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(54) **Igniter for electric ignition systems.**

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Description

The present invention relates to an igniter for electric ignition systems used for electric detonators and automotive air bag gas generators.

The conventional type of igniter for electric ignition systems used for the above-mentioned application is made up of two lead wires 11, with their ends functioning as a pair of terminals 13, and a heating element 15 disposed between the paired terminals 13, as shown in Fig. 8 of the accompanying drawings. The heating element 15 is a fine platinum wire or nichrome wire having a high electric resistance, and it is bonded and connected to the terminals 13 with solder or electrically conductive adhesive 17. When turned on, this type of igniter for electric ignition systems 18 permits an electric current to flow through the high-resistance heating element 15 via the conductors 11 of the lead wires and the terminals 13, generating heat in the heating element 15 as the result of conversion from electric energy into thermal energy.

The above-mentioned conventional type of igniter for electric ignition systems 18 may be used for an electric detonator, i.e. an electric ignition system as shown in Fig. 9 of the accompanying drawings, in which the reference numeral 19 denotes two lead wires to supply an electric current. Between the ends of the conductors 11 of the lead wires 19 is disposed the igniter for electric ignition systems 18. Around the igniter for electric ignition systems 18 is disposed the priming charge 21. On the priming charge 21 is disposed the blasting powder 23. The lead wires 19 and the priming charge 21 are surrounded by the insulation resin 25 and 26, respectively, which prevent the priming charge 21 from being ignited by static electricity. When triggered, the electric detonator mentioned above permits an electric current to flow through the lead wires 19 and the igniter for electric ignition systems 18. The electric current generates thermal energy which ignites the priming charge 21 which, in turn, explodes the blasting powder 23.

In the meantime, as the speed of automobiles increases, the development of the safety air bag is going on for the reduction of shocks to the driver in the event of an accident. The safety air bag is inflated by a pyrotechnic gas generator. The igniter 18 for the gas generator is required to have a high reliability so that it never works when the car is in the normal state but generates a gas instantaneously for the reduction of shocks to the driver in the event of an accident. In the conventional safety air bag, this reliability is achieved by providing the igniter 18 with two or three heating elements 15 arranged in parallel so that ignition takes place certainly even in the case where one of the heating elements 15 is disconnected from the terminal 13.

The conventional igniter 18 mentioned above has a disadvantage that there is no way to confirm that the fine heating element 15 is firmly connected to the terminal 13 of the lead wire 19 because the connection is made with adhesive or solder. It has another disadvantage that there is a possibility that the heating element 15 is disconnected from the terminal 13 while the air bag is left unused for a long period of time in an environment where there are considerable temperature changes, vibrations and shocks. With the heating element disconnected, the igniter does not work.

For the conventional igniter 18 to be highly reliable it is necessary that the igniter 18 be provided with two or three heating elements arranged in parallel. This creates difficulties of making the fine heating elements uniform in resistance and igniting performance.

From DE-A-36 06 364 an igniter is known comprising a heat element which has a rectangular shape when presented in a top plan view. The cross-section of the heating element is constant over the whole length of the element connecting the terminals. AD igniter according to the preamble of claim 1 is known from US-A-3 420 174 and comprises an electric heating element deposited on the surface of a heat sink, said heat sink being so arranged as to have a good thermal contact with all parts of the heating element, and electrical leads which conduct electric current to the heating element in the form of a thin film bridge. The leads are moulded or cemented into the heat sink. The ends of the two leads are made flush with the surface of the heat sink so that the thin film bridge may be deposited on the heat sink surface and may also make electrical contact with the leads.

It is an object of the invention to provide an igniter which may be easier manufactured and which permits a more stable detonation.

This object is achieved by an igniter comprising the features of claim 1.

The shape of the igniter of the present invention is made under the necessity of securing reliability. The shape of the heating part according to the invention permits a smaller mass of the heating element and an efficient generation of thermal energy.

Further embodiments of the invention are mentioned in the subclaims.

According to one embodiment of the present invention the heating element is covered with a protective coating film made of an inorganic material to ensure good heat conduction and to maintain the initial performance over a long period of time.

Preferred examples of the present invention are described in connection with the following drawings.

Fig. 1 is a plan view showing the igniter for electric ignition systems in one example of the present invention.

Fig. 2 is a longitudinal sectional view taken along the line II-II in Fig. 1.

Fig. 3 is a longitudinal sectional view showing the igniter of the present invention applied to the gas generating system to inflate an air bag.

Fig. 4 is a perspective view showing the plug proper shown in Fig. 3.

Fig. 5 is a plan view showing the heating element as shown in Fig. 3, with the protective coating film formed thereon.

Fig. 6 is a sectional view taken along the line VI-VI in Fig. 5.

Fig. 7 is a graph showing the relationship between the thickness of the protective coating film and the ignition time.

Fig. 8 is a perspective view showing a conventional igniter.

Fig. 9 is a longitudinal sectional view showing a conventional igniter applied to an electric detonator.

Fig. 1 is a plan view showing one embodiment of the igniter for electric ignition systems pertaining to the present invention. In Fig. 1, the reference numeral 31 denotes a rectangular thin insulating board, about 0.6 mm thick, made of ceramics. This thin insulating board may be replaced by an insulation layer formed on a glass plate or metal plate.

On the thin insulating board 31 are disposed a pair of terminals 33 at a certain distance apart, and between the paired terminals 33 are disposed two heating elements 35. The terminals 33 and the heating elements 35 are integrally made of metal thin film.

Fig. 2 is a longitudinal sectional view of the igniter 36 taken along the line II-II in Fig. 1. There are shown the thin insulating board 31 and the terminals 33 and heating elements 35 of nichrome, tantalum nitride, or other metal thin film formed thereon. Incidentally, the terminals 33 and heating elements 35 may be of single-layered structure or multiple-layered structure 37,39.

When triggered, the igniter 36 constructed as mentioned above permits an electric current to flow through the terminals 33 and heating elements 35, generating heat in the heating elements 35.

The igniter for electric ignition systems mentioned above is produced in the following manner. At first, the thin insulating board 31 of ceramics is entirely coated with metal thin film, 500 to 5000 Å thick, by the sputtering method or vacuum deposition method. The metal thin film is subjected to photo-etching to remove the unnecessary part indicated by the chain line in Fig. 2. Thus the terminals 33 and heating elements 35 of metal thin film are integrally formed as shown in Fig. 1.

The igniter for electric ignition systems 36 constructed as mentioned above differs from the conventional one in that it is not necessary to bond the fine heating element 15 to the terminals 13 of lead wires with solder or electrically conductive adhesive as shown in Fig. 8. According to this invention, the terminals 33 and heating elements 35 are integrally formed on the thin insulating board 31. Therefore, the heating element 35 works certainly to generate heat even in a severe environment. This leads to the reliability of the igniter for electric ignition systems 36.

According to the deposition and etching processes, it is possible to form the terminals 33 and heating elements 35 in an extremely small size, and it is also possible to arrange fine heating elements 35 in parallel. Thus, this manufacturing process permits the easy production of the extremely small, highly reliable igniter for electric ignition systems 36.

Fig. 3 is a longitudinal sectional view of the igniter for electric ignition systems pertaining to the present invention which is applied to the air bag gas generator. The reference numeral 41 indicates the lead wire for an electric current.

The lead wire 41 is made up of the conductor 43, which is a tin-plated soft copper wire, and the covering 44 of crosslinked polyethylene. The end of the conductor 43 of the lead wire 41 is connected to the solderless terminal 47 of oxygene-free copper having the projecting part 45.

The solderless terminal 47 and the lead wire 41 are fixed to the plug proper 49 made of insulating resin such as polyethylene, polyvinyl chloride, and Ryton. The plug proper 49 is composed of two split parts as shown in Fig. 4. The part 51 to hold the solderless terminal has the projection 55 for pressing, and the part 53 to hold the lead wire has the projection 56 for pressing. When the two parts of the plug proper 49 are joined together, the projection 55 presses the projecting part 45 of the solderless terminal 47 in place and the projection 56 presses the lead wire 41 in place.

To facilitate the joining of the two halves of the plug proper 49, one half is provided with the semicylindrical fitting piece 57 and the other half, the hole (not shown) to receive the fitting piece 57. In addition, to facilitate the joining of the two halves of the plug proper 49 by ultrasonics, each half is provided the V-shaped rib 58 on one side thereof.

The upper part of the joined plug proper 49 is provided with the fitting cap 59 made of an insulating resin such as polyethylene, polyvinyl chloride, and Ryton. The plug assembly composed of the plug proper 49 and the cap 59 is protected by the plug case 61 made of aluminum, iron, or stainless steel.

At the center 63 of the plug assembly is disposed the above-mentioned igniter 36. On the thin insulating board 31 of the igniter 36 are integrally formed the terminal 33 and heating element 35 by deposition. The terminal 33 is fixed to the center 63 of the plug assembly by bending the end of the projecting piece 45 of the solderless terminal 47. The end of the projecting piece 45 is bonded to the terminal 33 with solder 65. The igniter 36 is firmly bonded to the center 63 of the plug with an epoxy adhesive.

The top of the heating element 35 is covered with the protective coating film 67, about 3 μm thick, made of inorganic thin film such as silicon oxide and silicon nitride, as shown in Figs. 5 and 6. The protective coating film 67 of desired shape as shown in Fig. 5 is formed by deposition through plasma reaction or the like and then dry etching with a gas. The protective film 67 controls the ignition time according to its thickness. Experimental results indicate that the thicker the protective coating 67, the longer the ignition time as shown in Fig. 7.

The upper part of the plug proper 49 is filled with the priming charge 69 such as tricinate, lead rhodanide and potassium chlorate, diazonitrophenol, and barium styphnate. In other words, the priming charge 69 is on the protective coating film 67.

The igniter 36 constructed as mentioned above is installed in the ignition system for the air bag gas generator. When triggered, the igniter permits an electric current to flow through the conductor 43 of the lead wire 41, the solderless terminal 47, the terminal 33, and the heating element 35 having a smaller surface area. The electric current generates heat in the heating element 35. The heat ignites the priming charge 69 placed on the heating element 35, and the priming charge 69 melts the top of the cap 59 and ignites the blasting powder (not shown). The blasting powder generates a gas to inflate the air bag instantaneously.

The air bag ignition system constructed as mentioned above has many advantages as follows: The cap 59 fitting to the plug proper 49 keeps the priming charge 69 in the plug proper 49 and prevents spark discharge which is otherwise induced between the solderless terminal 47 and the plug case 61 by static electricity. The lead wire 41 and the solderless terminal 47 are protected from being pulled out or bent, because the lead wire 41 is pressed in place by the pressing projection 56 formed in the lead wire holder 53 and the projecting piece 45 of the solderless terminal 47 is pressed in place by the pressing projection 55 formed in the solderless terminal holder 51. The protective coating film 67 separates the heating element 35 from the priming charge 69, thereby protecting the heating element 35 from corrosion, breakage, and change in resistance which would otherwise occur when the priming charge 69 deteriorates. It is possible to properly change the thickness of the protective coating film 67, the surface area and material of the heating element 35, and the kind of the priming charge 69 according to the desired performance of the igniter 36. This contributes to the high safety and reliability even in a severe environment. The igniter 36 is fixed by bending the end of the projecting piece 45 of the solderless terminal 47 and the projecting piece 45 is fixed to the terminal 33 on the thin insulating board 31 with solder. This connecting method is easier and certainer than the conventional direct connecting method, and contributes to high safety and reliability even in a severe environment.

In the above-mentioned example, the lead wire 41 is connected to the igniter 36 through the solderless terminal 47. Alternatively, the conductor 43 of the lead wire 41 may be connected directly to the terminal 33 of the igniter 36 without the solderless terminal 47.

It goes without saying that the igniter for electric ignition systems pertaining to the present invention may be used for electric detonators and firearms as well as the gas generating system to inflate an air bag.

The igniter for electric ignition systems pertaining to the present invention has the heating element which is narrower than the part adjoining the terminal 33 so that the heating element generates a prescribed amount of heat. The number of the heating elements may be one or two or more according to the object, although it is two in the above-mentioned example. The heating element as shown in Fig. 1 is used for the ignition system in which the heating element is not subject to peeling and corrosion, and the heating element as shown in Fig. 5 is used for the ignition system in which the heating element is subject to peeling and corrosion.

As mentioned above, the igniter of the present invention is made up of integrally formed terminals and heating elements of metal thin film. Therefore, it maintains its stable ignition performance, high safety, and high reliability over a long period of time even in a severe environment.

Claims

1. An igniter for electric ignition systems, comprising

a pair of terminals (33) totally of metal thin film formed and disposed a certain distance apart and

at least one heating element (35) of metal thin film which integrally connects said terminals

(33) to each other and which has such a shape that the middle part is narrower than the part adjoining each terminal (33),
characterized in that
said pair of terminals (33) is
- completely disposed on the surface of a thin insulating board (31); and
- fixed to the center (63) of a plug assembly by bending the end of a projecting piece (45) of a solderless terminal (47) and bonding said end to the terminal (33) with solder (65).

2. An igniter as claimed in claim 1, wherein said metal thin film is formed on a thin insulating board (31) by the sputtering method, vacuum deposition method, or the like.

3. An igniter as claimed in claim 1 or claim 2, wherein said thin insulating board (31) is a ceramic board, a glass board, or a metal plate having an insulation layer formed on the surface thereof.

4. An igniter as claimed in any of claims 1 to 3, wherein said heating element (35) is covered with a protective coating film (67) of inorganic thin film.

5. An igniter as claimed in claim 4, wherein said protective coating film (67) is formed on the thin insulating board (31) including the heating element (35) by the plasma reaction method.

6. An igniter as claimed in claim 4 or 5, wherein the protective coating film (67) is made of silicon oxide or silicon nitride (Si_3N_4).

Patentansprüche

1. Zündelement für elektrische Zündsysteme, mit zwei Polen (33), die vollständig aus einem dünnen Metallüberzug gebildet und in einem bestimmten Abstand voneinander angeordnet sind, und
mit wenigstens einem Heizelement (35) aus einem dünnen Metallüberzug, das die genannten Pole (33) zur Bildung einer Einheit verbindet und so geformt ist, daß der Mittelteil schmaler als der jeden Pol (33) verbindende Teil ist,
dadurch gekennzeichnet, daß
die zwei Pole (33)
- vollständig auf der Oberfläche einer dünnen Isolierplatte (31) angeordnet sind; und
- an der Mitte (63) einer Steckeranordnung dadurch befestigt sind, daß das Ende eines vorstehenden Stücks (45) eines lötfreien Pols (47) umgebogen und mit dem Pol (33) mittels Lötmittel (65) verbunden ist.

2. Zündelement nach Anspruch 1, dadurch **gekennzeichnet**, daß der dünne Metallüberzug auf einer dünnen Isolierplatte (31) durch Zerstäuben, Vakuumbeschichten o. dgl. ausgebildet ist.

3. Zündelement nach Anspruch 1 oder 2, dadurch **gekennzeichnet**, daß die dünne Isolierplatte (31) eine Keramikplatte, Glasplatte oder eine Metallplatte mit einer auf der Oberfläche vorhandenen Isolierschicht ist.

4. Zündelement nach einem der Ansprüche 1 bis 3, dadurch **gekennzeichnet,** daß das Heizelement (35) mit einer Schutzschicht (67) aus einem anorganischen dünnen Film bedeckt ist.

5. Zündelement nach Anspruch 4, dadurch **gekennzeichnet,** daß die Schutzschicht (67) auf der dünnen isolierplatte (31) einschließlich des Heizelementes (35) mittels des Plasma-Reaktionsverfahrens ausgebildet worden ist.

6. Zündelement nach Anspruch 4 oder 5, dadurch **gekennzeichnet,** daß die Schutzschicht (67) aus Siliziumoxyd oder Siliziumnitrid (Si_3N_4) besteht.

Revendications

1. Allumeur pour système d'allumage électrique comportant :
- deux bornes (33) formées intégralement par un film métallique mince et disposées à une certaine distance l'une de l'autre ; et
- au moins un élément chauffant (35) en film métallique mince qui raccorde lesdites bornes (33) l'une à l'autre et dont ils font partie intégrante, et qui présente une forme telle que sa partie centrale est plus étroite que les parties adjacentes à chacune des bornes (33),

caractérisé en ce que lesdites bornes (33) sont :
- placées en totalité sur la surface d' une plaque isolante mince (31) ; et
- fixées au centre (63) d'un ensemble de bougie en recourbant l'extremité d'une partie saillante (45) d'une borne sans soudure (47) et en reliant ladite extrémité à la borne (33) avec la soudure (65).

2. Allumeur suivant la revendication 1, caractérisé en ce que ledit film métallique mince est formé sur une plaque isolante mince (31) par projection, dépôt sous vide ou analogue.

3. Allumeur suivant l'une quelconque des revendications 1 ou 2, caractérisé en ce que ladite plaque isolante mince (31) à est une plaque en céramique, une plaque de verre ou une plaque métallique portant en surface une couche isolante.

4. Allumeur suivant l'une quelconque des revendications 1 à 3, caractérisé en ce que ledit élément chauffant (35) est recouvert d'un film protecteur (67) réalisé en une matière inorganique mince.

5. Allumeur suivant la revendication 4, caractérisé en ce que ledit film de revêtement protecteur (67) est formé sur la plaque isolante mince (31) incluant l'élément chauffant (35) par la méthode de réaction plasma.

6. Allumeur suivant l'une quelconque des revendications 4 ou 5, caractérisé en ce que le film de revêtement protecteur (67) est réalisé en oxyde de silicone ou en nitrure de silicone (Si_3N_4).

FIG.1

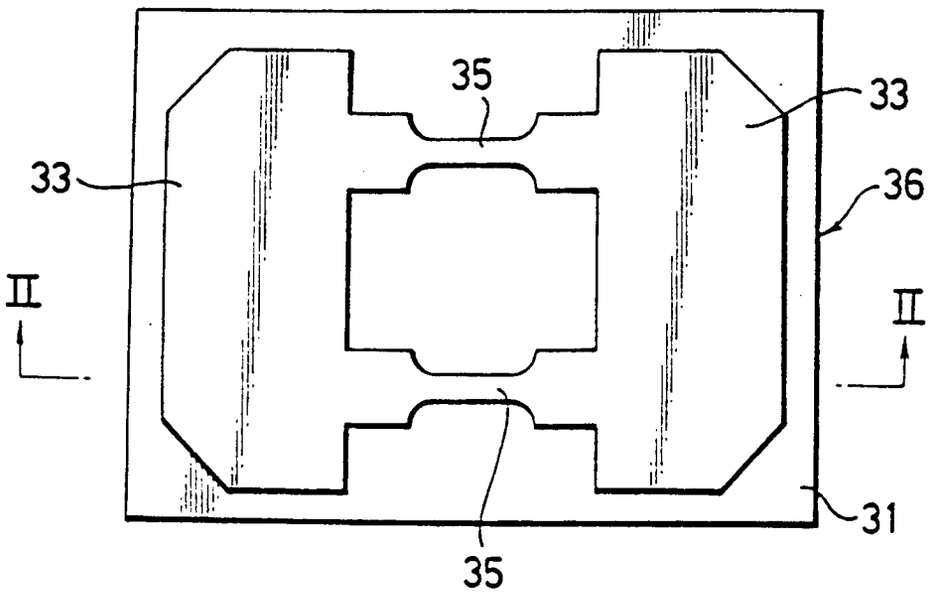


FIG.2

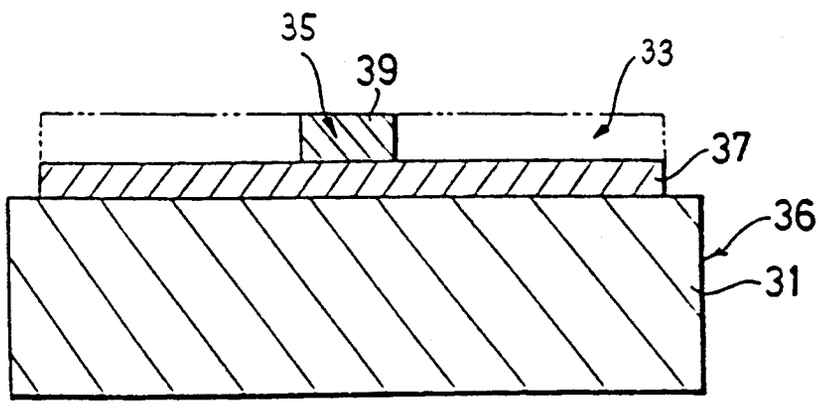


FIG.3

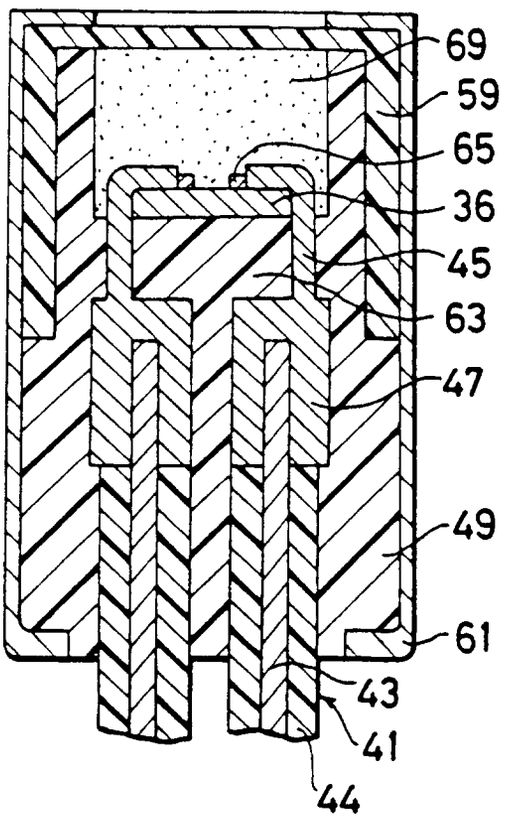


FIG.4

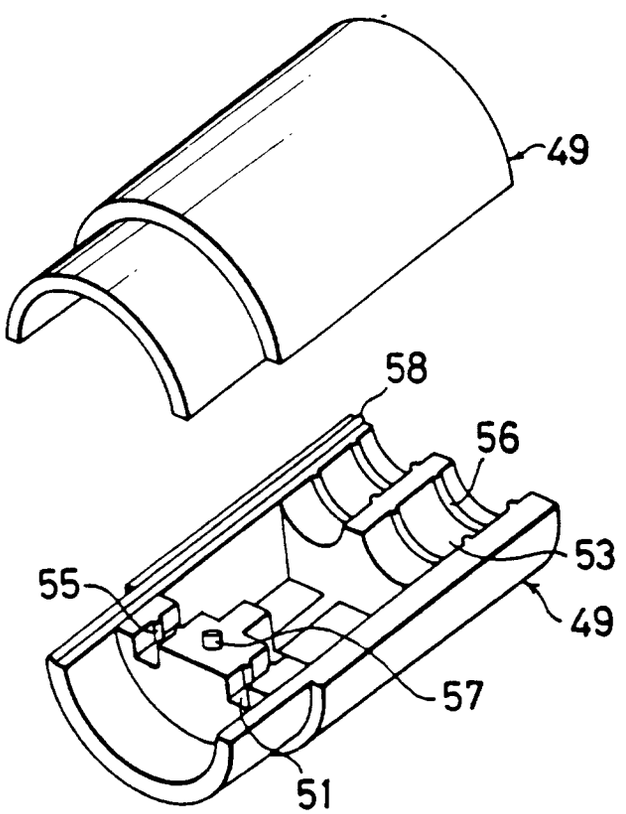


FIG.5

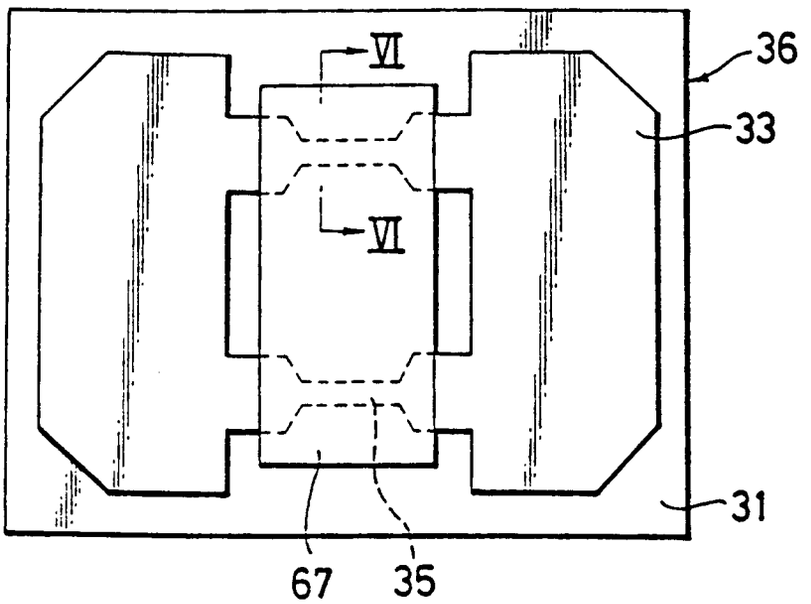


FIG.6

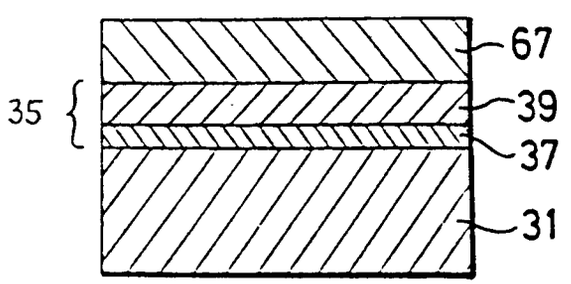


FIG.7

a graph showing the relationship between the thickness of the protective coating film and the ignition time

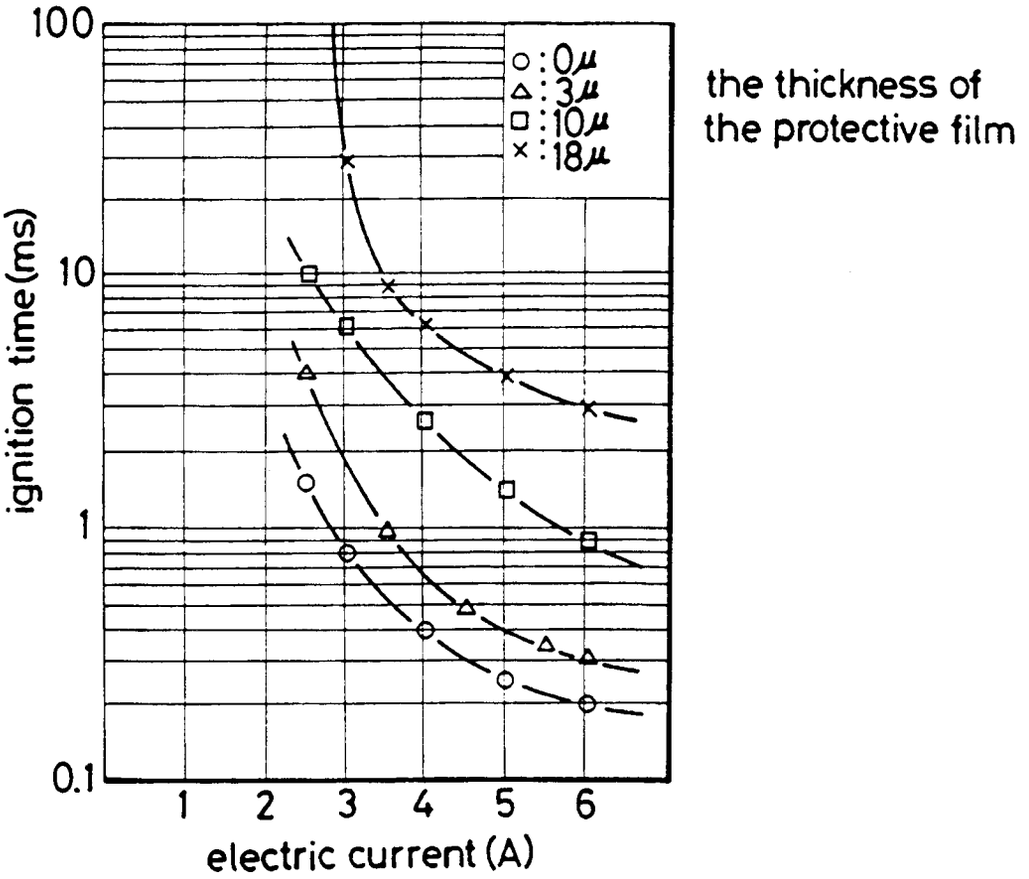


FIG.8

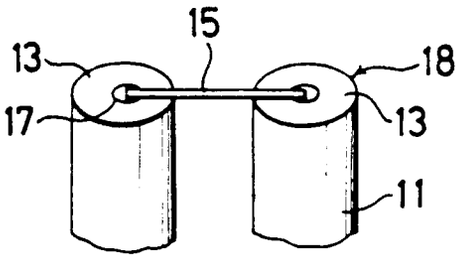


FIG.9

