(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 505 947 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **92104916.9**

(51) Int. Cl.5: **H01F 31/00**

(22) Date of filing: **20.03.92**

(30) Priority: **29.03.91 JP 66492/91**
06.12.91 JP 100834/91 U

(43) Date of publication of application:
30.09.92 Bulletin 92/40

(84) Designated Contracting States:
CH DE ES FR GB IT LI SE

(71) Applicant: **KABUSHIKI KAISHA SANYO DENKI SEISAKUSHO**
4-1, Kamitsuchii 2-chome
Gifu-shi Gifu(JP)

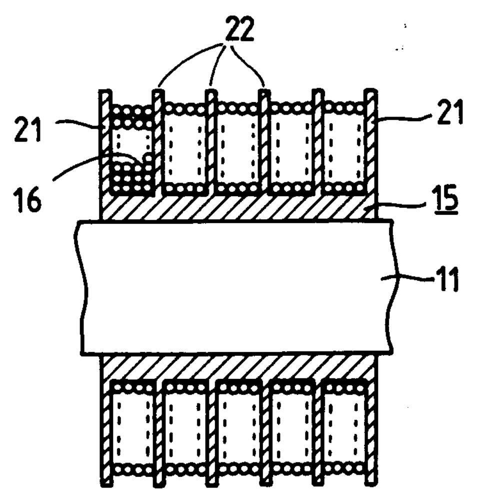
(72) Inventor: **Amano, Shintetsu**
10, Wakamiya-cho 2-chome
Gifu-shi, Gifu(JP)
Inventor: **Hori, Isao**
2, Ooborakirigaoka 3-chome
Gifu-shi, Gifu(JP)
Inventor: **Ichimiya, Fumio**
1835-35, Shimoukai
Gifu-shi, Gifu(JP)
Inventor: **Matsui, Toshihiro**
779, Hora
Gifu-shi, Gifu(JP)

(74) Representative: **Blumbach Weser Bergen**
Kramer Zwirner Hoffmann Patentanwälte
Radeckestrasse 43
W-8000 München 60(DE)

(54) **Transformer for gas tube sign.**

(57) A low-voltage winding and a high-voltage winding are wound on a main iron core (11). Between these low-voltage and high-voltage windings, a leakage iron core is interpositioned. A minimum of 5 flanges (22) is formed integratedly on a bobbin (15) of the high-voltage winding , in equal intervals. Between these flanges, the high-voltage winding is wound in split sections. Thus, the number of connectable back border tubes can be increased by one or more from that with a conventional transformer of a non-split type winding.

FIG. 5



EP 0 505 947 A2

Rank Xerox (UK) Business Services

BACKGROUND OF THE INVENTION

The present invention relates to a transformer used for discharging a neon gas tube or an argon gas tube by stepping up AC power to a high voltage.

Fig. 1 shows a simple composition of a transformer for gas tube sign, which will hereinafter be called a neon transformer. A low-voltage winding (primary winding) 12 is wound on a main iron core 11 and, separately from the low-voltage winding 12, a high-voltage winding (secondary winding) 13 is wound on the main iron core 11. A leakage iron core 14 is disposed between the low-voltage winding 12 and the high-voltage winding 13. The main iron core 11 is structured so that a closed magnetic circuit is composed. By applying AC power, for instance utility AC power is applied between both ends of the low-voltage winding 12 to generate a high voltage between both ends of the high-voltage winding 13. The neon transformer is operated to discharge and light up a neon gas tube or an argon gas tube not illustrated in Fig. 1 by said high voltage.

A conventional high-voltage winding 13 is shown in Fig. 2 where the main iron core 11 penetrates through a bobbin 15 on which an insulated copper wire 16 is wrapped in order while intercalating interlayer paper 17 between each layer. The interlayer paper 17 is intended to have complete insulation between adjacent layers of the copper wire 16.

A voltage waveform generated across both ends of the high-voltage winding of the neon transformer, when the gas tube is lighted up, is shown in Fig. 3, in which transient vibration occurs at the beginning of each half cycle of input AC power and then it turns to a smooth waveform. A period T_A represents the duration of the transient vibration, in which discharging is so unstable as creating flickering. Discharging is stabilized in a following period T_B. If the transient vibration period T_A is long in excess, the system will not be suitable for a gas tube sign. With a shorter gas tube connected to a neon transformer, the transient vibration period T_A becomes longer.

As a result of various experiments and study on the transient vibration period T_A, the following conclusions have been derived. That is, the high-voltage winding 13 of the neon transformer is shown by a circuit of Fig. 4. In Fig. 4, each inductance L for a turn of the copper wire 16 is connected in series to each other. There is a capacitance Cs between both ends of each inductance L and a transformer casing (or iron core). There is also a line capacitance Cw between each inductance L and a parallel adjacent line. Such a distributed constant circuit as described above exists for each winding layer. In addition, a capacitance C_L may also exist between each winding layer, according to the concept of equivalent circuit. In operation, a gas tube 18 is connected between both terminals of said entire distributed constant circuit.

In the circuit shown in Fig. 4, each capacitance is charged alternately with positive and negative charges every half cycle of AC power. Each of such charging is activated in a resonance state of the capacitance and the inductance, while creating transient vibration. At the beginning of each half cycle of AC power, a transient vibration period T_A is created as shown in Fig. 3. Energy charged in all capacitances Cs, Cw and C_L is expressed by $CV^2/2$ (where C and V represent a total capacitance and a voltage across both ends of the high-voltage winding 13, respectively). Therefore, the larger the total capacitance C, the higher the voltage becomes while resulting in a larger amount of charges supplied to each capacitance. Also, time to supply the charges is made longer. In other words, the larger the capacitance component of the high-voltage winding 13, the longer the transient vibration period T_A results. Furthermore, a higher voltage V brings about a longer transient vibration period T_A.

With a gas tube 18 in a larger tube length, the amount of electrical loading becomes larger. Thus, Q of the resonance circuit for transient vibration is correspondingly lower, with which transient vibration becomes less attenuating. As a result, the transient vibration period T_A becomes longer.

An object of the present invention is to provide a neon transformer of which the lighting capability can be improved while making the length of a connectable gas tube (number of gas tubes) larger.

Another object of the present invention is to offer such a neon transformer as easily manufactured.

SUMMARY OF THE INVENTION

According to the present invention, with such a neon transformer as a low-voltage winding and a high-voltage winding are wound separately on a main iron core and there is a leakage iron core disposed between the low-voltage winding and high-voltage winding, the high-voltage winding is wound in 4 or more split sections without intercalating any interlayer paper.

However, it is intended to have the length of a neon gas tube or argon gas tube larger than a unit length for the purpose of easily designing a neon gas tube sign indication system, than a case of using a conventional neon transformer with the high-voltage winding in nonsplit type. In this regard, any of the following neon transformers is assumed.

(1) A neon transformer where a high voltage of about 8000 V or higher is obtained between output terminals of the high-voltage winding and, when the output terminals are shorted, an output current of about 20 mA or more is obtained while a gas tube with a neon gas charged is to be connected between said output terminals.

(2) A neon transformer where a high voltage of about 6000 V or higher is obtained between output terminals of the high-voltage winding and, when the output terminals are shorted, an output current of about 30 mA or more is obtained while a gas tube with a neon gas charged is to be connected between said output terminals.

(3) A neon transformer where a high voltage of about 5000 V or higher is obtained between output terminals of the high-voltage winding and, when the output terminals are shorted, an output current of about 20 mA or more is obtained while a gas tube with an argon gas and a very small quantity of mercury charged is to be connected between said output terminals.

(4) A neon transformer where a high voltage of about 4000 V or higher is obtained between output terminals of the high-voltage winding and, when the output terminals are shorted, an output current of about 30 mA or more is obtained while a gas tube with an argon gas and a very small quantity of mercury charged is to be connected between said output terminals.

In addition, according to the present invention, the high-voltage winding is wound on a coil bobbin comprising a cylindrical drum with a plurality of flanges disposed in an axial direction on the outer periphery thereof. By means of these flanges, the high-voltage winding is split and wound on the drum. On plate surfaces of the flanges, formed are compound impregnation accelerating portions that are shaped in an elevated or recessed form while extending from the outer fringes thereof up to the drum. Said compound impregnation accelerating portions are composed in extension on the peripheral surface of the drum.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view for briefly showing a conventional neon transformer;

Fig. 2 is a section view indicating a wound state of the high-voltage winding thereof;

Fig. 3 is a view depicting a waveform of a high-voltage output from a conventional neon transformer;

Fig. 4 is a diagram of an equivalent circuit for the high-voltage winding of a conventional neon transformer;

Fig. 5 is a section view denoting an example of the high-voltage winding, an essential portion of the present invention;

Fig. 6 is an equivalent circuit diagram of the high-voltage winding shown in Fig. 5;

Figs. 7A and 7B are views for showing waveforms of high-voltage outputs in embodiments of the present invention, respectively;

Figs. 8A and 8B are views that depict waveforms of high-voltage outputs in embodiments of the present invention, respectively;

Fig. 9 is a sketch typically showing a neon transformer of which the neutral point of the high-voltage winding is grounded;

Fig. 10 is an equivalent circuit diagram for the transformer of Fig. 9;

Fig. 11 is a section view showing a state that a neon transformer according to the present invention is encased;

Fig. 12 is an oblique view for depicting an example of the appearance of the high-voltage winding, an essential portion of the present invention;

Fig. 13 is a front view of Fig. 12;

Fig. 14 is an oblique view for showing the appearance of the high-voltage winding, an essential portion of the present invention; and

Fig. 15 is a front view of Fig. 14.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 5 shows an example of the high-voltage winding, an essential portion of the embodiment according to the present invention. A main iron core 11 is penetrated into a cylindrical drum 15a of a bobbin 15. The bobbin 15 is composed in such a manner that, on the cylindrical drum 15a, there are flanges 21 at both ends and 4 flanges 22 provided integratedly on the outer periphery of the drum 15a while dividing a space between the flanges 21 at both ends into 5 equal sections in the axial direction. An insulated copper wire (for example, a polyvinyl formal or other low-dielectric-constant material insulated copper wire) 16 is wrapped in order by a predetermined number of layers without intercalating any interlayer paper, in a terminal section as separated by the flanges on the outer periphery of the drum 15a. Next, the copper wire is wound for the adjacent section thereto, while winding the copper wire sequentially in following sections in the same way. In other words, the high-voltage winding 13 is divided into 5 sections where the copper wire is wrapped in this embodiment.

Since the embodiment is composed as described above, an equivalent circuit of said high-voltage winding 13, corresponding to Fig. 4, becomes as shown in Fig. 6. An inductance L of a turn of the winding is the same as that of a conventional transformer. Also, a capacitance Cs to the casing and a capacitance Cw between lines are also the same as those in a conventional transformer. However, an interlayer capacitance of the embodiment becomes a value peculiar to each section of divisional winding, namely a capacitance C_L' smaller than a conventional value. In addition, there is an intersection capacitance Cp that did not exist conventionally.

As described above, the interlayer capacitance C_L' becomes one fifth of the conventional interlayer capacitance C_L shown in Fig. 4, by ignoring the affect of the interlayer paper. Since five these sections are connected in series, the whole interlayer capacitance becomes 1/25 of the conventional interlayer capacitance C_L. Because no interlayer paper is used actually according to the present invention, the value becomes larger than the above. A capacitance C of the neon transformer, when looked from the load side, is determined mainly by C_L' and Cw. Therefore, according to the present invention, the capacitance C of the high-voltage winding 13 is made smaller than conventional values. Consequently, a transient vibration period T_A of the embodiment becomes shorter than conventional values. Correspondingly, a lighting capability of a neon tube is improved to have a length of a connectable gas tube (or a number of gas tubes) made larger.

An experiment was performed in such conditions as an output voltage of the high-voltage winding 13 of 15 kV, a short-circuit current of 20 mA (a maximum output of a standard model) for a neon transformer with a load of 10 back border tubes (straight neon gas tubes of 15 mm in diameter, 1.5 m in length each with a neon gas charged at a pressure of 9 mmHg) connected in series to each other. That is, the length of loaded neon gas tubes was made 15 m while splitting the winding into 5 sections as shown in Fig. 5. At that time, an output voltage waveform of the high-voltage winding 13 became as shown in Fig. 7A. To the contrary, when the high-voltage winding 13 was split into 2 sections of winding while using interlayer paper and keeping all other conditions the same as above. At that time, an output voltage waveform of the high-voltage winding became as shown in Fig. 7B. Comparing both waveforms, it is understood that the transient vibration period T_A of the former is considerably shorter than that of the latter.

When 4-split wound high-voltage winding shown in Fig. 5 was used with a load of 11 back border tubes (a total length of 16.5 m) and maintaining all other conditions the same as before for another experiment. At that time, an output waveform became as shown in Fig. 8A. Although the transient vibration period T_A in this case became longer than that of the waveform shown in Fig. 7A, it was still shorter than that of the waveform in Fig. 7B. By increasing the number of divisions for the split winding of the high-voltage winding 13, the entire capacitance C can be made further smaller thereby improving a lighting capability. In another experiment with a number of divisions of 10, a load of 10 back border tubes and keeping all other conditions the same as before, a high-voltage output waveform became as shown in Fig. 6B. In fact, the transient vibration period T_A of the waveform is further shorter than that of the waveform shown in Fig. 7A.

Still another experiment was performed with an output voltage 9 kV from the high-voltage winding and short-circuit currents (secondary short-circuit currents) of 20 mA and 30 mA with the output terminals thereof shorted. Several gas tubes with neon gases or gas tubes with argon gases and very small quantities of mercury charged were connected to the transformer. At that time, the number of split sections in the high-voltage winding was varied. Thus, the relationship between the number of sections and the maximum lengths of lighted tubes was obtained by the experiment. The result was as follows.

Maximum length of lighted tube (m) - Output voltage 9 kV						
Secondary short-circuit current	Type of tube	No. of sections				
		1	2	4	5	10
20 mA	Neon Argon	8.9 13.0	9.5 14.2	10.6 15.8	10.8 16.2	11.6 17.3
30 mA	Neon Argon	12.1 17.3	12.9 18.5	14.3 20.8	14.7 21.5	15.7 22.9

"1" of No. of sections above indicates that the winding was wrapped without splitting. Interlayer paper was used for section Nos. 1 and 2 but not used for the other cases. The loads used for the experiment included back border tubes together with other tubes in various lengths of 0.1 - 1.4 m varied by 10 cm intervals for finely adjusting lengths of the load. For measurement, an approximate maximum length of a lighted tube was calculated according to the expectation for each neon transformer. A lighting state was observed from a load length slightly smaller than each calculated tube length and the tube length was gradually increased in 10 cm intervals. Thus, a length immediately before changing from a stabilized state to an unstabilized state was recorded as a maximum length of lighted tube.

According to the result of this experiment, it is understood that the larger the number of sections for the high-voltage winding, the longer the maximum length of lighted tube becomes regardless of neon or argon gas tube and secondary short-circuit current. Since the discharge inception and retention voltages of an argon gas tube are lower than those of a neon gas tube, a maximum length of lighted tube for an argon gas tube is about 1.5 times larger than that of a neon gas tube also with a split winding. The larger the secondary short-circuit current regardless of a neon or argon gas tube, the larger the energy can be supplied into the tube, so the maximum length of lighted tube becomes larger as also easily understood.

According to a conventional practice, a neon transformer with 2-split winding is also used to reduce an interlayer voltage. Although a lighting capability of an ordinary neon transformer is expressed in a maximum length of lighted tube when a rated voltage is applied, the length of all connected neon or argon gas tubes is actually limited at a maximum length about 0.8 - 0.9 times as large as said maximum length of lighted tube in considering performance variances in manufacturing the neon or argon gas tubes, regulations of power supply voltage and the fluctuation of the characteristics of the neon transformer and so on. Furthermore, since a practical construction work is normally performed in the units of each back border tube (1.5 m long), a transformer with a 2-split winding is classified into the same lighting capability as that of a transformer with single-section winding as long as a field work is concerned. In addition, it is not revealed in the prior art that, by using a 2-split winding, a lighting capability of the transformer is increased from that of a transformer with a single-section winding.

Still another experiment was performed by varying a voltage across output terminals (secondary voltage) of the high-voltage winding using neon gas tubes, while obtaining maximum lengths of lighted tube with a secondary short-circuit current of 30 mA. The result became as follows. The number of split sections for the high-voltage winding was 4.

Maximum length of lighted tube (m) -- 4 sections								
Secondary voltage (kV)	3	4	5	6	8	9	12	15
30 mA Neon	4.3	6.2	7.8	9.3	12.7	14.3	19.4	24.4

As a result, it is revealed that the higher the secondary voltage, the larger the maximum length of lighted tube results.

As described before, a conventional work to construct a gas tube sign apparatus is performed in the unit of each back border tube (1.5 m). In addition, neon transformers practically used are operated by various secondary output voltages and secondary short-circuit currents. From this viewpoint, another experiment was performed to determine conditions for that maximum lengths of lighted tube became longer than the length of a back border tube (1.5 m) per section. As a result, it was revealed that the maximum number of sections for the high-voltage winding was 4 in all cases, with the following other conditions.

Maximum length of lighted tube (unit in m)

Secondary voltage		8 kV	5 kV	6 kV	4 kV
No. of sections	Secondary short-circuit current	20 mA	20 mA	30 mA	30 mA
1	Maximum length	7.9	7.1	7.8	7.5
4		9.4	8.7	9.3	9.0
Type of tube		Neon	Argon	Neon	Argon

Hence, it is revealed that a necessary condition with neon gas tubes is a minimum number of split sections of 4 in the high-voltage winding with neon gas tubes in a minimum secondary voltage of 8 kV and a minimum secondary short-circuit current of 20 mA or those in a minimum secondary voltage of 6 kV and a minimum secondary short-circuit current of 30 mA. With argon gas tubes, a minimum necessary number of split sections for the high-voltage winding is 4 in a minimum secondary voltage of 5 kV and a minimum secondary short-circuit current of 20 mA or in a minimum secondary voltage of 4 kV and a minimum secondary short-circuit current of 30 mA.

Methods to connect the high-voltage winding 13 in operation are classified into three types; first, it is not connected to the ground; second, one end of the high-voltage winding 13 is connected to the transformer casing that is grounded; and a center point thereof is grounded because harmful electric shock may occur with a secondary short-circuit current of 25 mA or more, thirdly. With the neutral point earthed, connection details are shown in Fig. 9 where a low-voltage winding 12 is wound on the main iron core 11. In both sides thereof, split high-voltage windings 13a and 13b are wound on the main iron core 11, while leakage iron cores 15a and 15b being positioned in between the low-voltage winding 12 and the high-voltage windings 13a and 13b. A connection point between the high-voltage windings 13a and 13b, namely a center point of the high-voltage winding 13 is connected to for instance the transformer casing and electrically grounded as shown in Fig. 10. When the present invention applies to this embodiment, each of the high-voltage windings 13a and 13b is wound in two or more split sections because the high-voltage winding 13 is divided into the high-voltage windings 13a and 13b.

The neon transformer according to the present invention as described above is housed in a cylindrical casing 31 of which one end is opened and the other end is closed, as a transformer unit 32 as shown in Fig. 11. In said transformer unit 32, a 3-leg iron core is made of silicon steel sheets. In a center leg thereof, namely in an upper part of the main iron core 11, the high-voltage winding 13 is wounded and supported thereby. In addition, a space remaining in the casing 31, except for the transformer unit 32, is filled with an insulating compound 35. Said insulating compound 35 comprises a low-viscosity resin (Epoxy, etc.) and a filler (insulation particles such as silicon sand, etc.) which are filled in the casing 31 and then hardened by heating.

As shown in Figs. 12 and 13, a coil bobbin 15 comprises a drum 15a with a square-cylindrical section, on which a copper wire 16 is wound, and flanges 21 and 22 formed in plurality (in this case, 7 pieces) equipped on the outer periphery of said drum 15a. Said flanges 21 and 22 are formed substantially in a square shape with equal intervals along an axial direction of the drum 15a. Grooves 36 are provided as recesses to accelerate the impregnation of the insulating compound 35 from the outer fringes of each opposite surface of the flanges 21 and 22, up to the outer periphery of the drum 15a. Each groove 36 is formed to have a semi-circular section. Two rows of the grooves are constructed in each quadrant of the square flanges 21 and 22. In addition, the grooves 36 are structured so that each groove 36 on both surfaces of a flange 22 is dislocated from each other. Also, each groove 36 is extended as a groove 37 on the outer periphery of the drum 15a in an axial direction thereof from a position on the drum 15a to another position thereon while arriving at another flange.

The diameter of the copper wire 16 is 50 μm to 100 μm, approximately and wound on the bobbin 15 by for instance several million turns. A winding start portion 16a of the copper wire 16 is located near the drum 15a and a winding end portion 16b is positioned near an outer fringe of the flange 21. Furthermore, a pair of lead wires 16c led out of the copper wire 16 is connected to a pair of output terminals 38 in the secondary side as shown in Fig. 11.

Referring to Fig. 11, a low-voltage winding 12 is wound and supported in a lower part of the high-voltage winding 13, with a separating gap. Lead wires (not illustrated) of said low-voltage winding 12 are connected to a power-factor improvement capacitor 39 and input lead wires, not illustrated.

In between the low-voltage winding 12 and the high-voltage winding 13, a pair of insulation spacers 41 is inserted and disposed to insulate them. In addition, a pair of leakage iron cores 14 is mounted and disposed between said insulation spacers 41 and the low-voltage winding 12. In an upper part of the transformer unit 32, there is provided an input unit 42 incorporating a fuse, etc. and a bushing 43 to insulate the output terminals 38.

When the transformer unit 32, etc. are housed into the casing 31 while charging the insulating compound 35 into the remaining space, the insulating compound 35 is impregnated between each turn of the wire of the high-voltage winding 13. The insulating compound 35 is impregnated from the flanges 21 and 22 toward the drum 15a through the grooves 36 and 37. Consequently, the high-voltage winding 13 is completely and satisfactorily impregnated with the insulating compound 35 between each turn of the wires which are completely insulated eventually.

If such grooves 36 and 37 are not provided, the winding must be insulated by impregnating a varnish under a reduced pressure. At that time, the winding should be treated through various processes including preparatory drying, impregnation of varnish and hardening by heating, requiring a minimum processing time as long as three days. However, by providing the grooves 36 and 37, such a varnish insulating process can be omitted and the transformer unit 32 can be housed directly into the casing 31 and then insulated. Thus, a work efficiency can be improved while reducing a manufacturing cost in the stage of products in process.

As an accelerating portion to accelerate the impregnation of the insulating compound 35, elevations 44 and 45 shown in Fig. 14 and 15 may also be provided in place of the grooves 36 and 37. Said elevations 44 and 45 have semi-circular sections and are formed in three rows in each quadrant of the flanges 21 and 22 (4 quadrants in this embodiment). Moreover, the elevations 44 are projected in opposition to each other on both surfaces of a flange 22. In addition, the copper wire 10 is wound on the drum 15a so that it engages with the peaks of the elevations 44 and 45.

The shapes of the grooves 36 and 37 and the elevations 44 and 45 may also be shaped otherwise, for instance in a triangular section. It is also possible to provide a plurality of sets of several grooves 36 and 37 in contact with each other. Furthermore, the grooves 37 and the elevations 45 can also be formed obliquely to an axial center. The grooves 36 and 37 may also be formed substantially on all flanges.

According to the present invention as described above, the high-voltage winding is wound in four or more split sections. Therefore, an interlayer capacitance can be reduced considerably. Thereby, a maximum length of lighted tube can be made larger than that of a conventional winding, by a length of a back border tube. Therefore, the number of neon gas tubes or argon gas tubes required for a gas tube sign board can be reduced resulting in more easy and simple construction work. Although a split-winding system applies, an automatic winding machine can be used because no interlayer paper is used, so manufacturing becomes easier.

The larger the secondary short-circuit current, the more the lighting capability is enhanced. Consequently, the length of lighted tube becomes longer even at a lower voltage. Also with argon gas tubes, it becomes possible to light up a longer total tube length than that of neon gas tubes. Hence, the effect of the present invention is significant even at a lower voltage. The larger the tube diameter and the lower the gas pressure (mmHg) with the same type of gas used for the tubes, the larger the length of lighted tube results. Therefore, the effect of the present invention is more significant.

Furthermore, a varnish-impregnating process is no longer required according to the present invention, by constructing a recessed or elevated accelerating portion to accelerate impregnating an insulating compound. Thus, the neon transformer can be manufactured at lower cost during shorter manufacturing time.

Claims

1. A transformer for gas tube sign comprising:

a main iron core,

a low-voltage winding and a high-voltage winding that are wound on said main iron core, and

a leakage iron core disposed between said low-voltage winding and said high-voltage winding,

wherein a high voltage of about 8,000 V or higher is obtained between output terminals of said high-voltage winding between which is to be connected a gas tube with a neon gas charged and, when said output terminals are shorted, an output current of about 20 mA or more is obtained,

characterized in that said high-voltage winding is wound in four or more split sections without intercalating any interlayer paper.

2. A transformer for gas tube sign comprising:

a main iron core,

a low-voltage winding and a high-voltage winding that are wound on said main iron core, and

a leakage iron core disposed between said low-voltage winding and said high-voltage winding,

wherein a high voltage of about 6,000 V of higher is obtained between output terminals of said high-voltage winding between which is to be connected a gas tube with a neon gas charged and, when said output terminals are shorted, an output current of about 30 mA or more is obtained,

characterized in that said high-voltage winding is wound in four or more split sections without intercalating any interlayer paper.

3. A transformer for gas tube sign comprising:

a main iron core,

a low-voltage winding and a high-voltage winding that are wound on said high-voltage winding,

wherein a high voltage of about 5,000 V or higher is obtained between output terminals of said high-voltage winding between which is to be connected a gas tube with an argon gas and a very small quantity of mercury charged and, when said output terminals are shorted, an output current of about 20 mA or more is obtained,

characterized in that said high-voltage winding is wound in four or more split sections without intercalating any interlayer paper.

4. A transformer for gas tube sign comprising:

a main iron core,

a low-voltage winding and a high-voltage winding that are wound on said high-voltage winding,

wherein a high voltage of about 4,000 V or higher is obtained between output terminals of said high-voltage winding between which is to be connected a gas tube with an argon gas and a very small quantity of mercury charged and, when said output terminals are shorted, an output current of about 30 mA or more is obtained,

characterized in that said high-voltage winding is wound in four or more split sections without intercalating any interlayer paper.

5. The transformer of any one of Claim 1, 2, 3 or 4, wherein

said high-voltage winding is wound on a coil bobbin comprising a cylindrical drum and a plurality of flanges disposed in an axial direction on an outer periphery of said drum,

said flanges split said high-voltage winding which is wound on said drum, and

an elevated or recessed compound impregnation accelerating portion is formed on plate surfaces of said flanges in such a range as from the outer fringes thereof to said drum.

6. The transformer of Claim 5, wherein said compound impregnation accelerating portion is formed by extending on a peripheral surface of said drum.

FIG. 1

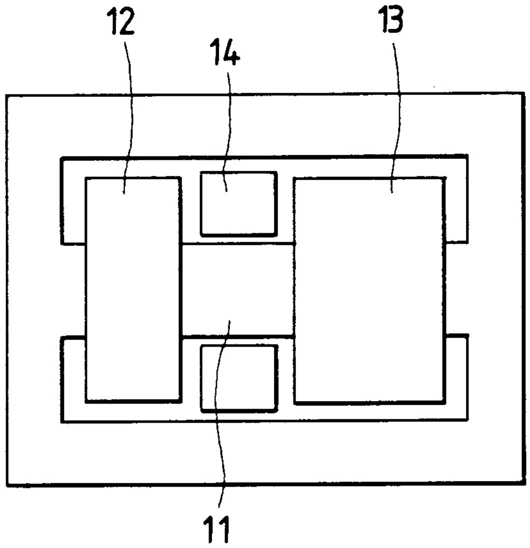


FIG. 2

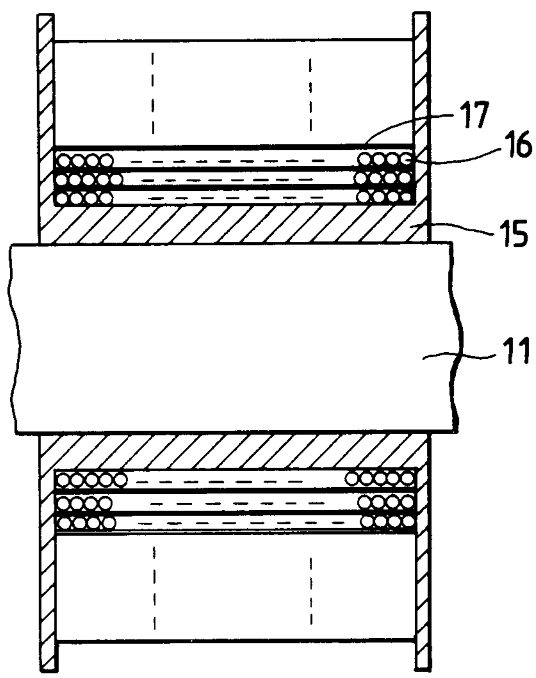


FIG. 3

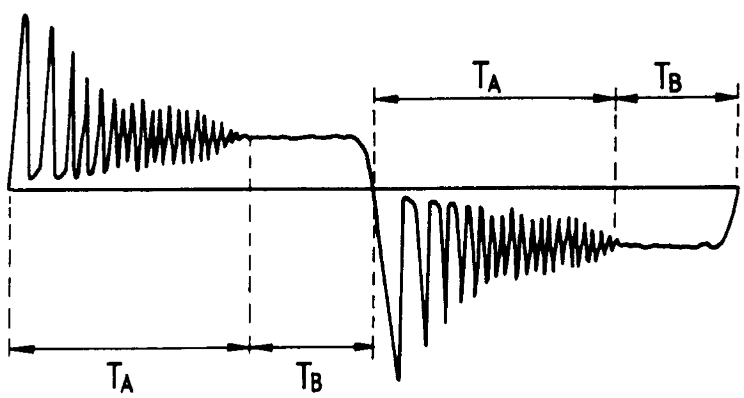


FIG. 4

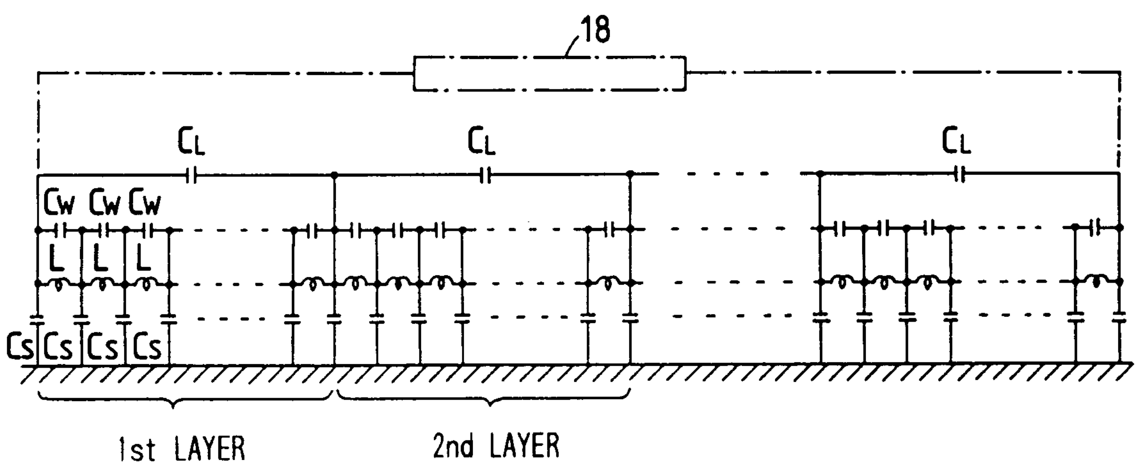


FIG. 5

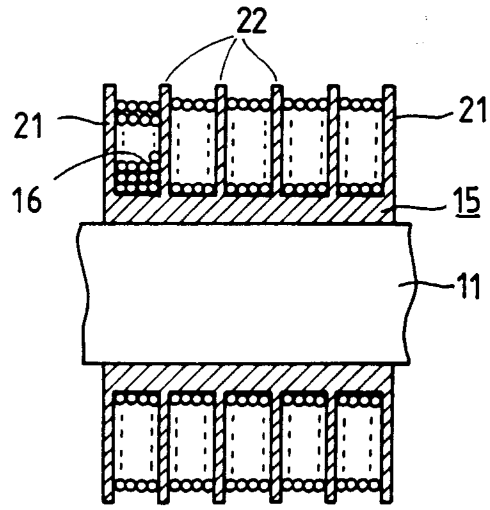

22
21
21
16
15
11

FIG. 6

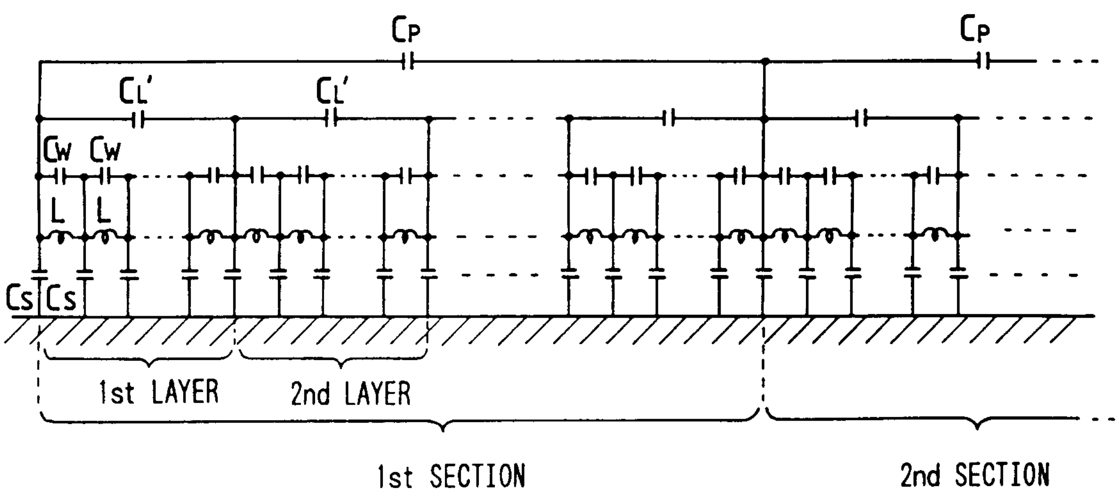

CP
CP
CL'
CL'
CW CW
L L
Cs Cs
1st LAYER
2nd LAYER
1st SECTION
2nd SECTION

FIG. 7A

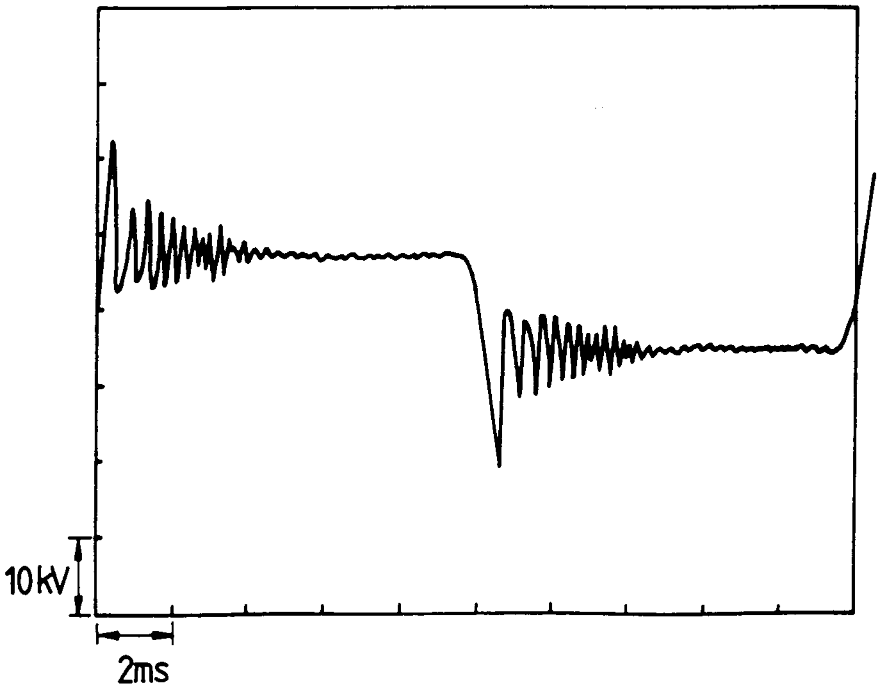


FIG. 7B

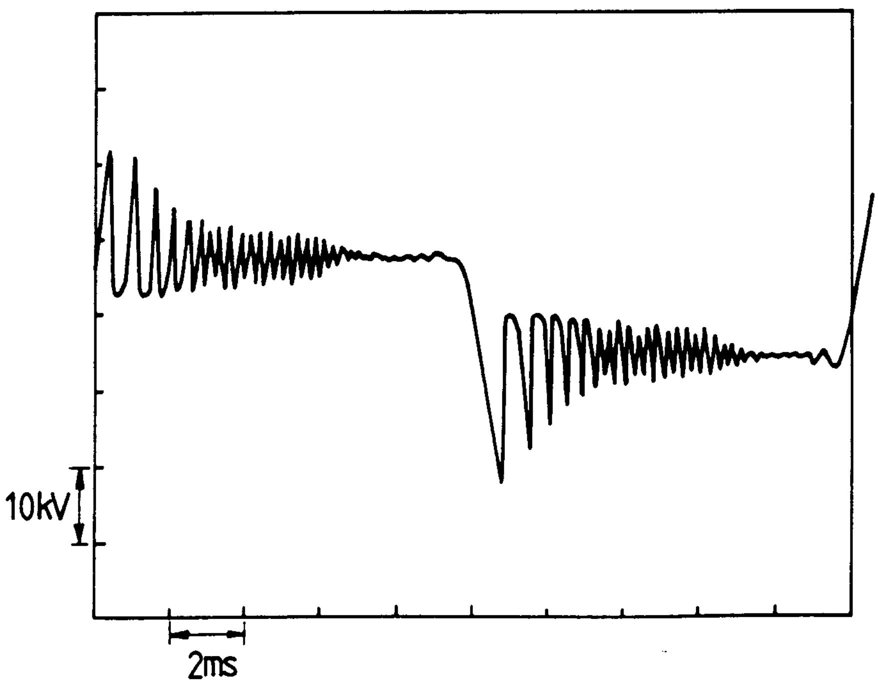


FIG. 8A

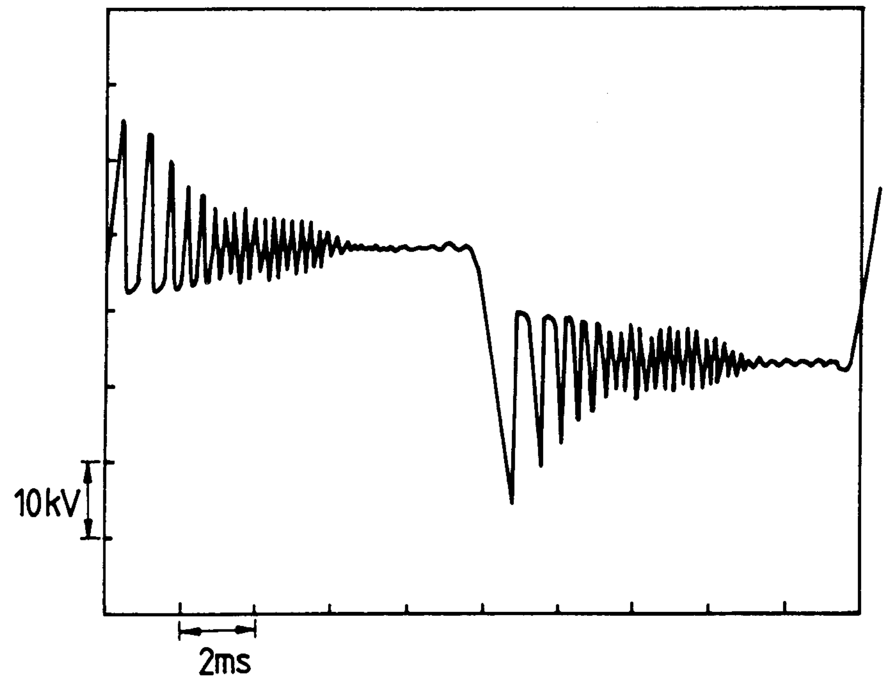


FIG. 8B

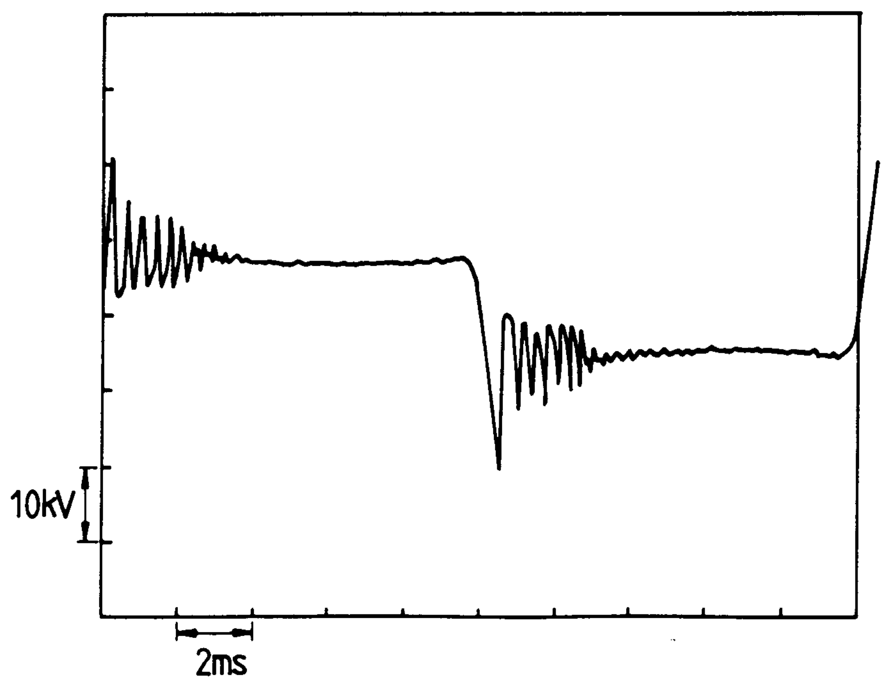


FIG. 9

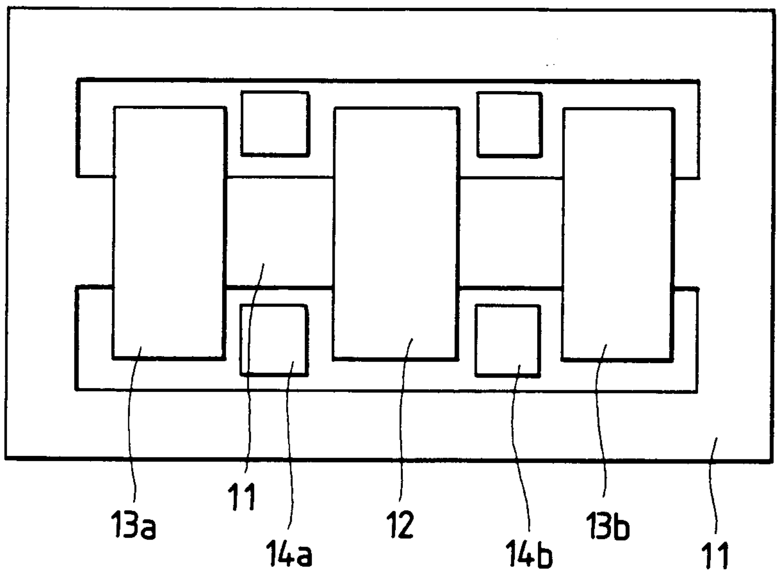


FIG. 10

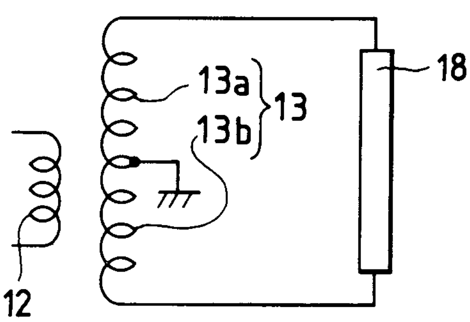
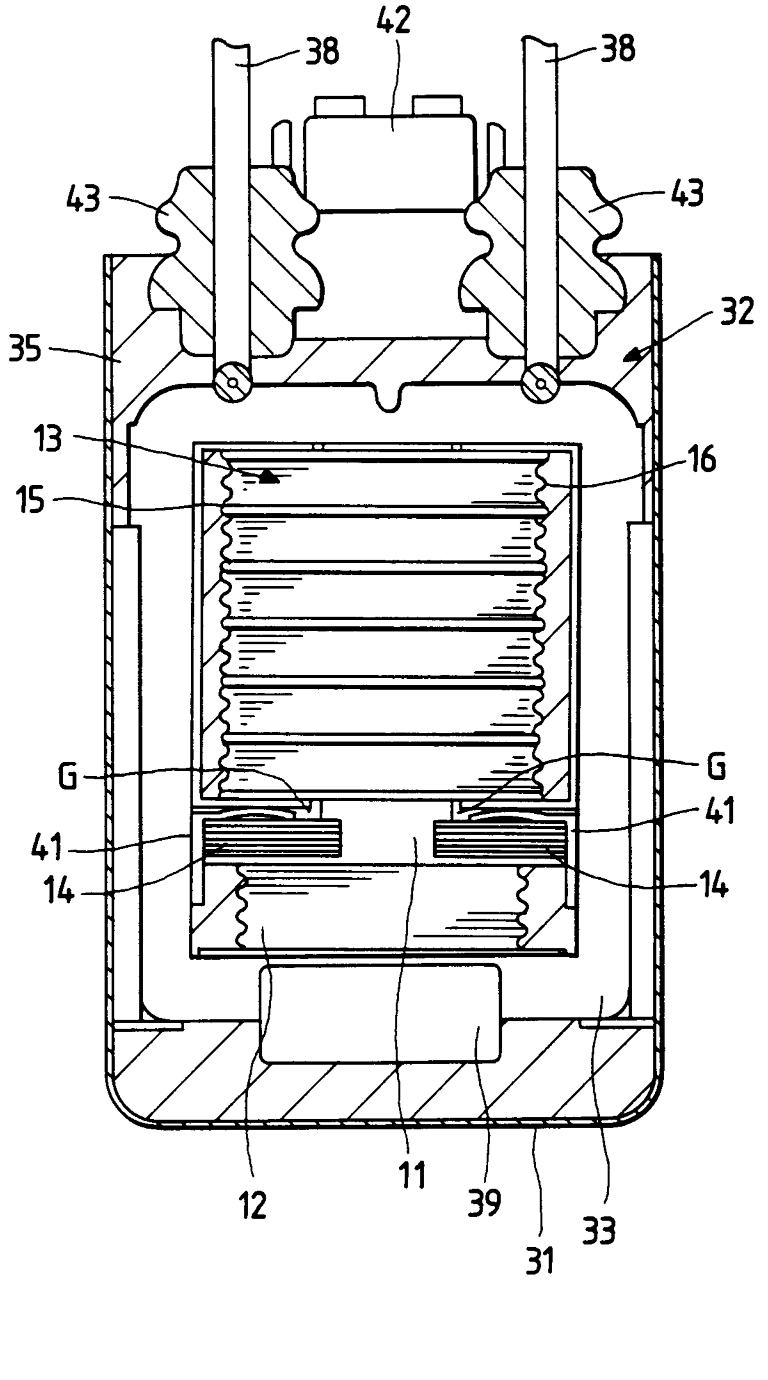
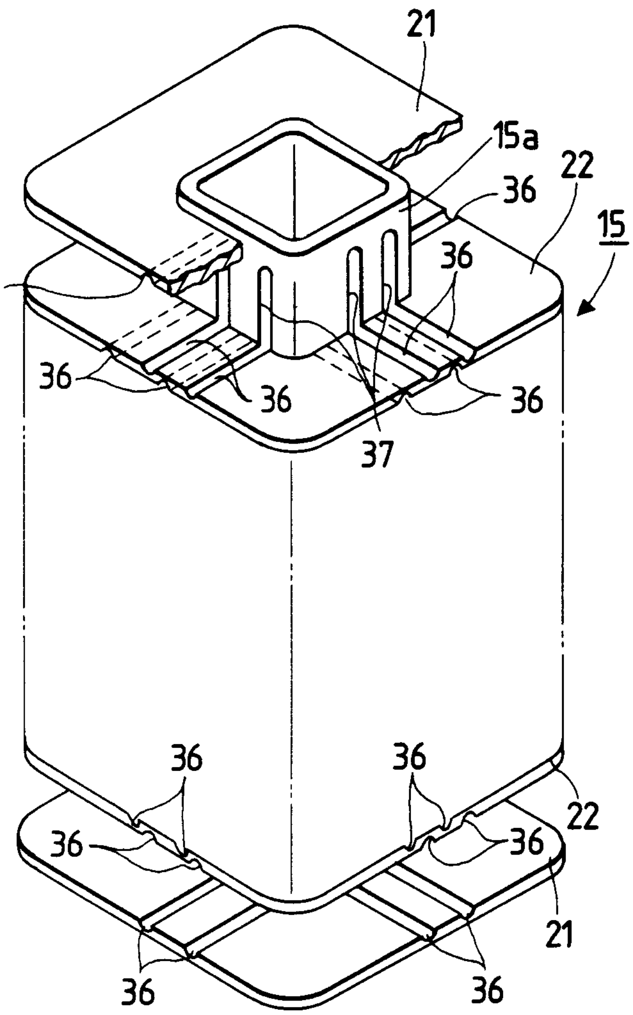


FIG. 11

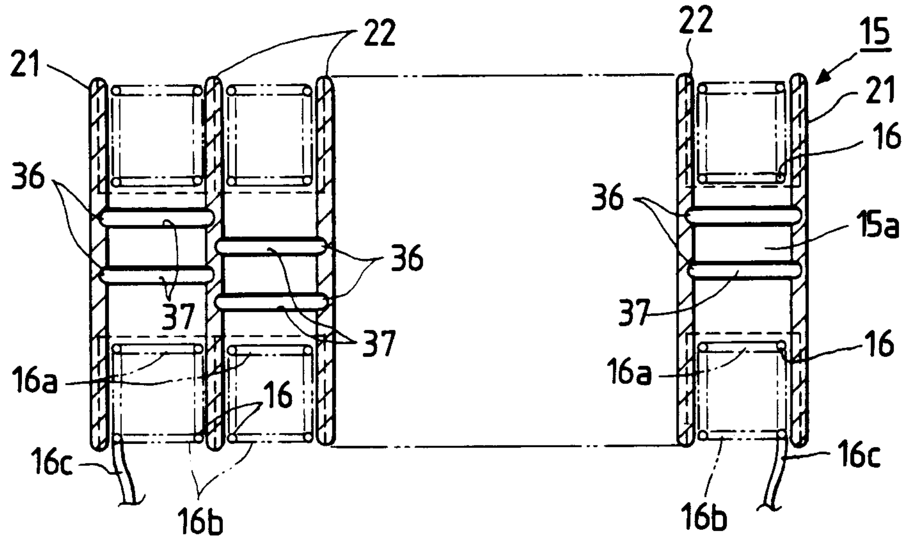




21
15a
22
36
15
36
36
36
36
36
37
36
36
22
36
36
21
36
36

FIG. 12

FIG. 13



21
22
22
15
21
16
36
36
15a
36
37
37
37
16
16a
16
16a
16c
16b
16b
16c

FIG. 14

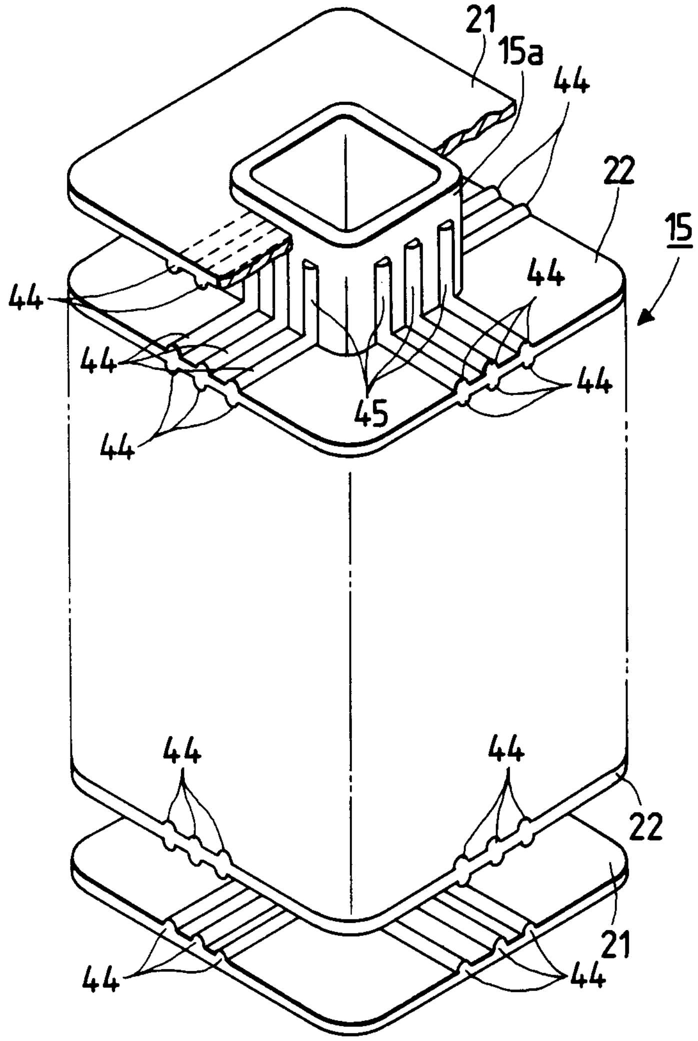
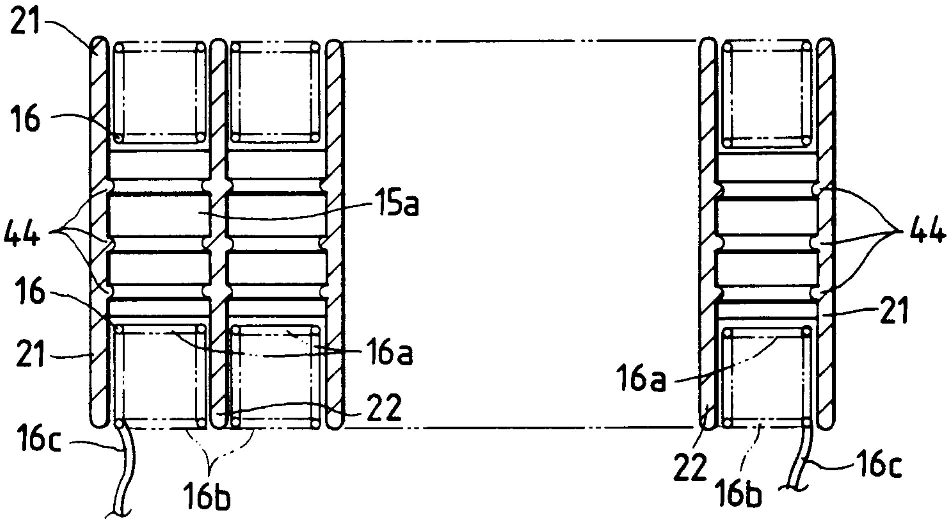

21
15a
44
22
15
44
44
44
45
44
44
44
44
22
21
44
44

FIG. 15


21
16
44
16
21
16c
16b
15a
16a
22
44
21
16a
22
16b
16c