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(72) Inventeurs/Inventors:
JINNO, RIHO, JP;
NAKAMURA, KAZUYUKI, JP

(73) Propriétaire/Owner:
MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD., JP

(74) Agent: ROBIC

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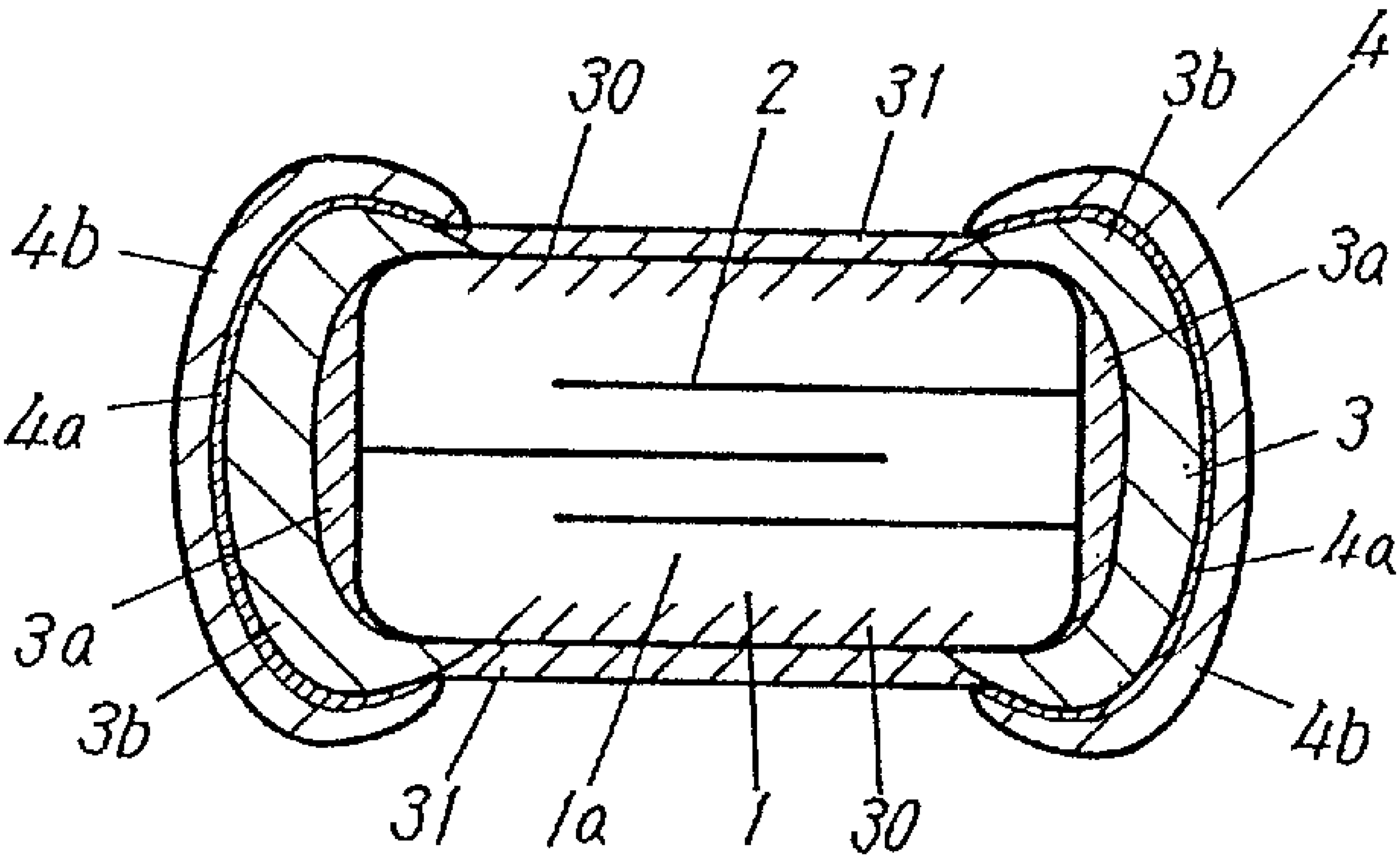
(54) Title: ELECTRONIC COMPONENT AND METHOD OF MANUFACTURE THEREFOR



(57) Abrégé/Abstract:
An electronic part having electrodes whose ends are covered with resin for preventing moisture from entering into the part. The part comprises external electrodes (3) formed on both end faces of a varistor element (1) constituted by alternating ceramic sheets (1a) and internal electrodes (2), an internal insulating layer (30) formed by covering or filling up pores in the element (1) with an Si resin, and an external-surface insulating layer (31) formed so as to coat the external surface of the element (1) and the end sections of the electrodes (3).

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(71) 出願人(米国を除くすべての指定国について)
松下電器産業株式会社
(MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.)[JP/JP]
〒571 大阪府門真市大字門真1006番地 Osaka, (JP)
(72) 発明者;および
(75) 発明者/出願人(米国についてのみ)
神野理穂(JINNO, Riho)[JP/JP]
〒570 大阪府守口市西郷通1丁目24-11-419 Osaka, (JP)
中村和幸(NAKAMURA, Kazuyuki)[JP/JP]
〒061-14 北海道恵庭市福住町2-7-3 Hokkaido, (JP)
(74) 代理人
弁理士 滝本智之, 外(TAKIMOTO, Tomoyuki et al.)
〒571 大阪府門真市大字門真1006番地
松下電器産業株式会社内 Osaka, (JP)

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(54)Title: ELECTRONIC PARTS AND METHOD FOR MANUFACTURING THE SAME

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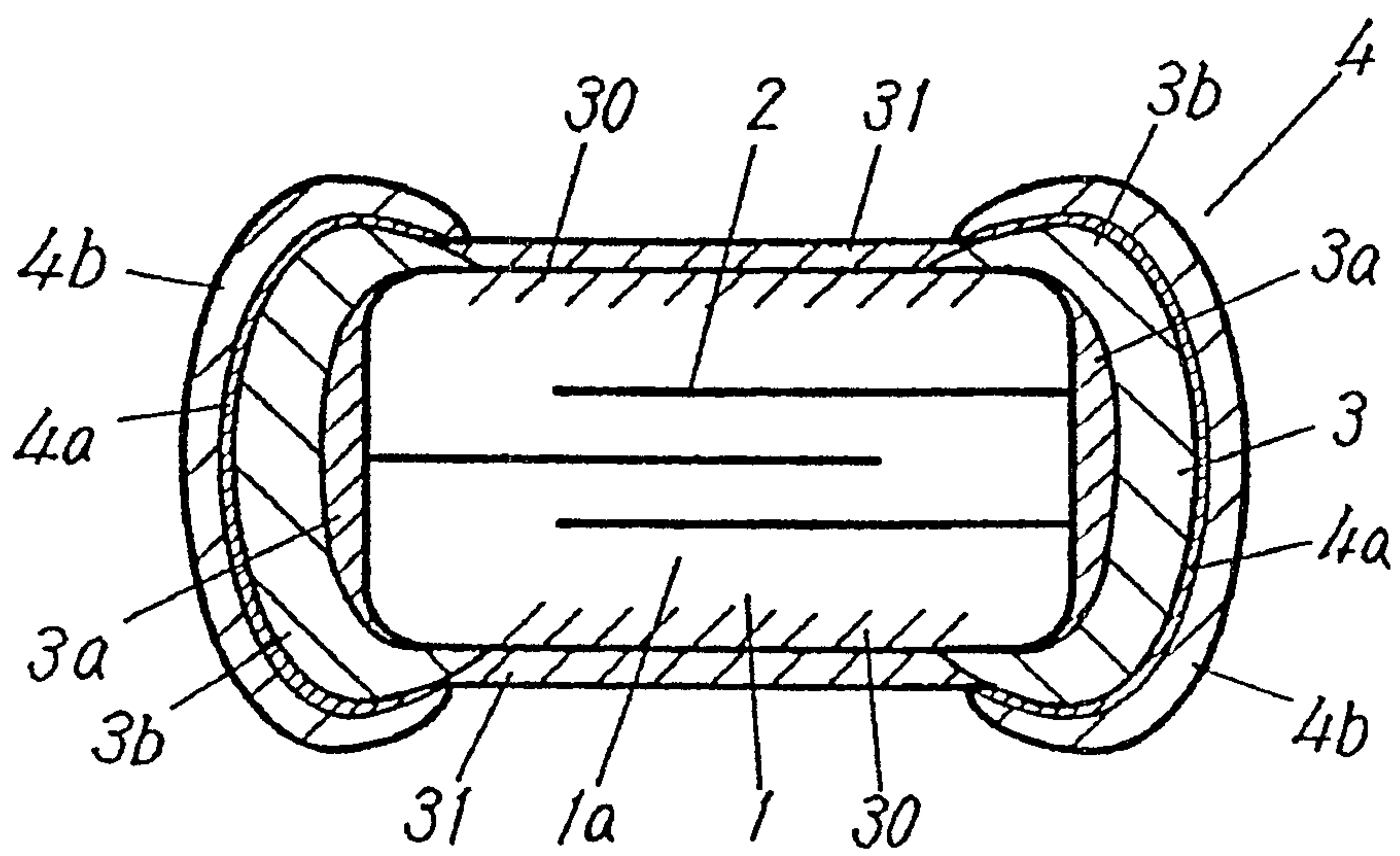

(57) Abstract

An electronic part having electrodes whose ends are covered with resin for preventing moisture from entering into the part. The part comprises external electrodes (3) formed on both end faces of a varistor element (1) constituted by alternating ceramic sheets (1a) and internal electrodes (2), an internal insulating layer (30) formed by covering or filling up pores in the element (1) with an Si resin, and an external-surface insulating layer (31) formed so as to coat the external surface of the element (1) and the end sections of the electrodes (3).

SPECIFICATION

TITLE OF THE INVENTION

Electronic Component and Method of Manufacture Therefor

TECHNICAL FIELD

The present invention relates to electronic components such as a multilayer varistor etc., and a method of manufacturing the same.

BACKGROUND ART

A conventional electronic component having at least a pair of electrodes on the surface of body is impregnated with resin on the surface only in an area where the electrodes are not formed.

The water-resisting quality may be improved by the resin impregnated in the body. However, there is a problem in the above described structure that the water etc. sneaks into through the edge of electrode causing deteriorated characteristics.

DISCLOSURE OF THE INVENTION

The present invention aims to present an electronic component with which the sneaking of water etc. through the electrode edge is prevented by covering the electrode edge with an insulating layer.

According to the present invention, there is provided an electronic component comprising:

a ceramic body having an outer surface;

a pair of electrodes formed on portions of the outer surface of said ceramic body, one electrode of said pair of electrodes being spaced apart from the other electrode of said pair of electrodes, and each electrode of said pair of electrodes having an edge in contact with the outer surface of said ceramic body and facing the edge of the other electrode; and an unitary insulation layer formed on said ceramic body, between said electrodes, said unitary insulation layer having:

an outer portion which is formed over the outer surface of said ceramic body and said edges of said electrodes; and

an inner portion which is formed inside of said ceramic body and said electrodes, and formed underneath said edges of said electrodes,

wherein the unitary insulation layer is composed of an organic material which is impregnated in said ceramic body and said electrodes, said unitary insulation layer preventing peeling off of the edge of said electrodes and also preventing liquid from entering the electronic component.

According to the present invention, there is also provided a method of manufacturing an electronic component comprising steps of:

forming at least a pair of electrodes on a surface of a body at a specified clearance;

contacting the surface of said body with an impregnating solution containing at least an organic substance for covering the surface of said body with said impregnating solution wherein a portion of said impregnating solution is impregnated into said body;

removing a part of the impregnating solution covering the surface of said body;

hardening the organic substance contained in said impregnating solution such that at least a part of said portion of said impregnating solution is separated out of said body and forms an outer surface insulating layer that covers at least a portion of said body, thereby forming the outer surface insulating layer and an inner surface insulating layer simultaneously; and

removing the hardened organic substance on a surface of the pair of electrodes by grinding so that ends of the pair of the electrodes are covered with the hardened organic substance.

With the above described structure in which an insulation layer provided on the surface covers ____________________________________ the edge of electrodes, peeling-off at the edge of electrode is prevented, at the same time the sneaking of water through the electrode edge is also avoided.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a cross sectional view showing a multilayer varistor according to an embodiment of the present invention. Fig.2 is a chart showing manufacturing process steps of a multilayer varistor according to an embodiment of the present invention. Fig.3 is a cross sectional view showing a varistor after silicone varnish impregnation according to an embodiment of the present invention. Fig.4 is a cross sectional view showing a varistor after centrifugal processing according to an embodiment of the present invention. Fig.5 is a cross sectional view showing a varistor after toluene impregnation according to an embodiment of the present invention. Fig.6 is a cross sectional view showing a varistor after silicone resin curing according to an embodiment of the present invention. Fig.7 is a cross sectional view showing a varistor after grinding according to an embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

In the following, an electronic component according to the present invention and a method of manufacturing the same is described in detail referring to drawings.

As shown in Fig. 1, there are plural internal electrodes 2 made mainly of nickel (Ni), inside varistor 1. These internal electrodes 2 are alternately pulled out to respective ends of varistor 1 to be electrically connected with external electrodes 3. The external electrode 3 is comprised of at least two layers; an inner layer 3a is made mainly of Ni, an outer layer 3b is made mainly of silver (Ag).

A ceramic sheet 1a existing between and outside the internal electrodes 2 is made mainly of $SrTiO_3$, containing Nb_2O_5, SiO_2 etc. as subordinate component. A within-the-surface insulation layer 30 is a layer formed by covering the porous surface inside the varistor 1 or filling the pore with silicone resin. An outside-the-surface insulation layer 31 is a layer of silicone resin covering the edge of external electrode 3. On the surface of external electrode 3 is a layer of plating 4, comprised of Ni layer 4a and solder layer 4b.

As shown in Fig. 2, the ceramic sheet 1a is manufactured through the process (11); mixing of raw materials, calcination, crashing, slurrying and forming in a sheet form. The ceramic sheet 1a and internal electrodes 2 are laminated (12), cut (13), binder is removed (14), chamfered (15), and the edge is curved. Inner layer 3a of external electrode 3 is formed through coating (16) and sintering (17) at 1200 - 1300℃ in reducing atmosphere. Then, outer layer 3b is formed through coating (18) and heating (19) at 800 - 850℃ for reoxidizing. A completely dried varistor 1 is immersed (20) in silicone varnish containing 75% toluene as resolvent to have the varistor 1 impregnated with silicone varnish.

Varistor 1 is pressurized (21) by 6 - 1500kg/cm^2 for e.g. 2 minutes while being immersed in the silicone varnish in order to have the varistor 1 impregnated further with the silicone varnish, and then restored to the normal atmospheric pressure, at which the multilayer varistor is put on service. The varistor 1 at this stage is covered thick with silicone varnish 5 for the entire surface, with the vaistor 1 and the external electrodes 3 impregnated with silicone varnish 5, as shown in Fig. 3. The pressurizing force may be determined according to the density of varistor 1; namely, varistor 1 of a higher density may be pressurized with a higher force for the easier impregnation. In the case of a varistor whose main component is ZnO, the density of which is high and the pressurizing force may be raised to 500 - 1500kg/cm².

The varistor 1 is taken out of the silicone varnish, and put into a metal basket (or metal net etc.) to be set on a centrifugal separator having inner diameter of e.g. 60cm running at 500 - 1500 r/min. (22 in Fig. 2) for removing most portion of unnecessary silicone varnish sticking on the surface of varistor 1, as shown in Fig. 4. Then, the metal basket containing the varistor is immersed in toluene (23), vibrated for 5 - 60sec., taken out, and quickly heated at e.g. 60℃ for removing the toluene sticking on the surface of varistor 1, as shown in Fig. 5. Instead of immersing in toluene, varistor 1 may be taken out of the metal basket to be put in SiO_2 powder, which is inert to the silicone varnish, to have unnecessary silicone varnish 5 sticking on the surface of varistor 1 absorbed, and then separating the varistor 1 using a sieve or such other devices. Through the above described procedure, unnecessary portion of silicone varnish 5 sticking on the surface of varistor 1 is removed.

And then, varistor 1 is put on a metal net to be heated at a temperature (approximately 125 - 200℃) higher than the curing temperature of silicone resin contained in the silicone varnish 5 for curing (24) the silicone resin. When, a part of the silicone resin impregnated within external electrodes 3 and inside of varistor 1 is separated out to cover the surface, and a varistor 1 as shown in Fig. 6 is obtained. After this, varistor 1 is put into a container of e.g. polyethylene together with an abrasive of SiC and water, the container sealed, and provided with mechanical movement such as revolution, vibration etc. for grinding (25) the surface, in order to remove the silicone resin covering the surface of external electrodes 3 to a degree so as plating and other succeeding process steps are not ill-affected. During the surface grinding (25), the silicone resin on the surface of external electrodes 3 is selectively removed by a mechanical stress given to varistor 1 due to a fact that the adhesion strength of silicone resin after curing is stronger with respect to varistor 1 than with the surface of external electrode 3. Some of the silicone resin may remain in the inner surface of external electrode 3, the electrical contact of external electrode 3 is not affected by the silicone resin.

The surface of external electrode 3 of varistor 1 is plated (26) to obtain a multilayer varistor as illustrated in Fig. 1.

As described in the above, a multilayer varistor having enhanced water-resisting property is implemented by the formation of a silicone resin-impregnated within-the-surface insulation layer 30 inside the varistor 1, with which multilayer varistor the peeling-off at the edge of external electrode 3 is also prevented by the formation of an outside-the-surface insulation layer 31, and the external electrode 3 does not ill-affect plating (26) and other post processes.

Now in the following, description will be made on some of the noticeable items regarding a multilayer varistor according to the present embodiment and its manufacturing method.

Referring to Fig. 1, by forming an outside-the-surface insulation layer 31 so as it covers the edge of external electrodes 3 formed at the ends of varistor 1 covering a part of the side surface, the sneaking of plating liquid, water etc. into inside of varistor 1 through the boundary between external electrode 3 and varistor 1 is prevented.

As an outside-the-surface insulation layer 31 and a within-the-surface insulation layer 30 have glossy surface, whether or not the within-the-surface insulation layer 30 and the outside-the-surface insulation layer 31 are formed can be visually identified by inspecting the surface of a multilayer varistor. This makes the selection work easier.

Although silicone resin has been exemplified as the insulation material for forming the outside-the-surface insulation layer 31 and the within-the-surface insulation layer 30, other resins may of course be used provided that they satisfy a certain heat resistivity, insulating property, water-repellent property, and low water-absorbing property; either one, or more than one, of epoxy resin, acrylic resin, polybutadiene resin, phenolic resin, etc. may be used for the purpose, besides the silicone resin.

Instead of the resin, or in mixture with the resin, at least one kind of metal alkoxide selected from the group of silicon, titanium, aluminium, zirconium, yttrium and magnesium may be used to obtain a same effect.

When the metal alkoxide is used, the impregnating solution is made with alcohol or other such solvents that dissolve metal alkoxide.

The within-the-surface insulation layer 30 has preferably a greatest possible thickness in so far as the characteristics of a multilayer varistor is not affected, at the same time the thinnest part of the within-the-surface insulation layer 30 of silicone resin after curing is preferably equal to or thicker than 10 μm. This is adjustable through the selection of the viscosity of silicone varnish 5, the rate of solvent and the pressurizing force.

The effect of pressurizing is enhanced by providing a state where the pressure is lower than the normal atmospheric pressure prior to the step of pressurizing for impregnation of silicone varnish 5 into varistor 1.

Besides SiO_2 exemplified as the powder inert to silicone varnish 5, other powders may also be used provided that they do not react with the impregnation solution to be impregnated into varistor 1; either one, or a mixture, of ZrO_2, Al_2O_3, MgO may serve a same purpose.

A harder outside-the-surface insulation layer 31 is formed by thoroughly removing a solvent contained in silicone varnish 5 impregnated into varistor 1 by heating, prior to curing, at a temperature lower than boiling point.

The moisture-resisting property may be improved further by repeating the process steps from the immersion in silicone varnish 5 through the surface grinding for plural times, preferably twice. By so doing, the silicone resin is impregnated further into inside of varistor 1.

It is preferred that the edge of body has a curved shape. This shape alleviates the concentration of stress to one part of external electrode 3 when removing organic substance on external electrode 3 by grinding.

Although in the present embodiment a multilayer varistor using strontium titanium oxide as the main component is exemplified, the same effects are implementable also with a multilayer varistor using zinc oxide as the main component, as well as ceramic thermistors, capacitors, resistors and other electronic components in general. Not only in the multilayer type electronic components, the present invention implements the same effects in electronic components of any shapes, for example a disk shape electronic component.

INDUSTRIAL APPLICABILITY

The insulation layer formed by impregnation into inside of the surface prevents deterioration of the moisture-resisting property, and the insulation layer formed on the surface enhances the strength of electrode preventing the peeling-off at the edge of electrode. Furthermore, this contributes to prevent the sneaking of moisture etc. into the inside through the edge of electrode. The moisture-resisting property is enhanced a step further.

WHAT IS CLAIMED IS:

1. An electronic component comprising:

a ceramic body having an outer surface;

a pair of electrodes formed on portions of the outer surface of said ceramic body, one electrode of said pair of electrodes being spaced apart from the other electrode of said pair of electrodes, and each electrode of said pair of electrodes having an edge in contact with the outer surface of said ceramic body and facing the edge of the other electrode; and

an unitary insulation layer formed on said ceramic body, between said electrodes, said unitary insulation layer having:

an outer portion which is formed over the outer surface of said ceramic body and said edges of said electrodes; and

an inner portion which is formed inside of said ceramic body and said electrodes, and formed underneath said edges of said electrodes,

wherein the unitary insulation layer is composed of an organic material which is impregnated in said ceramic body and said electrodes, said unitary insulation layer preventing peeling off of the edge of said electrodes and also preventing liquid from entering the electronic component.

2. The electronic component of claim 1, wherein the unitary insulation layer is formed with at least one of metal alkoxide and resin.

3. The electronic component of claim 1, wherein the unitary insulation layer is formed with metal alkoxide, the metal alkoxide comprising at least one selected from the group consisting of silicon alkoxide, titanium alkoxide, aluminium alkoxide, zirconium alkoxide, yttrium alkoxide and magnesium alkoxide.

4. The electronic component of claim 1, wherein the unitary insulation layer is formed with resin, the resin being at least one selected from

the group consisting of silicone resin, epoxy resin, acrylic resin, polybutadiene resin and phenolic resin.

5. The electronic component of claim 1, wherein a thickness of the unitary insulation layer impregnated into the body is not less than 10 µm.

6. The electronic component of claim 1, wherein a thickness of the unitary insulation layer on the body is less than a greatest thickness of the pair of electrodes contacting the unitary insulation layer.

7. The electronic component of claim 1, wherein an end of the body has a curved shape.

8. A method of manufacturing an electronic component comprising steps of:

forming at least a pair of electrodes on a surface of a body at a specified clearance;

contacting the surface of said body with an impregnating solution containing at least an organic substance for covering the surface of said body with said impregnating solution wherein a portion of said impregnating solution is impregnated into said body;

removing a part of the impregnating solution covering the surface of said body;

hardening the organic substance contained in said impregnating solution such that at least a part of said portion of said impregnating solution is separated out of said body and forms an outer surface insulating layer that covers at least a portion of said body, thereby forming the outer surface insulating layer and an inner surface insulating layer simultaneously; and

removing the hardened organic substance on a surface of the pair of electrodes by grinding so that ends of the pair of the electrodes are covered with the hardened organic substance.

9. The method of manufacturing an electronic component of claim 8, wherein the step of contacting the body with the impregnating solution is repeated for plural times.

10. The method of manufacturing an electronic component of claim 8, wherein the organic substance contains at least one of metal alkoxide and resin.

11. The method of manufacturing an electronic component of claim 8, wherein the organic substance contains metal alkoxide, the metal alkoxide comprising at least one selected from the group consisting of silicon alkoxide, titanium alkoxide, aluminium alkoxide, zirconium alkoxide, yttrium alkoxide and magnesium alkoxide.

12. The method of manufacturing an electronic component of claim 8, wherein the organic substance contains resin, the resin being at least one selected from the group consisting of silicone resin, epoxy resin, acrylic resin, polybutadiene resin and phenolic resin.

13. The method of manufacturing an electronic component of claim 8, wherein the body is pressurized while being contacted with the impregnating solution.

14. The method of manufacturing an electronic component of claim 8, wherein the organic substance on the surface of the body is removed by at least one means of centrifugal separation, washing with an organics-dissolving liquid, and contacting with a powder inert to the impregnating solution.

15. The method of manufacturing an electronic component of claim 14, wherein the powder contains at least one selected from the group consisting of SiO_2, ZrO_2, Al_2O_3 and MgO.

16. The method of manufacturing an electronic component of claim 8, wherein the grinding is conducted at least by moving a container in which the body and a liquid are contained.

17. The method of manufacturing an electronic component of claim 8, wherein the pair of electrodes is formed after an edge of the body is made to have a curved shape.

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Fig. 1

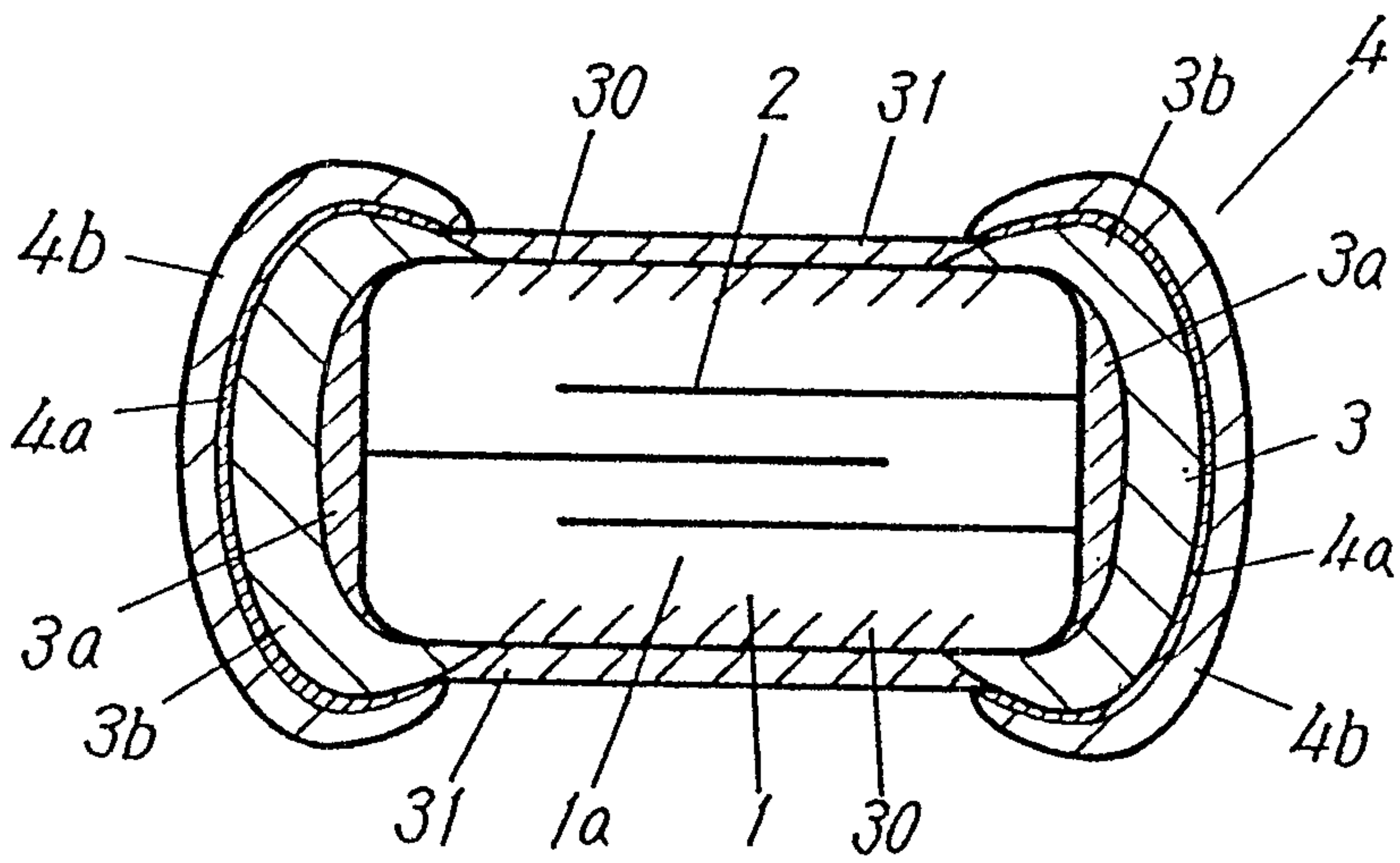


FIG. 2

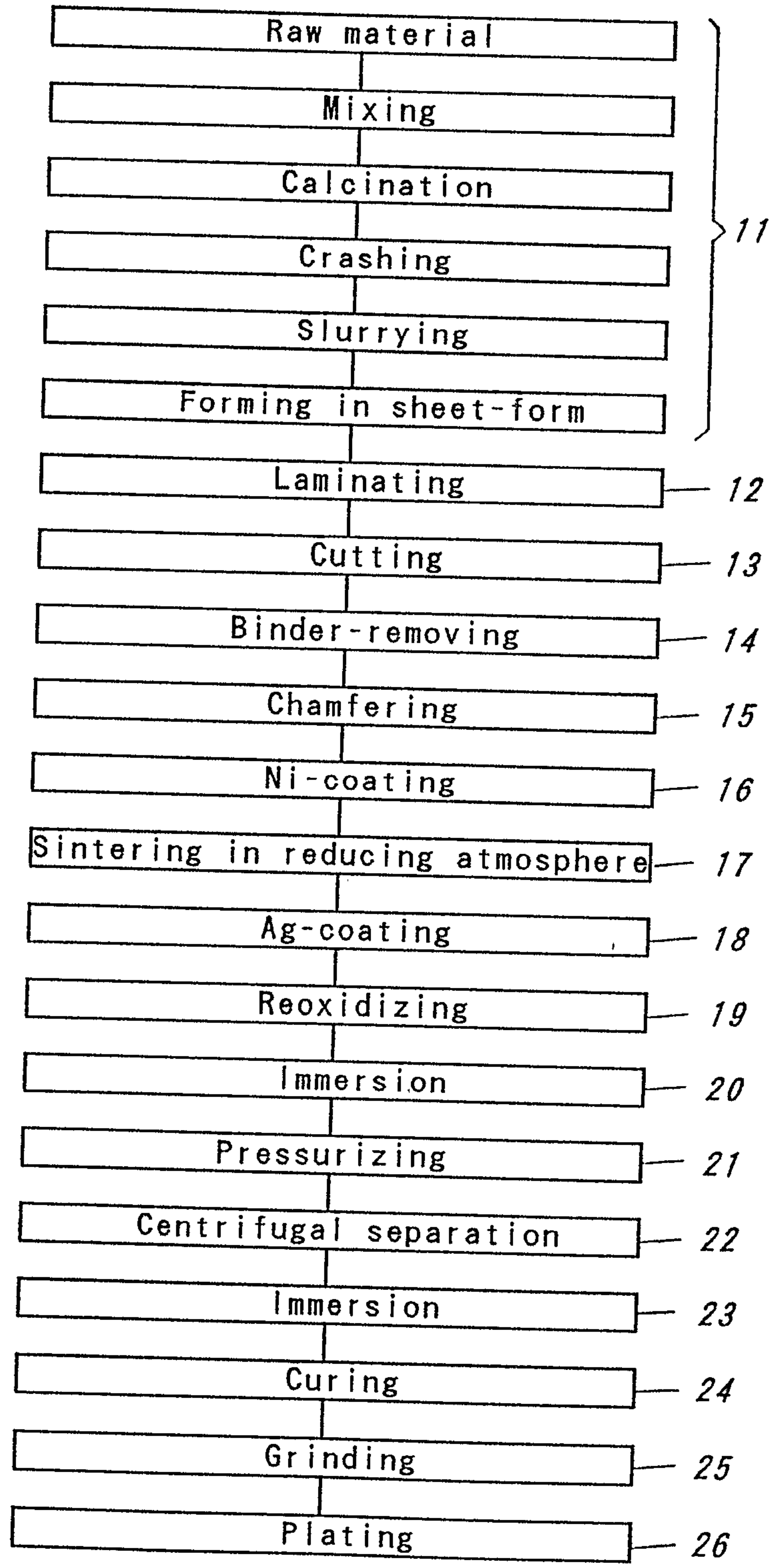

Raw material
Mixing
Calcination
Crashing
Slurrying
Forming in sheet-form
11
Laminating
12
Cutting
13
Binder-removing
14
Chamfering
15
Ni-coating
16
Sintering in reducing atmosphere
17
Ag-coating
18
Reoxidizing
19
Immersion
20
Pressurizing
21
Centrifugal separation
22
Immersion
23
Curing
24
Grinding
25
Plating
26

Fig. 3

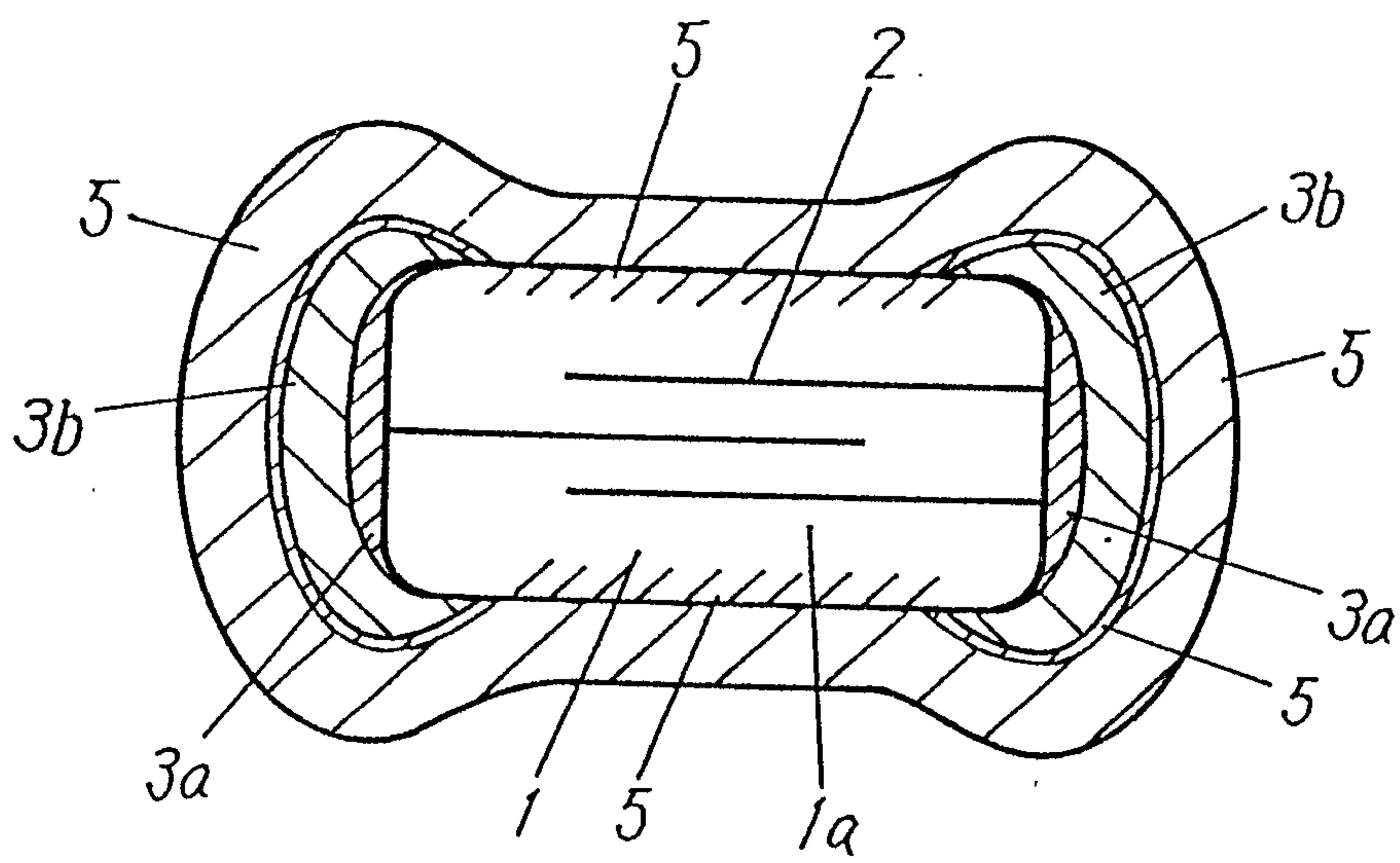


Fig. 4

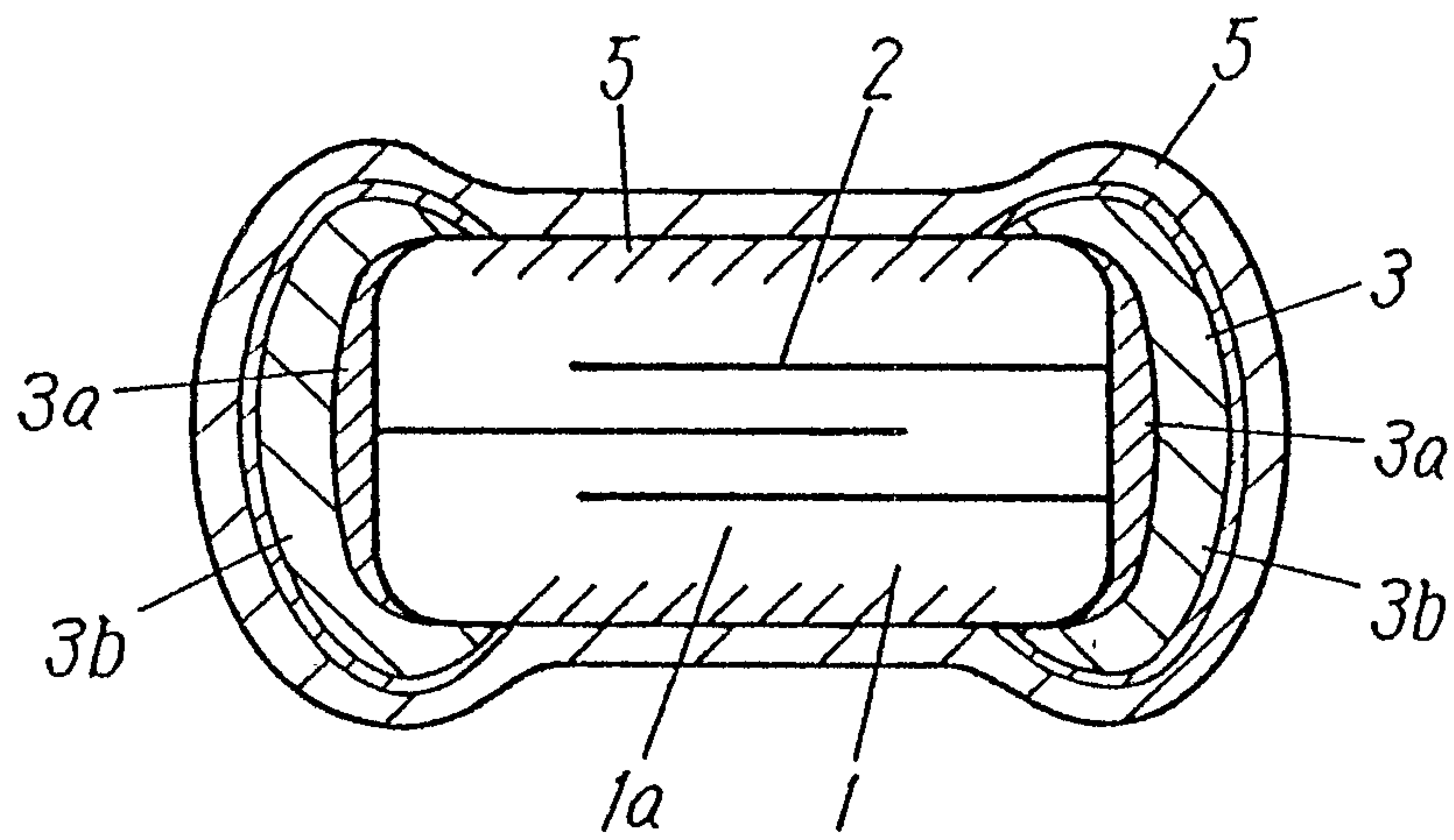


Fig.5

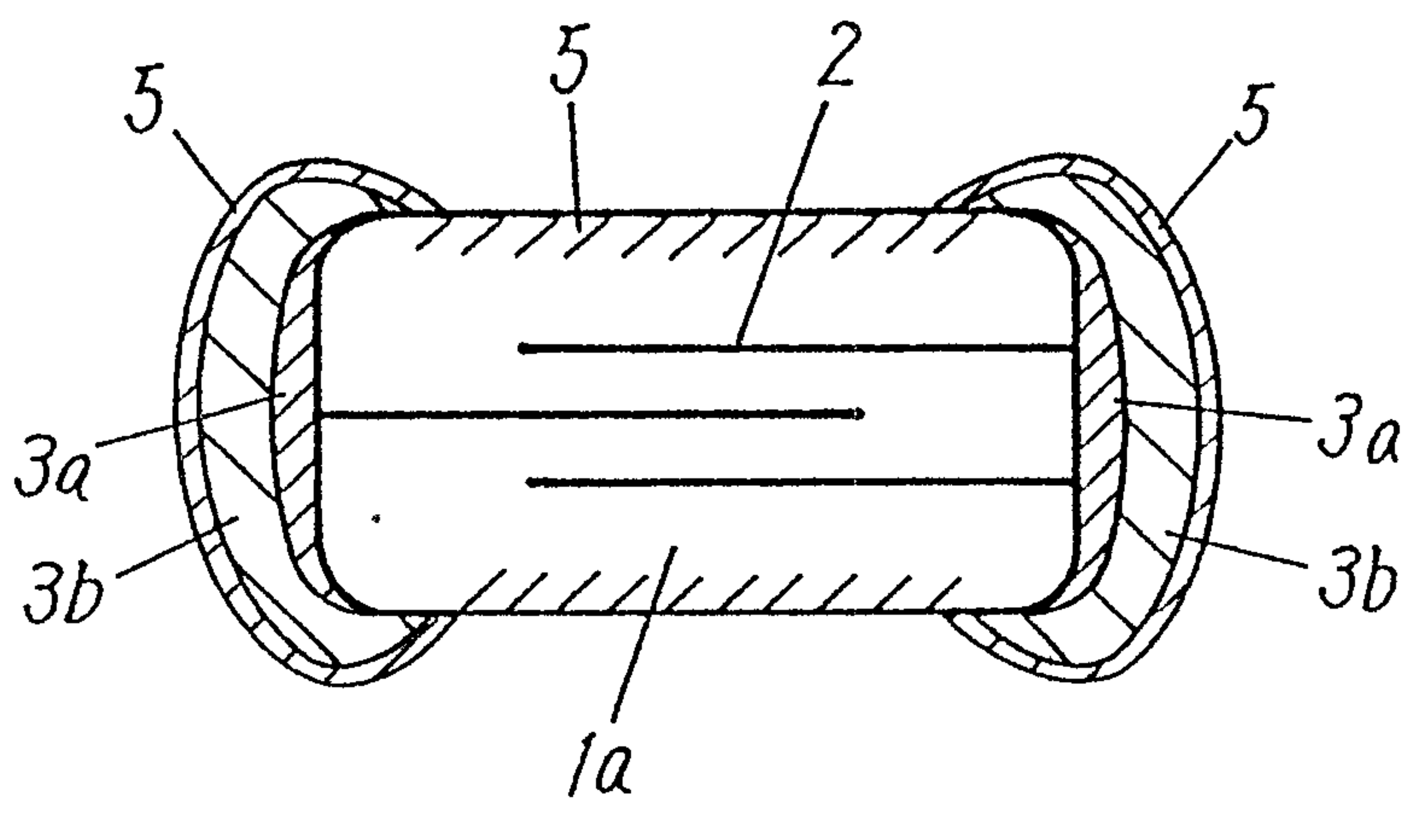


Fig. 6

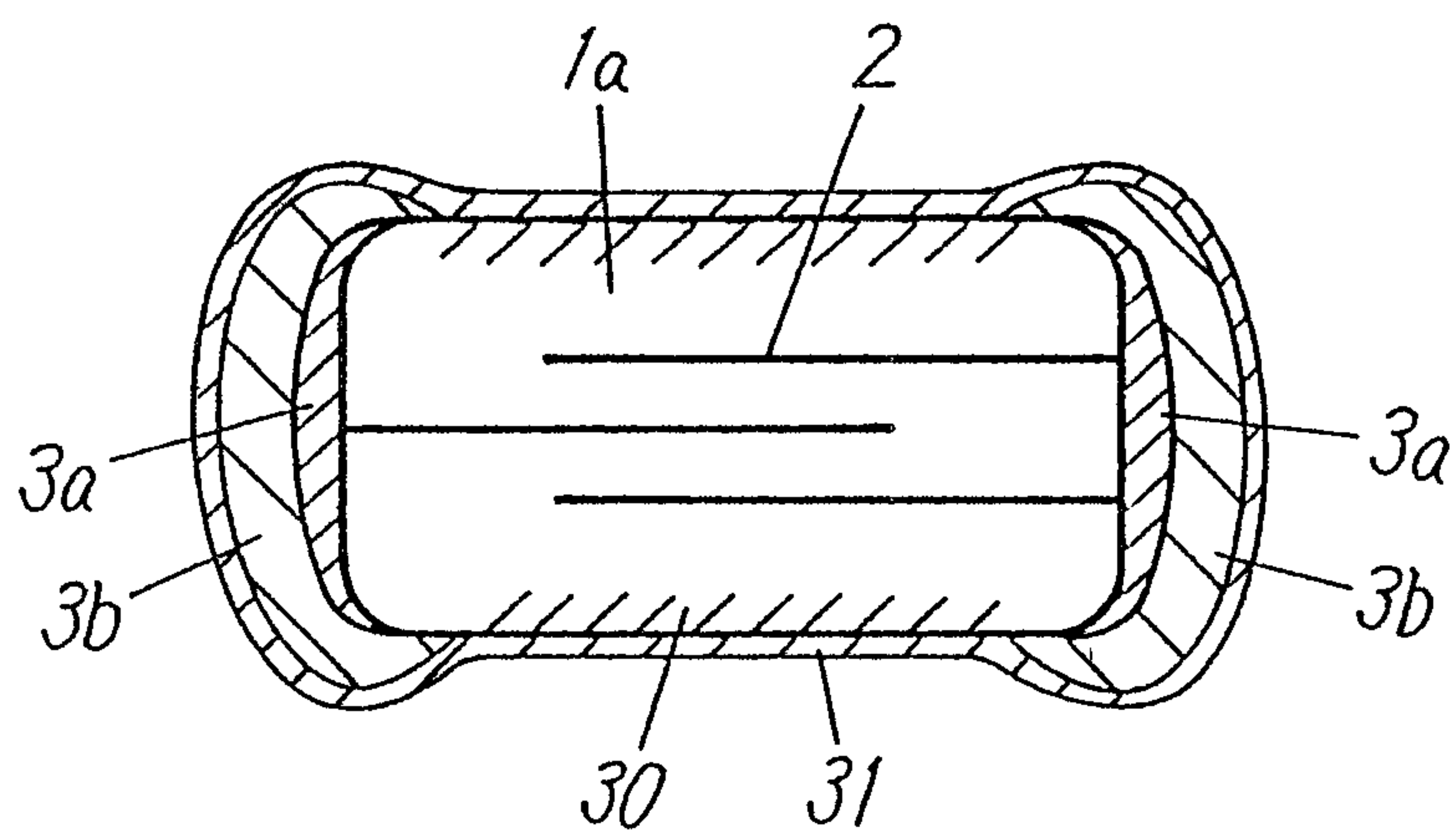
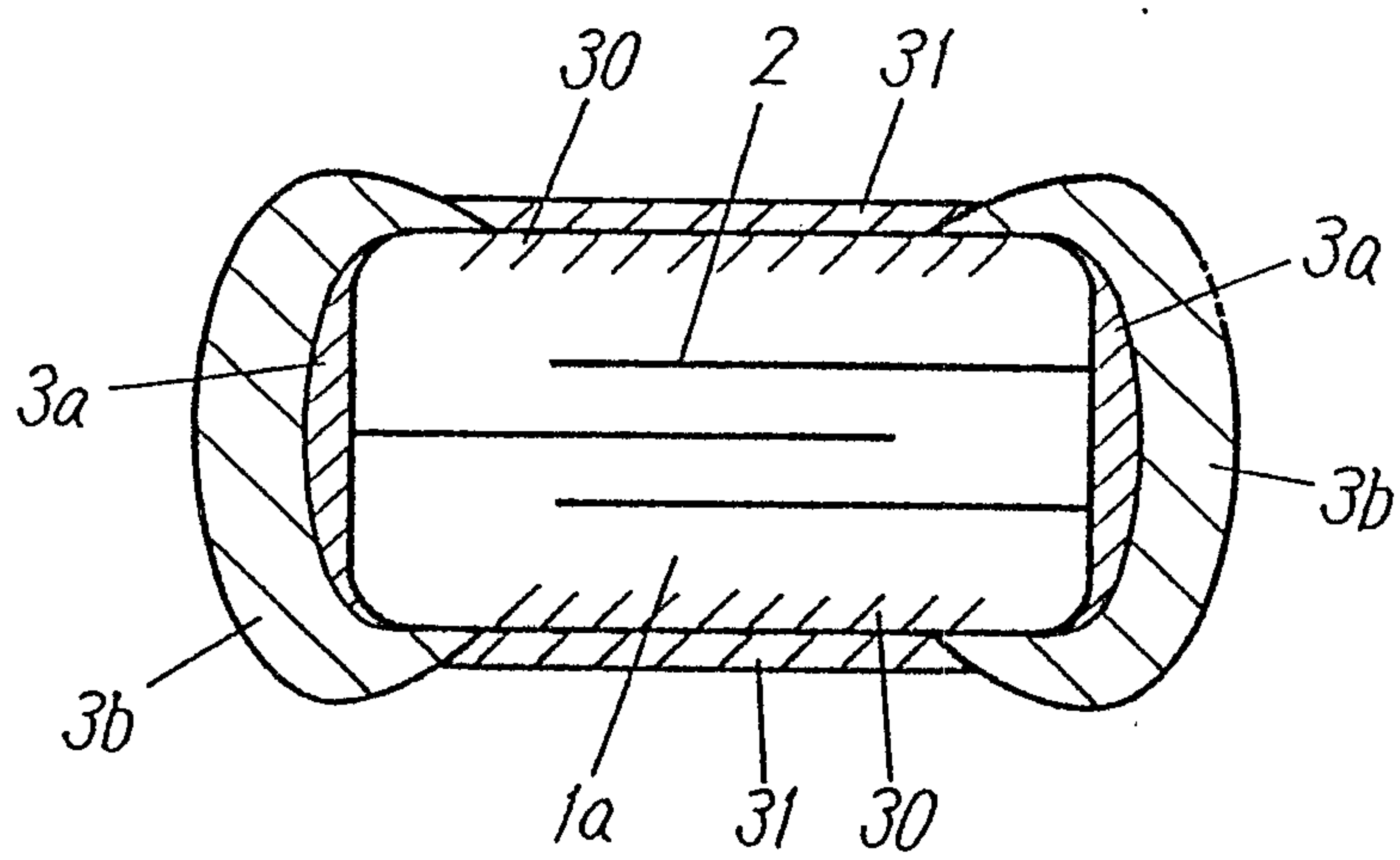
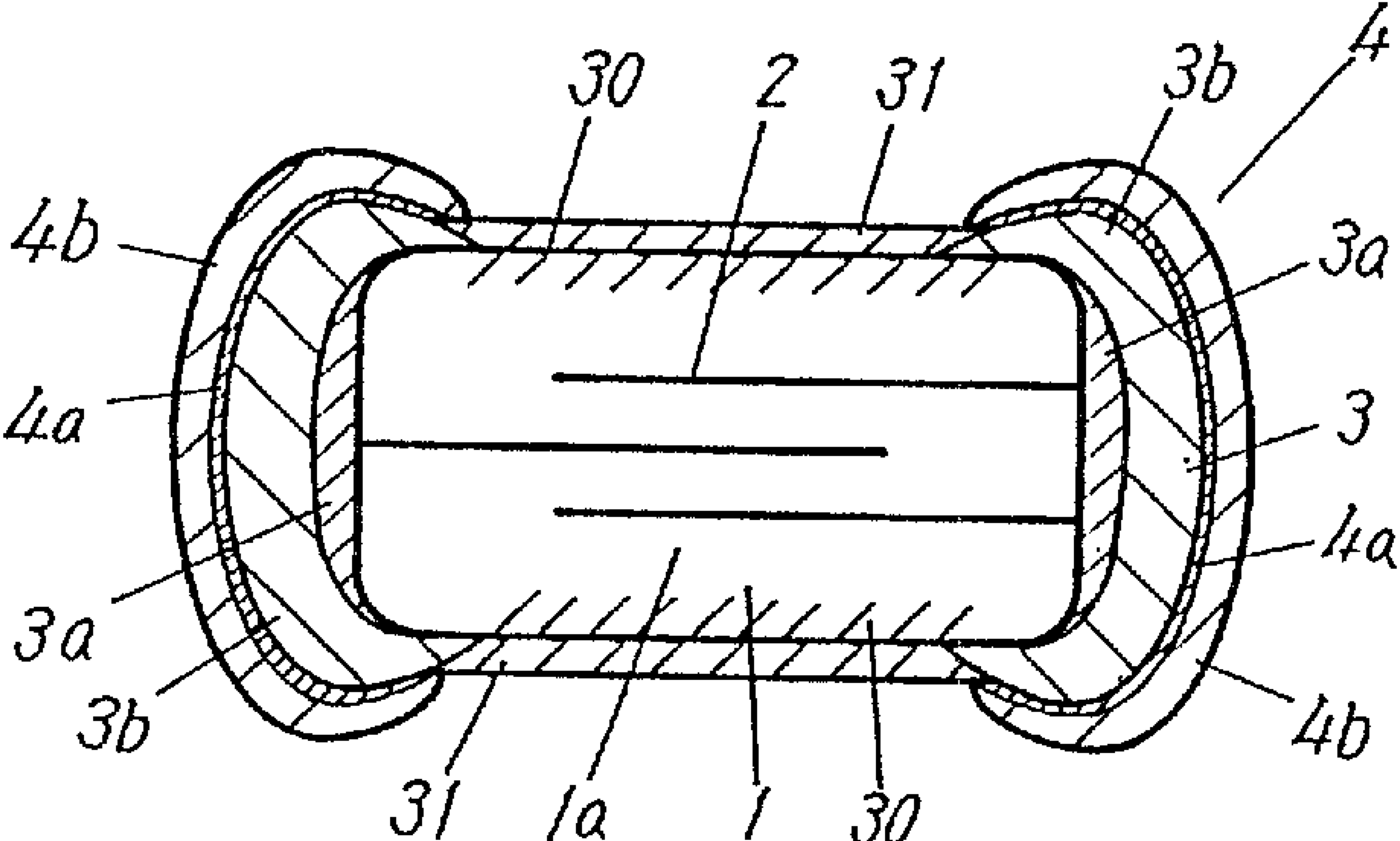


Fig.7



EXPLANATION OF THE NOTATIONS OF THE DRAWINGS

1	Varistor
2	Internal electrode
3	External electrode
3a	Inner layer
3b	Outer layer
4	Plating layer
4a	Ni plating
4b	Solder plating
5	Silicone varnish
30	Within-the-surface insulation layer
31	Outside-the-surface insulation layer



30
2
31
3b
4
4b
3a
4a
3
3a
4a
3b
4b
31
1a
1
30