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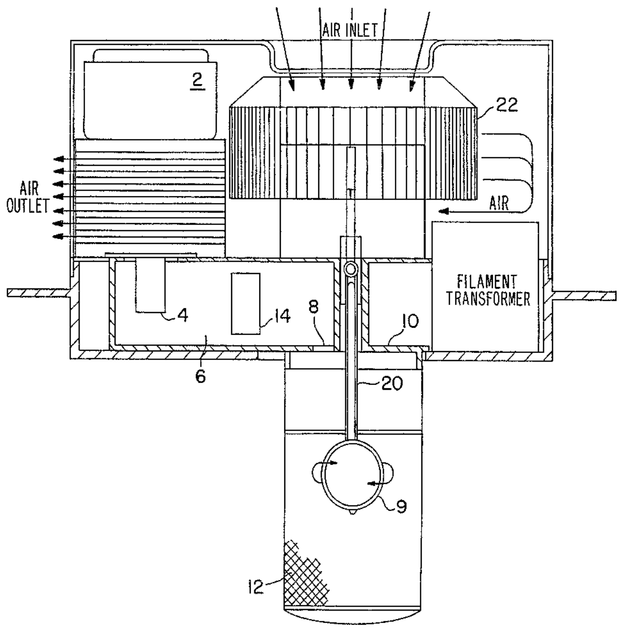
(54) **DISPOSITIF D'ACCORD A INDUCTANCE POUR LAMPES A DECHARGE PILOTEES PAR MICRO-ONDES**

(54) **INDUCTIVE TUNERS FOR MICROWAVE DRIVEN DISCHARGE LAMPS**




(57) Lampe sans électrodes (9) alimentée par RF et mettant en application un dispositif d'accord à inductance (14) dans le guide d'ondes (6) couplant l'alimentation RF (2) à la cavité (10, 12) de la lampe, afin de limiter la réflexion de l'énergie RF et de permettre à la lampe (9) de fonctionner efficacement.

(57) An RF powered electrodeless lamp (9) utilizing an inductive tuner (14) in the waveguide (6) which couples the RF power (2) to the lamp cavity (10, 12), for reducing reflected RF power and causing the lamp (9) to operate efficiently.

PCT

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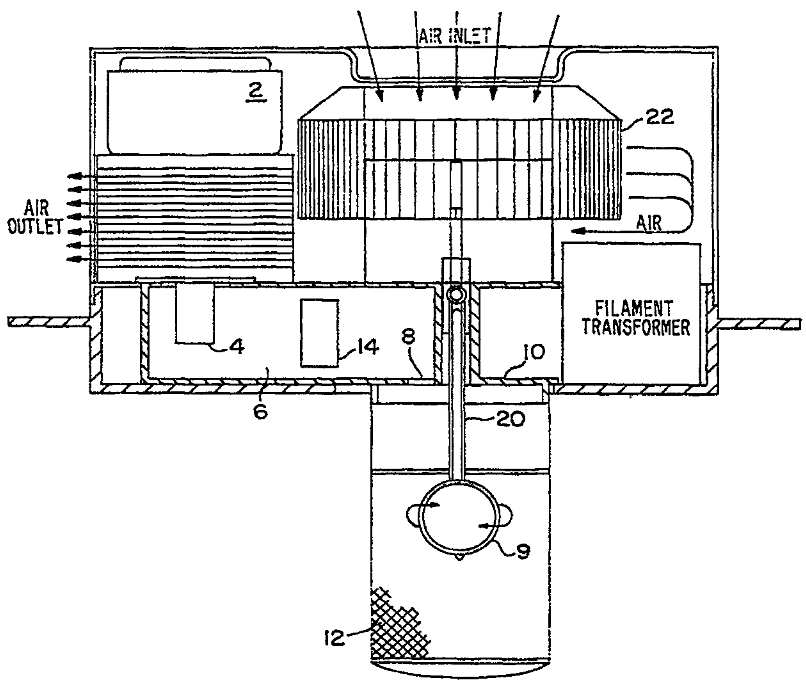
(54) Title: INDUCTIVE TUNERS FOR MICROWAVE DRIVEN DISCHARGE LAMPS

(57) Abstract

An RF powered electrodeless lamp (9) utilizing an inductive tuner (14) in the waveguide (6) which couples the RF power (2) to the lamp cavity (10, 12), for reducing reflected RF power and causing the lamp (9) to operate efficiently.



# INDUCTIVE TUNERS FOR MICROWAVE DRIVEN DISCHARGE LAMPS

## BACKGROUND OF THE INVENTION

### a. Field of the Invention

This invention refers to the field of radio-frequency driven arc lamps in which the structure includes a closed waveguide, and particularly to those lamps which utilize a magnetron as the source of power.

### b. Description of the Prior Art

These lamps employ an ionizable medium enclosed in a sealed transparent envelope which produces visible light or ultraviolet light when excited by an intense microwave field. The lamp envelope or bulb is enclosed in a metal container or cavity which confines the microwaves while providing for the escape of the light, usually by means of a metal screen. Microwaves are admitted into the cavity through an aperture which connects to the adjoining waveguide, the other end of which couples to the magnetron.

Rf power from the magnetron travels through the waveguide to the cavity and excites the discharge lamp. Any power that is not absorbed by the lamp reflects back to the magnetron. The aperture defining the end of the cavity may be used to define a resonance in the cavity which intensifies the fields at the bulb to provide increased power absorption, thus reducing the reflected power.

A magnetron is a self-excited oscillator with a direct connection between its resonator and the output load. Any reflection from the load has a strong effect on the performance, changing the operating frequency, the power output and the operating stability. Strong reflections at a particular phase known as the "sink" reduce the stored energy in the magnetron's resonator, causing instability and frequency jumping.

The lamp itself places several different requirements on its power source. Before ionization, gases in the bulb do not absorb microwave power. The electric field intensity within the bulb must be built up to a high level to achieve breakdown. Once ionization occurs, the bulb must heat to evaporate any condensed fill materials. The impedance of the bulb is much lower than the non-ionized case, and changes as the bulb heats, bringing the condensates into the discharge. And finally the long term operating condition is reached in which light output efficiency is the dominant concern.

These impedance changes result in a variety of reflected values at the magnetron. The designer can adjust the aperture of the cavity, the length of the waveguide and may add a variety of tuning elements into the waveguide. The goal is to keep the high reflection before ionization away from the sink, to avoid frequency-jumping during the warm-up cycle and to provide a good match with stable characteristics during long-term operation.

Other considerations may also enter into the design. The product needs to be economical, compact in size, durable, and reproducible. Cost prevents the use of isolators. Compact size holds the waveguide to a minimum length.

While many types of irises and posts are well-known in microwave design, the tuning element frequently used in microwave arc lamps is the capacitive screw or a fixed height knob of the same size. This has the advantage of attaching to only one wall and is more easily installed than a post which must contact two opposite walls. When a waveguide length (between the magnetron antenna and the coupling slot) greater than half a guide-wavelength is available, this capacitive tuner may be used to match a moderate mismatch or any phase. The tuner has two effects. The reflection coefficient is added to the reflection coefficient of the load beyond it. Secondly, the effective length of the waveguide is increased by a small amount.

## SUMMARY OF THE INVENTION

In the course of making a new lamp design, the cavity and the coupling iris were established. The waveguide length and magnetron position were also established. However, the impedance match was not optimum and the waveguide length (referred to in the preceding paragraph) was less than half a wavelength. Attempts to add a capacitive tuner showed that it was unsuitable, the best location being directly above the magnetron antenna.

An inductive tuner was placed on the side wall of the waveguide between the magnetron and the cavity aperture. A metal protrusion at the side of a waveguide acts like an inductive iris, raising the cutoff frequency of the waveguide at its location. Thus, the tuner provides a reflection coefficient with an inductive phase and shortens the effective length of the waveguide a small amount. The lamp design operates efficiently with this tuner. The inductive tuner may be a single block, semi-cylinder, or hemisphere or combination thereof attached to one side wall, or two such objects may face each other on opposite walls. These shapes are appropriate where the tuners are to be installed in a waveguide after it is built, as for example, by screws, soldering or welding.

The tuner may also be molded into the waveguide wall. Depending upon the method of construction it may be advantageous to form the tuner to join to the upper and/or lower broad wall of the waveguide as a thick iris.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic representation of a microwave lamp.

Figure 2 illustrates an inductive tuner in the form of a single block.

Figure 3 illustrates an inductive tuner in the form of two blocks which face each other on opposite waveguide walls.

Figure 4 illustrates an inductive tuner in the form of a semi-cylinder contacting the broad walls of a waveguide.

Figure 5 illustrates an inductive tuner in the form of a semi-cylinder which does not contact the broad walls of a waveguide.

**DESCRIPTION OF PREFERRED EMBODIMENTS**

Referring to Figure 1, a microwave lamp is shown. Magnetron 2 has antenna 4 which protrudes into closed waveguide 6. At the other end of the waveguide, coupling slot 8 is located, which couples microwave power into the resonant cavity defined by bottom 10 and screen 12 in which bulb 9 is located. In accordance with the invention, inductive tuner 14 is attached to a side wall of the waveguide.

It is noted that the waveguide has broad walls and narrow walls (side walls). Since the magnetic field is high at the side walls, a metal protrusion placed there will act as an inductive tuner.

In any given lamp, the location of the tuner as well as its size and shape are determined by experimentation, with the aid of a network analyzer. As known to those skilled in the art, the network analyzer is first calibrated with the aid of a sliding short. The impedance is then observed with the lamp in the starting and running conditions without a tuner. If significant reflection is present when the lamp is at operating temperature a tuner of trial size and shape is used and its position changed to determine the position of optimum operation. If significant reflection is still present, the size and/or shape of the tuner is varied, and various positions again tried.

In the embodiment of Figure 1, rectangular waveguide 6 is 1.7" high, 2.84" wide, and 4.8" long on the inside. The distance from the middle of the tuner to the slot end of the waveguide is about 1 7/8", and the tuner is about 5/8" wide, 1 1/4" long, and has a thickness of about .35". The coupling slot 8 is 2 3/8" long and .53" wide. The microwave cavity is 2.93" in diameter and 6.2" tall. The bulb 9 is 35 mm inside diameter and contains a fill of sulfur and rare gas such as argon.

Both the waveguide and the tuner may be made of aluminum. It is preferable to make the waveguide and the tuner of the same material to minimize corrosion.

A motor rotates both the shaft 20 to which bulb 9 is attached and blower wheel 22 which provides air for cooling the magnetron.

Figure 2 is a cut-away detail of waveguide 6 of Figure 1, and shows the inductive tuner in the form of metal block 14.

Figure 3 shows an alternative embodiment wherein two such blocks 14'a and 14'b face each other on opposite waveguide walls.

Figure 4 shows a further alternative embodiment which utilizes a protrusion in the form of semicylinder 14" which contacts the top and bottom broad walls 30 and 32 of the waveguide.

Figure 5 shows still a further embodiment which utilizes semi-cylinder 14''' which does not contact the broad walls of the waveguide.

While the invention has been disclosed employing illustrative embodiments, it is to be understood that variations will occur to those skilled in the art. For example the tuners may have different shapes than illustrated, or cylindrical posts may be used. The scope of the invention is defined by the following claims.

CLAIMS

1) An RF powered electrodeless lamp comprising,

means for generating RF power,

a bulb containing a discharge forming medium disposed in a cavity,

a waveguide for coupling said RF power to said cavity, said waveguide having a coupling slot, and

an inductive tuner disposed in said waveguide.

2) The lamp of claim 1 wherein said inductive tuner comprises at least one metal protrusion disposed on a waveguide wall.

3) The lamp of claim 2 wherein said waveguide has narrow walls and broad walls, wherein said metal protrusion is disposed on a narrow wall.

4) The lamp of claim 3 wherein said at least one metal protrusion comprises a metal block.

5) The lamp of claim 4 wherein said metal block is rectangular.

6) The lamp of claim 5 wherein said at least one metal block comprises two rectangular metal blocks disposed on opposite waveguide walls.

7) The lamp of claim 4 wherein said at least one metal block comprises a semi-cylindrical metal block.

8) The lamp of claim 7 wherein said metal block contacts said broad walls at its extreme ends.

9) The lamp of claim 7 wherein said metal block at its extreme ends does not contact said broad walls.

10) The lamp of claim 2 wherein said means for generating RF power is a magnetron having an antenna and wherein the waveguide length from the antenna to said coupling slot is less than half a wavelength.

11) An RF powered electrodeless lamp comprising

means for generating RF power, a bulb containing a discharge forming medium disposed in a cavity, a waveguide for coupling said RF power to said cavity, and inductive tuning means disposed in said waveguide for minimizing power which is reflected back to said means for generating RF power.

12) The lamp of claim 11 wherein said waveguide has a coupling slot.

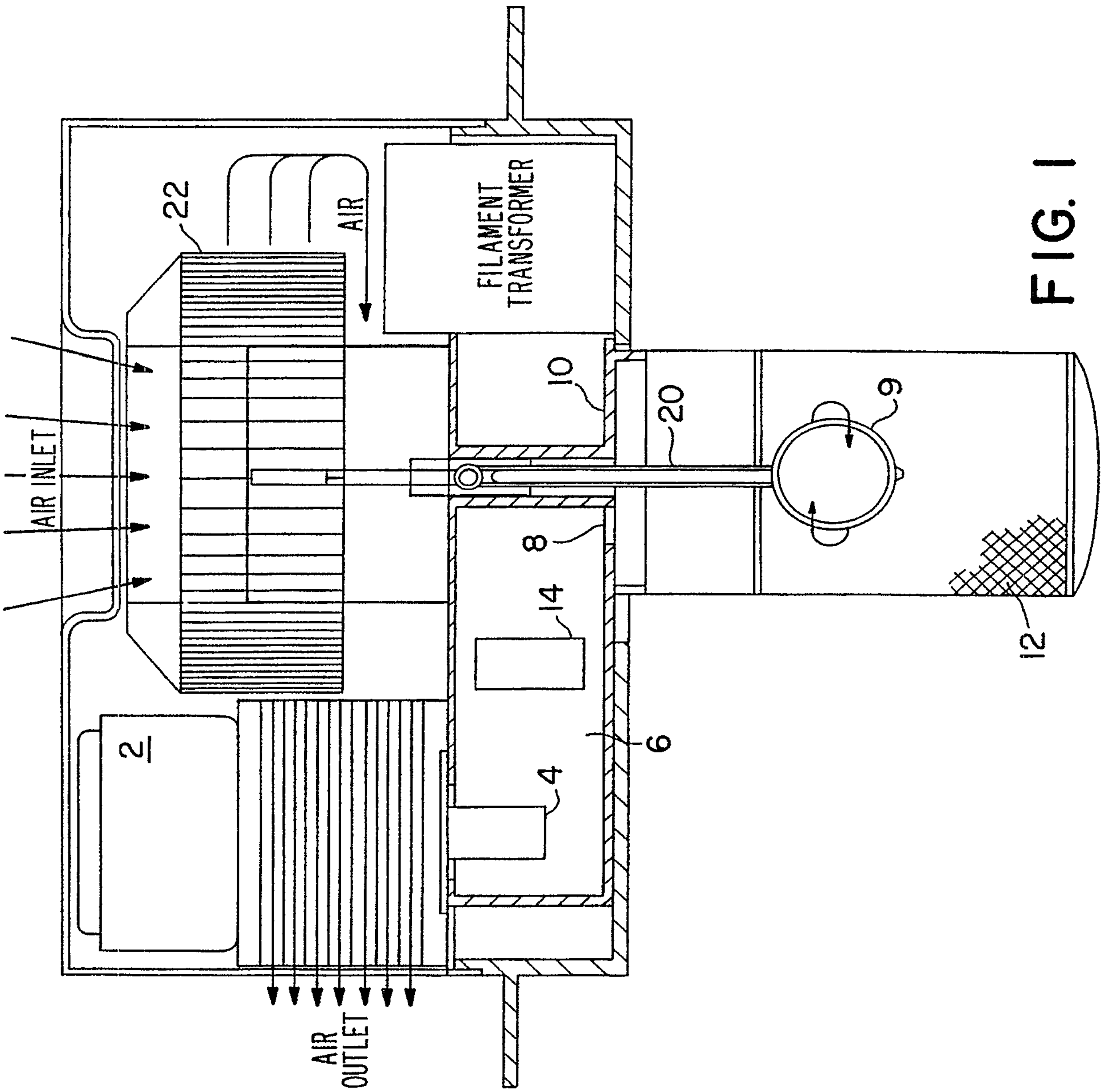

22
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FIG. 1

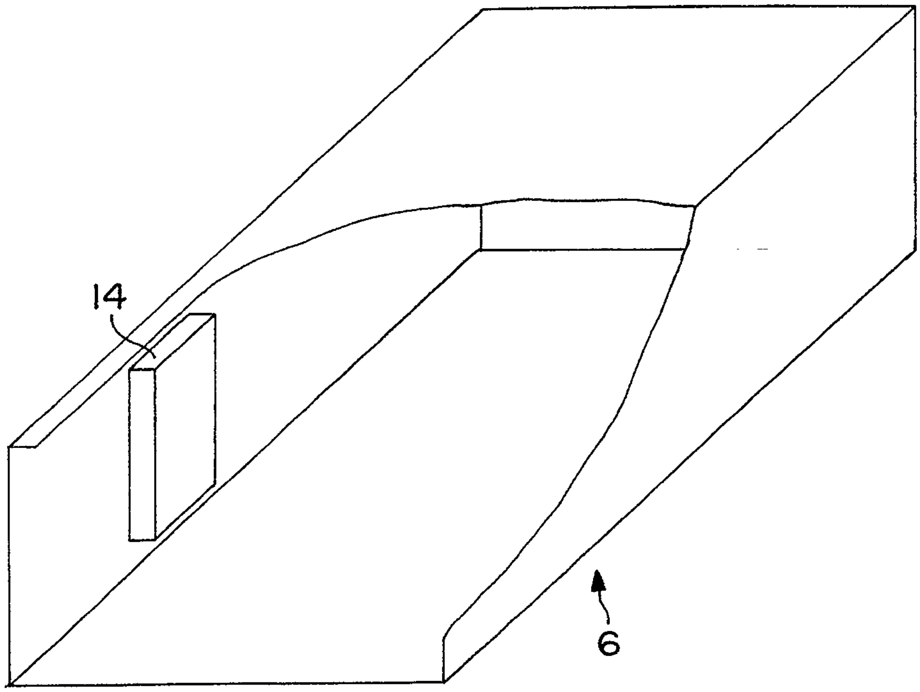



FIG. 2

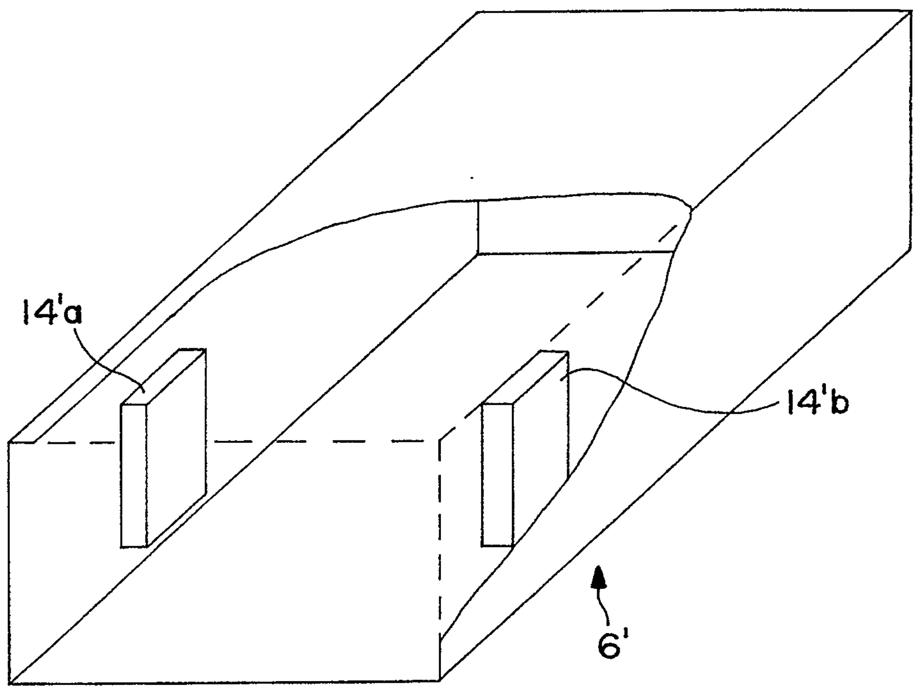



FIG. 3

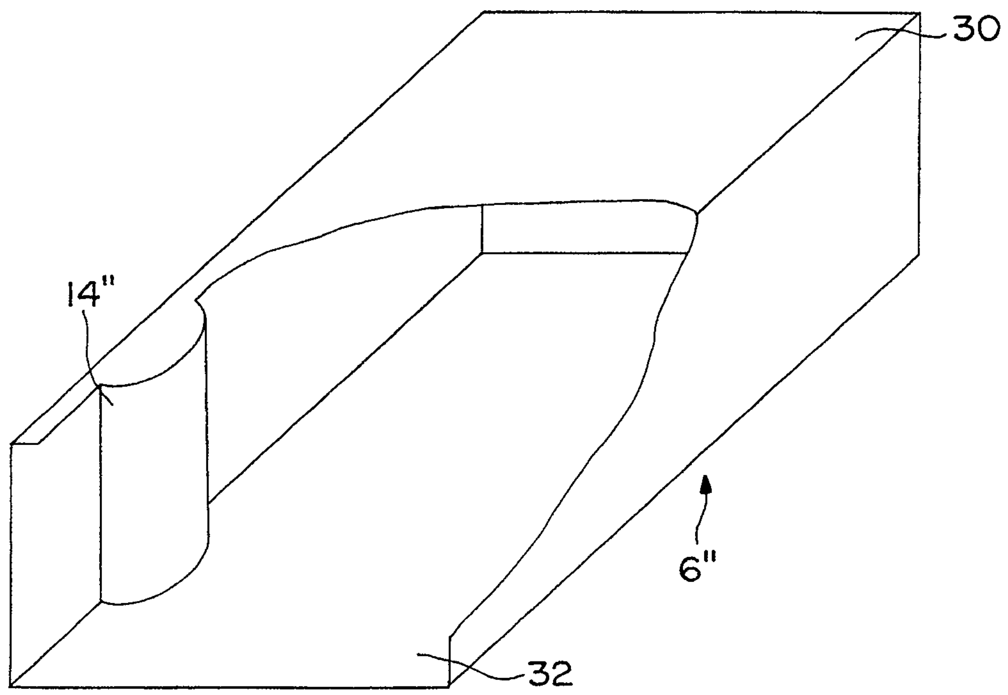



FIG. 4

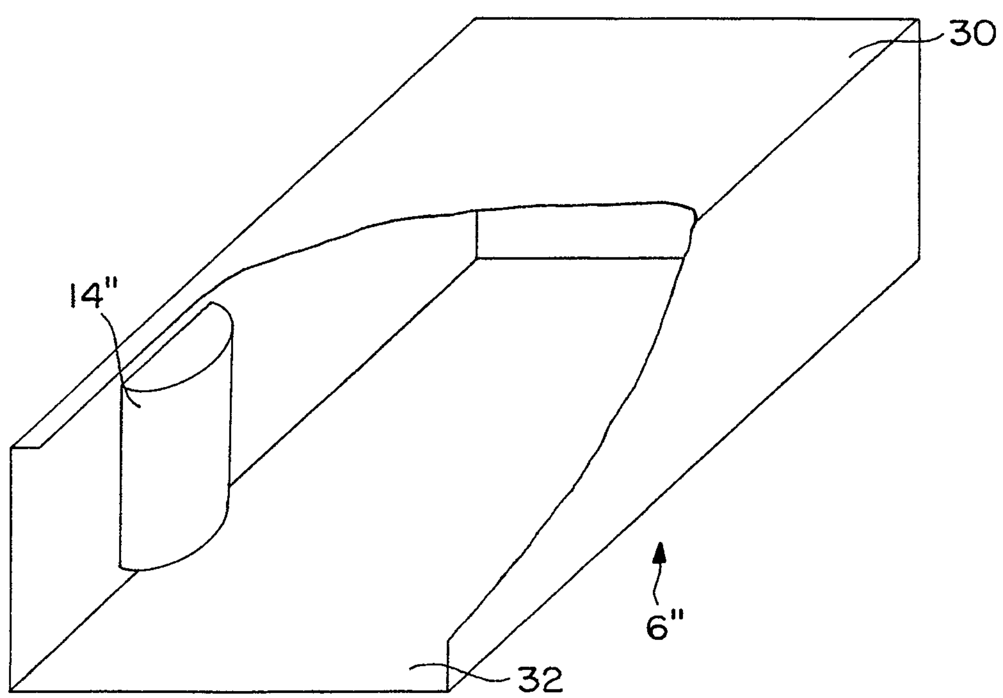
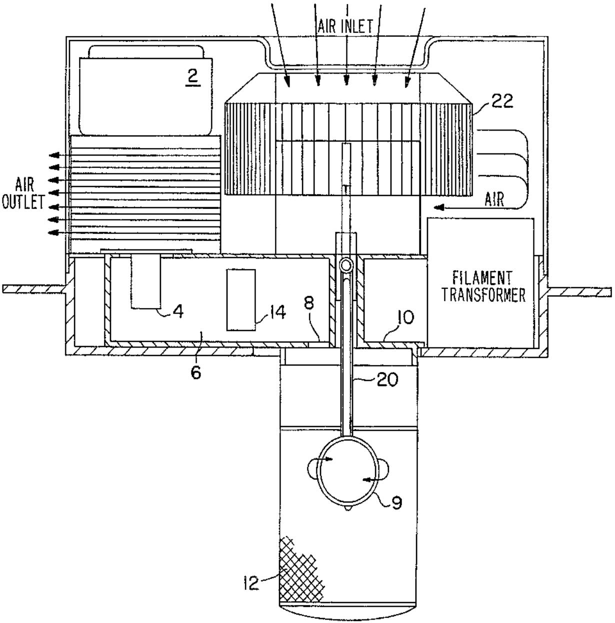



FIG. 5



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