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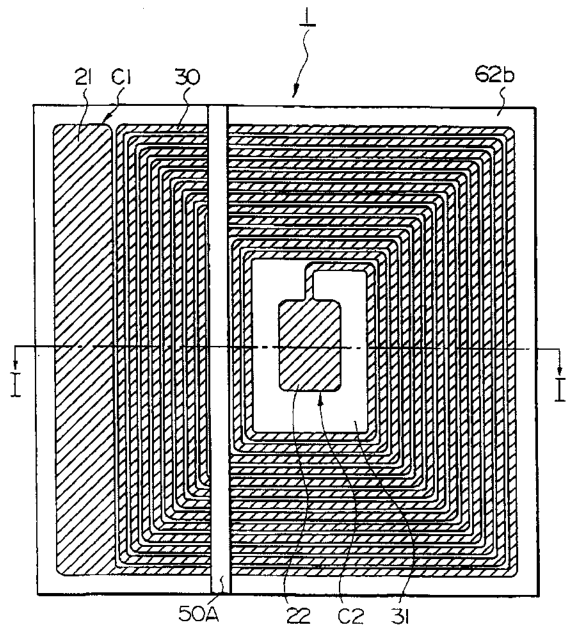
(54) Resonant sensor

(57) A resonant sensor of a simple structure for use in an electronic security system, which can increase the reliability of electronic deactivation therefor, is disclosed. The resonant sensor comprises a resonant circuit having an induction coil (30), wherein a conductive piece (50A) is provided on the induction coil through an insulating layer, over a plurality of turns of the induction coil (30).

FIG. 2



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a resonant sensor for use in an electronic security system, which has a resonant circuit for resonating with an electromagnetic wave of a specific frequency and to which electronic deactivation of the resonant circuit can be performed. The resonant sensor according to the present invention can be used as a resonant label, a resonant tag or the like, which is attached to an article in a store, a book in a library or the like, to prevent to be carried them out illegally or by mistake.

Description of Related Art

To attach a resonant label or a resonant tag to an article in order to prevent it from being taken out of a store or the like illegally, has been known. It has been also known that the resonant label or the resonant tag has a resonant sensor to which electronic deactivation thereof can be performed. Hereinafter, any of a resonant label, a resonant tag, and a resonant sensor will be referred to "a resonant sensor". This type of the resonant sensor includes a resonant circuit which resonates with an electromagnetic wave of a specific frequency (resonant frequency). When an article provided with the resonant sensor is illegally taken out of a store without passing through a cashier, the resonant circuit of the resonant sensor resonates with electromagnetic waves emitted from a detecting apparatus provided at the exit of the store or the like, and thereby the presence of the resonant sensor is detected and alarm is outputted. On the other hand, when an article is legally taken out of a store through a cashier, the resonant sensor attached to the article is deactivated by a deactivator equipped at the site of the cashier to output no alarm through the detecting apparatus. For this reason, the resonant sensor is provided with means for enabling deactivation of the resonant sensor.

An existing general resonant sensor is constituted by sandwiching a dielectric substrate by a pair of capacitor plates to form a capacitor and electrically connecting the capacitor with an induction coil formed on one surface of the substrate. To deactivate the resonant sensor, a means is known, in which a recess is formed on a portion of a capacitor, a target dielectric-breakdown portion is formed by making the thickness of the substrate of the recessed portion smaller than that of other portions, electromagnetic waves having a sufficiently large energy of a frequency coinciding with the resonant frequency of the resonant circuit is applied by a deactivator equipped at the site of a cashier or the like to cause electric discharge at the target dielectric-breakdown portion, and a short circuit is formed between the capacitor plates by a filamentous metallic conductor produced between the both capacitor plates due to the electric discharge, as described in United States Patent No. 4,498,076.

However, it has been clarified by the inventors of the present invention that the resonant sensor disclosed in the above United States Patent No. 4,498,076 has the following problems.

That is, a recess point to be broken between the both capacitor plates must be present on the capacitor plates at the target dielectric-breakdown portion and therefore, it is necessary to carry out a processing for forming the recess while accurately performing a position adjustment. Moreover, the dielectric of the recess must be accurately formed to have a predetermined thickness. However, in existing general resonant sensors, there are variations in the position of the recess point to be broken and in thickness of the dielectric of the recess. Therefore, unanticipated accidents sometimes happen or are apt to happen, because the resonant sensor being not deactivated.

SUMMARY OF THE INVENTION

The present invention was developed in view of the above-described problems. An object of the present invention is to provide a resonant sensor having a simple structure which can be easily manufactured. Another object of the present invention is to provide a resonant sensor which can increase the reliability of electronic deactivation therefor. A further object of the present invention is to secure a large Q value which is a function for representing signal sensitivity, enough to put a resonant sensor to practical use.

In accordance with one aspect of the present invention, the resonant sensor comprises a resonant circuit which has an induction coil, wherein a conductive member is provided on the induction coil through a first insulating layer, over a plurality of turns of the induction coil.

The resonant sensor may comprise a plurality of induction coils, and one or more conductive members may be provided on at least one of the induction coils. The conductive member may have a linear shape or a beltlike shape, e.g., a metal foil, a metallized plastic fin, a metal wire or the like, having a width not more than 10 mm, preferably, not more than 1 mm. The conductive member may have a successive or discontinuous linear shape. Preferably, the conductive member comprises a plastic layer, and a conductive layer provided on at least one of the front and rear surfaces thereof. Although the thickness of the conductive member is not limited, a thickness not more than 100 μm is preferred.

The reason why the width of the conductive member of not more than 10 mm is preferred is to maintain the Q value of the resonant sensor for practical applications by restraining Q value drop. Herein, the standard of the Q value for practical applications is the one having a Q value drop of not more than 10% of the Q value of the resonant sensor having no conductive member. The relationship between the Q value and the width of the conductive member has been clarified by the inventors. When the Q value of the resonant sensor having no conductive member is 100, Q values of the resonant sensors having conductive members with various widths are as follows.

WIDTH OF CONDUCTIVE MEMBER	Q VALUE
0.7 mm	99
1.0 mm	98
5.0 mm	95
10.0 mm	91
11.0 mm	89
15.0 mm	70

The conductive member may comprise a plastic layer, and a conductive layer may be provided on at least one of the front and rear surfaces thereof. The plastic layer may be made of polyethylene, polypropylene, polyester, polyamide, polyimido, polyether imido, aramid, cellulose, or the like. Although the material for the conductive layer is not limited, a metal, e.g., aluminium, copper, iron, nickel or the like, carbon, or the like may be preferably used. The conductive layer on the plastic layer may be formed by a process selected from the group consisting of laminating, vapor deposition, coating, and sputtering.

The conductive member may comprise a metal wire. Although the material and the sectional shape of the metal wire are not limited, it is preferably to use a rectangular (flat) wire or a round wire which comprises copper, aluminium, nickel, iron or the like, as a principal ingredient.

The first insulating layer may have a thickness not larger than 7 μm, preferably not larger than 3 μm, more preferably not larger than 1 μm. The reason for this is that a thickness larger than 7 μm requires a large voltage to cause a dielectric breakdown. For the first insulating layer, a resin based on a polymer of alkyd, phenol aldehyde, vinyl, epoxy, urethan, acrylic or nitride monomer; or a resin based on polyolefine, polyamide, polystylene, polyester, nitrile or the like, can be used alone or in a mixture thereof.

Preferably, the first insulating layer comprises a resist ink. The first insulating layer may be formed by a printing, e.g., gravure printing, silk screen printing, offset printing or the like.

Because such a first insulating layer of a resist ink can be easily formed by a printing, it is possible not only to obtain an extremely thin coating of ink, that is, an extremely thin insulating layer, e.g., 0.3-0.8 μm thickness at dry state, but to control the thickness of the insulating layer with sufficient precision. Therefore, it is possible to extremely increase the reliability of electronic deactivation. For the resist ink, for example, a resin based on a polymer of alkyd, phenol aldehyde, vinyl, epoxy, urethan, acrylic or nitride monomer; or a resin based on polyolefine, polyamide, polystylene, polyester, nitrile or the like, can be used alone or in a mixture thereof.

In such a resonant sensor, a conductive member is provided on the induction coil through a first insulating layer, over a plurality of turns of the induction coil. Therefore, when the sensor approaches an electronic deactivator which generates an electromagnetic wave having a high power density and including a wave with the resonant frequency of the resonant sensor, the resonant sensor resonates at the specific frequency, so that a large current flows in the induction coil to generate a large voltage. Thereby, electrical discharges are repeatedly carried out between the turns of the induction coil and the conductive member provided thereon through the first insulating layer, so that the first insulating layer is finally destroyed and a short circuit occurs. Consequently, the resonant frequency of the resonant sensor is extremely shifted and the resonant sensor is electronically deactivated. The resonant sensor according to the present invention has a very simple structure and can be easily manufactured.

In accordance with another aspect of the present invention, the resonant sensor for use in an electronic security system comprises: a dielectric substrate; a resonant circuit formed on the dielectric substrate, which comprises at least one induction coil, and at least two capacitors, wherein the induction coil is formed on one surface of the substrate, each capacitor comprises a first conductive layer which is formed on one surface of the substrate and is connected with an end of the induction coil, and a second conductive layer which is formed on the other surface of the substrate and is opposed to the first conductive layer; and at least one bridging conductive layer connecting the second conductive layers; and at least one conductive member provided on the induction coil through a first insulating layer, over a plurality of turns of the induction coil.

In accordance with another aspect of the present invention, the resonant sensor for use in an electronic security system comprises: a dielectric substrate; a resonant circuit formed on the dielectric substrate, which comprises an induction coil and a capacitor, wherein on one side of the substrate the induction coil is formed and is connected with an inner conductive layer which serves as the first capacitor plate of the capacitor and with a first outer conductive layer, and on the other side of the substrate a second capacitor plate of the capacitor is formed and is opposed to the inner conductive layer and through a bridging conductive layer is connected with a second outer conductive layer which is opposed to and coupled to the first outer conductive layer; and at least one conductive member provided on the induction coil through a first insulating layer, over a plurality of turns of the induction coil.

Preferably, the conductive member is disposed at a position which departs from the corresponding positions of the capacitor and of the bridging conductive layer. Because the conductive member is disposed at a portion not to capacitor-couple with conductive layers of the capacitors or the bridging conductive layer, it is possible to exert no adverse effect to the resonant characteristics of the resonant sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus do not limit the present invention, and wherein;

FIG. 1 is a plan view of the resonant sensor according to the first embodiment of the present invention;

FIG. 2 is a bottom view of the resonant sensor according to the first embodiment of the present invention;

FIG. 3 is a vertical sectional view of the completed resonant sensor according to the first embodiment of the present invention, taken substantially along the lines I-I of FIGS. 1 and 2;

FIG. 4 is a vertical sectional view of the completed resonant sensor according to the second embodiment of the present invention;

FIG. 5 is a vertical sectional view of the completed resonant sensor according to the third embodiment of the present invention, taken substantially along the lines II-II of FIG. 6;

FIG. 6 is a bottom view of the resonant sensor according to the third embodiment of the present invention;

FIG. 7 is a vertical sectional view of the completed resonant sensor according to the fourth embodiment of the present invention, taken substantially along the lines III-III of FIG. 8;

FIG. 8 is a bottom view of the resonant sensor according to the fourth embodiment of the present invention;

FIG. 9 is a plan view of the resonant sensor according to the fifth embodiment of the present invention;

FIG. 10 is a bottom view of the resonant sensor according to the fifth embodiment of the present invention;

FIG. 11 is a plan view of the resonant sensor according to the sixth embodiment of the present invention;

FIG. 12 is a bottom view of the resonant sensor according to the sixth embodiment of the present invention;

FIG. 13 is a vertical sectional view of the completed resonant sensor according to the sixth embodiment of the present invention, taken substantially along the lines IV-IV of FIGS. 11 and 12.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, the resonant sensor according to embodiments of the present invention will be explained with reference to the drawings.

FIGS. 1 and 2 are plan and bottom views of a circuit part of the resonant sensor according to the first embodiment of the present invention, and FIG. 3 is a enlarged vertical sectional view of the completed resonant sensor according to the first embodiment.

The resonant sensor comprises a dielectric substrate 10; a resonant circuit which comprises an induction coil 30, a first capacitor C1, and a second capacitor C2; and a conductive member 50A, as shown in FIGS. 1-3.

The induction coil 30 is formed on the lower surface of the dielectric substrate 10 through an adhesive layer 62b. Although the pattern of the induction coil 30 is not limited, it has 13 turns and an outline of approximately rectangular shape, and has an approximately rectangular coil window portion 31 at approximately the center thereof, in this embodiment.

The first capacitor C1 comprises a first conductive layer 21 and a third conductive layer 23, which are faced with each other through the substrate 10. The first conductive layer 21 having a long beltlike shape is formed on the lower surface 10b of the substrate 10 through an adhesive layer 62b, outside the induction coil 30, and is connected with the outer end of the induction coil 30. The third conductive layer 23 which has an approximately similar shape to that of the first conductive layer 21 and is formed on the upper surface 10a of the substrate 10 through an adhesive layer 62a.

The second capacitor C2 comprises a second conductive layer 22 and a fourth conductive layer 24, which are faced with each other through the substrate 10. The second conductive layer 22 having a small approximately rectangular shape is formed in the rectangular coil window 31 on the lower surface of the substrate 10 through the adhesive layer 62b and is connected with the inner end of the induction coil 30. The rectangular second conductive layer 22 is disposed a small distance apart from the induction coil 30 in the rectangular coil window 31 so that the central point (not illustrated) of the rectangular second conductive layer 22 coincides with the intersection point (not illustrated) between diagonals of the rectangular coil window 31. The fourth conductive layer 24 which has an approximately similar shape to that of the second conductive layer 22 and is formed on the upper surface 10a of the substrate 10 through the adhesive layer 62a. The fourth conductive layer 24 is connected with the third conductive layer 23 through a bridging conductive layer 40.

The dielectric substrate 10 is made of a polyolefine film, e.g., polyethylene or polypropylene, or polystyrene film or the like. The above conductive layers 21, 22, 23, and 24, the induction coil 30, and the bridging conductive layer 40, though not limited, are formed by forming, for example, an aluminum foil into a pattern.

The conductive member 50A is provided and secured on a predetermined portion of the induction coil 30 through a first insulating layer 60, over a plurality of turns 30a and 30b of the induction coil 30, as shown in FIGS. 2 and 3. The conductive member 50A is fixed to the portion of the induction coil 30 so as to be pressed down to the portion by a pressure sensitive adhesive layer 63.

The first insulating layer 60 comprises a material having a suitable insulation performance, e.g., a resist ink layer or the like, and has a thickness not more than 7 μm, preferably not more than 3μm, more preferably not more than 1μm. For the resist ink, for example, a resin based on a polymer of alkyd, phenol aldehyde, vinyl, epoxy, urethan, acrylic or nitride monomer; or a resin based on polyolefine, polyamide, polystylene, polyester, nitrile or the like, can be used along or in a mixture thereof.

That is, when the resonant sensor resonates with electromagnetic waves with a normal power density outputted from a detecting device, electric discharge does not occur between the turns 30a and 30b of the induction coil 30 and the conductive member 50A by a voltage generated between the turns of the induction coil 30 due to a current flowing through the induction coil 30. However, when the resonant sensor resonates with electromagnetic waves with a high power density outputted from a deactivator, a sufficiently high voltage to cause electric discharges is generated between the turn(s) 30a and/or 30b of the induction coil 30 and the conductive member 50A by a current flowing through the induction coil 30. Then, electric discharges are repeated between the turn (s) 30a and/or 30b of the coil 30, and the conductive member 50A, and a short circuit is formed between the coil turn 30a and the conductive member 50A and/or between the coil turn 30b and the conductive member 50A. Accordingly, the capacitance C of the capacitor formed between these members is changed. When a short circuit is formed between both the coil turns 30a and 30b and the conductive member 50A finally, the coil turns 30a and 30b are short-circuited through the conductive member 50A. Consequently, not only the capacitance of the capacitor formed between these members but also the inductance L of the resonant circuit are changed, so that the resonance frequency. of the resonant circuit is greatly shifted.

In the present invention, it is essential that the conductive member 50A is provided on the induction coil 30 through an insulating layer, over a plurality of turns of the induction coil 30. The reason for this is as follows.

If the conductive member 50A is provided on a single turn of the induction coil 30, electric discharges occur only between the single turn of the induction coil 30 and the conductive member 50A, and a short circuit is formed therebetween to cause a change of the capacitance C. When the change of the capacitance C is sufficiently large, the resonance frequency of the resonant circuit is largely shifted. In this case, because the resonant sensor is not detected by the detecting device, there is no problem. However, when the change of the capacitance C is small, because the change of the resonance frequency of the resonant sensor is small, the resonant sensor is detected by the detecting apparatus. Therefore, the reliability of the resonant sensor is decreased.

On the contrary, in the present invention, that is, when the conductive member 50A is provided on the induction coil 30 through an insulating layer, over a plurality of turns of the induction coil 30, even if a short circuit is formed only between one turn 30a of the induction coil 30 and the conductive member 50A at first, and the change of the capacitance C is small, electric discharges occur between other turns 30b of the induction coil 30 and the conductive member 50A from one to another, and short circuits are formed therebetween, until a sufficiently large change of the capacitance C is obtained by the deactivator. In this case, because short circuits are formed between a plurality of turns of the induction coil 30 and the conductive member 50A, not only the capacitance C is largely changed but also the inductance L is consequently changed. Accordingly, it is possible to obtain a resonant sensor which can be deactivated with certainty by a deactivator.

The resonant sensor 1 constituted as described above is manufactured, for example, as shown below.

First, an aluminum foil 40a having a thickness of approximately 10 μm and no pattern is laminated with an adhesive on the upper surface 10a of the substrate 10 through the adhesive layer 62a. An aluminum foil 40b having a thickness of approximately 50 μm and no pattern is laminated with an adhesive on the lower surface 10b of the substrate 10 through the adhesive layer 62b. It is also possible to adhere an aluminum foil to the upper and lower surfaces 10a and 10b of the substrate 10 made of a polyolefine film which can be thermally bonded by means of, for example, extrusion lamination or heat lamination without using any adhesive.

Then, resist inks 60 and 61 are applied on the lower and upper aluminum foils 40b and 40a in a predetermined patterns for the capacitor plates and the induction coil and the like, respectively, by means of, for example, gravure printing while both-side patterns being registered. Thereafter, each aluminum foil is etched through the eaching process to form a resonant circuit. Because the resist ink layer 60 is formed through printing, it is possible to control the coating amount of ink, that is, the thickness of an insulating layer very thinly and very accurately to a thickness, for example, in the range of 0.3 to 0.8 μm at dry state. Resist printing can be realized not only by the gravure printing but also by the silk printing or offset printing.

Then, wood free paper (protective paper) 66 is laminated to the top of the adhesive layer 62a by using an adhesive or a pressure sensitive adhesive 65. Thereafter, a releasing paper having a coating layer of pressure sensitive adhesive on one of its surfaces is laminated onto the surface of the induction coil 30 while setting the conductive member 50A so that the conductive member 50A comes into contact with the induction coil 30 at the predetermined position. The conductive member 50A is pressed against and secured onto the induction coil 30 by the adhesive 63.

The conductive member 50A is made by bonding conductive films 52 and 53 made of an aluminum foil or the like to the both sides or either side of a base film 51 of a polyamide or the like and thereafter by slitting it to a narrow width of, for example, approximately 0.7 mm as shown in Fig. 3. Though not specified, it is possible to form the conductive member 50A by setting the thickness of a polyamide film to approximately 16 μm or the thickness of an aluminum foil to approximately 7 μm. When a conductive film is provided on each of the both sides of the base film 51, no problem occurs even if the conductive member 50A is turned over during adhesive treatment because of a small width of the conductive member 50A. That is, there is no problem even if either of the conductive films 52 and 53 is in contact with the first insulating layer 60 on the induction coil. Moreover, because a base film 51 is used only for the purpose of reinforcement of the strength of the conductive member 50A so as not to be broken during the processing, use of a conductive film is preferable as the base film. The resonant sensor 1 is completed in accordance with the above process.

The resonant sensor 1 having the above structure is deactivated as described below.

When the resonant sensor resonates with electromagnetic waves with a high power density outputted from a deactivator, a sufficiently high voltage to cause electric discharges is generated between the turn(s) 30a and/or 30b of the induction coil 30 and the conductive member 50A by a current flowing through the induction coil 30. Then, electric discharges are repeated between the turn(s) 30a and/or 30b of the coil 30 and the conductive member 50A, and a short circuit is formed between the coil turn 30a and the conductive member 50A and/or between the coil turn 30b and the conductive member 50A. Accordingly, the capacitance C of the capacitor formed between these members is changed. When a short circuit is formed between both the coil turns 30a and 30b and the conductive member 50A, finally, the coil turns 30a and 30b are short-circuited through the conductive member 50A. Consequently, not only the capacitance of the capacitor formed between these members but also the inductance L of the resonant circuit are changed, so that the resonance frequency of the resonant circuit is greatly shifted.

In the present invention, the conductive member 50A is provided on the induction coil 30 through an insulating layer, over a plurality of turns of the induction coil 30. Therefore, even if a short circuit is formed only between one turn 30a of the induction coil 30 and the conductive member 50A at first, and the change of the capacitance C is small, electric discharges occur between other turns 30b of the induction coil 30 and the conductive member 50A from one to another until, and short circuits are formed therebetween, until a sufficiently large change of the capacitance C is obtained by the deactivator. In this case, because short circuits are formed between a plurality of turns of the induction coil 30 and the conductive member 50A, not only the. capacitance C is largely changed but also the inductance L is consequently changed. Accordingly, it is possible to obtain a resonant sensor which can be deactivated with certainty by a deactivator.

According to the above embodiment 1, it is possible to obtain a structure which can be deactivated only by securing the conductive member 50A onto the turns of the induction coil 30 through an insulating layer such as the resist ink layer 60 or the like. Therefore, it is possible to obtain the resonant sensor 1 with a simple structure, which can be deactivated and be easily manufactured.

In the case of the above first embodiment, the conductive member 50A is set to the illustrated position because it is preferable to set the conductive member 50A at a portion where the conductive member 50A does not capacitor-couple with conductive layers 40a of the capacitors or a bridging conductive layer 40 set at the upper surface 10a of the substrate 10 so that the resonance characteristics is not affected. However, it is also permitted that the conductive member 50A are set everywhere so long as the conductive member 50A extends over a plurality of turns. Moreover, it is possible to provide the conductive members 50A at a plurality of positions.

Fig. 4 is an enlarged sectional view of a finished product of the resonant sensor of the second embodiment. The resonant sensor 2 of the second embodiment differs from that of the first embodiment in that a metallic film of aluminum foil or the like or a metallic wire of aluminum wire or the like is used as the conductive member 50B.

According to the embodiment, it is possible to obtain the resonant sensor 1 with an extremely simple structure, which can be deactivated and be easily manufactured.

Since other structures in this embodiment are approximately the same as those of the first embodiment, a detailed explanation for such structures is omitted. In FIG. 4 showing this embodiment, the same numbers are attached to structural members, elements or the like corresponding to those of the first embodiment.

Fig. 5 is an enlarged sectional view of a completed product of the resonant sensor of the third embodiment. Fig. 6 is a bottom view of the circuit of the resonant sensor.

The conductive member 50C in the resonant sensor of the third embodiment comprises a base film 70 of polyester or the like, a conductive material 81 adhered on the base film 70 through an adhesive 71, and a resist ink layer 80 provided on the upper surface of the conductive material 81. The conductive material 81 is arranged to face the induction coil 30 through the resist ink layer 80, the adhesive 72, and the resist ink layer 60, over a plurality of turns of the coil 30.

The conductive member 50C is formed by laminating a conductive material 81 such as an aluminum foil with no pattern on a base film 70 such as polyester with an adhesive 71, then printing a resist ink 80 in a predetermined pattern by means of gravure printing or the like, and finally performing etching. The conductive material 81 is formed into a pattern, for example, with a width of 0.7 mm and a length of 10 mm, as shown in Fig. 6. The conductive member can be formed into various shapes because it can be formed by means of printing a resist ink and etching. It is preferable that the adhesive 72 and the resist ink layers 60 and 80 serve as insulating layers and the total thickness is not more than 3 μm.

Since other structures and functions thereof in this embodiment are approximately the same as those of the first embodiment, a detailed explanation for such structures and functions is omitted. In FIGS. 5 and 6 showing this embodiment, the same numbers are attached to structural members, elements or the like corresponding to those of the previous embodiments.

Fig. 7 is an enlarged sectional view of a completed product of the resonant sensor of the fourth embodiment. Fig. 8 is a bottom view of the circuit of the resonant sensor.

Two conductive members 50D and 50E produced in a similar manner to that of the third embodiment are provided in the resonant sensor 4. These conductive members 50D and 50E are formed by laminating a conductive material 81 such as an aluminum foil with no pattern on a base film 70 such as polyester with an adhesive 71, then printing a resist ink 80 in a predetermined pattern by means of gravure printing or the like, and finally performing etching. The conductive member 50D is formed into a pattern, for example, with a width of 0.7 mm and a length of 10 mm, as shown in Fig. 8. The conductive member 50E is formed into a pattern, for example, with a width of 0.7 mm and a length of 5 mm.

Since other structures and functions thereof in this embodiment are approximately the same as those of the third embodiment, a detailed explanation for such structures and functions is omitted. In FIGS. 7 and 8 showing this embodiment, the same numbers are attached to structural members, elements or the like corresponding to those of the first embodiment.

FIGS. 9 and 10 are plan and bottom views of a circuit part of the resonant sensor 5 according to the fifth embodiment of the present invention, respectively.

The resonant sensor 5 comprises a resonant circuit comprising two induction coils 30X and 30Y, a first capacitor C1, a second capacitor C2, a third capacitor C3, and a fourth capacitor C4; and a conductive member 50F, as shown in FIGS. 9 and 10. The conductive member 50F is provided on only the induction coil 30Y through an insulating layer, over a plurality of turns of the induction coil 30Y.

Since other structures and functions thereof in this embodiment are approximately the same as those of the third embodiment, a detailed explanation for such structures and functions is omitted. In FIGS. 9 and 10 showing this embodiment, the same numbers are attached to structural members, elements or the like corresponding to those of the previous embodiments.

FIGS. 11 and 12 are plan and bottom views of a circuit part of the resonant sensor 6 according to the sixth embodiment of the present invention, and FIG. 13 is an enlarged vertical sectional view of the completed resonant sensor according to the sixth embodiment.

The resonant sensor 6 comprises a dielectric substrate 10; a resonant circuit which comprises an induction coil 30, and a capacitor C2 which is provided at approximately the center of the resonant sensor 6; and a conductive member 50G provided on the induction coil 30 through an insulating layer 60, over a plurality of turns 30a and 30b of the induction coil 30, similarly to the first embodiment. In this embodiment, a conductive layer 23 which is formed on the upper surface 10a of the substrate 10 and is connected with one capacitor plate 24 of the capacitor C2, is electrically connected with a conductive layer 21 which is formed on the lower surface 10b of the substrate 10 and is connected with the outer end of the induction coil 30, as shown in FIGS 11-13. For example, the electrical connection between the conductive layers 23 and 21 is carried out by pressing the substrate 10 vertically at approximately the center portions 90 and 91 of the conductive layers 23 and 21 so that the conductive layers 23 and 21 bring into contact with each other.

Since other structures and functions thereof in this embodiment are approximately the same as those of the first embodiment, a detailed explanation for such structures and functions is omitted. In FIGS. 11-13 showing this embodiment, the same numbers are attached to structural members, elements or the like corresponding to those of the previous embodiments.

As describe above in detail, in the case of the resonant sensor of the present invention, a conductive member is provided on the induction coil through an insulating layer, over a plurality of turns of the induction coil and therefore, a high voltage is generated between the conductive member and the induction coil and/or between the coil turns due to a large current flowing through the induction coil when the resonant sensor resonates with electromagnetic waves having a high power density and coinciding with a resonance frequency. Therefore, when the resonant sensor of the present invention approaches a deactivator for generating electromagnetic waves having a high power density and including a resonance frequency, electric discharge repeatedly occurs between the coil turns and the conductive member, finally a short circuit is formed between the conductive member and the induction coil and/or between the coil turns and the resonance frequency greatly shifts, and the resonant sensor is deactivated. Therefore, it is possible to obtain a resonant sensor which has a simple structure and can easily be manufactured.

Furthermore, because the resonant sensor according to the present invention has an extremely simple structure in which a conductive member is provided on the induction coil through an insulating layer, the thickness of the insulating layer can be easily controlled. Therefore, it is possible to provide a resonant sensor which can increase the reliability of electronic deactivation therefor.

Claims

1. A resonant sensor comprising a resonant circuit which has an induction coil, wherein a conductive member is provided on the induction coil through an insulating layer, over a plurality of turns of the induction coil.

2. A resonant sensor as claimed in claim 1; wherein the resonant sensor comprises a plurality of induction coils, and the conductive member is provided on at least one of the induction coils.

3. A resonant sensor as claimed in claim 1, wherein the conductive member has a linear shape or a belt-like shape having a width not more than 10 mm.

4. A resonant sensor as claimed in claim 3, wherein the conductive member has a linear shape having a width not more than 1 mm.

5. A resonant sensor as claimed in claim 3, wherein the conductive member has a successive linear shape.

6. A resonant sensor as claimed in claim 3, wherein the conductive member has a discontinuous linear shape.

7. A resonant sensor as claimed in claim 3; wherein the conductive member comprises a plastic layer, and a conductive layer provided on at least one of the front and rear surfaces thereof.

8. A resonant sensor as claimed in claim 7; wherein the conductive member has a successive linear shape having a width not more than 1 mm.

9. A resonant sensor as claimed in claim 7; wherein the plastic layer is made of polyamide.

10. A resonant sensor as claimed in claim 7; wherein the conductive layer on the plastic layer is formed by a process selected from the group consisting of laminating, vapor deposition, coating, and sputtering.

11. A resonant sensor as claimed in claim 1, wherein the conductive member comprises a metal wire.

12. A resonant sensor as claimed in claim 1, wherein the insulating layer has a thickness not larger than 7 μm.

13. A resonant sensor as claimed in claim 1, wherein the insulating layer has a thickness not larger than 3 μm.

14. A resonant sensor for use in an electronic security system comprising:

a dielectric substrate;

a resonant circuit formed on the dielectric substrate, which comprises at least one induction coil, and at least two capacitors, wherein the induction coil is formed on one surface of the substrate, each capacitor comprises a first conductive layer which is formed on one surface of the substrate and is connected with an end of the induction coil, and a second conductive layer which is formed on the other surface of the substrate and is opposed to the first conductive layer; and at least one bridging conductive layer connecting the second conductive layers; and

at least one conductive member provided on the induction coil through a first insulating layer, over a plurality of turns of the induction coil.

15. A resonant sensor for use in an electronic security system comprising:

a dielectric substrate;

a resonant circuit formed on the dielectric substrate, which comprises an induction coil and a capacitor, wherein on one side of the substrate the induction coil is formed and is connected with an inner conductive layer which serves as the first capacitor plate of the capacitor and with an first outer conductive layer, and on the other side of the substrate a second capacitor plate of the capacitor is formed and is opposed to the inner conductive layer and through a bridging conductive layer is connected with a second outer conductive layer which is opposed to and coupled to the first outer conductive layer; and

at least one conductive member provided on the induction coil through a first insulating layer, over a plurality of turns of the induction coil.

16. A resonant sensor as claimed in claim 14 or 15, wherein the first insulating layer comprises a resist ink.

17. A resonant sensor as claimed in claim 16, wherein the first insulating layer has a thickness not more than 3 µm.

18. A resonant sensor as claimed in claim 14 or 15, wherein the conductive member comprises a second insulating layer, and a conductive layer provided on at least one of the front and rear surfaces thereof.

19. A resonant sensor as claimed in claim 18, wherein the second insulating layer and the conductive layer have approximately the same surface area.

20. A resonant sensor as claimed in claim 14 or 15, wherein the conductive member is disposed at a position which departs from the corresponding positions of the first and second capacitors and of the bridging conductive layer.

FIG. 1

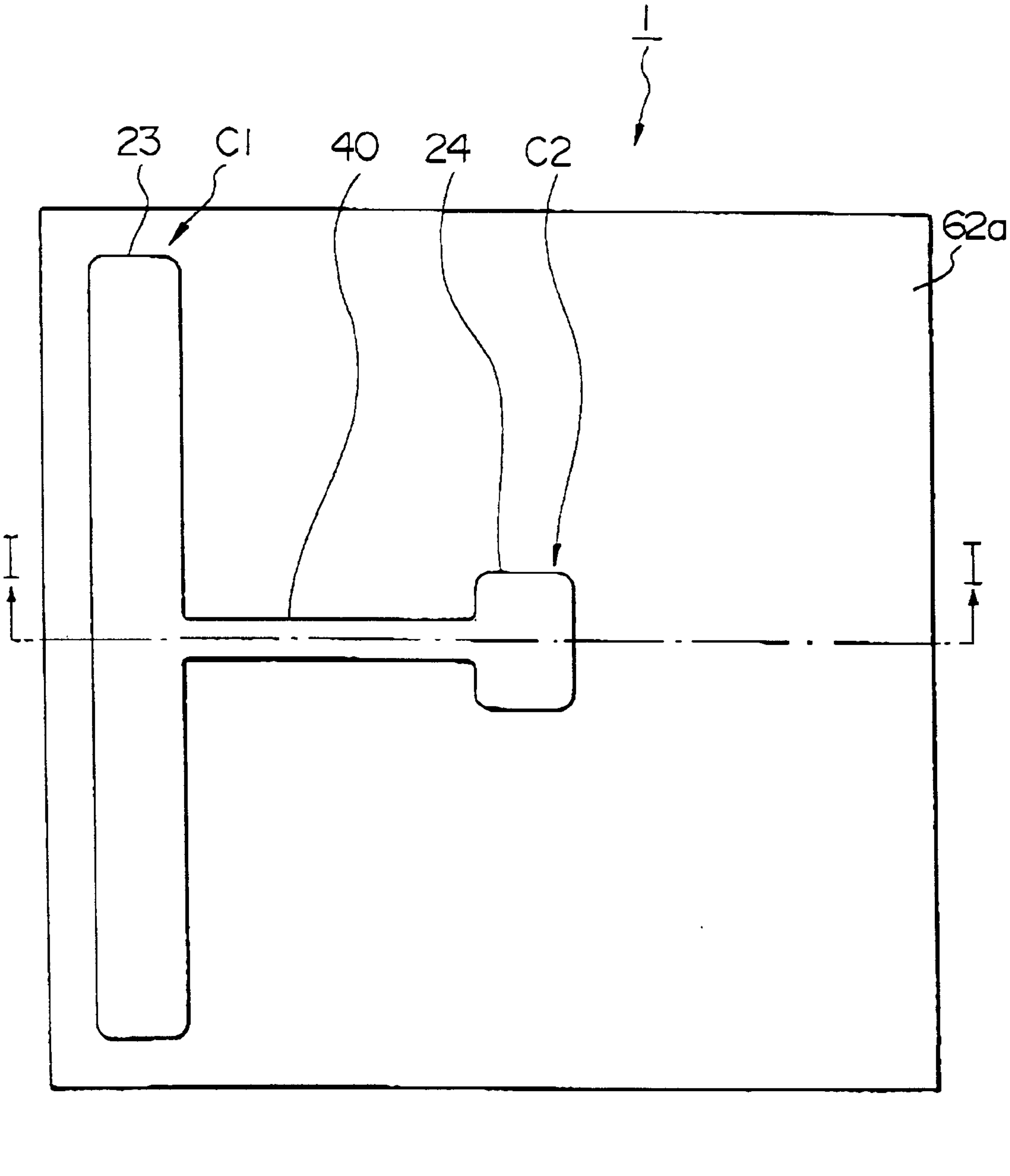


FIG. 2

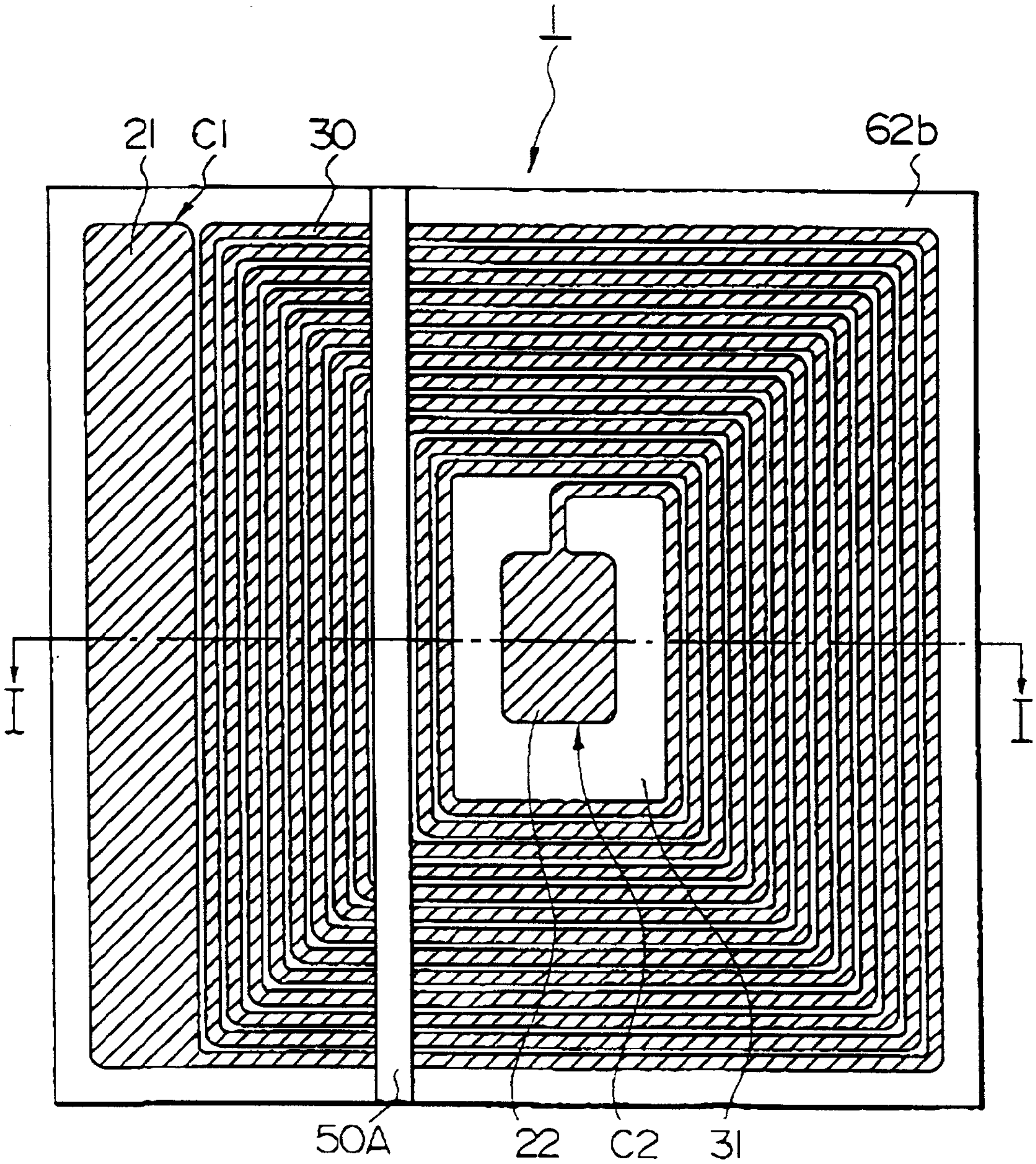
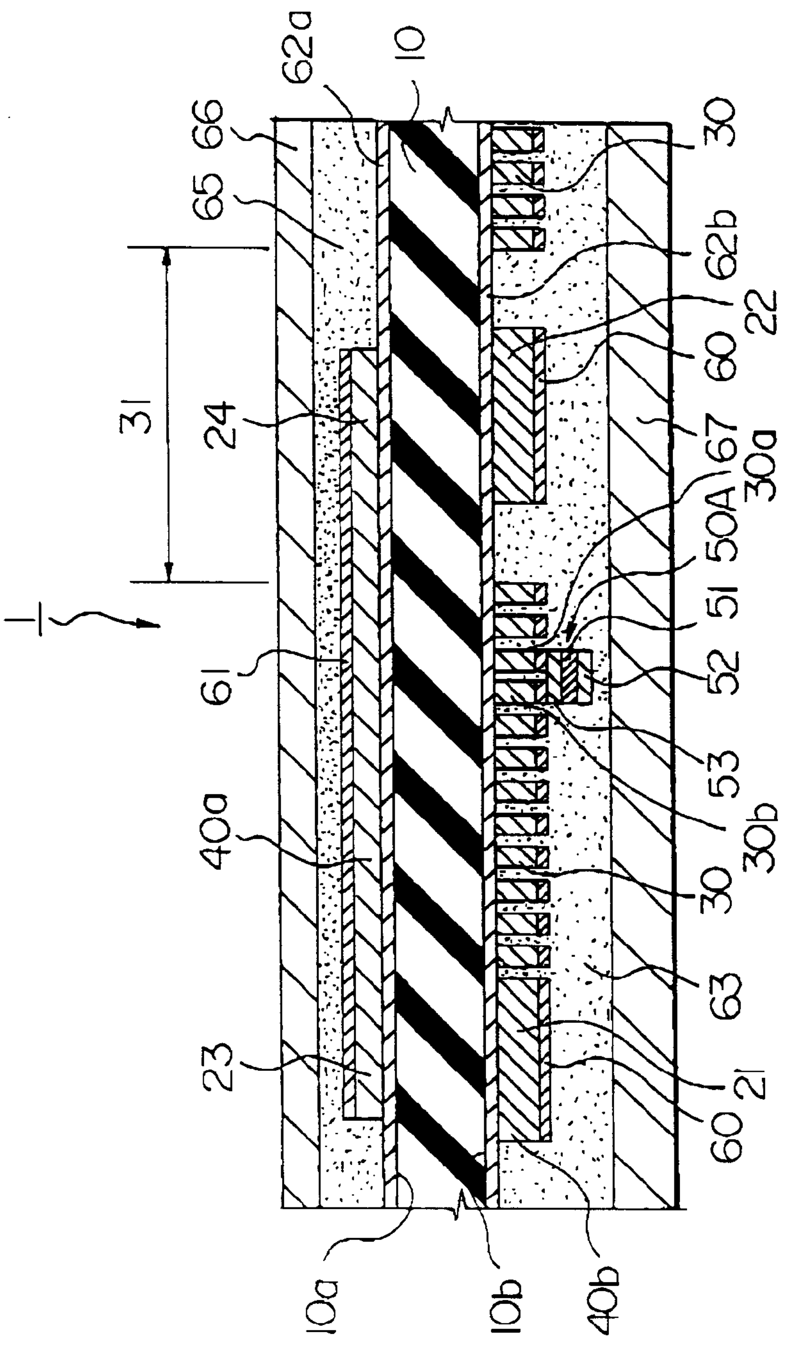


FIG. 3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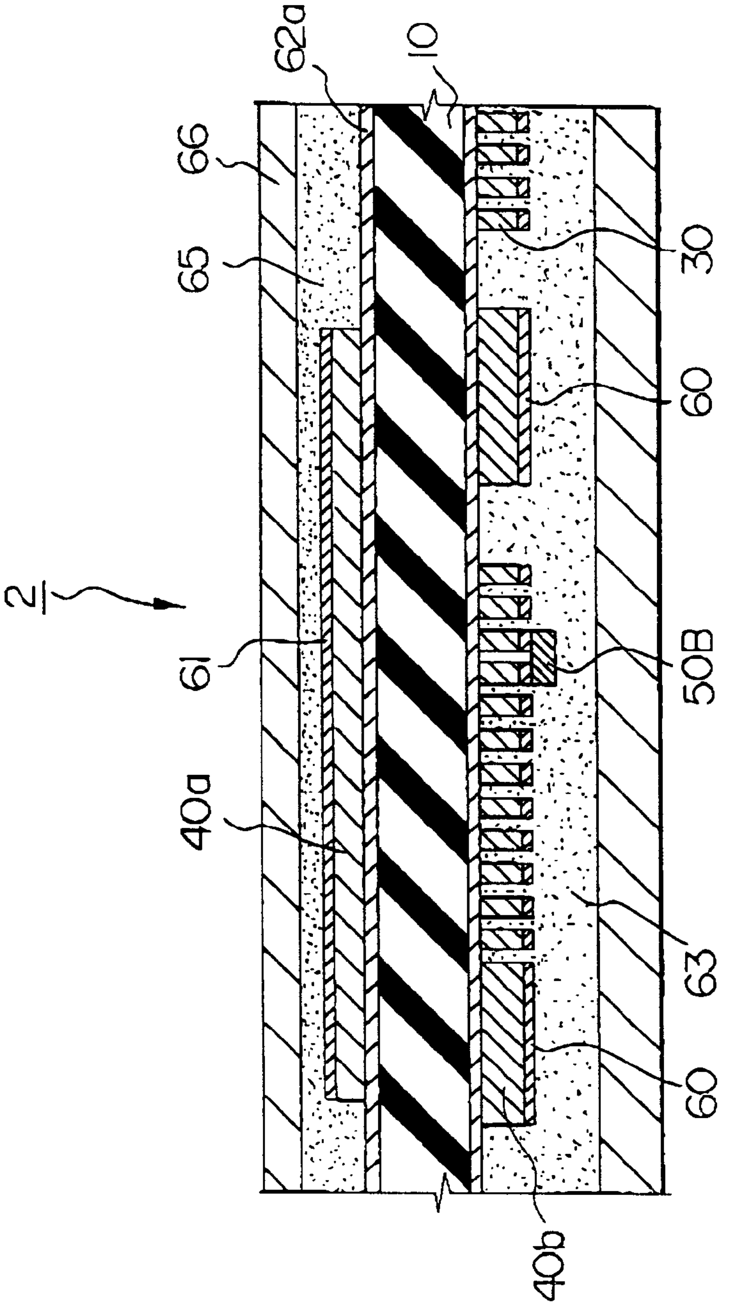


FIG. 4

FIG. 5

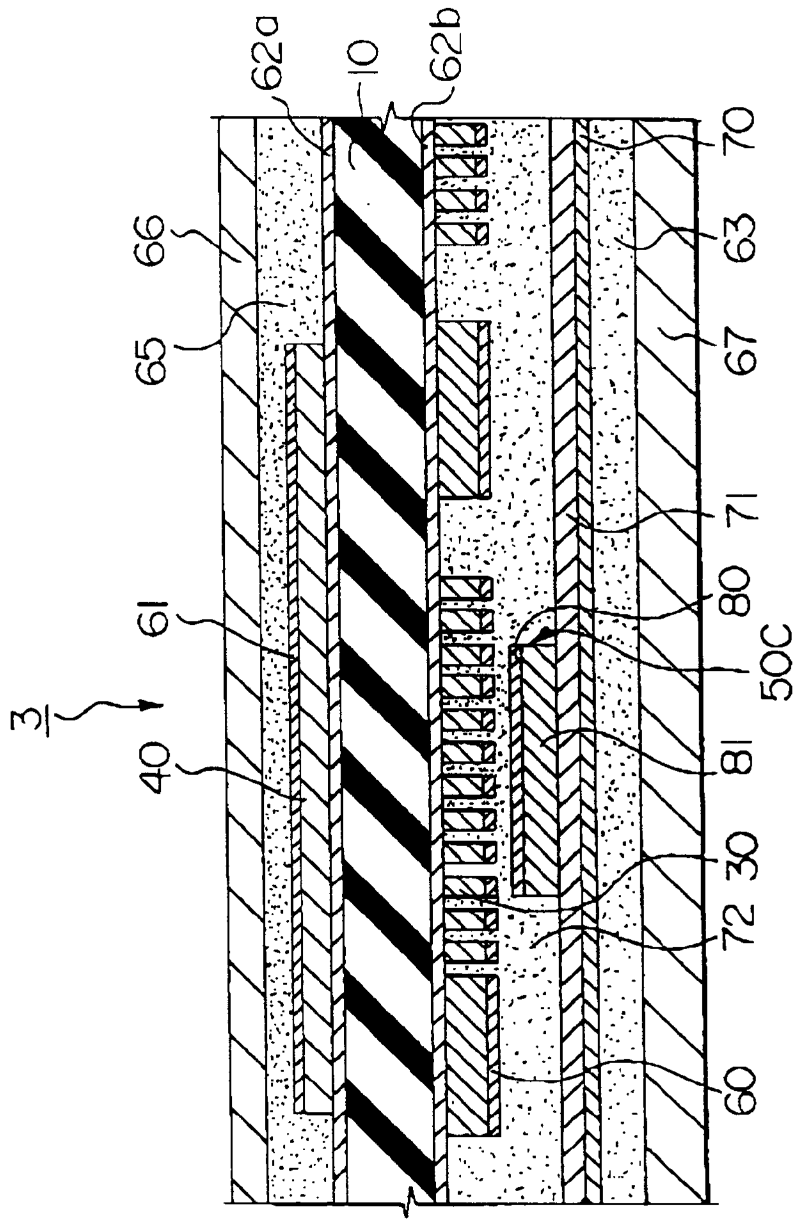


FIG. 6

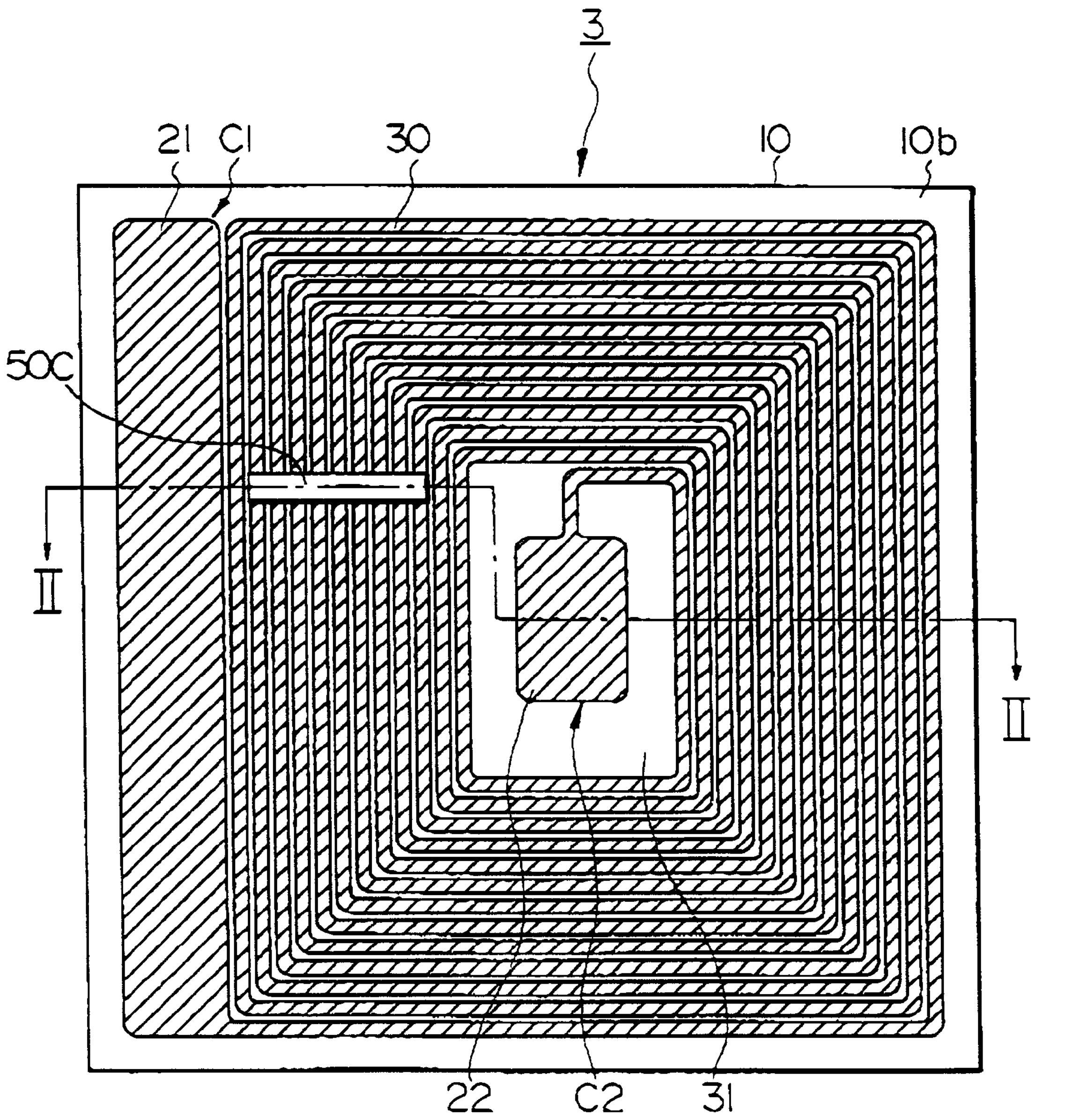


FIG. 7

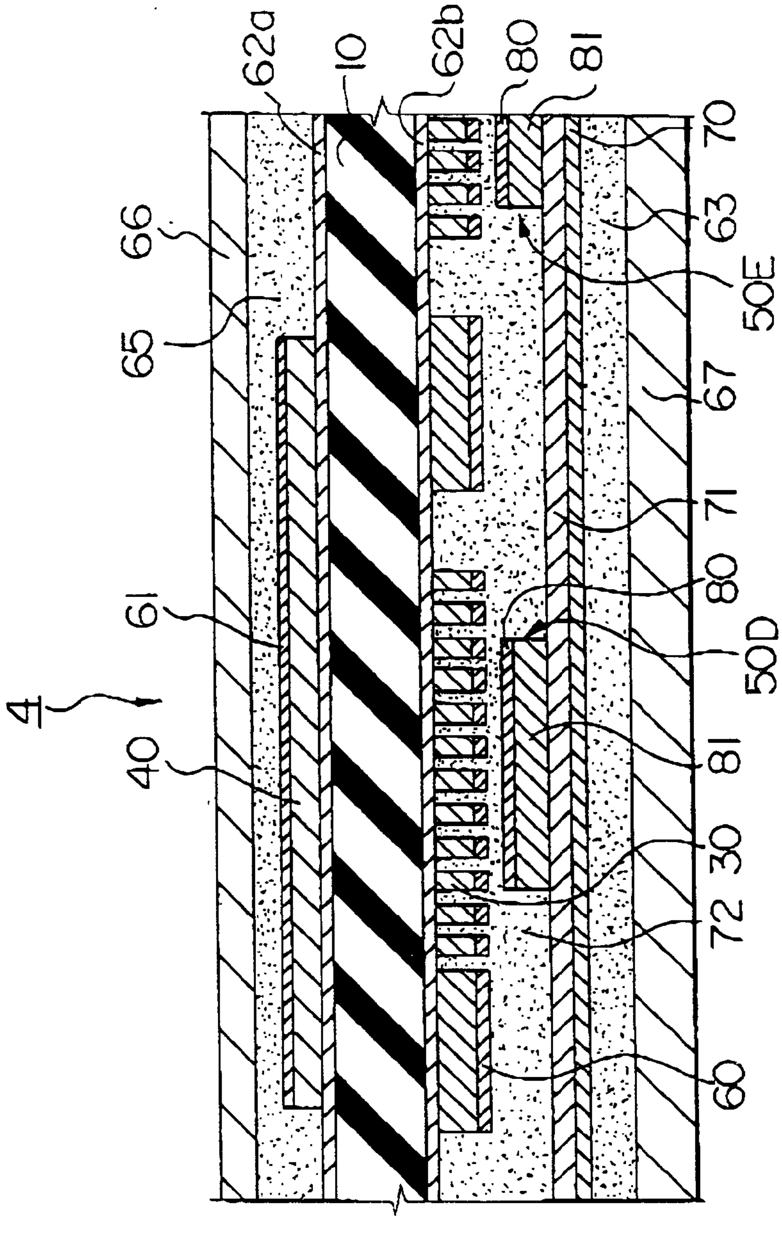


FIG. 8

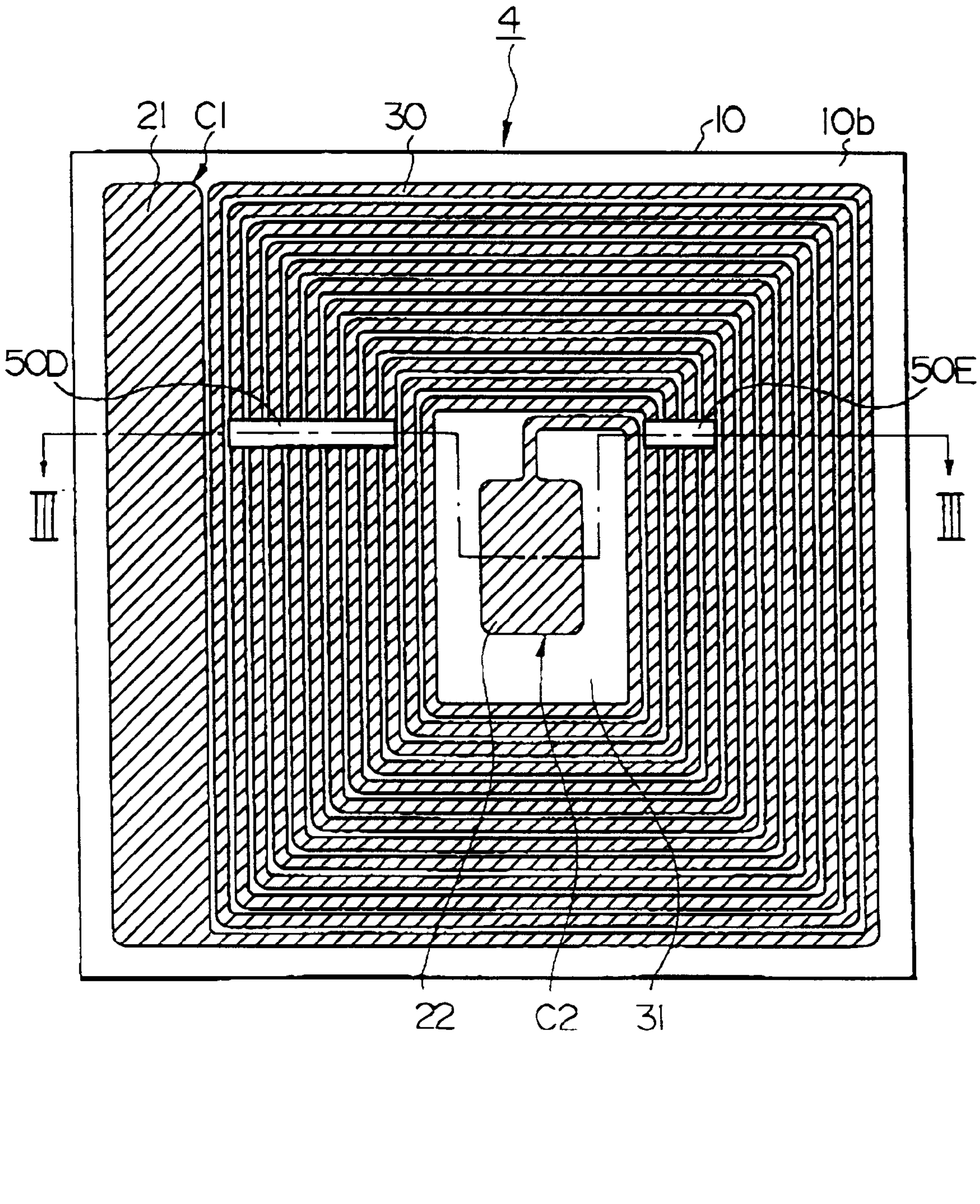


FIG. 9

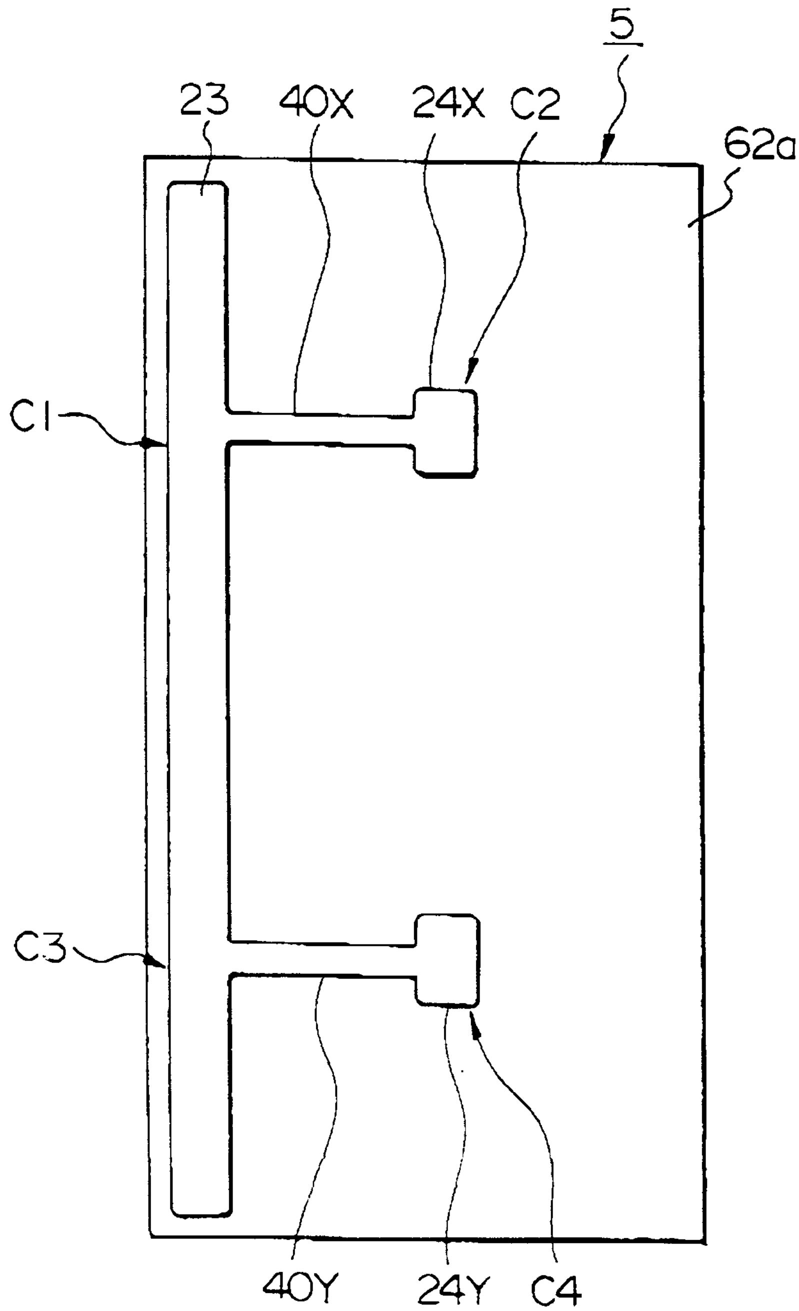


FIG. 10

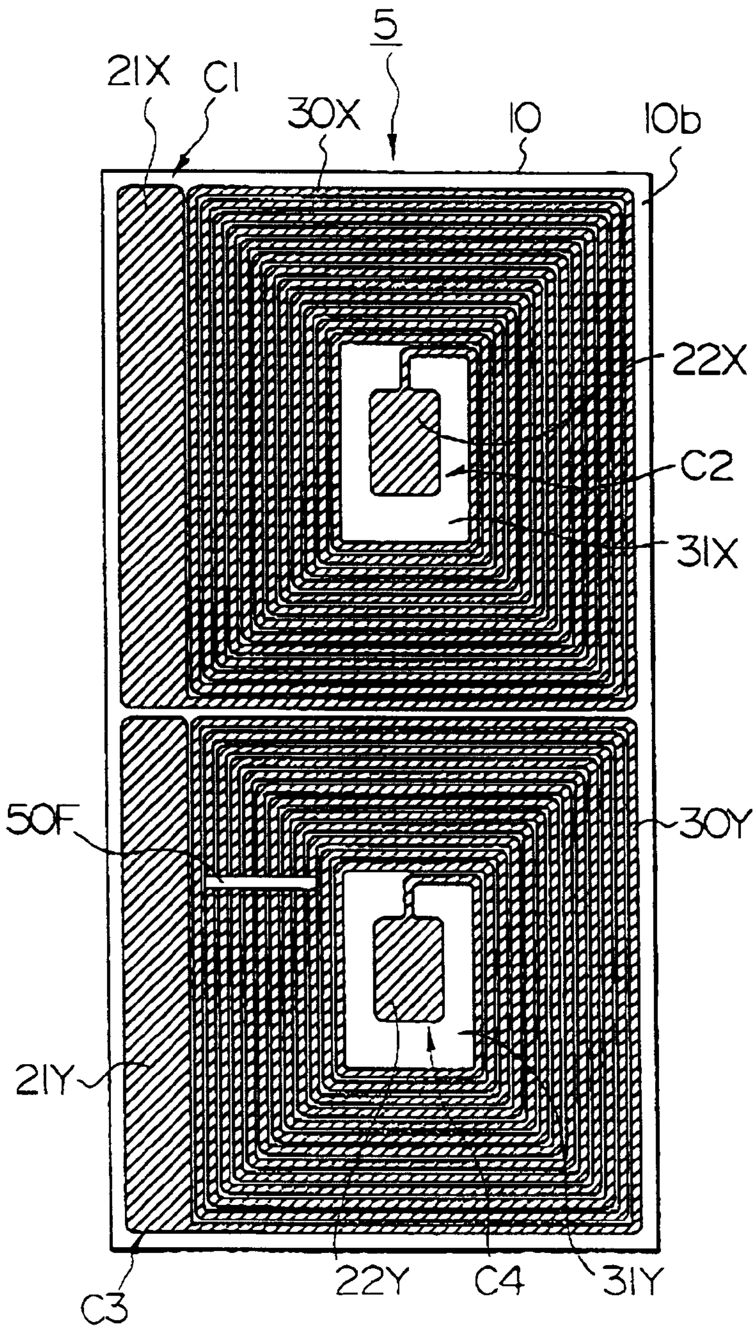


FIG. 11

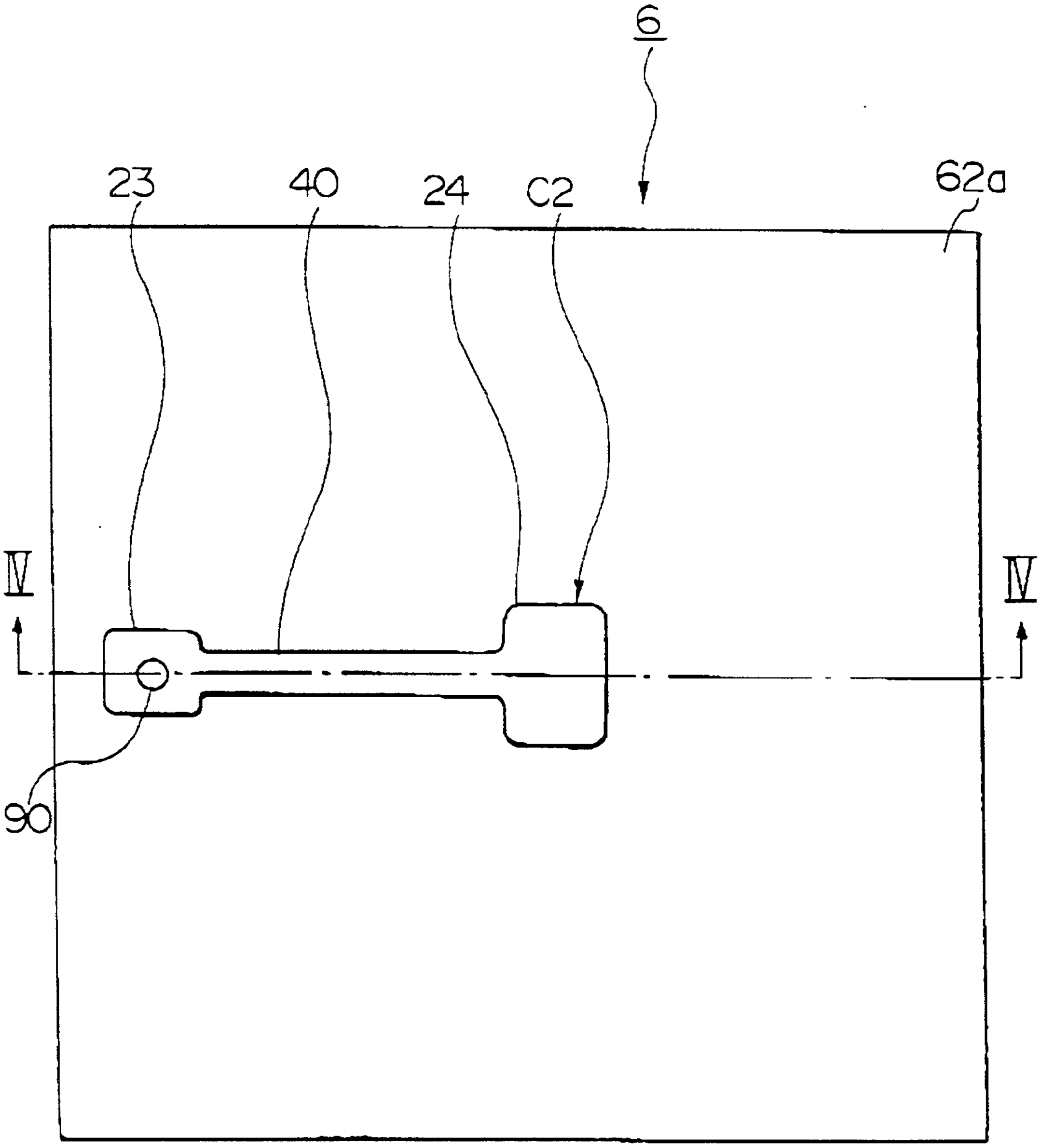


FIG. 12

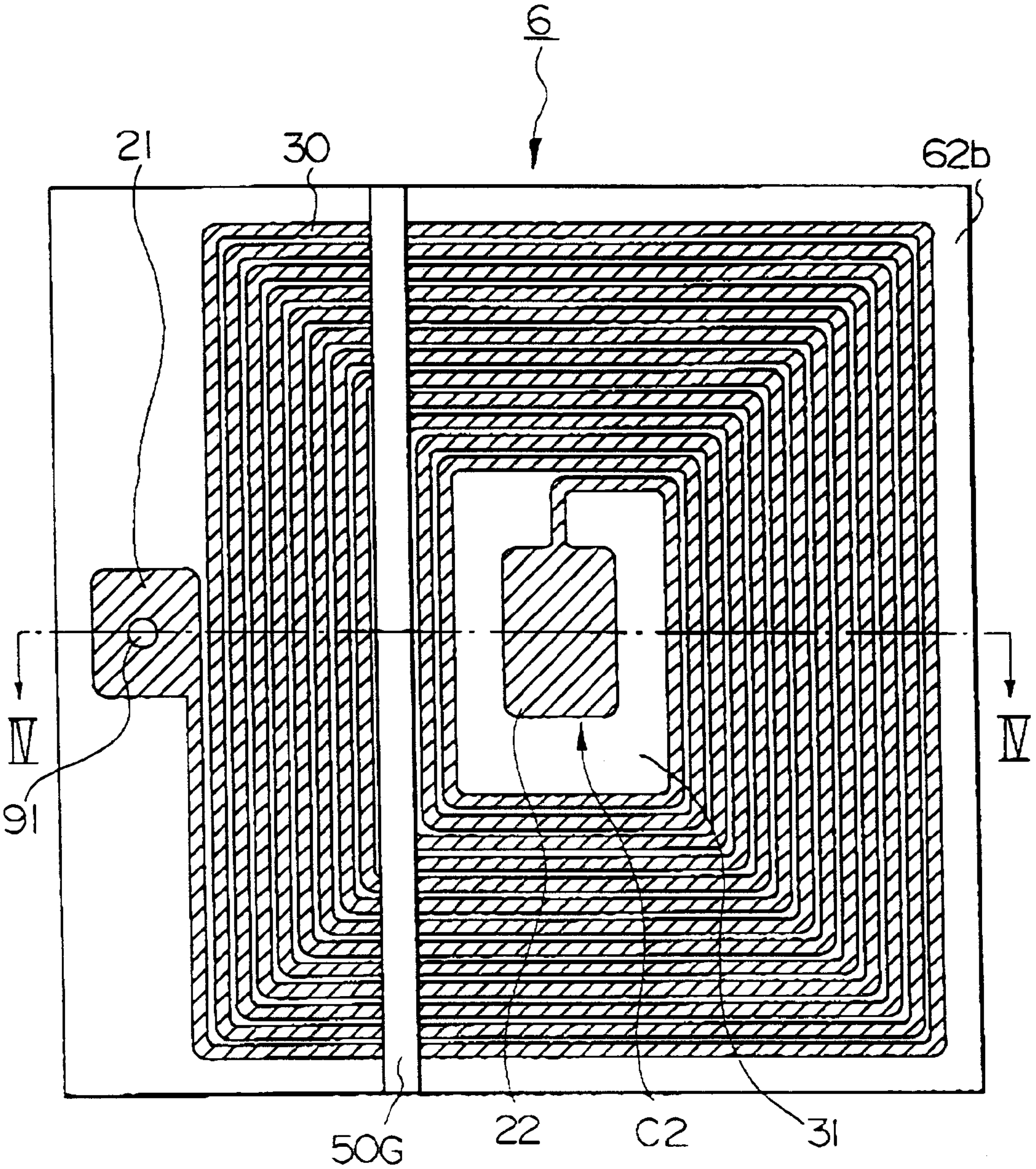
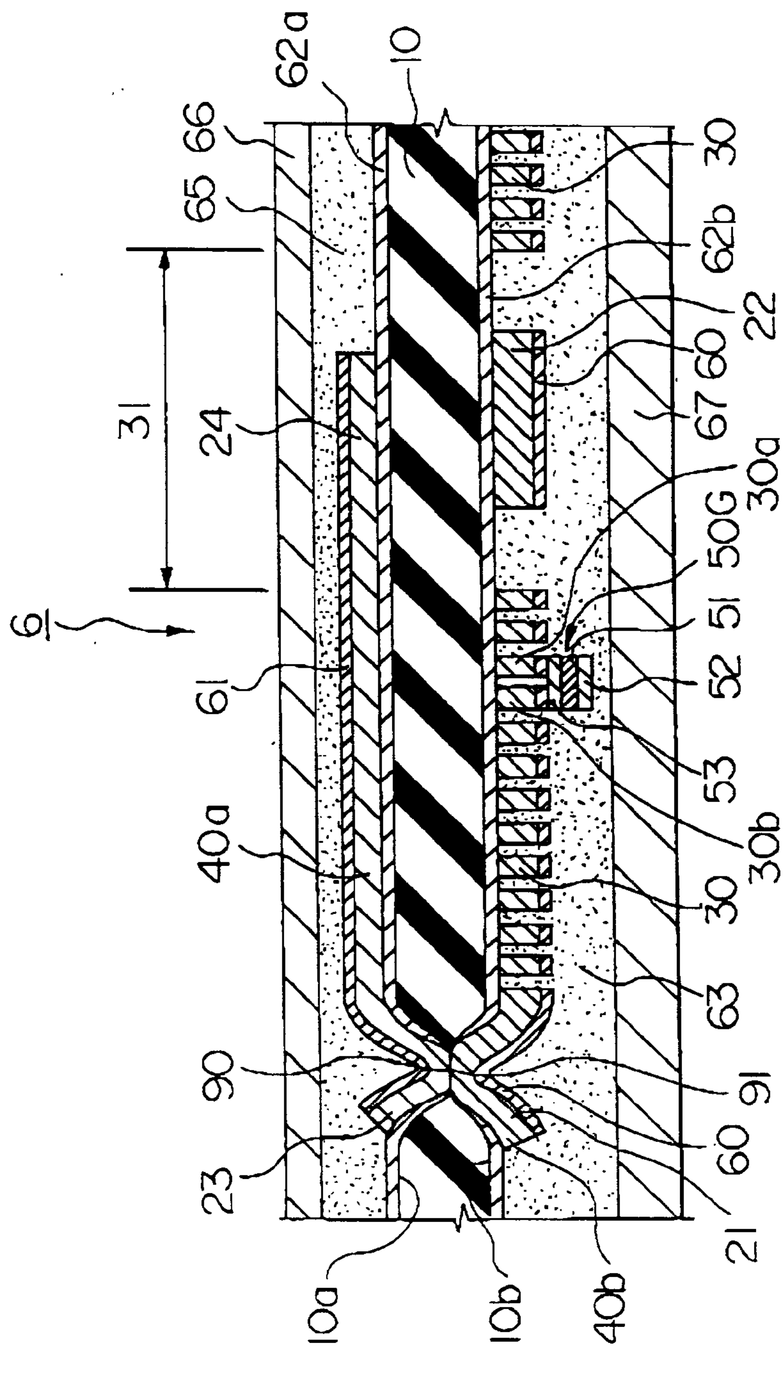


FIG. 13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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 5779

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.6)
A	GB-A-2 234 885 (MONARCH MARKING SYSTEMS,INC.) * abstract; figures 15,20,25 * * page 12, line 21 - page 13, line 10 * ---	1,2	G08B13/24
A	EP-A-0 380 426 (TOKAI METALS CO.,LTD.) * abstract; figures 1,4 * ---	1,14,15	
D,A	US-A-4 498 076 (LICHTBLAU) * the whole document * -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
G08B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	15 November 1995	Danielidis, S

CATEGORY OF CITED DOCUMENTS

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