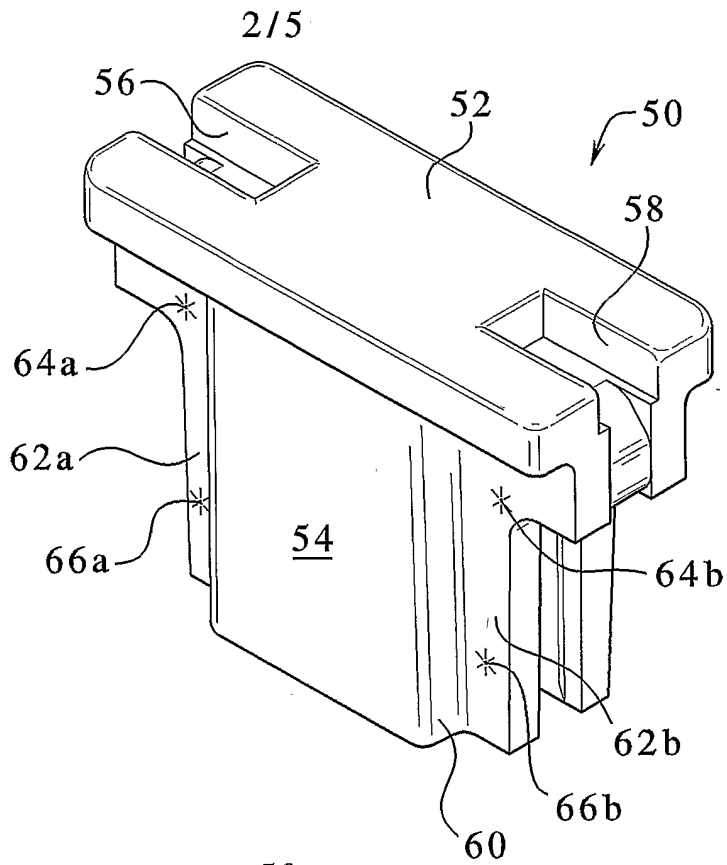


FIG. 6

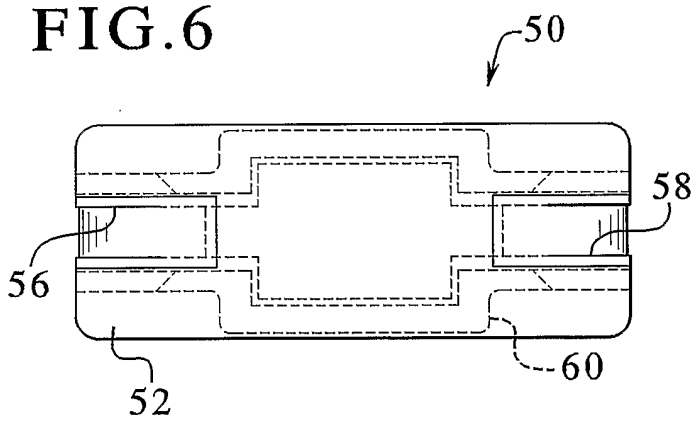


FIG. 7

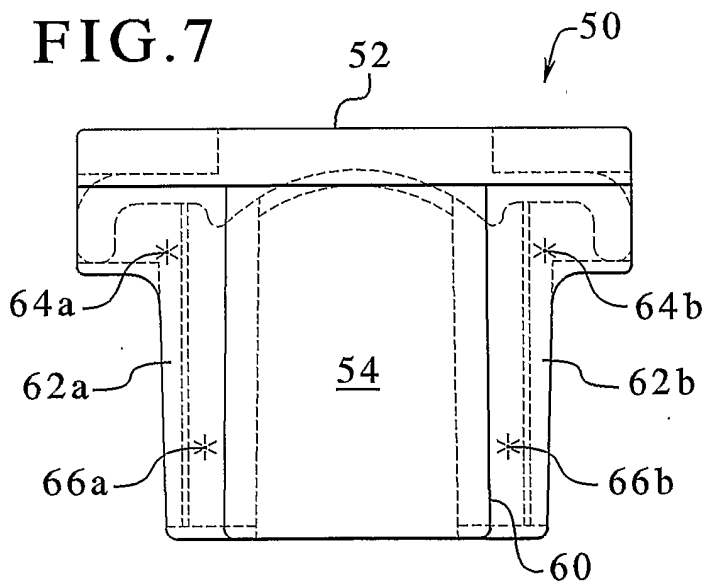
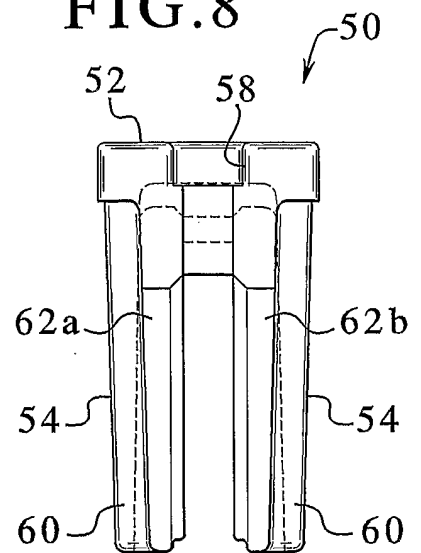


FIG. 8



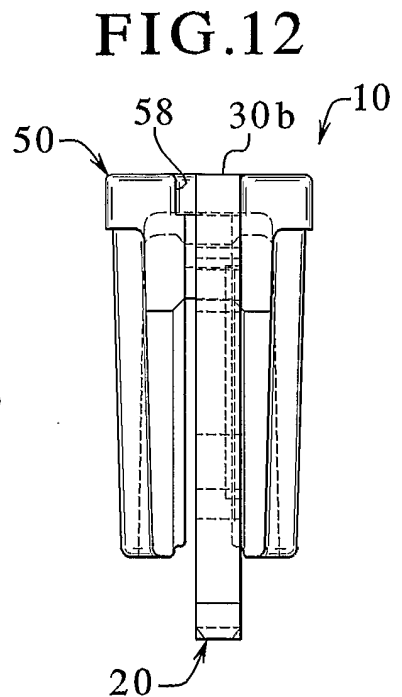
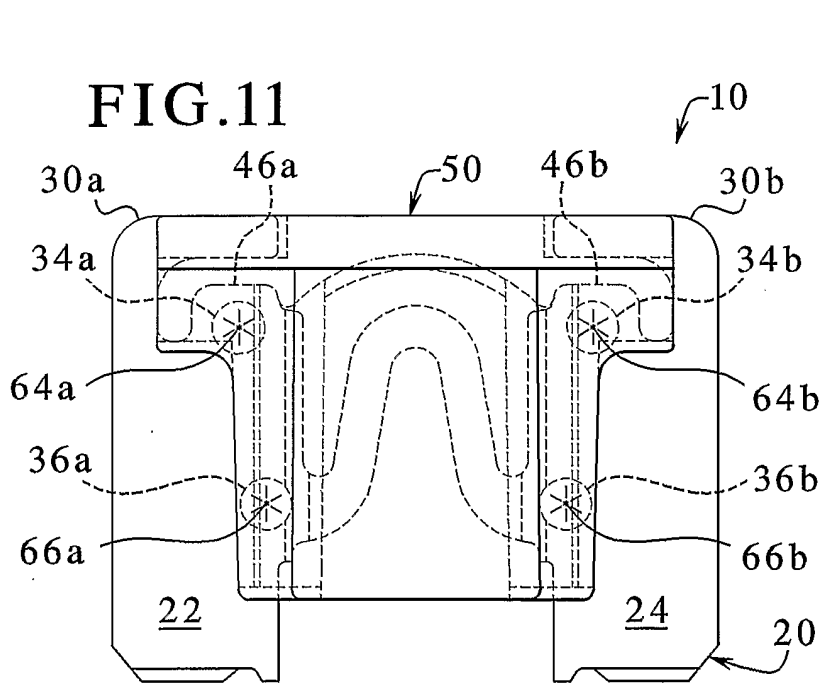
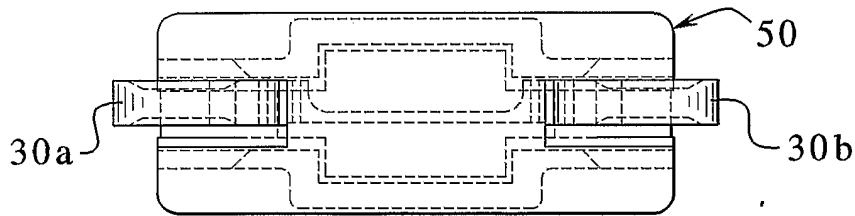
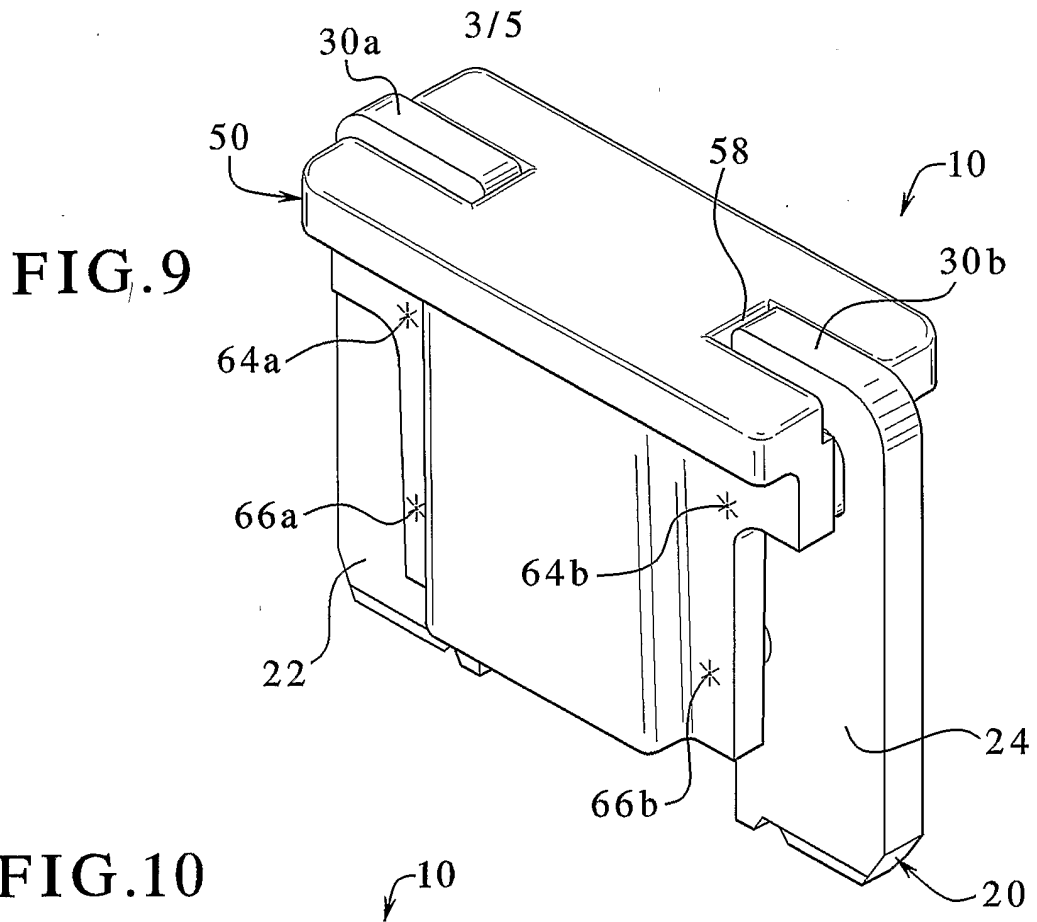


FIG.13

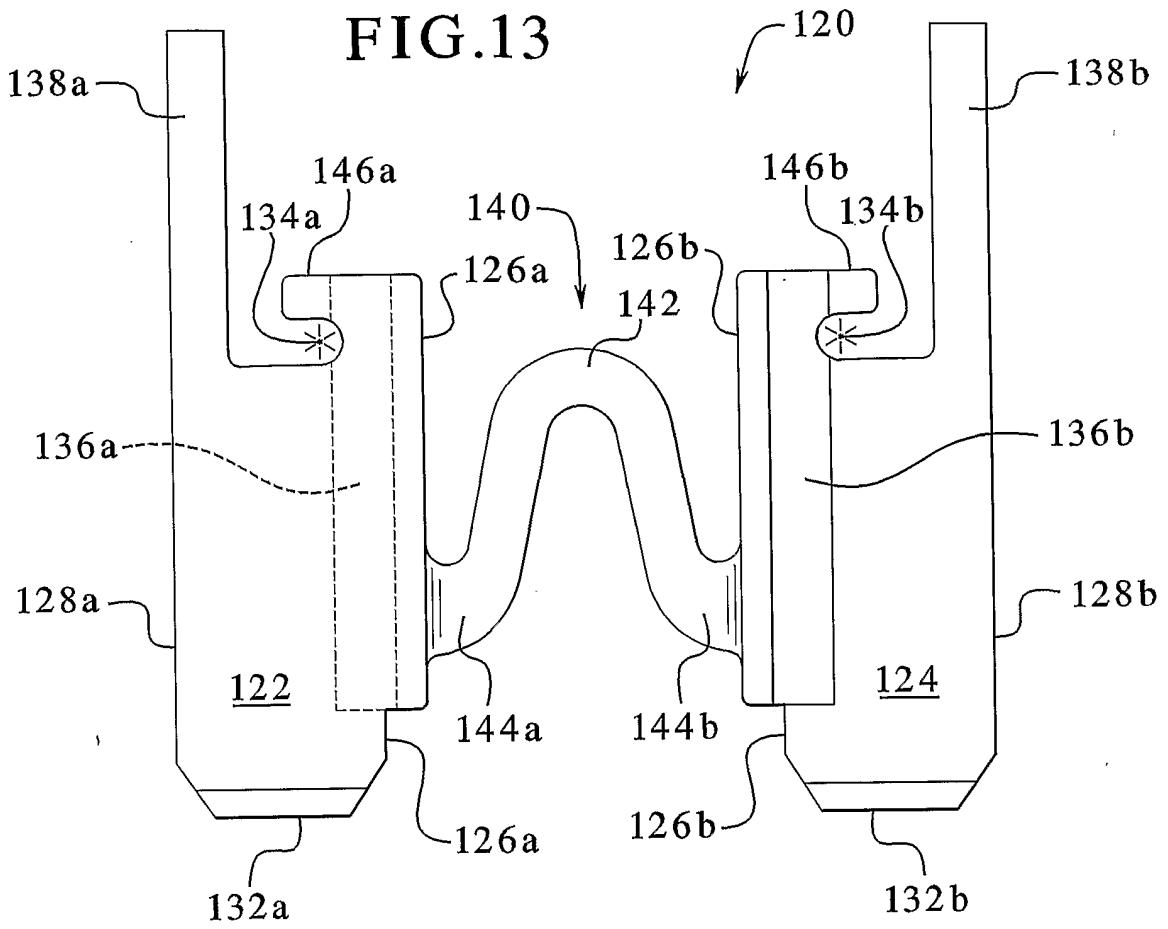


FIG.14

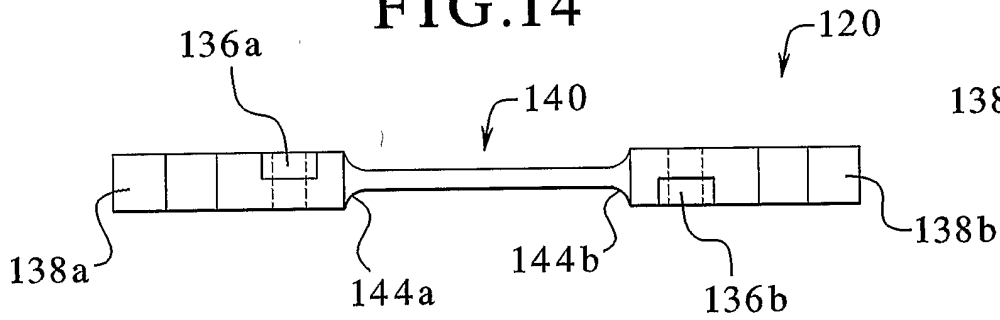


FIG.15

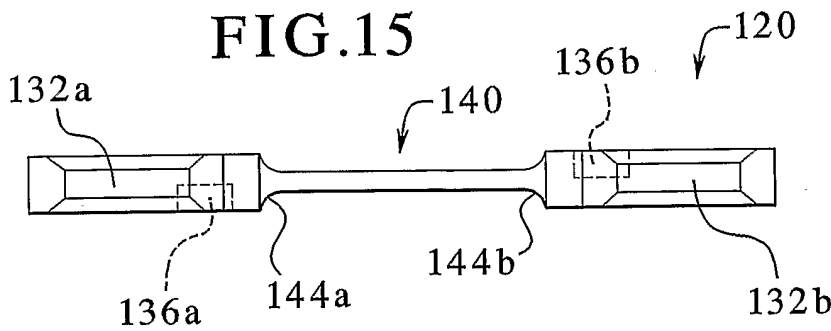


FIG.16

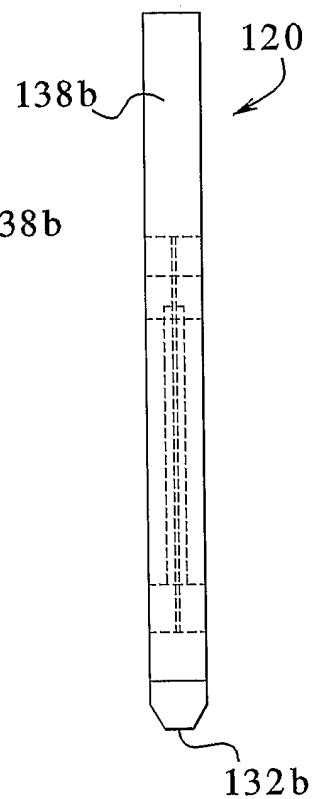


FIG.17

