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

(11) EP 0 821 832 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
23.10.2002 Bulletin 2002/43

(21) Application number: **96913001.2**

(22) Date of filing: **22.04.1996**

(51) Int Cl.[7]: **H01J 65/04**

(86) International application number:
PCT/US96/05556

(87) International publication number:
WO 96/033509 (24.10.1996 Gazette 1996/47)

(54) **COMPACT MICROWAVE LAMP**

KOMPAKTE MIKROWELLEN LAMPE

LAMPE COMPACTE A HYPERFREQUENCES

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI NL PT SE

(30) Priority: **21.04.1995 US 426603**

(43) Date of publication of application:
04.02.1998 Bulletin 1998/06

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Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a microwave powered lamp, and particularly to a lamp of the type defined in the precharacterizing portion of claim 1.

[0002] Recently, microwave powered lamps utilizing sulfur or selenium based fills for efficiently radiating in the visible region have been disclosed. For example, see U.S. Patent No. 5,404,076, issued April 4, 1995.

[0003] Such microwave lamps may be used as illumination sources, which find a particular use in commercial or industrial lighting. For such lighting applications, it is desirable to build a lamp system which fits within the general outline of some of the lamps already in existence. Many of these are equipped with rather large inductive ballasts which are installed in overhead locations adjoining the associated lamp. Accordingly, a new lamp system will have greater utility if it occupies a package of comparable size which can be similarly placed. This requires the various parts of the electrodeless lamp system to be kept as small as reasonably possible. These parts include a quartz bulb to contain the arc plasma housed within a microwave cavity having a metal mesh to contain the microwaves but allow the escape of light, a magnetron to produce the microwaves, a waveguide to carry the microwaves from the magnetron to the cavity, a power supply to drive the magnetron and cooling fans or other means to cool the magnetron and its power supply. The lamp bulb is rotated within the microwave cavity to stabilize the discharge which adds a motor to the system as well.

[0004] To increase the versatility of the new lamp and, therefore, the number of sites in which it can be used, the lamp itself does not include a reflector. Rather the lamp is to be inserted through a hole in reflectors of several designs, suitable for use in applications requiring light dispersal over different areas. This requires the light source to extend outward from the lamp case a distance of at least 100 mm. Keeping the entry hole to a small diameter increases the efficiency of the reflector.

[0005] It is desirable to keep the overall length of the lamp as small as possible. Since the motor which rotates the bulb must be placed outside of microwave fields, it potentially adds length to the lamp system. In one such configuration, the bulb stem is fed through the coupling slot and the waveguide, and the motor and coupler are located on the other side of the waveguide, resulting in a very long stem which is subject to breakage.

[0006] A further problem is encountered in that the waveguide must have a sufficiently narrow width so that the cutoff frequency is high enough to eliminate spurious interference signals from being generated, but must have a height sufficient to prevent arcing at the location of the magnetron antenna. A conventional WR-284 waveguide is narrow enough to eliminate interference signals, but because of its height which correlates to its width in a conventional ratio of about 1 to 2, arcing results.

[0007] EP-A-0 153 745 discloses various microwave discharge lamp configurations. A conventional waveguide cross-section of 95 mm x 54 mm is disclosed.

[0008] U.S. Patent No. 4,903,935 (Wood) discloses a microwave discharge lamp utilizing a tilted rotating bulb.

SUMMARY OF THE INVENTION

[0009] It is thus an object of the invention to provide a microwave powered illumination lamp having a compact structure.

[0010] It is a further object of the invention to provide a lamp in which arcing is obviated.

[0011] In accordance with the invention, an electrodeless lamp of the type mentioned above comprises the features of the characterizing portion of claim 1.

[0012] In this way, the height of the magnetron antenna is accommodated without arcing, while spurious signals which might cause interference are eliminated.

[0013] The invention will be better understood by referring to the accompanying drawings, wherein:

Figure 1 is a side view of a lamp in accordance with an embodiment of the invention.

Figure 2 is a top view of the waveguide portion of the lamp depicted in Figure 1.

Figure 3 is a sectional view of the waveguide of the lamp of Figure 1 taken perpendicular to the coupling slot.

Figure 4 is a plan view which depicts how the magnetron and associated components are mounted in the lamp of Figure 1.

DETAILED DESCRIPTION

[0014] Referring to Figure 1, a lamp in accordance with an embodiment of the invention is shown. The lamp is comprised of bulb 2 which is located in a microwave cavity. The bulb may be made of quartz and encloses a discharge forming medium, for example, a sulfur or selenium based fill.

[0015] The microwave cavity is cylindrical, and is comprised of a side wall structure, and two end walls. The side wall structure and top end wall in the orientation of Figure 1 are made of a cylindrical metallic mesh, shown in part at reference numeral 3, which allows light to exit but is substantially opaque to microwave radiation. The bottom end wall of the cavity in the orientation of Figure 1 is the outside surface 8 of waveguide 10.

[0016] As mentioned above, the microwave lamp depicted in Figure 1 may be used to replace existing non-microwave lamps, and it is therefore desirable for the lamp to be made as compact as possible so as to fit within the general outline of existing lamps.

[0017] In some microwave lamps of the prior art wherein the bulb stem extends from an end wall, it passes through the waveguide which feeds the cavity, and the motor and coupling ferrule are mounted on the opposite side of the waveguide, far enough away to be clear of microwave fields. Such an arrangement, however, may have the effect of increasing the overall length of the lamp, as well as the length of the bulb stem, thereby making it subject to breakage.

[0018] In accordance with the present invention, the coupling slot is located to one side of center in the cavity end wall, while the bulb stem is fed through the end wall to the other side of center canted in relation to the end wall, with the motor and ferrule being mounted outside the cavity and away from the waveguide. Additionally, the longitudinal direction of the waveguide extends parallel to the end wall of the cavity, so as to not extend the length of the lamp. The result is a more compact lamp of shorter overall length, wherein the bulb is more ruggedly supported on a shorter stem.

[0019] Referring to Figure 1 and 2, rectangular waveguide 10 is shown, having inside wall 12 and outside wall 8 (see Fig. 1). The top walls of the waveguide have coupling slot 14 therein, which is shown in Figure 2. As is also shown in Figure 2, end wall 16 of the waveguide is slightly wider than the coupling slot 14.

[0020] Returning to Fig. 1, magnetron 18 having antenna 20 is mounted to the waveguide, as shown. Microwave power is fed into the waveguide and through coupling slot 14 (see Fig. 2) to the microwave cavity, where it excites the fill in bulb 2. In Figure 2, hole 21 is shown, through which the magnetron antenna and a gasket protrude.

[0021] Referring to Fig. 1, bulb stem 22 is passed through hole 24 at an angle of other than 90°, (about 77° in the preferred embodiment) so that the bulb is centrally located in relation to the mesh side wall structure of the cavity. The motor 26 is mounted to motor support 28, while ferrule 30 couples the motor shaft to the bulb stem, which is typically made of quartz. Extension 34 of support 28 is secured to the bottom outside surface of the waveguide, while gap 36 is present between the motor support and the end wall of the waveguide.

[0022] In Figure 1, the top wall 8 of the waveguide extends to the left at reference numeral 40 past the end of the waveguide. Additionally, the top of the waveguide is flush against plate 32, which is secured to plate 42 at the ends thereof with flanges 44 and 46. Referring to Figures 1 and 2, metallic ring 52 is mounted on the top surface of the waveguide (cavity end). The cylindrical mesh is secured to this ring by a clamp, and the mesh passes through a hole in plate 42. As shown in Fig. 1, a transparent cylindrical envelope 54 which may be made of glass or quartz surrounds the screen, and is mounted on plate 42, for example by retainer 56. Thermal insulation is disposed in the space between plates 32 and 42.

[0023] In the operation of the lamp, microwave power generated by the magnetron is fed through the waveguide and the coupling slot into the cavity in which bulb 2 is located. In order to make the device as compact as possible and to provide a stable relationship between the magnetron and the cavity, magnetron antenna 20 is located 1/4 guide wavelength (the wavelength of signals propagating within the waveguide) from coupling slot 14.

[0024] Additionally, it was found that a waveguide having a width sufficiently narrow to have a cut-off frequency sufficiently high to eliminate spurious signals was necessary. For example, a waveguide was tried which accommodated the magnetron antenna produced out of band signals 200 Mhz below the normal operation point of 2450 Mhz, and the use of the 1/4 wavelength waveguide length referred to above tends to aggravate this situation. It was found that a WR-284 (equivalent IEC designation, R-32) waveguide was sufficiently narrow to eliminate spurious signals, but it was found that the height of this waveguide, which is 3.404 cm (1.340 in.), was too small to accommodate the magnetron antenna without arcing. To solve this problem, a non-conventional waveguide was used having about the width of the WR-284 waveguide, which is 7.214 cm (2.840 in.), and about the height of the WR-340 (equivalent IEC designation, R-26) waveguide, which is 4.318 cm (1.700 in.). This blocks the transmission of signals below 2078 Mhz and helps to suppress the low frequency out of band signals by reducing the phase shift between the magnetron and the coupling slot. At the same time, the height of the waveguide is sufficient to accommodate the magnetron antenna without arcing. The dimensions for Electronics Industry Association (EIA) standard waveguides are given in Samuel Y. Liao, Microwave Devices and Circuits, Prentice Hall, Englewood Cliffs, New Jersey, 1990, page 118.

[0025] The waveguide end wall behind the magnetron is moved farther away than is the usual practice. In prototype testing, a metal tuning knob was used to match the impedance of the lamp to the waveguide. This knob functioned as a capacitor at its location. With the length reduction to one quarter wavelength, this position became the same as the magnetron antenna. A tuning knob might have been placed beside the antenna, taking care to avoid arcing, however, the magnetron antenna itself is a capacitor across the waveguide. This is usually compensated by placing the end wall in an inductive position, closer to the antenna than a quarter wavelength. By moving the wall farther out, the inductance is reduced and the antenna is seen as the desired tuning capacitance. The best position was found experimentally by using a movable waveguide end wall.

[0026] In many previous microwave lamps, matching is accomplished by placing a tuning knob in the waveguide. If all possible load phases are to be corrected, a half-wavelength of waveguide is needed. According to the invention, the system was matched by placing a thin block 60, shown in Figure 2, beside the slot 14 to modify the current path.

[0027] Referring to Figure 3, which is a view as seen from the back of the lamp in Figure 1 (left to right reversed), dielectric member 62, which may be made of mica is depicted. This member rests against the inside end wall of the waveguide and protrudes through coupling slot 14 while resting against the edge of the slot. It may be substantially as wide as the slot. The purpose of member 62 is to prevent arcing across the slot.

[0028] Figure 4 is a plan view of the magnetron and associated components, which are located on plate 32 shown in Figure 1.

[0029] Magnetron 18 receives filament power from filament transformer 70, while stepdown transformer 72 may be used to provide power for bulb rotator motor 26, shown in connection with motor mount 28 and capacitor 74. In Figure 4, magnetron cooling air blower 76 is depicted as is PC control board 78. Finally, waveguide 10 is shown feeding coupling slot 14.

[0030] While the invention has been described in connection with a preferred embodiment, variations will occur to those skilled in the art, and it is therefore understood that the invention herein is defined in the claims which are appended hereto.

Claims

1. A compact electrodeless lamp, comprising:

a microwave cavity;

a bulb (2) disposed in the microwave cavity, the bulb (2) containing a discharge forming fill;

a magnetron (18) for providing microwave power at 2450 MHz, the magnetron having an antenna (20);

a waveguide (10) connected to the magnetron (18) so that the antenna (20) of the magnetron (18) extends inside the waveguide (10) and parallel to a height dimension of the waveguide (10), the waveguide (10) including a slot (14) in a wall (8, 12) of the waveguide (10) for coupling the microwave power to the microwave cavity,

characterized in that the distance between the antenna (20) and the slot (14) is about ¼ guide wavelength and the width of the waveguide (10) is equal to the width of a WR-284 waveguide and wherein the height of the waveguide (10) is equal to the height of a WR-340 waveguide.

2. The electrodeless lamp as recited in claim 1, further comprising a block (60) positioned inside the microwave cavity adjacent to the slot (14).

3. The electrodeless lamp as recited in claim 2, wherein the block (60) is thin.

4. The electrodeless lamp as recited in claim 2, wherein the block (60) comprises a fixed metallic tuning member.

5. The electrodeless lamp as recited in claim 1, further comprising a dielectric member (62) positioned against a wall of the slot (14) and extending into the microwave cavity.

6. The electrodeless lamp as recited in claim 5, wherein the dielectric member (62) is made of mica.

7. The electrodeless lamp as recited in claim 5, wherein the dielectric member (62) extends through the slot (14).

8. The electrodeless lamp as recited in claim 5, wherein the dielectric member (62) is substantially as wide as the slot (14).

9. The electrodeless lamp as recited in claim 5, wherein an end wall (16) of the waveguide (10) is substantially aligned with the wall of the slot (14), and wherein the dielectric member (62) extends through the slot (14) and is positioned against the end wall (16) of the waveguide (10).

Patentansprüche

1. Kompakte, elektrodenlose Lampe, die folgendes umfaßt:

einen Mikrowellenhohlraum;

einen in dem Mikrowellenhohlraum angeordneten Kolben (2), wobei der Kolben (2) eine eine Entladung erzeugende Füllung enthält;

ein Magnetron (18) zur Bereitstellung von Mikrowellenleistung bei 2450 MHz, wobei das Magnetron eine Antenne (20) hat;

einen Wellenleiter (10), der mit dem Magnetron (18) verbunden ist, so daß sich die Antenne (20) des Magnetrons (18) im Inneren des Wellenleiters (10) und parallel zu einer Höhenabmessung des Wellenleiters (10) erstreckt, wobei der Wellenleiter (10) einen Schlitz (14) in einer Wand (8, 12) des Wellenleiters (10) umfaßt, um die Mikrowellenleistung an den Mikrowellenhohlraum zu koppeln,

dadurch gekennzeichnet, daß der Abstand zwischen der Antenne (20) und dem Schlitz (14) etwa 1/4 der Wellenlänge des Wellenleiters beträgt und die Breite des Wellenleiters (10) gleich der Breite eines Wellenleiters WR-284 ist, und daß die Höhe des Wellenleiters (10) gleich der Höhe eines Wellenleiters WR-340 ist.

2. Elektrodenlose Lampe nach Anspruch 1, die ferner einen im Inneren des Mikrowellenhohlraums angrenzend an den Schlitz (14) positionierten Block (60) umfaßt.

3. Elektrodenlose Lampe nach Anspruch 2, bei der der Block (60) dünn ist.

4. Elektrodenlose Lampe nach Anspruch 2, bei der der Block (60) ein feststehendes metallisches Abstimmelement umfaßt.

5. Elektrodenlose Lampe nach Anspruch 1, die ferner ein dielektrisches Element (62) umfaßt, das an einer Wand des Schlitzes (14) positioniert ist und sich in den Mikrowellenhohlraum erstreckt.

6. Elektrodenlose Lampe nach Anspruch 5, bei der das dielektrische Element (62) aus Glimmer besteht.

7. Elektrodenlose Lampe nach Anspruch 5, bei der sich das dielektrische Element (62) durch den Schlitz (14) erstreckt.

8. Elektrodenlose Lampe nach Anspruch 5, bei der das dielektrische Element (62) im wesentlichen so breit wie der Schlitz (14) ist.

9. Elektrodenlose Lampe nach Anspruch 5, bei der eine Stirnwand (16) des Wellenleiters (10) im wesentlichen mit der Wand des Schlitzes (14) fluchtet, und bei der sich das dielektrische Element (62) durch den Schlitz (14) erstreckt und an der Stirnwand (16) des Wellenleiters (10) positioniert ist.

Revendications

1. Lampe compacte sans électrode, comprenant :

une cavité hyperfréquence;

une ampoule (2) disposée dans la cavité hyperfréquence, l'ampoule (2) contenant un remplissage formant une décharge;

un magnétron (18) pour délivrer un courant hyperfréquence à 2450 MHz, le magnétron étant pourvu d'une antenne (2);

un guide d'onde (10) relié au magnétron (18) de telle sorte que l'antenne (20) du magnétron (18) s'étende à l'intérieur du guide d'onde (10) et parallèlement à une dimension de la hauteur du guide d'onde (10), le guide d'onde (10) incluant une fente (14) dans une paroi (8, 12) du guide d'onde (10) pour coupler le courant hyperfréquence à la cavité hyperfréquence;

caractérisée en ce que la distance entre l'antenne (20) et la fente (14) est environ le quart de la longueur d'onde du guide et la largeur du guide d'onde (10) est égale à la largeur d'un guide d'onde WR-284, et dans laquelle la hauteur du guide d'onde (10) est égale à la hauteur d'un guide d'onde WR-340.

2. Lampe sans électrode selon la revendication 1, comprenant de plus un bloc (60) positionné à l'intérieur de la cavité hyperfréquence, de façon adjacente à la fente (14).

3. Lampe sans électrode selon la revendication 2, dans laquelle le bloc (60) est fin.

4. Lampe sans électrode selon la revendication 2, dans laquelle le bloc (60) comprend un élément de réglage métallique fixe.

5. Lampe sans électrode selon la revendication 1, comprenant en outre un élément diélectrique (62) positionné contre une paroi de la fente (14) et s'étendant dans la cavité hyperfréquence.

6. Lampe sans électrode selon la revendication 5, dans laquelle l'élément diélectrique (62) est composé de mica.

7. Lampe sans électrode selon la revendication 5, dans laquelle l'élément diélectrique (62) s'étend à travers la fente (14).

8. Lampe sans électrode selon la revendication 5, dans laquelle l'élément diélectrique (62) est sensiblement aussi large que la fente (14).

9. Lampe sans électrode selon la revendication 5, dans laquelle une paroi d'extrémité (16) du guide d'onde (10) est sensiblement aligné avec la paroi de la fente (14), et dans laquelle l'élément diélectrique (62) s'étend à travers la fente (14) et est positionné contre la paroi d'extrémité (16) du guide d'onde (10)

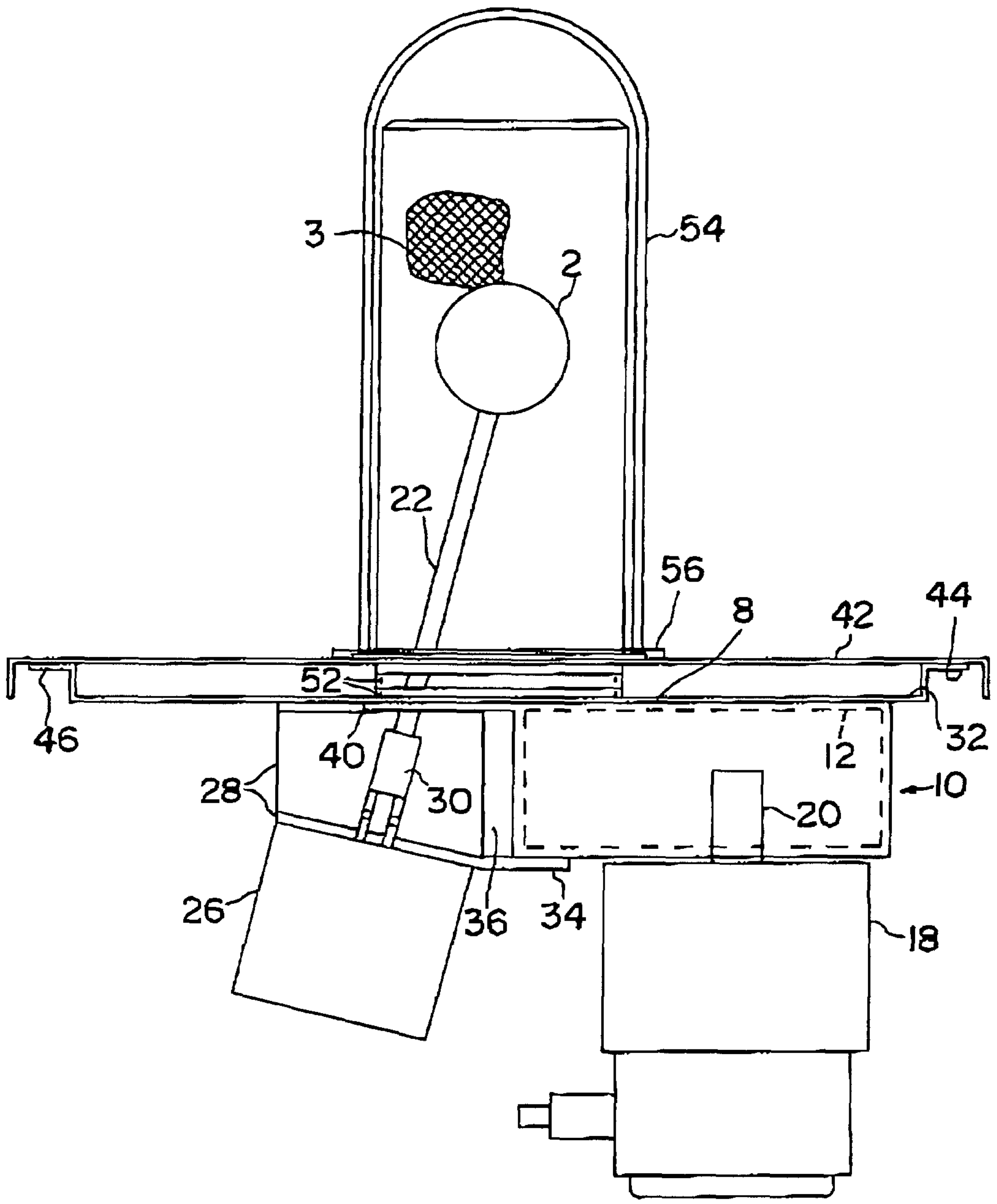

FIG.1

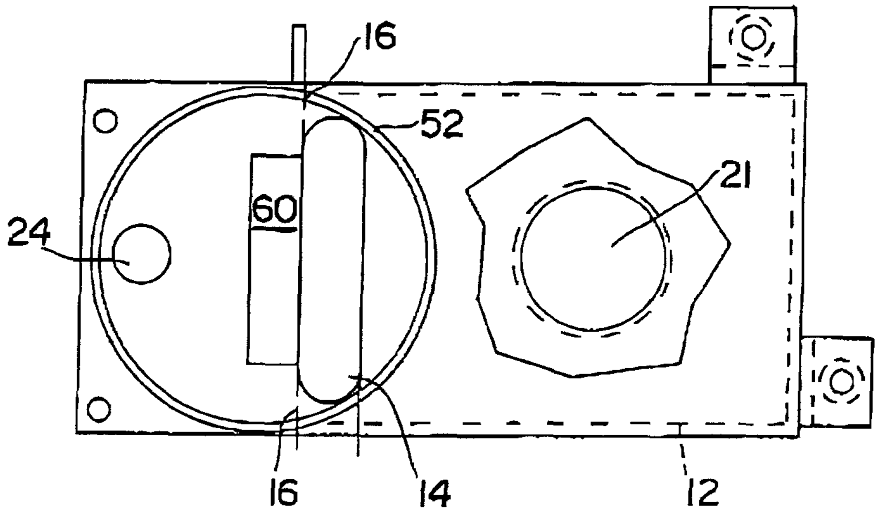

FIG. 2

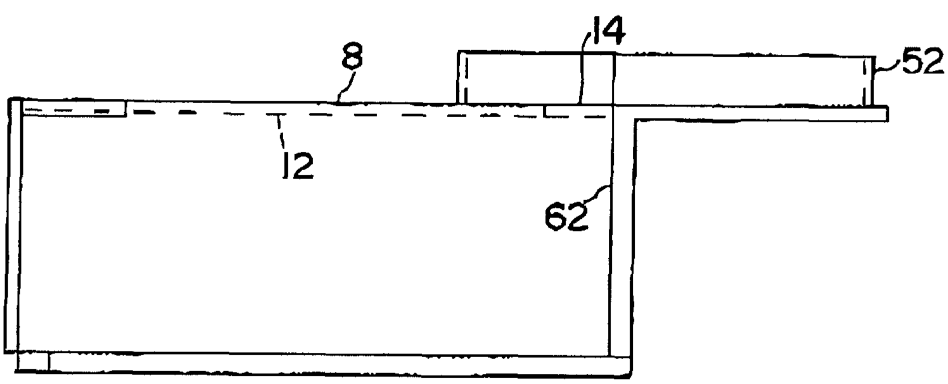

FIG. 3

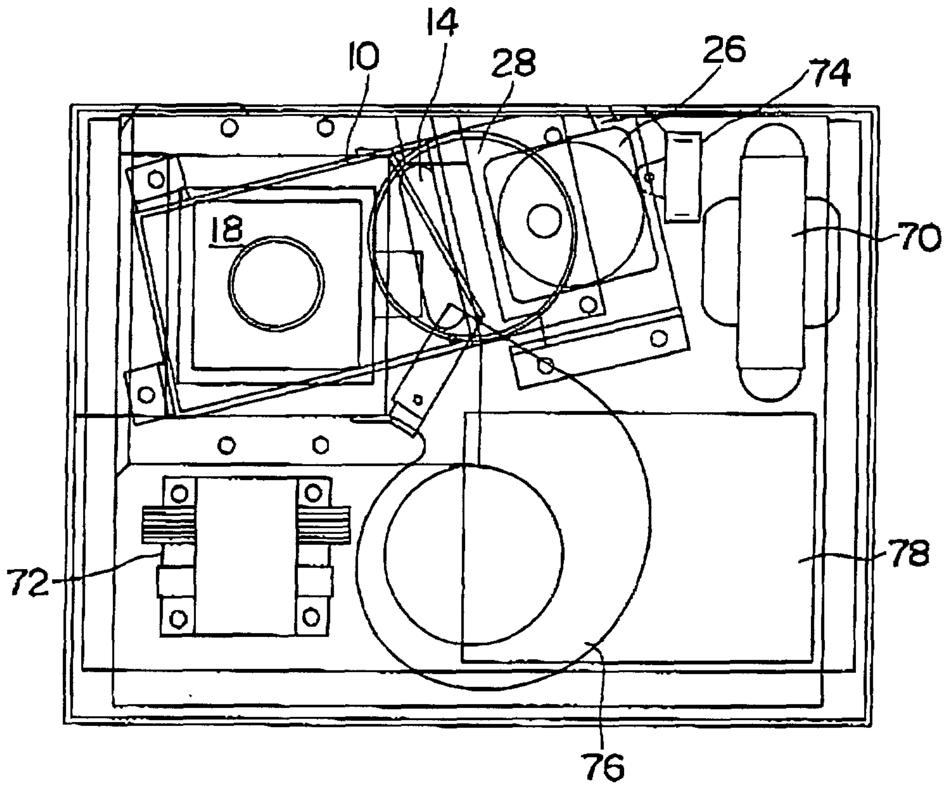

FIG.4