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(54) Hot cathode type discharge lamp apparatus.

(57) Hot cathode type discharge lamp apparatus of the invention is composed of a tube for discharge lamp, a cathode electrode member in nearly cylindrical form made of a semiconductor porcelain and arranged within the tube and including a longitudinal circumferential surface made a discharge surface, and two lead wires connected to both longitudinal ends of the cathode electrode member and penetrating an end portion of the tube. In the discharge lamp apparatus, since an electron emission material is not used in the cathode electrode but the semiconductor porcelain is used, activation of the electron emission material due to heating is not produced, thereby blackening phenomenon of the tube wall of the discharge tube can be prevented and the life becomes long.

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HOT CATHODE TYPE DISCHARGE LAMP APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to discharge lamp apparatuses, and more particularly to a hot cathode
5 type discharge lamp apparatus.

A fluorescent lamp is known as a hot cathode type discharge lamp apparatus. Cathode of the fluorescent lamp is constituted in process that electron emission material comprising oxides of barium, strontium and calcium as main constituent is applied to surface of a tungsten film in coil form.

However, the electron emission material is subjected to thermal decomposition corresponding to the
10 electrode temperature, and active material with electron emission property, for example, Ba atom is produced. The active material is transferred to the top end of the electrode due to surface diffusion thereby the work function at the top end of the electrode is lowered. When the electrode temperature is high, the thermal decomposition becomes rapid and supply of the active material becomes large, thereby evaporation of the active material from the electrode is increased and the evaporated material is adhered to the
15 tube wall of the lamp and the tube wall is blackened. Consequently, the luminous flux of the lamp is deteriorated and the life of the lamp is decreased.

SUMMARY OF THE INVENTION

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As above described, the prior art has problems in the activation of the electron emission material on the cathode surface, the blackening of the lamp, deterioration of the luminous flux and the decrease of the tube life.

In order to solve the above-mentioned problems, an object of the invention is to provide a hot cathode
25 type discharge lamp apparatus wherein a tube wall of a lamp (light emission tube) is prevented from being blackened, the luminous flux is not deteriorated, and the life of the tube becomes long.

In order to attain the above object, a hot cathode type discharge lamp apparatus of the invention is composed of a discharge lamp tube, a cathode electrode member in nearly cylindrical form made of a semiconductor porcelain and arranged within the tube and having a discharge surface on a longitudinal
30 circumferential surface, and two lead wires connected to both longitudinal ends of the cathode electrode member and penetrating an end portion of the discharge lamp tube.

In such a discharge lamp apparatus, since an electron emission material is not used in the cathode electrode but a semiconductor porcelain is used, activation of electron emission material due to heating is not produced and the light emission tube is prevented from being blackened and the life of the tube
35 becomes long.

BRIEF DESCRIPTION OF THE DRAWINGS

40 FIG. 1 is a sectional view of main part of a discharge lamp apparatus as an embodiment of the invention;

FIG. 2 is a sectional view of a modification of a cathode electrode member in FIG. 1;

FIG. 3 is a schematic illustration of an experiment device for the cathode electrode of the invention;

FIG. 4 is a graph illustrating experimental data of the cathode electrode;

45 FIG. 5 is a sectional view of main part of a discharge lamp apparatus as another embodiment of the invention;

FIG. 6a is a side view of a cathode electrode member in FIG. 5;

FIG. 6b is a sectional view of a modification of a cathode electrode member in FIG. 5;

50 FIG. 7 is a sectional view of main part of a discharge lamp apparatus as another embodiment of the invention;

FIG. 8 is a front view of a cathode electrode in FIG. 7; and

FIG. 9 is a sectional view of a modification of a cathode electrode member in FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of the invention will now be described in detail.

A hot cathode type discharge lamp apparatus shown in FIG. 1 is composed of a tube 1 for discharge lamp, a cathode electrode member 2 using a semiconductor porcelain and arranged within the tube 1, and a pair of lead wires 3a, 3b which support the cathode electrode member 2 within the tube 1 and near an end portion 1a of the tube 1.

The cathode electrode member 2 is made of a semiconductor porcelain, and comprises a linear discharge surface 2a disposed on a longitudinal circumferential surface, a cylindrical base 2b, and lead wire connecting portions 2c, 2d formed respectively on both ends of the base 2b.

The lead wires 3a, 3b are arranged with prescribed spacing and penetrate the end portion 1a of the tube 1, and the penetrating portion is sealed by the end portion 1a. Top end portions 3c, 3d extending within the tube 1 are wound on the lead wire connecting portions 2c, 2d so that the cathode electrode member 2 is supported within the tube 1 in parallel arrangement to the end portion 1a, and rear end portions 3e, 3f are projected to outside from the tube 1.

A power source is connected to the rear end portions 3e, 3f, thereby the cathode electrode member 2 is energized.

As shown in FIG. 2, a conductive film 4 may be coated on both ends of the base 2b by means of evaporation, sputtering or the like so as to form lead wire connecting portions 12c, 12d.

In this case, contact resistance between the lead wires 3a, 3b and the base 2d can be reduced because of existence of the conductive film 4.

A semiconductor porcelain as a raw material for the cathode electrode 2 will now be described in detail.

For example, a valency compensation type semiconductor porcelain may be mentioned as the semiconductor porcelain. A typical example of the valency compensation type semiconductor porcelain is that using barium titanate.

The valency compensation as known well consists in that metal ion having valency different by value ± 1 from that of constitution metal ion of metal oxide is added as an impurity, and increase or decrease of the charge quantity produced by introduction of the impurity is compensated by the number of valency of the constitution metal ion.

The valency compensation semiconductor forming agent can be exemplified by Y, Dy, Hf, Ce, Pr, Nd, Sm, Gd, Ho, Er, Tb, Sb, Nb, W, Yb, Sc, Ta or the like. These can be used together for adding. Adding amount of the adding agent is preferably 0.01 ~ 0.8 mol %, particularly 0.1 ~ 0.5 mol %.

On the other hand, a raw material to constitute the cathode electrode made of the semiconductor porcelain in the embodiment is preferably titanates. In addition to the above-mentioned barium titanate, strontium titanate, calcium titanate or lanthanum titanate may be used. Composite material of these may be used. Further, titanate acid in the titanates may be replaced by at least one of zirconic acid, silicic acid and stannic acid.

The semiconductor porcelain for the discharge electrode in the invention may be a forced reduction type semiconductor porcelain. This can be obtained by method of reducing the semiconductor porcelain for the cathode electrode as above described, and further by method of reducing without adding the semiconductor forming agent if the sufficient reducing condition is supplied. Reduction in this case may be performed in the reducing atmosphere of N_2 or H_2 and preferably in the temperature condition of 700°C or more, particularly in 1,200 ~ 1,450°C.

The electrode may be formed by using the valency compensation type and the forced reduction type together. Modes of the concurrent use are as follows:

(a) A semiconductor forming agent is added, and a molding body of a valency compensation type semiconductor porcelain is formed.

(b) The molding body in (a) is directly reduced and burned, or a sintering porcelain in air burning is further reduced and burned, thereby a semiconductor porcelain in concurrent use of valency compensation type and forced reduction type can be obtained.

A concrete experiment example will now be described.

Top end of a valency compensation type semiconductor porcelain was ground into conical form of about 60°, and specific resistance of the obtained semiconductor porcelain was 9.9Ωcm.

Further, the H_2 density was made 20 % in the reducing atmosphere of $H_2 + N_2$, and the semiconductor porcelain was reduced and burned at 1,250°C and the stabilizing time 2 Hr. Specific resistance of the burned porcelain was 0.90Ωcm.

Similar results were obtained in other titanates. Results are summarized in Table 1.

Table 1

Specific Resistance of Various Semiconductor
Porcelains for Discharge Electrode

No.	Composition	before reduction (Ω cm)	after reduction (Ω cm)
(1)	BaTiO ₂ - Y ₂ O ₃ 0.15 mol% - SiO ₂ 0.6 wt%	9.9	0.90
(2)	SrTiO ₃ - Dy ₂ O ₃ 0.3 mol% - SiO ₂ 0.6 mol%	0.50	0.048
(3)	SrTiO ₃ 62 wt% - La ₂ O ₃ 3TiO ₂ 10 wt% - CaTiO ₃ 27.7 wt% - Nb ₂ O ₅ 0.3 wt%	0.35	0.032

Similar results were obtained when titanitic acid in the titanates was replaced by at least one of zirconic acid, silicic acid and stannic acid.

In order to study the easiness of electron emission, the electric field emission intensity was measured regarding the above-mentioned specimens No. 1 through No. 3. For comparison, the measurement was performed also regarding Al, Cu, Fe having the work function being relatively low. Results are shown in FIG. 4. In FIG. 4, discharge generating voltages in a polyethylene container (kV) are taken in ordinate, and specimen cathodes are arranged in abscissa. The specimen cathodes are Cu, Al, Fe as comparison examples and the specimens No. 1 ~ No. 3 arranged in Table 1. A device shown in FIG. 3 was used in the experiment. The device comprises a polyethylene container 5 of 15 mm in width, 5 mm in length and 10 mm in height, and silver paste 6 is applied to the bottom surface of the container 5. A specimen electrode 2' was arranged above the bottom surface and an AC power source 7 was connected between the specimen electrode 2' and the silver paste 6. Radius R at the top end arc-shaped portion of the specimen electrode 2' is made 20 μ m, and distance D between the top end portion of the specimen electrode 2' and the silver paste 6 is made 4 mm. The starting voltage was 10 kV, and the voltage was increased in 1kV per minute.

As a result, characteristics as shown in FIG. 4 were obtained. As clearly seen from FIG. 4, in any of the specimens in the experiment, the discharge is easily generated even at low generating voltage in comparison to conventional examples.

According to the results, it is understood that the semiconductor porcelain for the cathode electrode in the embodiment has equivalent or more excellent characteristics in comparison to metals.

Consequently, the cathode electrode 2 made of the semiconductor porcelain in the embodiment can obtain the stabilized discharge characteristics and the manufacturing cost can be decreased.

Next, various modifications of the discharge lamp apparatus using the above-mentioned cathode electrode will be described in sequence.

FIG. 5 shows a second embodiment of the invention. In FIG. 5, a discharge lamp apparatus is composed of a tube 21 for discharge lamp, a cathode electrode member 22 using a semiconductor porcelain and arranged within the tube 21, and a pair of lead wires 23a, 23b which support the cathode electrode member 22 within the tube 21 and near an end portion 21a of the tube 21. The cathode electrode member 22 is provided on both ends of a base 22b with lead wire connecting portions 22c, 22d having smaller diameter than that of the base 22b, and top end portions 23c, 23d of the lead wires 23a, 23b are wound respectively on the lead wire connecting portions 22c, 22d thereby the cathode electrode member 22 is supported. In such constitution of the lead wire connecting portions, the winding work of the lead wires becomes easy.

In another example of the cathode electrode member shown in FIG. 6, conductive films 34, 34 are coated on outer circumference of lead wire connecting portions 32c, 32d respectively. In such constitution, electric connection between the lead wires and the cathode electrode is secured.

A third embodiment of the invention will now be described in detail referring to FIG. 7. A hot cathode type discharge lamp apparatus shown in FIG. 7 is composed of a tube 41 for discharge lamp, a cathode electrode member 42 using a semiconductor porcelain and arranged within the tube 41, and a pair of lead wires 43a, 43b which support the cathode electrode member 42 within the tube 41 and near an end portion 41a of the tube 41.

As shown in FIG. 8, the cathode electrode member 42 comprises a cylindrical base 42b having a linear cylindrical discharge surface 42a, and lead wire connecting portions 42c, 42d formed respectively on both ends of the base 42b. The lead wire connecting portions 42c, 42d are formed into grooves by cutting the base 42b at slightly inner portions from both ends.

The lead wires 43a, 43b are arranged with prescribed spacing and penetrate the end portion 41a of the tube 41, and the penetrating portion is sealed by the end portion 41a. Top end portions 43c, 43d extending within the tube 41 are wound on the lead wire connecting portions 42c, 42d in arbitrary turns so that the cathode electrode member 42 is supported within the tube 41 in parallel arrangement to the end portion 41a, and rear end portions 43e, 43f are projected to outside from the tube 41. A power source is connected to the rear end portions 43e, 43f, thereby the cathode electrode member 42 is energized. In such constitution of the connecting portions, the wound lead wires are not moved outwards and not slipped away.

In place of the cathode electrode member 42, as shown in FIG. 9, a cathode member 52 may be used where a conductive film 54 is coated on outer circumference of lead wire connecting portions 52c, 52d by means of evaporation, sputtering or the like.

When the cathode electrode member 52 is used, contact resistance between the lead wires 53a, 53b and the cathode electrode member 52 can be reduced because of existence of the conductive film 54.

According to the hot cathode type discharge lamp apparatus of the invention as above described in detail, since an electron emission material is not used in the cathode electrode but the semiconductor porcelain is used, chemical reaction due to heating is not produced, thereby blackening phenomenon of the tube wall of the light emission tube can be prevented and the life of the discharge lamp apparatus becomes long. Also, since the semiconductor porcelain is cheap, cost of the apparatus is reduced. Further, since the semiconductor porcelain may be formed in any shape, shape of the semiconductor may be selected corresponding to the use object so as to obtain required characteristics.

Claims

1. Hot cathode type discharge lamp apparatus, comprising:
a tube for discharge lamp;
a cathode member in nearly cylindrical form made of a semiconductor porcelain and arranged within the tube and including a longitudinal circumferential surface made a discharge surface; and
two lead wires connected to both longitudinal ends of the cathode electrode member and penetrating an end portion of the tube.
2. Hot cathode type discharge lamp apparatus as set forth in claim 1, wherein the semiconductor porcelain is a valency compensation type semiconductor porcelain or a forced reduction type semiconductor porcelain or a semiconductor porcelain in concurrent use of both.
3. Hot cathode type discharge lamp apparatus as set forth in claim 1, wherein the semiconductor porcelain has main constituent being one or two or more selected from oxides of titanium, barium, strontium, calcium, lanthanum, zirconium and the tin.
4. Hot cathode type discharge lamp apparatus as set forth in claim 1, wherein the semiconductor porcelain has adding agent of valency compensation semiconductor forming agent being one or two or more selected from Y, Dy, Hf, Ce, Pr, Nd, Sm, Gd, Ho, Er, Tb, Sb, Nb, W, Yb, Sc and Ta.
5. Hot cathode type discharge lamp apparatus as set forth in claim 1, wherein the cathode electrode member comprises a cylindrical base with a linear discharge surface, and lead wire connecting portions provided on both ends of the base, said lead wire connecting portions being supported by the lead wires.
6. Hot cathode type discharge lamp apparatus as set forth in claim 5, wherein the lead wire connecting portions of the cathode electrode member are formed in smaller diameter than that of the cylindrical base.
7. Hot cathode type discharge lamp apparatus as set forth in claim 5, wherein the lead wire connecting portions of the cathode electrode connecting member are provided with a conductive film applied to surface thereof.
8. Hot cathode type discharge lamp apparatus as set forth in claim 5, wherein the lead wire connecting portions of the cathode electrode member are cut grooves.

FIG. 1

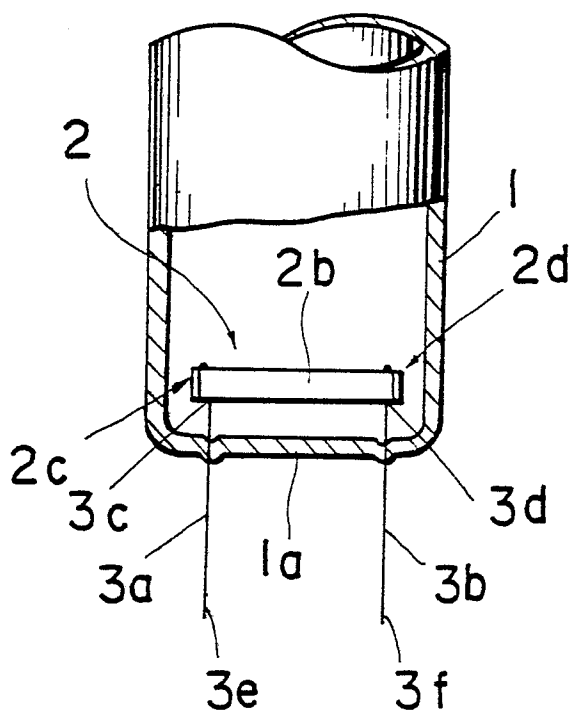


FIG. 2

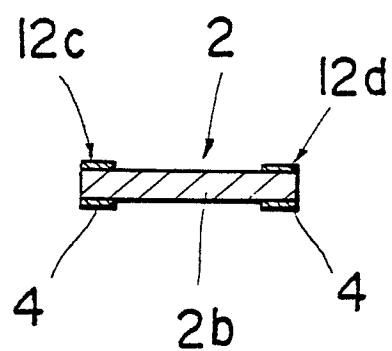


FIG. 3

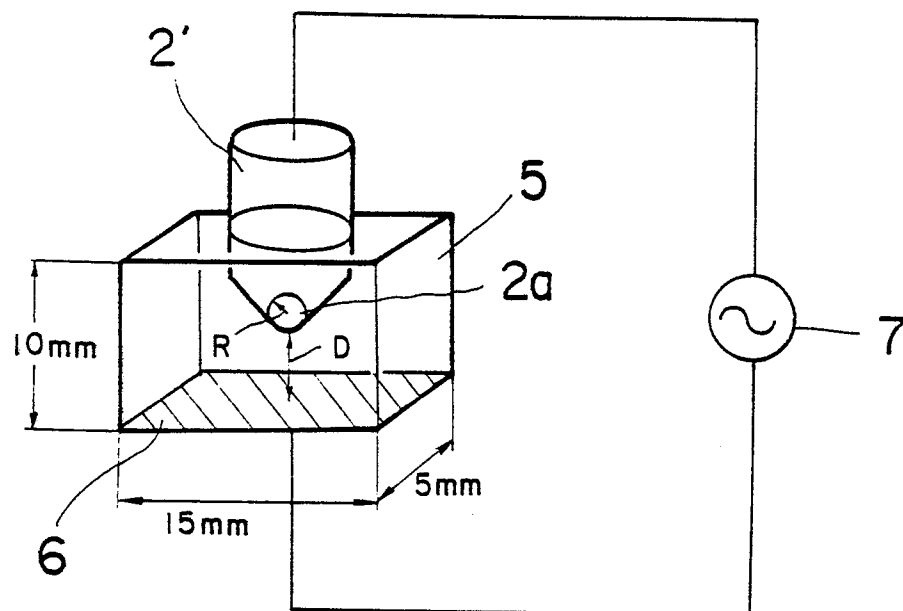


FIG. 4

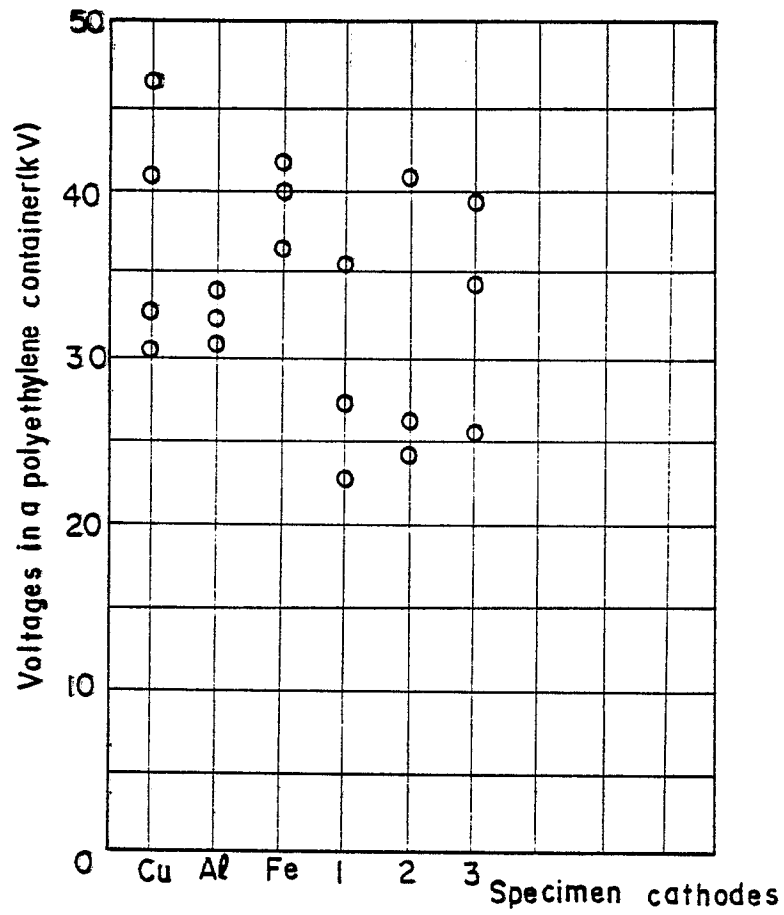


FIG. 5

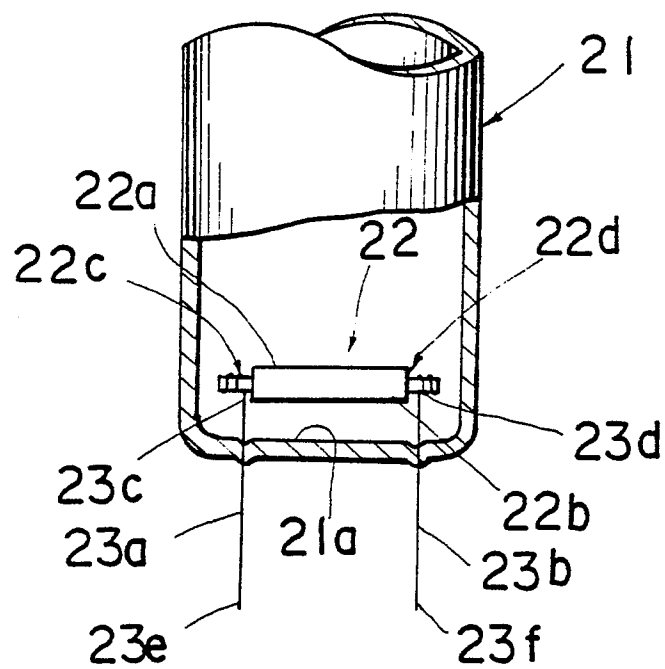


FIG. 6

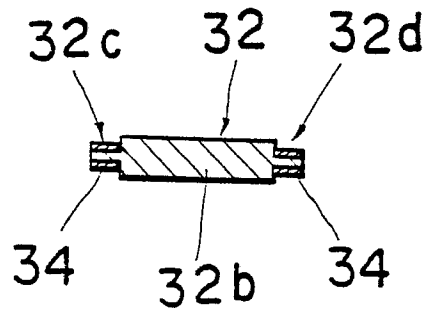


FIG. 7

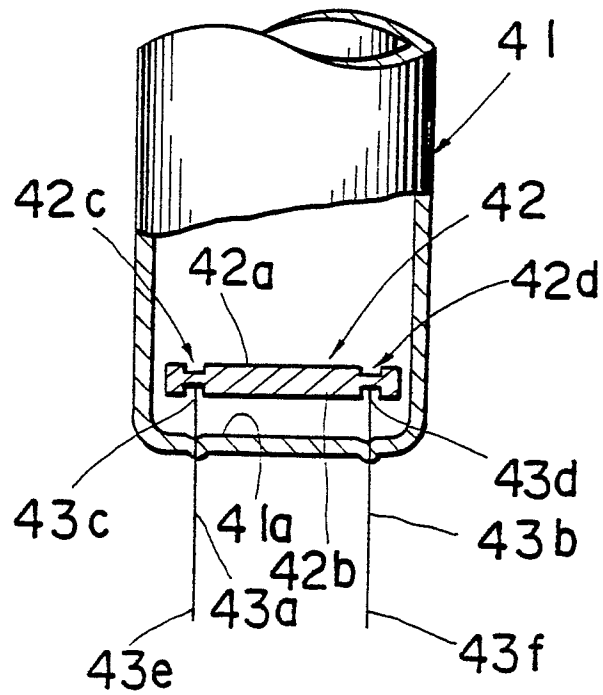


FIG. 8

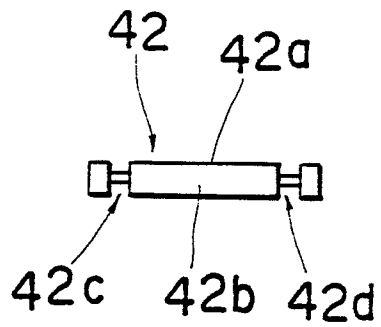


FIG. 9

