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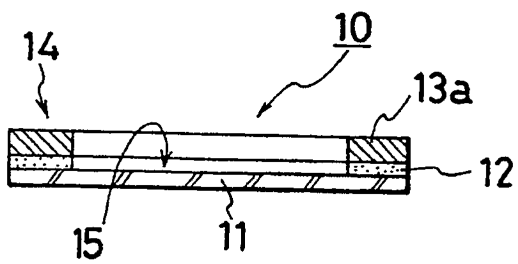
(54) **Dustproofing film for waveguide and method for production thereof.**

(57) A dustproofing film (10) for a waveguide (4) is disclosed which is characterized by having an adhesive agent (12) applied to a peripheral edge area thereof and having formed in the area surrounded by the peripheral edge area a region not covered at all with any adhering substance and consequently allowing the electromagnetic wave to pass.

A method for the production of a dustproofing film (10) for a waveguide (4) is disclosed which is characterized by cutting a prescribed shape (15) from a double-faced adhesive tape (20), removing a peel paper (13a) from one surface of the adhesive tape (20), attaching the part of the adhesive tape remaining (14) after the removal of the prescribed shape (15) to a film (11) formed of synthetic resin thereby forming a sheet material having formed within the area of the adhesive tape remaining after the removal of the prescribed shape a region (15) covered with neither an adhesive agent or a peel paper and consequently allowing the electromagnetic wave to pass, and cutting a prescribed shape from the sheet material around the periphery of the region for passage of the electromagnetic wave thereby forming around the periphery of the region for passage of the electromagnetic wave a peripheral edge region (14) having a peel paper (13b) attached thereto through the medium of an adhesive agent (12).

FIG. 1



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This invention relates to a dustproofing film for a waveguide to be used in the formation of a primary radiation device of a parabolic antenna and to a method for the production thereof.

Recently, television broadcasting utilizing an artificial satellite has been increasing. In satellite broadcasting, the wave from an artificial satellite is converged by a reflecting mirror of a parabolic antenna 1 installed outdoors and the converged wave is received by a primary radiation device 2 as illustrated in Fig. 11. Then, the received signal is processed by a tuner installed indoors and the resultant reproduced image is displayed on a television receiver.

The primary radiation device 2 of the parabolic antenna 1, as illustrated in Fig. 12, comprises a flared horn 3 serving as an entrance for the wave converged by the reflecting mirror, a waveguide 4 serving as a transmitting path for electromagnetic wave energy, and a low noise block converter (LNB) 5 serving as a receiver connected to the trailing end of the waveguide 4. The LNB 5 is a waveguide of one kind. The primary radiation device 2 illustrated in Fig. 12 is portrayed as having inside the waveguide 4 a polarizer 6. The term "polarizer" as used herein means a device for discriminating a cross polarized electromagnetic radiation in the radio communication system. In the frequency band surpassing the microwave band, two perpendicularly cross polarized electromagnetic radiations (a vertically polarized electromagnetic radiation and a horizontally polarized electromagnetic radiation in the linear polarized electromagnetic radiations) are simultaneously utilized for the purpose of augmenting the capacity for communication and, at the same time, avoiding interference with radio channels. On the receiving side, a coil 7 of the polarizer 6 is operated to induce Faraday rotation of the received electromagnetic wave and effect discrimination between the vertically polarized electromagnetic radiation and the horizontally polarized electromagnetic radiation in the cross polarized electromagnetic radiations.

The component parts which are incorporated in the primary radiation device 2 as described above are individually manufactured, stored, and managed and are combined to assemble the primary radiation device at the site of installation. When the waveguide 4 and the LNB 5 as manufactured are stored in a warehouse, transported in the process of commercial distribution, or installed and put to service, fine dust steals its way into the waveguide 4 and the LNB 5. When the dust enters their interiors, the wave passing their internal transmission paths collides against the dust and gets reflected randomly and succumbs to the drawback of the so-called insertion loss by being seriously attenuated or absorbed.

Heretofore, for the elimination of this drawback of insertion loss, a dustproofing film 9 formed of a film 9a such as of polyimide resin having an adhesive agent 8 applied across the whole of one surface thereof is fixedly attached to an opening 4a side of the waveguide 4 as illustrated in Fig. 13 so as to prevent the dust from entering the interior. A peel paper (not shown) is kept attached to the adhesive agent 8 side of the dustproofing film 9 until the dustproofing film 9 is put to use.

In the conventional dustproofing film 9, however, since the adhesive agent 8 is applied across the whole of one side of the dustproofing film 9, the electromagnetic wave which penetrates the dustproofing film 9 and reaches the interiors of the waveguide 4 and the LNB 5 entails the drawback of insertion loss, though in a different sense from the aforementioned insertion loss, by being reflected, attenuated, or absorbed by the adhesive agent 8. The conventional dustproofing film 9 consequently degrades the gain of the waveguide and exerts an adverse effect on the ability of the parabolic antenna 1 to receive the electromagnetic wave, a fact which forms a fatal drawback for receiving devices of this class used in satellite broadcasting. This statement holds good with other waveguide-containing systems than those for use in satellite broadcasting.

An object of this invention is to provide a dustproofing film for a waveguide free from the drawbacks of the prior art mentioned above and which does not induce the phenomenon of insertion loss,and a method for the production thereof.

The dustproofing film of this invention is characterized by having an adhesive agent applied to a peripheral area thereof and having formed in the area thereof surrounded by the peripheral area a region completely free of adhering substance and permeable to the electromagnetic wave.

The dustproofing film of this invention has no adhesive agent applied to the region thereof intended for passage of the electromagnetic wave. It does not, therefore entail the insertion loss due to an adhesive agent as encountered heretofore.

The method for the production of the dustproofing film of this invention comprises cutting a prescribed shape from a double-faced adhesive tape which has a peel paper on each side, removing a peel paper from one surface of the part of the adhesive tape remaining after the removal of the shape mentioned above, applying the adhesive side of the remaining adhesive tape to a film formed of a synthetic resin such as polyimide thereby forming a sheet material having formed in the part of the prescribed shape cut out of the double-faced adhesive tape a region covered with neither the adhesive agent nor the peel paper and consequently allowed to pass the electromagnetic wave, and cutting a prescribed shape from the sheet material around the periphery of the region used for passage of the electromagnetic wave thereby forming around the periphery of the region for passage of the electromagnetic wave a peripheral region having a peel paper attached thereto through the medium of the adhesive agent.

First, in the method for the production of the dustproofing film of this invention, by cutting the prescribed shape from the double-faced adhesive tape with two peel papers, removing a peel paper from one side of the adhesive tape, and applying the adhesive side of this adhesive tape to a film, there is obtained the sheet material which has formed in the part removed in the prescribed shape the region containing the film alone and consequently allowing passage of the electromagnetic wave. Then, by cutting the entire sheet material around the periphery of the permeable region, thereby forming around the periphery of the region for passage of the electromagnetic wave a peripheral region having a peel paper attached thereto through the medium of the adhesive agent, there is completed the dustproofing film. By this method, the dustproofing film can be produced simply by cutting and removing the sheet material of a three-layer construction. This method is extremely simple as compared with the method which comprises attaching an adhesive agent and a peel paper exclusively to part of the peripheral region.

An embodiment of the invention will now be described by way of example only and with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal cross section of a dustproofing film as one embodiment of the present invention.

Fig. 2 is a plan view of the dustproofing film of Fig. 1.

Fig. 3 is a longitudinal cross section illustrating the state in which the dustproofing film is applied fast to a waveguide.

Fig. 5, Fig. 6, Fig. 7, Fig. 8, Fig. 9, and Fig. 10 are longitudinal cross sections illustrating serially-a process for the production of a dustproofing film according to the present invention.

Fig. 11 is a schematic side elevation of a parabolic antenna.

Fig. 12 is a partially sectioned side elevation of a primary radiation device.

Fig. 13 is a longitudinal cross section illustrating the state in which the conventional dustproofing film is applied to a waveguide.

Now, a construction and method according to this invention will be described below with reference to the accompanying drawings. Like reference numerals used for the components parts of the conventional countertypes denote like component parts used for the present invention.

Fig. 1 and Fig. 2 illustrate a dustproofing film 10 as one embodiment of this invention. In the present embodiment, a film 11 of polyimide resin produced by DuPont and Company and marketed under trademark designation of "Capton" is prepared. A peripheral edge region 14 is formed by applying a double-faced adhesive tape 20 produced by Sony Chemical Co., Ltd. and marketed under product code of "T4100" fast around the periphery of the film 11. The double-faced tape 20, as illustrated in Fig. 5, has peel papers 13a and 13b attached to the opposite surfaces of an adhesive agent 12. In the state of Fig. 1 in which the double-faced adhesive tape is adhering to the film 11 mentioned above, the peel paper 13b on one side of the adhesive agent has been already removed as a matter of course. The dustproofing film 10 has formed in the area surrounded by the peripheral region 14 a region 15 not covered at all with the adhesive agent 12 and consequently allowing the electromagnetic wave to pass.

Optionally, a handling piece 16 may be disposed in part of the peripheral edge of the dustproofing film of the peel paper 13a as indicated by a chain line in Fig. 2 so that when a person is about to apply the dustproofing film to a given surface, he is able to grip the dustproofing film by this handling piece without smearing the region 15 for passage of the electromagnetic wave with the dirt from his hand and then may peel the peel paper 13a and position the dustproofing film 10 as a whole with ease. This handling piece 16 may be formed on the film 11 side.

The dustproofing film 10 which is constructed as described above is produced by the following procedure. First, the adhesion agent 12 is applied throughout to one surface of the peel paper 13b as illustrated in Fig. 4. Subsequently, the peel paper 13a is attached to the adhesive agent 12 as illustrated in Fig. 5, to form the double-faced tape 20 of the form of a three-layer sheet. Then, a cylindrical punching blade 18 is prepared and passed through the double-faced tape 20 to cut out a circle (in the state shown in Fig. 7) as illustrated in Fig. 6. Subsequently, the peel paper 13b on the lower surface side is removed as illustrated in Fig. 8 and the remaining part of the tape 20 is applied fast to the film 11 of the form of a sheet as illustrated in Fig. 9, to form a sheet material 17 provided with the region 15 for passage of the electromagnetic wave. Thereafter, a cylindrical cutting blade 19 having a larger diameter than the aforementioned cutting blade 18 is passed through the sheet material 17 as illustrated in Fig. 10. As a result, the dustproofing film 10 is produced which has the peel paper 13a attached thereto through the medium of the adhesive agent 12 around the periphery of the region 15 for passage of the electromagnetic wave.

The dustproofing film 10 produced as described above is put to use bv having the peel paper 13a removed and then having the exposed surface of the dustproofing film 10 applied ·ast to the opening 4a side end face of the waveguide 4 through the medium of the adhesive agent 12 in the peripheral region 14 as illustrated in Fig. 3, for example. In this case, it is necessary that the region 15 for passage of the electromagnetic wave which is not covered at all with the adhesive agent 12 should be of a size identical to or slightly larger than the size of the opening 4a. This is because the adhesive agent 12 would be exposed on the inner surface side of the waveguide 4 and, similarly to the conventional countertype, would cause the phenomenon of insertion loss of the electromagnetic wave being transmitted inside the waveguide 4 if the aforementioned region 15 had a smaller size than the opening 4a.

Where the peel paper 13a is removed from the dustproofing film 10 prior to the application of the dustproofing film 10 to the waveguide 4, the handling piece 16 is available for the handling of the dustproofing film 10. The person gripping the dustproofing film 10 by the handling piece 16 is allowed to position the dustproofing film 10 relative to the waveguide 4. The provision of this handling piece 16 therefore, enables the application of the dustproofing film to a given surface to be carried out accurately, quickly, and easily. Incidentally, another method conceivable for the fast attachment of the film 11 would comprise applying the adhesive agent 12 to the opening 4a side end face and thereafter attaching the film all by itself to the adhesive agent. This method, however, is not adoptable because it has the disadvantage that the applied layer of the adhesive agent 12 lacks uniformity of thickness and the applied adhesive agent 12 protrudes into the region 15 for passage of the electromagnetic wave and entails the conventional drawback.

The following table shows the results of an experiment conducted by the present applicant to confirm the effect of this invention. In this experiment, a comparative sample obtained by preparing a waveguide 4 of a zinc alloy measuring 21 mm in inside diameter and 25 mm in outside diameter and applying the conventional dustproofing film 9 illustrated in Fig. 13 to the opening 4a side end face of the waveguide 4 and a sample of this invention obtained by similarly applying the dustproofing film 10 of this invention illustrated in Fig. 3 to the sample waveguide 4 as mentioned above were used. The two films were both made of Capton film 25 µm in thickness (produced by DuPont and Company) and the adhesive agents were both the product (T4100) of Sony Chemical Co., Ltd. applied in a thickness of 45 µm. The experiment consisted in projecting an electromagnetic wave of a frequency of 10.95 to 12.75 GHz through the dustproofing films 9 and 10, measuring the amounts of the electromagnetic wave which had permeated through the films, finding their differences, and determining the amounts of reflection as reflection loss and the amounts of absorption.

Table

Insertion loss	Conventional product	Product of this invention	Difference
Reflection loss	12.7 dB	12.2 dB	0.5 dB
VSWR	1.65	1.60	0.05

The numerals indicated represent average values of the results of five measurements. The term "reflection loss" used herein means the sum of the amount reflected and the amount absorbed and the acronym "VSWR"used herein means the reflection loss obtained of the LNB.

It is clearly noted from this table that the product of this invention was better than the conventional product by 0.5 dB in reflection loss and by 0.05 in VSWR. These numerical values of the product of this invention represent performances one rank higher than those of the countertype currently in use in the field of devices of this kind available for satellite broadcasting.

This invention is not limited to the embodiment described above but may be suitably modified. For example, the waveguide comes in various types such as a circular waveguide, a square waveguide, and a ridge waveguide. The dustproofing film of this invention can be applied equally effectively to all of these types. Of course, the shape and the size of the dustproofing film are altered so as to suit the shape and the size of the particular kind of waveguide to be selected. For the dustproofing film, such a resinous material as Teflon may be used instead of the polyimide resin.

The dustproofing film of this invention allows both the reflected and absorbed amounts of electromagnetic wave to be decreased because it is not covered at all by the adhesive agent in the region for passage of the electromagnetic wave as described above. It is, therefore, capable of amply lowering the reflection loss of the electromagnetic wave and notably improving the performances of devices for satellite broadcasting.

Moreover, the method of production according to this invention allows the dustproofing film to be produced simply by cutting the prescribed shape from the sheet material of a three-layer construction. The dustproofing film, therefore, can be produced very accurately, rapidly, and easily.

Claims

1. A dustproofing film for a waveguide, characterized by having an adhesive agent applied to a peripheral edge area thereof and having formed in the area surrounded by said peripheral edge area a region not covered at all with any adhering substance and consequently allowing an electromagnetic wave to pass.

2. A dustproofing film according to claim 1, wherein the adhesive agent is covered with a peel paper.

3. A dustproofing film according to claim 1 or claim 2, wherein a removable handling piece is disposed in part of the peripheral edge of said dustproofing film or said peel paper.

4. A dustproofing film according to claim 1, 2 or 3, wherein the region coated with said adhesive agent comprises a double-faced adhesive tape.

5. A method for the production of a dustproofing film for a waveguide, which method is characterized by comprising a step of removing a prescribed shape from a double-faced adhesive tape, having two peel papers, a step of removing a peel paper from one surface of said double-faced adhesive tape from which said prescribed shape has been removed, a step of applying to a synthetic resin film said double-faced adhesive tape from one surface of which said peel paper has been removed thereby forming a sheet material having formed in the area remaining after the removal of said prescribed shape a region not covered with either said adhesive agent or said peel paper and consequently allowing the electromagnetic wave to pass, and a step of cutting a prescribed shape from said sheet material around the periphery of said region for passage of said electromagnetic wave thereby forming around the periphery of said region for passage of the electromagnetic wave a peripheral edge region having a peel paper attached thereto through the medium of an adhesive agent.

6. A method according to claim 5, wherein said film is formed of polyimide resin.

FIG.1

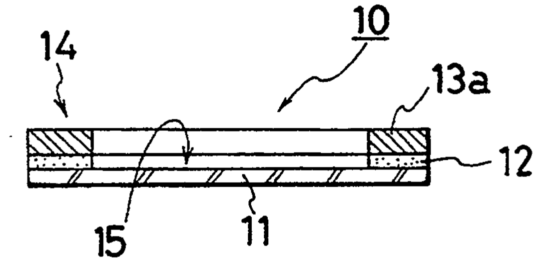

FIG.2

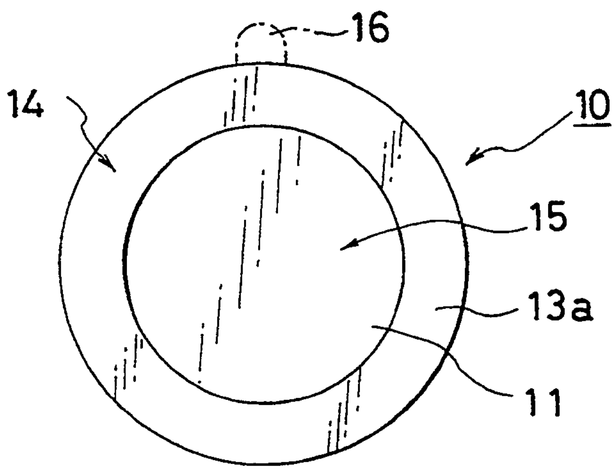

FIG.3

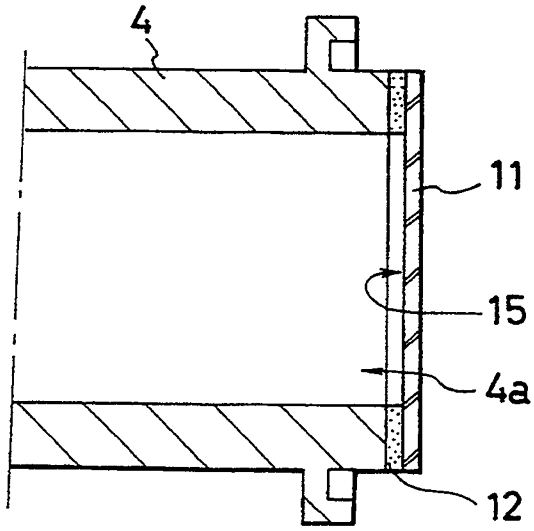

FIG.4

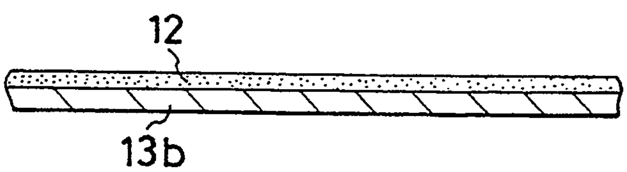

FIG.5

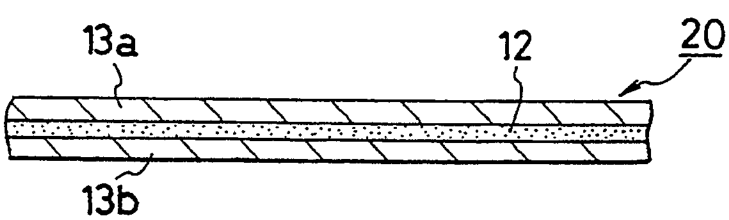

FIG.6

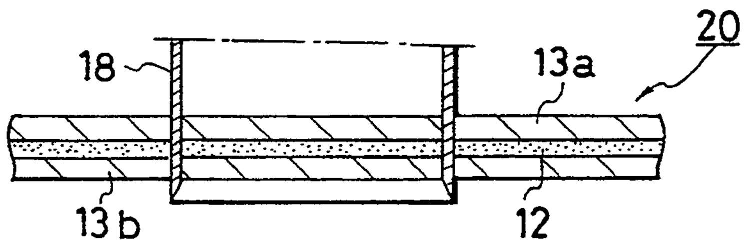

FIG.7

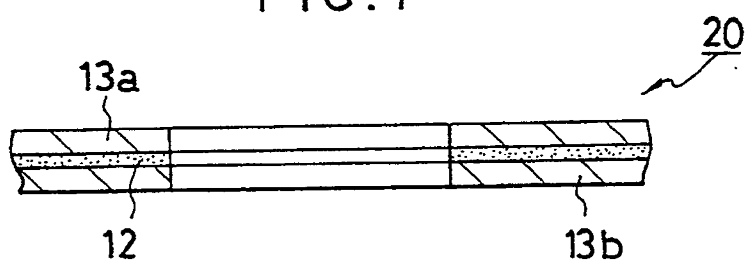

FIG.8

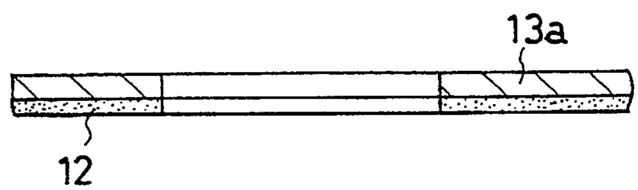

FIG.9

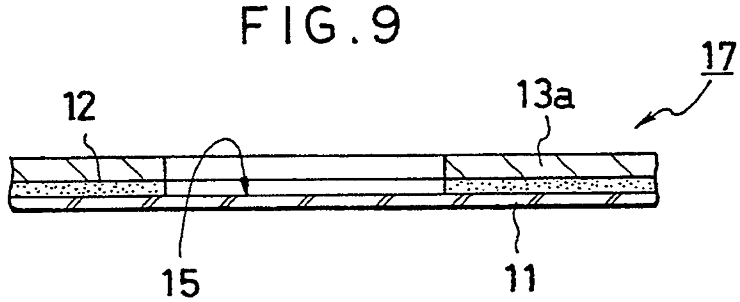

FIG.10

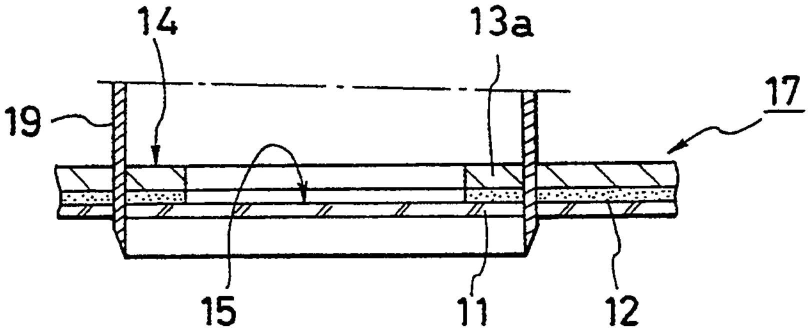

FIG.11

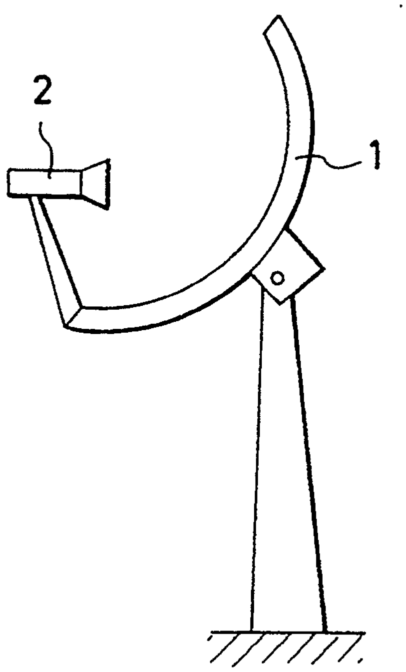

FIG.12

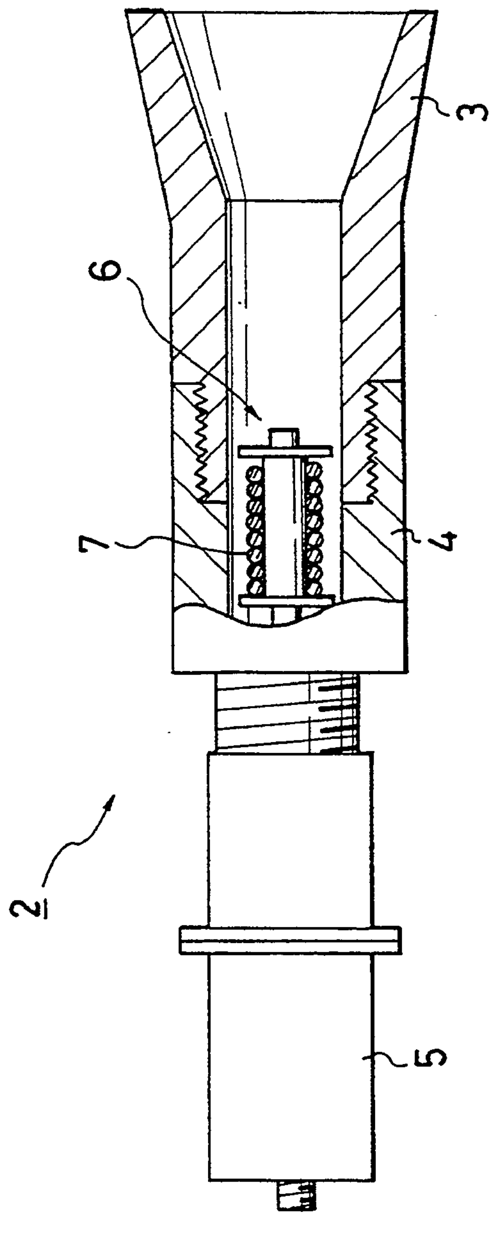

FIG.13