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(54) Low pressure mercury vapour discharge lamp and lighting apparatus using the same

(57) The low pressure mercury vapour discharge lamp (1) has a sealed light-transmitting envelope (10). An electrode means (14) is provided for generating a discharge within the envelope (10). A pellet (16) is adhered to an inner surface of the envelope (10) to provide an adhesion portion whose average diameter is d/3 or more if an average diameter of the pellet is d (mm). The pellet (16) is an amalgam having a mercury vapour pressure between 0.1 and 0.245 Pa when the ambient temperature is 25°C and having a melting temperature at an intermediate temperature between an operating temperature of the envelope (10) when the lamp (1) is energized and a melting temperature of said envelope (10).

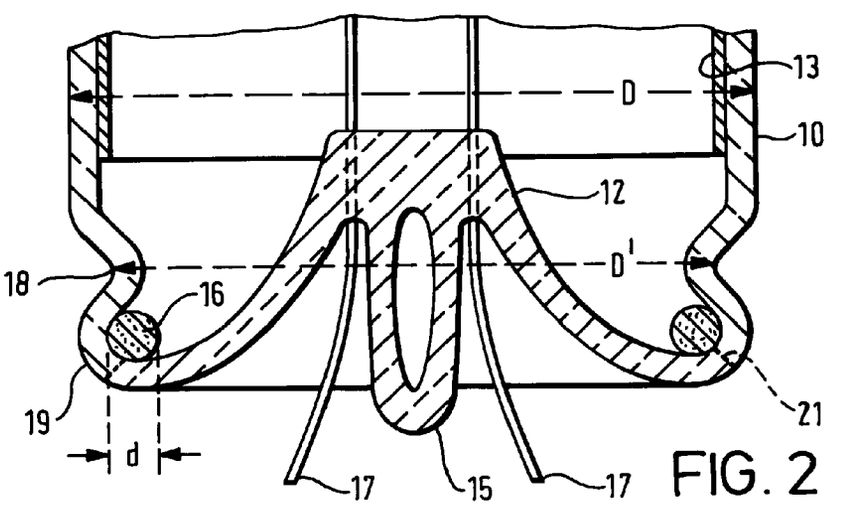

FIG. 2

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Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to a low pressure mercury vapor discharge lamp having an amalgam for providing a mercury vapor therein.

2. Description of the Related Art

All low pressure mercury vapor discharge lamps such as fluorescent lamps contain mercury which is vaporized during lamp operation. The mercury vapor atoms efficiently convert electrical energy to ultraviolet radiation with a wavelength of about 254 nm when the mercury vapor pressure is in the range of approximately 0.6 to 1.0 Pa (optimally about 0.8 Pa) during the lamp operation.

In a conventional low pressure mercury vapor discharge lamp, mercury is typically introduced into the lamp as a liquid in an amount according to a wattage and rated life of the lamp.

However, the high speed, automated manufacturing processes typically used to dose each lamp with liquid mercury lack precision because of the nature of the liquid mercury, the length and configuration of the path by which introduced, and the atomization of the mercury by the high velocity puff of inert gas used to effect introduction. As a result of the variability in the amount of mercury which reaches the lamp, a considerable excess of liquid mercury is introduced into each lamp.

For example, in a 40 watt conventional fluorescent lamp a minimum amount of mercury vapor is about 0.06 mg for obtaining the mercury vapor pressure of about 0.8 Pa to 40°C, however, about 10 ~ 15 milligrams of liquid mercury are typically needed to introduce into the lamp. Thus, some of the known manufacturing processes allot an average of many times the amount of liquid mercury needed to achieve average rated life.

In an attempt to introduce mercury into a lamp with a minimum amount needed to meet the average rated life, a fluorescent lamp containing a mercury zinc amalgam is disclosed in an international laid open patent application No. 94/18692. The lamp mercury is introduced in the form of solid zinc amalgam pellets instead of liquid mercury, therefore, it is easy to control the amount of mercury so as to minimize the amount thereof.

Japanese laid open patent application No. 6-260139/1994 also discloses a fluorescent lamp with mercury introduced in the form of a solid zinc amalgam pellet. According to this application, the amalgam pellet is fixed to an edge of the envelope. Therefore, a movement of the amalgam is prevented, which may cause damage of a phosphor coated on the inner surface of the envelope and parts, such as electrodes, provided in the envelope.

Although the amalgam pellet disclosed in the Japanese application is fixed to an edge of the envelope, the amalgam pellet tends to drop and move when the lamp is transported or operated.

SUMMARY OF THE INVENTION

Accordingly, the invention has as a primary object the provision of a low pressure mercury vapor discharge lamp that avoids movement of a pellet.

According to this invention a low pressure mercury vapor discharge lamp includes the following elements.

The low pressure mercury vapor discharge lamp has a sealed light-transmitting envelope. An electrode means for generating a discharge within the envelope. A pellet is adhered to an inner surface of the envelope with an adhesion portion the average diameter of which is d/3 or more for an average diameter d of the pellet (mm). The pellet comprises an amalgam having a mercury vapor pressure between 0.1 and 0.245 Pa for an ambient temperature of 25°C and having a melting temperature at an intermediate temperature between an operating temperature of the envelope when the lamp is energized and a melting temperature of said envelope.

In a further preferred embodiment according to the invention, a low pressure mercury vapor discharge lamp includes the following elements.

The low pressure mercury vapor discharge lamp has a sealed light-transmitting envelope. An electrode means is provided in the envelope for generating a discharge therebetween. A pellet is adhered to an inner surface of the envelope with an adhesion portion whose area is $\pi \times d \times d/36\ mm^2$ or more for an average diameter of said pellet is d (mm). The pellet comprises an amalgam having a mercury vapor pressure between 0.1 and 0.245 Pa for an ambient temperature of 25°C and having a melting temperature at an intermediate temperature between an operating temperature of the envelope when the lamp is energized and a melting temperature of the envelope.

According to another embodiment of the present invention, a lighting apparatus includes following elements.

The lighting apparatus has the low pressure mercury vapor discharge lamp mentioned above and a luminaire which houses the low pressure mercury vapor discharge lamp.

These and other aspects of the invention are further described in the following drawings and detailed description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be described in more details by way of examples illustrated by drawings in which:

FIGURE 1 is a front view of a low pressure mercury vapor discharge lamp according to a first embodiment of the present invention;

FIGURE 2 is a detailed cross sectional and broken view of a portion of the low pressure mercury vapor discharge lamp shown in Figure 1;

FIGURE 3 is a greatly enlarged detailed cross sectional and broken view of a detail of the part of the low pressure mercury vapor discharge lamp shown in Figure 2;

FIGURE 4 is a graph showing a relationship between an average diameter of an adhesion portion of a pellet and a dropping height in a drop test for testing lamps;

FIGURE 5 is a detailed portion cross sectional and broken view of a low pressure mercury vapor discharge lamp according to second embodiment of the present invention; and

FIGURE 6 is a schematic illustration of a lighting apparatus of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to Figures 1 to 4, a first embodiment of the present invention will be explained.

Figure 1 shows a low pressure mercury vapor discharge lamp 1. An envelope 10 of the low pressure mercury discharge lamp 1 has a circular bending configuration. The envelope 10 consists of a tube 11 having an outer diameter (D) of about 29 mm and stems 12, 12 sealed into each end of the tube 11 in the customary manner.

The tube 11 is made of a soda lime glass including no lead. A phosphor layer 13 for converting ultra violet rays to visible light is coated on the inner surface of the tube 11. The stems 12, 12 are made of a lead glass, which support a pair of electrodes 14, 14. The electrodes 14, 14 or electrode means are employed as a preheating type, however, other electrodes, such as a cold cathode, exciting coil for supplying magnetic power to the lamp, external electrode, may be used.

As shown in Figure 2, the stems 12, 12 are provided with an exhaust tube 15 that communicates with an opening in the stem wall and has its outer end hermetically tipped-off after the envelope 10 has been evacuated, charged with a suitable fill gas, and dosed with a predetermined amount of a pellet 16 in accordance with the lamp-manufacturing process described below. A suitable fill gas (not shown) is argon, neon, krypton or mixture thereof.

A boundary between the tube 11 and the stem 12, indicated by dashed line 21 in Figures 2 and 3, is a mixture of a lead glass and a soda lime glass. Each electrode 14 is connected to lead wires 17 which are sealed through the inner ends of the stem 12 and which extend into suitable bases (not shown) that are cemented to and enclose the ends of the envelope 10. The bases are each provided with suitable terminals (not shown), such as a pair of metal pins, that are electrically connected to the lead wires 17.

A recess 18 located around the boundary between the bulb 11 and the stem 12 is formed by moulding in order to facilitate holding by a chuck when the envelope 10 has to be bent in the usual manufacturing process of the lamps. An outer diameter (D') of the bulb 11 at the recess 18 is a few millimetres smaller than the diameter (D) of the envelope 10 at a position away from the ends. At the ends of the envelope 10 near the recess 18, a narrow valley 19 is formed between the stem 12 and the recess 18 when the envelope 10 is moulded.

A pellet 16 is so adhered to an inner surface of the valley 19 as to provide an adhesion portion 20, which includes zinc amalgam. The pellet 16 has a melting temperature between about 300°C ~ 400°C which is an intermediate temperature between an operating temperature of the envelope 10 when the lamp 1 is energized and a melting temperature of the envelope 10.

A suitable mercury amalgam can be one formed with zinc, with bismuth or with alloys of each or both. As glass including lead has a good wettability for such a metal, the pellet 16 adheres to the inner surface of the stem 12 made of the lead glass with a good adhesive strength.

The pellet 16 of zinc amalgam functions as a composition for releasing mercury vapor within a finished lamp 1. The zinc amalgam has a mercury concentration between 50 and 60 weight percent before the pellet 16 releases mercury vapor, the mercury vapor pressure of which is 0.22 Pa at 25°C. The mercury vapor pressure of the amalgam according to the present invention is in the range from 0.1 Pa to 0.245 Pa at 25°C, with preferred range being from 0.2 Pa to 0.245 Pa at 25°C so as approximately to attain the nature of pure mercury. The mercury concentration of the amalgam is preferably selected between 20 ~ 70 weight percent. If the mercury concentration of the amalgam is less than 20 weight percent, actual mercury vapor pressure during the lamp 1 operation becomes lower. While if the mercury concentration of the amalgam exceeds 70 weight percent, as mercury contained in the amalgam oozes from the pellet 16, it is difficult to handle the pellet 16 in the manufacturing processes of the lamp 1.

Instead of a single pellet a plurality of pellets may be so introduced into the envelope 10 so that actual mercury vapor pressure within the operating lamp is maintained at a sufficient level. A sufficient level of the actual mercury vapor pressure is not less than 0.6 Pa in order to attain the characteristics of general low pressure mercury vapor lamps with pure mercury introduced in the envelope.

After the pellet 16 releases mercury vapor, the amalgam has a mercury concentration below 1 weight percent near its surface, and has an inner mercury concentration between 1 and 10 weight percent. If the diameter of the pellet 16 is 1.5 mm, it can be introduced into various conventional low pressure mercury vapor discharge lamps. However, for a pellet 16 to be intro-

duced into a thin low pressure mercury vapor discharge lamp, such as with an envelope diameter of less than 15.5 mm, it is more convenient to introduce a pellet having a diameter smaller than 1.5 mm.

The adhesion portion 20 located between the pellet 16 and the surface of the valley 19 has an average diameter (d') of about 0.5 mm or more which is equivalent to or more than the diameter (d) of the pellet 16 divided by three (d/3). Therefore, the adhesion portion 20 has an area of π x d x d/36 mm^2 or more, in this embodiment that is 0.2 mm^2.

If the pellet 16 is not a sphere, the average diameter (d) of the pellet 16 is regarded as a diameter calculated from the volume of the pellet 16. The average diameter (d') of the adhesion portion 20 is also defined as the average of maximum and minimum measurements in the adhesion portion 20 for convenience or alternatively the area should correspond to the above specification. More, if a plurality of pellets is introduced into the lamp 1, each pellet should satisfy the above relationships of the average diameters (d, d') of the pellet 16 and adhesion portion 20.

Next, a manufacturing process of the lamp 1 will be described.

Each end of the tube 11, already coated with phosphor layer 13, is sealed with stems 12, 12 provided with the electrodes 14, 14 and the exhaust tubes 15, 15 for forming the envelope 10. Simultaneously the recesses 18, 18 are formed by a moulding, whereby the valleys 19, 19 are also formed near the respective ends of the tube 11. At this time, one of the exhaust tubes 15 is pinched off, while the other exhaust tube 15 is maintained open. Continuously, the envelope 10 is heated for softening with the envelope in a vertical location so that the end of the envelope 10 provided with the open exhaust tube 15 is positioned at an upper position.

The recess 19 located below is held by a chuck and the envelope 10 is wound around the drum of a conventional bending machine to form it into a circular configuration. At this time, nitrogen gas is provided in the envelope 10 to prevent deformation thereof.

Thereafter a suitable inert gas is introduced into the envelope 10 after all the air of the envelope 10 is extracted with heating through the open exhaust tube 15. Then the pellet 16 is introduced through the exhaust tube 15, and the exhaust tube 15 is pinched off. The pellet 16 falls to a bottom of the envelope 10 and reaches the valley 19. As the envelope 10 is maintained at a high temperature, partial mercury contained in the pellet 16 is evaporated within the envelope 10 and a surface of the pellet 16 is melted partially, whereby the pellet 16 adheres to the surface of the envelope 10 in the valley 19.

The adhesion portion 20 may be observed through the stem 12 as a glossy portion.

In this manufacturing process, since the residual heat of the envelope 10 is made use of for melting the pellet 16, additional heating is not used for heating of the pellet 16. However, additional heating of the pellet 16 may be used depending upon the melting temperature, the size, or the position of the pellet 16.

The heating time and temperature should be selected so as to melt the pellet 16 partially. If the pellet 16 is heated to excess, damage of the phosphor layer 13 can result because of an excess evaporation of mercury and zinc contained in the pellet 16.

It is preferable for the pellet 16 to be heated for 30 ~ 60 seconds at 300°C when the pellet 16 is introduced into the lamp 1 as described above.

Although the envelope 10 has a circular configuration in the present embodiment, other lamp configurations may be used.

Figure 4 shows experimental results of a vertical impact test obtained by dropping eight test samples. The test samples were made according to the manufacturing process so that the average diameters (d') of the adhesion portions 20 are different from each other. Each test sample was made identically except for the diameter (d') of the adhesion portion.

The vertical impact test is defined in Japanese industrial standard No. Z 0202, which corresponds to International standardization organization No. 2248.

The test samples are packaged in unitary corrugated fibreboard boxes. Further the unitary corrugated fibreboard box is packaged in a corrugated fibreboard shipping container. The corrugated fibreboard shipping container is dropped according to the method of the test. In the test samples, each pellet adhering to a surface of the envelope valley had a diameter (d) of about 1.5 mm.

In Figure 4, points marked by O or X indicate whether the pellet 16 remained adhered or became detached after the test sample contained into the shipping container had been dropped. A point marked as O indicates that the particular pellet 16 remained adhered, while a point marked as X indicates that the particular pellet 16 became detached from the valley 19.

According to Figure 4, a pellet 16 tended to become detached from the valley 19 if the diameter (d') of the adhesion portion 20 was small. Japanese industrial standard No. Z 0200 defines various dropping heights, depending on the weight of products, a product needs to survive and keep regular function, that is between 15 cm and 90 cm. Accordingly, if a pellet 16 maintains its adhesion after the test sample has dropped from a height of over 100 cm, the pellet 16 has sufficient adhesive strength. The results of the tests show that, when the diameter (d') of the adhesion portion 20 exceeds d/3, the pellet 16 has sufficient adhesive strength. Similarly, a pellet 16 has sufficient adhesive strength if the area of adhesion portion 20 exceeds π x d x d/36 .

Other embodiments in accordance with the present invention are shown in Figures 5 and 6 and explained next. Like reference characters designate identical or corresponding elements of the above disclosed first embodiment. The construction and operation of the following embodiments are substantially the same as the

first embodiment and, therefore, a detailed explanation of its operation is not provided.

Figure 5 shows a low pressure mercury vapor discharge lamp 1 according to a second embodiment of the present invention. The pellet 16 is adhered to two separate portions of the inner surface of the valley 19. The area of adhesion portion is for the pellet the sum of the two portions and this area satisfies the requirement of being π x d x d/36 or more.

In order to form two adhesion portions, the radius of curvature, Rg, of the inner curved surface of the base of the valley 19 should be smaller than half the average diameter, d, of the pellet 16.

According to this embodiment, sufficient adhesion area is maintained because the pellet 16 has two adhesion portions.

Figure 6 shows a lighting apparatus 30 according to the present invention. A suspended luminaire 31 houses the low pressure mercury vapor discharge lamp 1 and a stabilizer 32 for supplying electric power to the lamp 1. The luminaire 31 is employed as an enclosure of the stabilizer 32 and a reflector to control a luminous intensity distribution of the lamp 1.

While the invention has been described in connection with what are presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims.

Claims

1. A low pressure mercury vapor discharge lamp comprising:

   a sealed light-transmitting envelope (10);
   an electrode means (14, 14) for generating a discharge within said envelope (10); and
   an amalgam pellet (16) adhered to an inner surface of said envelope (10) by means of an adhesion portion (20);
   said low pressure mercury vapor discharge lamp being characterized in that said pellet (16) has an adhesion portion (20) the average diameter of which is d/3 or more, of where d is the average diameter of said pellet (16) and in that said pellet has a mercury vapor pressure between 0.1 and 0.245 Pa for an ambient temperature of 25°C and has a melting temperature at an intermediate temperature between an operating temperature of said envelope (10) when the lamp is energized and a melting temperature of said envelope (10).

2. A low pressure mercury vapor discharge lamp comprising:

   a sealed light-transmitting envelope (10);
   an electrode means (14, 14) for generating a discharge within said envelope (10); and
   an amalgam pellet (16) adhered to an inner surface of said envelope (10) by means of an adhesion portion (20);
   said low pressure mercury vapor discharge lamp being characterized in that said pellet (16) has an adhesion portion (20) the area of which is π x d x d/36 or more, where d is the average diameter of said pellet (16), and in that said pellet has a mercury vapor pressure between 0.1 and 0.245 Pa for an ambient temperature of 25°C and has a melting temperature at an intermediate temperature between an operating temperature of said envelope (10) when the lamp is energized and a melting temperature of said envelope (10).

3. A low mercury vapor pressure lamp according to claim 2, wherein said pellet (16) is adhered to at least two portions of the inner surface of said envelope (10).

4. A low mercury vapor pressure lamp according to any preceding claim, wherein said envelope (10) has a recess at at least one end thereof for accommodating said adhesion portion (20).

5. A low mercury vapor pressure lamp according to any preceding claim, wherein said envelope (10) includes a tube (11) having openings at both end thereof and stems (12, 12) sealed in each of said openings, when said tube (11) is made of a soda-lime glass and said stems (12, 12) are made of a lead glass, said pellet (16) being adhered across the junction between said tube (11) and one of said stems (12, 12).

6. A low mercury vapor pressure lamp according to any preceding claim, further including a phosphor layer (13) coated on the inner surface of said envelope (10) for converting ultra violet rays, emitted by the discharge, into visible light.

7. A low mercury vapor pressure lamp according to any preceding claim, wherein said envelope (10) has a circular configuration.

8. A low mercury vapor pressure lamp according to any preceding claim, wherein said amalgam substantially comprises a binary of zinc.

9. A low mercury vapor pressure lamp according to any preceding claim, further including means for controlling actual mercury vapor pressure of said envelope (10) so as to be not less than 0.6 Pa when the lamp is energized.

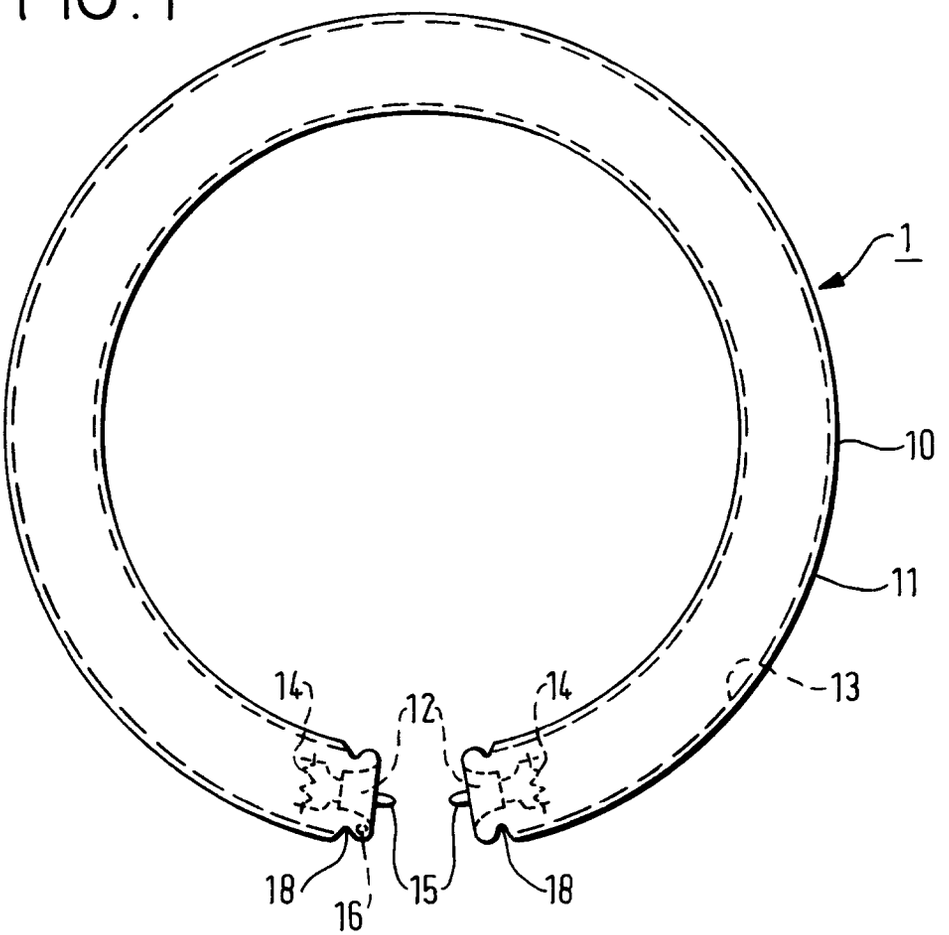
10. A low mercury vapor pressure lamp according to any preceding claim, wherein said amalgam has a mercury vapor pressure of between 0.2 Pa and 0.245 Pa for an ambient temperature of 25°C.

11. A low mercury vapor pressure lamp according to claim 10, wherein said pellet (16) substantially consists of an amalgam having a mercury vapour pressure of 0.22 Pa for an ambient temperature of 25°C.

12. A lighting apparatus comprising:

a low pressure mercury vapor discharge lamp (1) according to any preceding claim and
a luminaire (31) housing said low pressure mercury vapor discharge lamp (1).

FIG. 1



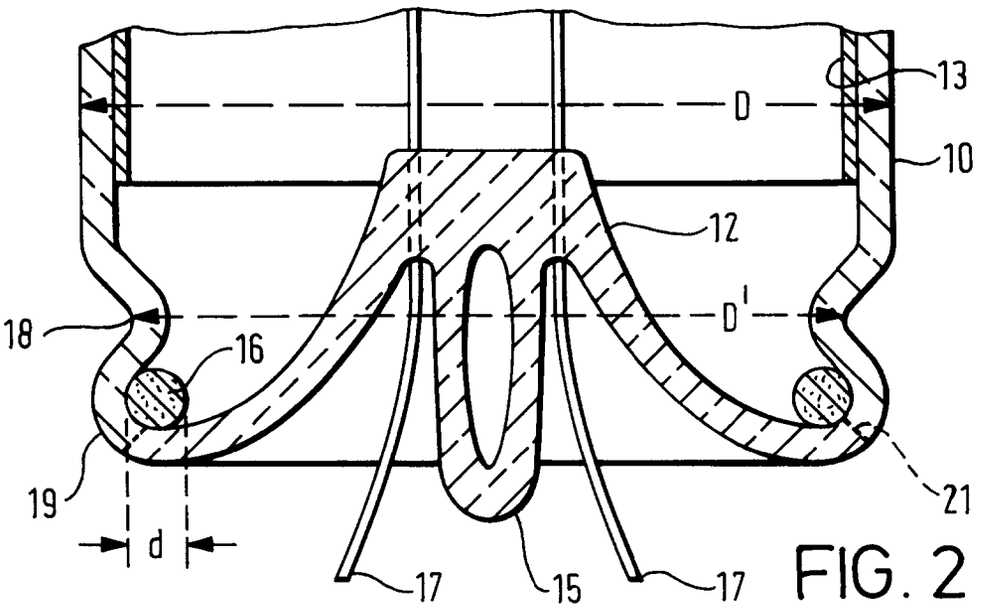


FIG. 2

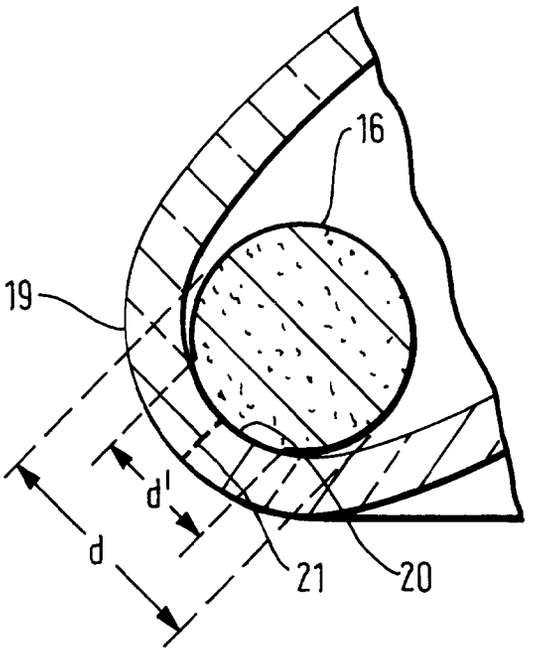

16
19
d'
d
21
20

FIG. 3

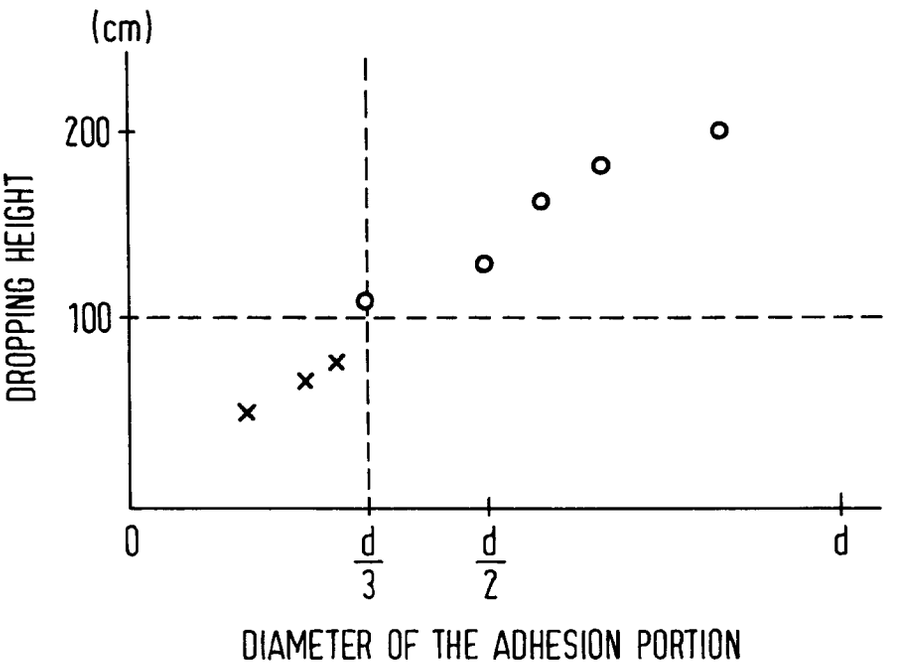
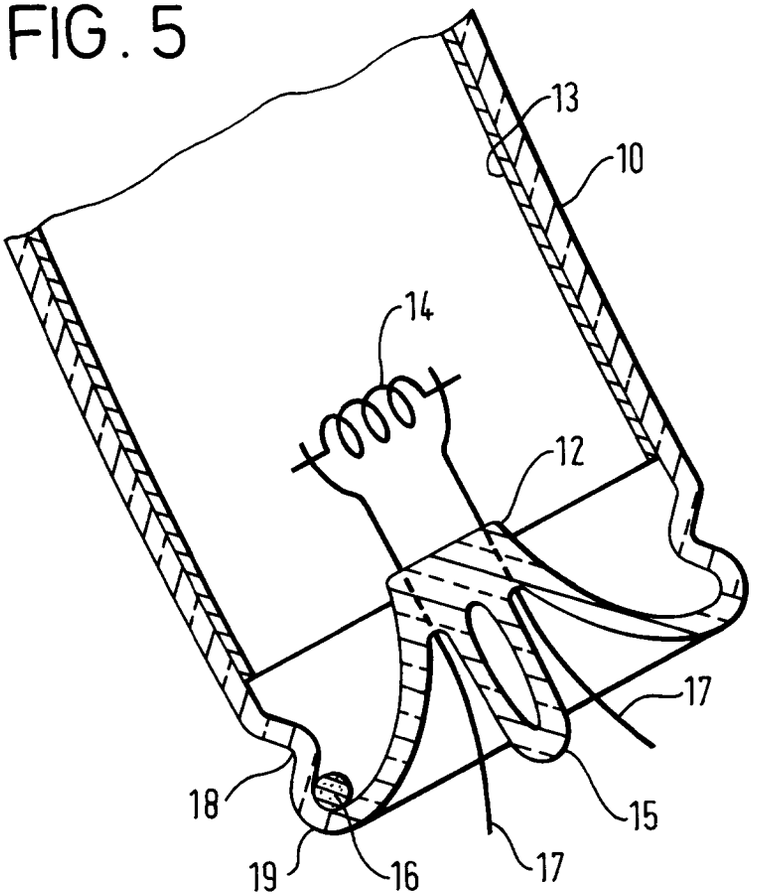

(cm)
200
100
DROPPING HEIGHT
0
d/3
d/2
d
DIAMETER OF THE ADHESION PORTION

FIG. 4

FIG. 5



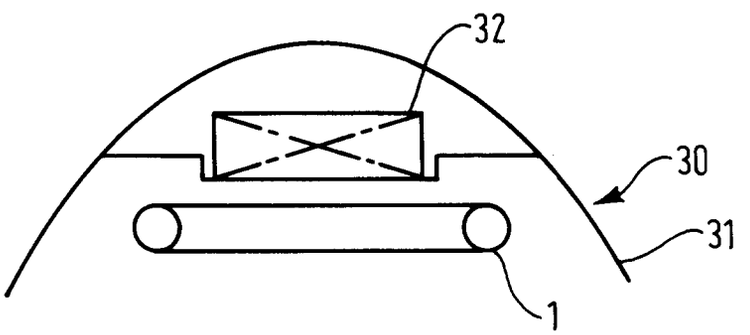


FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 8412

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	US-A-4 020 378 (MOREHEAD CHALMERS) 26 April 1977 * abstract; figures 2-4,10 * * column 2, line 12 - line 16 * * column 3, line 52 - line 59 * * column 4, line 4 - line 8 *	1,2,6-12	H01J61/28 H01J9/395
D,Y	PATENT ABSTRACTS OF JAPAN vol. 018, no. 658 (E-1643), 13 December 1994 & JP-A-06 260139 (NOMURA KOSAN KK), 16 September 1994, * abstract *	1,2,6-12	
Y	US-A-5 095 336 (CORONA STEPHEN C ET AL) 10 March 1992 * abstract *	1,2,6-12	
D,Y	WO-A-94 18692 (APL ENGINEERED MATERIALS INC) 18 August 1994 * abstract; figure 1 * * page 6, line 6 - page 7, line 6 *	1,2,6-12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) H01J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 August 1996	Martín Vicente, M

CATEGORY OF CITED DOCUMENTS

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